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EXPLAINING FOOD FOREST EMERGENCE IN THE NETHERLANDS: THE EFFECT OF SOCIAL CAPITAL, ENVIRONMENTAL AWARENESS AND INSTITUTIONAL SUPPORT

Abstract

Food forests are a type of agroforestry system that aims to mimic natural ecosystems by combining trees, shrubs and groundcover. They provide food as well as many social and environmental services, addressing several problems industrial agricultural practices cause. In the Netherlands, food forests have been significantly increasing in numbers in the last decade. This research aims to explore what factors influence food forests emergence on the Dutch municipality level. Three dimensions were identified by the literature as important for determining food forest establishment, namely social capital, environmental awareness and institutional support. This study compiled data on 387 food forests across 340 Dutch municipalities for the years 2010 until 2023 and performed a negative binomial regression analysis to investigate the impacts of these dimensions on food forest emergence.

The results showed a positive relationship between bonding social capital and food forest emergence. For bridging social capital, a negative relationship was found, although nuance was brought to this relationship through the evidence of an inverted U-shape, implying that bridging social capital has a positive impact on food forest emergence until a certain point after which it becomes negative. This suggests that some bridging social capital is beneficial, but too much may hinder the establishment of food forests. Environmental awareness is found to have a positive effect on food forest emergence, highlighting the importance of environmental consciousness among communities. In contrast, institutional support, measured by the presence of green parties in municipal councils, does not show a significant effect. Robustness of the results was tested by including province dummies and by performing a zero-inflated regression model both confirming the results.

Policymakers can use these results when trying to increase the number of food forest initiatives by focusing on building social capital and raising environmental awareness. Moreover, Dutch umbrella organizations could use data from this research to improve

connectivity between food forests and facilitate the sharing of capabilities, information and resources. This would contribute to decreasing the negative impacts related to intensive agriculture and will help the Dutch government to achieve their goal of having 1,000 hectares of food forest cover by 2030.

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1. Introduction

Industrial agricultural practices are a major cause of many environmental problems the world is facing today. Cropland and pastures are covering approximately 40% of total land surface (Vitousek et al., 1997; Campbell et al., 2017), which has caused high deforestation rates and, in turn, habitat loss for many animal and plant species. Additionally, the use of synthetic chemical pesticides and fertilizers is disrupting nitrogen and phosphorous cycles, causing soil erosion and water and air pollution (Horrigan et al., 2002). Moreover, agriculture is the main consumer of freshwater, as it accounts for approximately 70% of global freshwater withdrawals (Campbell et al., 2017). Hence, agriculture is seen as a major driver of three of the already transgressed planetary boundaries described by Steffen et al. (2015) (i.e., land-system change, extinction of species and climate change) and a significant contributor to change for many other planetary boundaries (Campbell et al., 2017).

As the global population (Kc & Lutz, 2017), income (Van Vuuren et al., 2017) and food consumption (Alexandratos & Bruinsma, 2012; Popp et al., 2017) are increasing and expected to continue to increase, it is necessary that new forms of sustainable farming practices are implemented. Food forests have been studied as a potential solution. They are a type of agroforestry system that aims to mimic natural ecosystems by combining trees, shrubs and groundcover. Besides food production, they provide environmental services, such as plant and wildlife shelter, carbon sequestration and soil regeneration (Young, 2017; Björklund et al., 2018), while also providing many social services like education and community building (Riolo, 2019; Clark & Nicholas, 2013). This thesis will focus on the case of food forestry in the Netherlands specifically.

In the Netherlands, food forests are an increasingly popular phenomenon. While the plantation of the first Dutch food forests dates back to the early 1990’s, the term gained greater notability since the 2010’s, after which hundreds of food forests have emerged (Wageningen

University & Research, n.d.). This is partially due to the efforts made by food forest initiatives, NGOs and local and national authorities, which signed the Green Deal on food forests in 2017 (Green Deal, n.d.). This agreement was made with the aim to scale up food forest initiatives in the Netherlands. After the agreement terminated in 2021, the collaboration continued under the name 'Netwerk Voedselbosbouw' (Food Forestry Network), which now strives for better, more encouraging conditions in laws and regulations, research and education and knowledge sharing (Green Deal, n.d.). Besides this, the Dutch government has included food forests in its national forest strategy, allocating 1,000 hectares to food forestry by 2030 (Ministry of Agriculture, Nature and Food Quality, 2020).

In many cases food forests can be considered citizen initiatives. They often arise as a way to create social networks, improve community livelihood and provide alternatives to failing mainstream systems (Riolo, 2019). Citizen initiatives are important drivers of change in different transitions often emerging as a response to failure of the market and the state in providing public goods and services (Teasdale, 2011). However, they run into several barriers during their creation and upscaling, e.g. lack of sufficient start-ups funds (Fransen et al., 2021), lack of specific knowledge and skills (Russell et al., 2019) and policy constraints (Albrecht & Wiek, 2021b).

The current citizen initiative literature has mostly focused on the success factors and barriers of different types of initiatives (Fransen et al., 2021; Russell et al., 2019), however, these factors are not equally distributed. Thus, it is surprising only few studies considered spatial dimensions that contribute to citizen initiative emergence (Wittenberg et al., 2023; Boon & Dieperink, 2014). For example, prior studies have shown that citizen initiatives rely on social networks, i.e. social capital, to successfully emerge (Fransen et al., 2021; Wittenberg et al., 2023), however, social capital exhibits geographic disparities in its distribution (Van Oorschot et al., 2006). Moreover, research has shown that the level of environmental awareness present in an area can be considered another important determinant of citizen initiative emergence, especially when the citizen initiative is related to sustainability (Boon & Dieperink, 2014; Feola & Butt, 2015). Finally, institutional support (e.g. financial support and providing access to knowledge and skills) has been found to be of high importance for citizen initiatives to become successful (Hoppe et al., 2015), however, policies regarding citizen initiatives differ both nationally as well as sub-nationally (Oteman et al., 2014; Martens, 2022). As these spatial dimensions clearly matter for citizen initiative emergence, this research will perform a municipality level, quantitative assessment to study the macro-level dynamics that influence food forest emergence.

Regarding food forests, the current literature is limited and mostly focuses on in-depth case studies (Riolo, 2019; Hammarsten et al., 2018), specific services, such as environmental services (Young, 2017), social services (Stoltz & Schäffer, 2018) and nutritional benefits (Nytofte & Henriksen, 2019). While some research has looked into the main barriers and success factors of food forests (e.g. Björklund et al., 2018; Albrecht & Wiek, 2021b) other research has focused on the potential of Urban Food Forestry as a scaling opportunity (e.g. Clark & Nicholas, 2013; Brito & Borelli, 2020). Although there has been some research focused on macro-level dynamics of food forests, for example, a country-level assessment on urban food forestry in Brazil (Brito & Borelli, 2020), or an evaluation on the sustainability of food forests worldwide (Albrecht & Wiek, 2021a), none of these studies have looked at factors influencing the emergence of food forests (both urban and rural) on a country level. Therefore, this research aims to fill this literature gap by addressing the following research question:

Which factors contribute to the emergence of food forest initiatives in Dutch municipalities?

The research considered three key factors: social capital, environmental awareness, and institutional support. To answer the research question, a regression analysis was performed to explore the relationship between the geographic distribution of food forests and the presence of social capital, environmental awareness and supportive institutions in municipalities. The regression analysis took a longitudinal approach, using data from 2010 to 2023.

This study will help create a greater understanding of food forests, their locations and patterns that facilitate their emergence. This will contribute to improving sustainability transitions by providing valuable insights for policymakers on where food forests are likely to emerge. Policymakers can use this information to create an enabling environment for the establishment and maintenance of food forests. Moreover, this thesis will help provide not only policymakers, but also umbrella food forest organizations with a complete overview of the current distribution of food forests in the Netherlands. This could help increase connectivity between them both locally and nationally, which previous research has called for (Groot & Veen, 2017). In turn, increased connectivity could improve awareness and generate knowledge spill overs on best practices which could help facilitate the successful upscaling of food forests that Dutch umbrella organizations are striving for. In addition, grassroot movements can be a real driver of change in sustainability transitions (Smith et al., 2016) and previous research has called for more research on how these movements can enable the upscaling of local innovations (Ornetzeder & Rohracher, 2013; Boyer, 2018). This research contributes to this by providing empirical evidence on what factors drive sustainable innovation at the local level. Besides, previous research has called for more quantitative approaches and comparative studies (Köhler et al., 2019) and the country level analysis of this study allows to compare across different social, cultural and geographical contexts. Finally, the longitudinal design significantly contributes to current food forest literature as it addresses temporal trends and potential causal relationships, providing insights into how social capital, environmental awareness and institutional support influence food forest emergence over time.

2. Theoretical framework

The theoretical framework focuses on food forests and the potential factors impacting their emergence. The theory on food forests is used to explain their background, dynamics and dimensions impacting their development and success. The main dimensions derived from the theory are social capital, environmental awareness and institutional support. Citizen initiative literature is applied to further elucidate the connections between these three dimensions and initiative emergence. Finally, an overview of the context and development of food forests in the Netherlands is provided.

2.1 Food forests

Food forests, also known as forest gardens or edible forests, are edible, perennial, polyculture systems designed and managed to mimic multistorey forest structures (Jacke and Toensmeier, 2006). They are inspired by the layers, diversity and interrelationships found in a natural forest and integrate plants at all structural levels, with the aim to create a self-sustaining and resilient ecosystem (Walker, 2015). Depending on environmental and socioeconomic conditions, different designs and techniques are used. However, in general the food forests are planted with a diversity of high and low trees, bushes, herbs, soil covers, tubers and climbers in such a way that maximizes beneficial plant interactions (Park et al., 2017). Most of the plant species found in food forests have direct uses such as food and medicine provision or building and art material supply. Other examples of indirect functions are nitrogen-fixing and pollination (Hills, 1988).

Food forestry has a long tradition among owners of small farms mainly in tropical, rural regions as so called “home gardens”. For example, Javanese home gardens originated in fishing villages that existed from 13,000 to 9,000 BC (Kumar & Nair, 2006). Food forests are used as a traditional means to adapt and transform lands in response to changing environmental and socioeconomic conditions (Hills, 1988). This tradition was picked up by early adopters in the

1990s and food forest start-ups have been steadily increasing since 2004 (Albrecht and Wiek, 2021a) and especially following the 2008 financial crisis, as a way to create social networks, improve community livelihood and provide alternatives to failing mainstream systems (Riolo, 2019).

Since 2010 food forests have been included in policies and municipality plans of cities such as Seattle (McLain et al., 2012), Parma (Riolo, 2019) and several cities in the Netherlands (San Giorgi, 2018). In addition, in 2016 the FAO recommended municipalities worldwide to implement policies, laws and regulations facilitating the development of more sustainable and equitable urban food forests (Salbitano et al., 2016).

Academic literature on food forests is still at a nascent stage. However, there is evidence suggesting food forests provide significant services to both humans and the environment (Albrecht & Wiek, 2021a; Riolo, 2019; Konijnendijk & Park, 2020). Clark and Nicholas (2013) introduced the concept of Urban Food Forestry as a way to improve the sustainability and resilience of urban communities. They argue that food forests have the potential to contribute to food security and mitigate malnutrition of local people, while also providing many ecosystem services and cultural, social, educational and economic services.

Following this, empirical research has been conducted on the benefits of food forests. For example, Albrecht and Wiek (2021a) researched the main services of over 200 food forests worldwide and found that most food forests perform well on social-cultural and environmental criteria but score low on economic criteria. Food forests enhance biodiversity, regenerate soils, conserve water and contribute to cooling their climate. Their social-cultural services include community building, recreation, education and research (Albrecht & Wiek, 2021a).

In-depth case studies on different food forests have also discussed this wide range of benefits and mostly mention the contributions to social cohesion, education, recreation, regulatory services and habitat provision (e.g. Björklund et al., 2018; Konijnendijk & Park, 2020; Riolo, 2019; Hammarsten et al., 2018). These case studies highlight that food forests play an important role in reconnecting people to nature. An example of an urban public food forests in Italy shows that exposure of adults and children to foraging and harvesting food directly from the plant, enhanced their access to health and wellbeing (Riolo, 2019). Besides this, the citizens participating in the forest developed place attachment and a sense of meaning, while the food forest also boosted relationships within and outside the neighbourhood (Riolo, 2019). This has also been found in community gardening research, as community gardening nurtures relationships, contributing to social cohesion and, in turn, increasing social capital (Firth et al., 2011; Hale et al., 2011). Furthermore, case study research on Dutch food forests discovered that the main motivations to start food forests were considered research, production, food forest education and enhancing social contact (Groot & Veen, 2017). Similar results were found in a research on 108 Dutch food forests, where education was the most named orientation, closely followed by social, recreation and production (Roodhof, 2024).

Albrecht and Wiek (2021b) studied the main barriers and success factors of seven food forests. They found that regulatory restrictions were one of the main barriers to successful food forest development, because regulatory agencies often do not recognize agroforestry as a legitimate type of land use. Favourable relationships with local authorities and NGOs can help overcome other main barriers like securing start-up funds and securing public land. In the field of community gardening there is evidence suggesting that communities that plan, implement and manage their gardens with support from the government or NGOs have more success, considering their establishment and longevity (Fox-Kämper et al., 2018; Jacob & Rocha, 2021). This is related to the previously mentioned barriers of securing land, governmental bureaucracy and lack of funding (Schmelzkopf, 2002; Thornton, 2017; Drake & Lawson, 2014), which were also found to be main challenges in research conducted on Dutch food forests specifically (Roodhof, 2024).

Food forest can frequently be considered citizen initiatives, due to their social nature (Riolo, 2019). Citizen initiatives are "*a form of self-organization in which citizens mobilize energy and resources to collectively define and carry out projects aimed at providing public goods or services for their community,"* (Igalla et al., 2019). Within these initiatives, citizens control the means, aims and implementation of activities, however, often in collaboration with governments, NGOs and other formal institutions (Edelenbos & Van Meerkerk, 2016). In the following sections, theory on other types of citizen initiatives will be referred to in the absence of extensive research on food forests. Some examples of these types of citizen initiatives are transition towns, renewable energy cooperatives, green space initiatives, car sharing initiatives or agricultural cooperatives. Most can be considered local sustainability initiatives as they consist of citizens that make contributions to sustainability transitions (Pesch et al., 2018). Some of these initiatives are more focused on developing new solutions that integrate social and technological elements to address challenges and promote sustainable practices (Pesch et al., 2019), such as car sharing initiatives. Other citizen initiatives may be more focused on collectively addressing community needs and pursuing common goals through active participation and collaboration (Pesch et al., 2019), such as community gardens. Food forests can be considered somewhat of both as they contribute to the development of an innovative alternative to conventional food production, while also consisting of citizens collectively pursuing the goal of growing food for private or communal use. What makes food forests different to most citizen initiatives is their longer-term commitment in planning because plants and trees can take years to mature and fully develop. However, due to the many similarities between food forests and the other types of citizen initiatives, the dynamics that apply on those can be used to theorize about the dynamics that are important for food forests.

From the aforementioned literature it is clear that there are three important dimensions to the development and success of food forests: social capital, environmental awareness and institutional support. It is important to note that besides these dimensions there are some more obvious factors influencing food forest emergence, such as the suitability and availability of land or the financial means and entrepreneurial skills of initiators (Roodhof, 2024; Albrecht & Wiek, 2021b). However, these are not the main focus of this research. Firstly, food forests have important social benefits and often emerge with the aim to enhance community building. Thus, social capital may be associated with food forest emergence. Secondly, the perceived environmental benefits are a key concern in the development of food forests. Therefore, a certain level of environmental awareness among participants may contribute to the creation of food forests. Lastly, successful food forests require some level of institutional support, as it helps overcome important barriers of implementation. In the next sections these three dimensions will be further discussed.

2.2 Social capital

The term social capital gained great notability due to James Coleman's 1988 paper "Social Capital in the Creation of Human Capital". He defines social capital as the resources rooted in social relationships and networks which can contribute to individual and collective success. Putnam (2000) built upon this idea by differentiating between "Bonding" and "Bridging" social capital. Bonding social capital refers to the horizontal relationships and social connections within close-knit groups, such as family or friends. These social relations and norms are built on similarity, informality and intimacy and contribute to a sense of belonging and support.

Bridging social capital relates to the connections and networks between diverse social groups or communities. It facilitates the exchange of ideas, information and resources between groups and bridges their connections.

Putnam (2000) discovered that in areas where social relationships are based on trust and shared values, rather than based on authority relations, citizens are way more likely to participate in social organizations. Thus, in places where social capital is higher, collective action is higher. The next sections will discuss research on the importance of bonding and bridging social capital in citizen initiative emergence and success.

First of all, a well-established social identity and cohesion within a community is a key factor in determining whether citizen initiatives emerge and whether they are successful (Haggett et al., 2013; Haggett & Aitken, 2015). A study on social factors influencing the success of community energy projects in Scotland found that a project is more likely to be successful when members of a community group have a history of familiarity that pre-dates the project (Haggett et al., 2013). Additionally, Verhoeven and Tonkens (2011) discovered in their research on resident's initiatives within the Amsterdam Neighbourhood approach, that initiators had strong rates of social capital, as they were active in various forms of participation like attending meetings of the neighbourhood or participating in an initiative of other residents. Moreover, good communication and trust among community members is critical to its success (De Haan et al., 2019). When there are high levels of trust among members, they are more likely to maintain mutually beneficial social exchanges, even if this involves costs for individuals (Shrestha, 2012). An example are community irrigation systems in Nepal, where head-end and tail-end farmers have managed to collectively design and enforce water allocation rules despite their conflicting interests, ensuring successful operation for centuries (Ostrom & Gardner, 1993).

Besides the importance of existing strong ties, it is crucial to have a network surrounding the initiative (De Haan et al., 2019). Studies show that having many diverse partnerships outside the community provides more opportunities to mobilize resources necessary for the initiative to be successful (Agranoff & McGuire, 2003; Shrestha, 2012). For example, in a case study on social capital formation in highland Ecuador, it was discovered that organizations and networks formed over time played an important role in providing access to capital for households and communities both directly and indirectly (Bebbington & Perreault, 1999). Furthermore, de Haan et al. (2019) studied the success of citizen initiatives from the perspectives of founders and found that initiatives with low bridging social capital were less likely to be evaluated as successful.

Spatial diffusion also seems to play a role in the emergence of citizen initiatives. First of all, initiatives are more likely to emerge when there are more, already established initiatives nearby, as these can contribute expertise and networks (Morgner et al., 2020). For example, research has shown that Community Resilience Initiatives often emerge out of existing community-based initiatives, because they can benefit from deep knowledge of specific target groups, skillsets, the existing organizational capacity and existing networks (Fransen et al., 2021). Moreover, the spatial distribution of social capital appears to be related to citizen initiative emergence. For example, Beltrán Tapia (2012) evaluated whether a pre-existing stock of social capital was related to the emergence of agricultural cooperatives in Spain and found that social capital had a highly significant statistic influence on the emergence. In the Netherlands specifically, neighbourhood attachment has been found to contribute to care collective emergence (Wittenberg et al., 2023). Similar results have been found in literature on energy cooperative participation and emergence (Caferra et al., 2023; Lode et al., 2022).

Moreover, a research studying food forestry in the Netherlands specifically found that practitioners experienced strong cohesion with other food forest practitioners as they share values such as contributing to nature, society, and prioritizing access to healthy food (Roodhof, 2024). Moreover, they often interact with other food forest practitioners through engaging in courses, activities and events, which not only forges new connections but also reinforces existing ones. Besides, more than half of the participants in Roodhof (2024)'s research was introduced to food forestry through their personal networks, illustrating the importance of bonding social capital on the emergence of food forest initiatives in the Netherlands. However, not all practitioners were introduced to food forestry through personal connections. Many were recruited actively, both locally (through connections with other local food networks) and trans-locally (through media and actively seeking out prospective practitioners in the agricultural sector), highlighting the importance of bridging social capital in Dutch food forestry emergence as well.

The aforementioned literature shows the importance of social capital on the emergence of citizen initiatives and, specifically, of food forests. First, personal relationships based on shared values are critical to the successful emergence of initiatives. Moreover, relationships outside the immediate locality allow for more access to resources necessary to start initiatives. Therefore, it is possible to assume that more food forests exist in places with higher stocks of bonding and bridging social capital.

H1: More food forests emerge in municipalities with higher levels of bonding social capital

H2: More food forests emerge in municipalities with higher levels of bridging social capital

2.3 Environmental awareness

Environmental awareness refers to one’s understanding of the environment and related issues (Ningrum & Herdiansyah, 2018). It includes the realization that humans and ecosystems co-exist in a shared environment and that human actions have an impact on the natural world (FDES, 2013). Increased environmental awareness changes people’s behaviour in such a way that benefits the environment (Clayton & Myers, 2015). This view has been supported by empirical evidence (Ningrum & Herdiansyah, 2018; Mkumbachi et al., 2020; Bülbül et al., 2020; Rubik et al., 2019). There are two main components that motivate people to take action for the environment. First, one’s value of the natural world is a critical factor predicting responsible environmental behaviour. This includes not only care for plants, animals and communities of living things (Stern, 2000) but also positive experiences of the natural world in childhood as well as early role models communicating nature’s value (Hungerford & Volk, 1990). The other main component relates to confidence, i.e. the self-perceived ability to reduce threats to the environment (Stern, 2000; Hungerford, 1990). An important indicator of this confidence is feeling part of a community and having networks that help one participate in environmental decision-making (Chawla, 2008).

Thus, environmentally aware people tend to take environmental action, however, do they also contribute to the emergence of citizen initiatives? Feola and Butt (2015) studied the spatial diffusion of Solidarity Purchasing Groups and Transition Town Networks in Italy and found that central Italy had the highest concentration of both, a historically left-wing area, characterized by relatively high levels of environmental awareness among the population. Moreover, Boon and Dieperink (2014) found that a high level of environmental awareness within a society prompted the emergence of local renewable energy organizations in the Netherlands. Additionally, strong environmental motives influenced the level of engagement in these initiatives positively (Bauwens, 2016). More research on different sustainability initiatives has shown that initiators tend to be concerned with community and sustainability (Broska, 2021; Casey et al., 2020; Ornetzeder & Rohracher, 2013; Truffer, 2003).

In the case of Dutch food forests specifically, Roodhof (2024) discovered that many food forest practitioners were driven by environmental values. More specifically, they believed in the idea that humans are part of nature, and that food production and nature conservation can be complementary rather than conflicting.

Thus, it is clear that environmental awareness is an important indicator of citizen initiative emergence and success. As the environment is a key concern of most food forests initiators it is possible to assume that more food forests emerge in places with higher levels of environmental awareness.

H3: More food forests emerge in municipalities with higher levels of environmental awareness

2.4 Institutional support

Good connections with local governments have been found to be an important driver of citizen initiatives success (Hoppe et al., 2015), while a lack of governmental support is seen as a key barrier to success (Verhoeven & Tonkens, 2011; Fransen et al., 2021). Government support is beneficial when it helps acquiring resources (i.e. financial, physical, informational), which may help facilitate opportunities for consolidation and growth (Fonchingong, 2005; Wiseman, 2006). Moreover, positive effects are reported when support has an active and open attitude towards the initiative, which can be both facilitative as well as cooperative. Even in cases where governments are less effective, e.g. when a government is lacking resources, support can still be helpful if it is tolerating and encouraging the initiative (Aladuwaka & Momsen, 2010; Johnson & Young, 1997). For example, when Hoppe et al. (2015) investigated the success of two local energy initiatives in the Netherlands and Germany, they found that besides financial support through funding and subsidies, it was important that the government was to "give citizens confidence" by letting them manage things on their own, but provide the ability to fall back on local government support in urgent cases.

Government support becomes negative when they are overactive, meaning when they start demanding their own programs rather than working together with the initiatives (Gonzales, 2010). Moreover, a lack of trust between communities and the government is a key barrier to success. For example, a study on community resilience in Liberia found that communities without trusted networks and organizational resilience experienced more death, mistrust, and trauma (Alonge et al., 2019).

Similar effects were found by Roodhof (2024)'s study on Dutch food forests. Flexible laws and regulations were found to be an important driver enabling prospective practitioners to initiate projects, while restrictive laws and lack of financial opportunities (i.e. subsidies and loans) were considered a key barrier. Additionally, she discovered that infrastructural circumstances vary considerably by province or municipality, highlighting the importance of local governments on the emergence of initiatives. In relation to this, a Dutch study of 264 green space initiatives by citizens found that municipalities were by far the most involved authority (Mattijssen et al., 2017). They assisted in management tasks, provided materials and advice or provided land or accommodation. The green space initiatives also relied upon local and regional authorities for subsidies, as this is their most prominent source of income. However, they often see the authorities as an 'unreliable' partner, because the future of subsidies tends to be uncertain.

Thus, it is clear that institutions play an important role in the emergence and success of citizen initiatives, mainly as facilitators. In the Netherlands the most important authority are municipalities. Therefore, it is assumable that in municipalities with more institutional support more food forests emerge.

H4: More food forests emerge in municipalities with higher levels of institutional support

2.5 The Dutch context

The Netherlands is known as one of the world's agriculture export leaders, characterized by intensive farming practices. This has led to significant environmental challenges, most dominantly excessive nitrogen emissions (Marra et al., 2022). To combat this, the Dutch government has taken regulatory measures aimed at reducing these emissions. These measures entail a decrease of livestock of approximately 30% by 2030, meaning farmers either have to move, make their practices more sustainable or completely quit (KvK, 2023). These measures have already increased the potential of scaling up food forests, as there are examples of livestock and dairy farmers changing their farms into food forests as a result of these measures (e.g. Buiter, 2022). However, starting a food forest in the Netherlands is difficult and the process can take several years. First of all, since it is the third most built country in the EU (PBL, 2019), and demands for housing and infrastructure are growing (Rijksoverheid, n.d.), land and plant scarcity is seen as a considerable challenge to food forest emergence (Roodhof, 2024). More importantly though, legislations make it difficult to find an appropriate space for planting. All Dutch provinces and municipalities have their own 'bestemmingsplan', a Dutch term for 'zoning plan', which is a legal document that outlines the designated land use for different areas within a province or municipality. This includes guidelines and regulations for certain activities and developments allowed in specific spaces, such as residential, industrial, agricultural and natural areas (Kenniscentrum Infomil, n.d.). This poses issues in the case of food forests as they often fall in between the categories of nature and agriculture. Land that is designated as 'nature' is less suited for food forestry due to stricter rules and legislations compared to agricultural land. However, agricultural land can be much more expensive (IVN, n.d.-a). Moreover, the land-use plan may include restrictive measures for starting food forests. A common example is not allowing any vegetation higher than 1.20 metres to preserve the openness of the landscape (Voedsel uit het Bos, n.d.). Therefore, Dutch regional and local authorities have a crucial influence on food forest development.

However, these conditions are currently changing. For example, some provinces and municipalities have made subsidies available for food forests and have made zoning laws more inclusive (Roodhof, 2024). Moreover, food forests initiatives signed the Green Deal on food forests ('Green Deal Voedselbossen') together with NGOs and local and national authorities in 2017. This Green Deal aimed to scale up the area of food forests in the Netherlands through the conduction of research, knowledge sharing and striving for better laws and regulations (Green Deal, n.d.). The coalition ended in 2021 but has continued their work under the name 'Netwerk Voedselbosbouw' (Food Forestry Network). The network now aims to promote an exponential increase in the area of food forests, by continuing their activities of conducting research, sharing knowledge and creating better conditions in the areas of policy, law and regulations (Green Deal, n.d.). Another important change in the food forest landscape is the creation of the National Forest Strategy by the Dutch government, wherein national and provincial governments jointly set out ambitions and goals for forests in the Netherlands and illustrate how these ambitions can take shape. In this strategy the government aims to have 25,000 ha of agroforestry and 1,000 ha of food forests specifically by 2030 (Ministry of Agriculture, Nature and Food Quality, 2020). These changes clearly indicate more favorable conditions for food forestry in the Netherlands.

3. Methododology

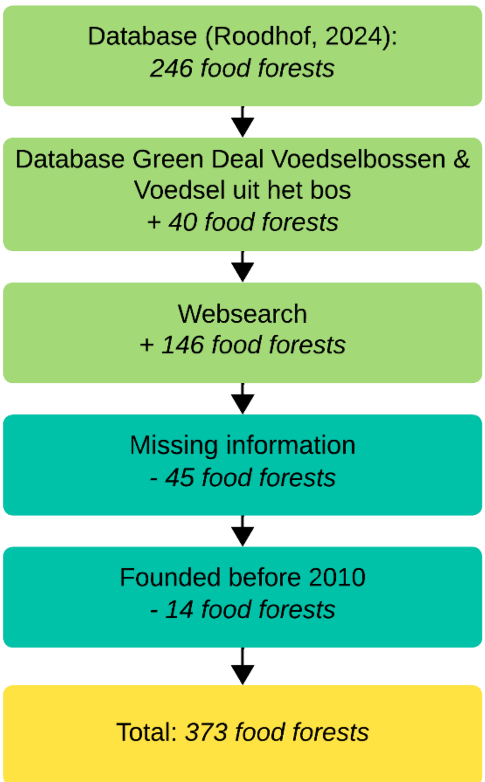
3.1 Research design

In order to test the relationship between macro level dynamics, i.e. the geographic distribution of food forests and the presence of social capital, environmental awareness and institutional support, a quantitative macro-level analysis was performed. A quantitative design allowed for a structured collection and assessment of data on such a large scale (Bryman, 2016). Moreover, this research used a longitudinal design, because it assessed the relationships between variables over time in order to address causality.

The research was conducted on the municipality level, because it aimed to address whether food forest emergence is correlated with certain macro-level characteristics (i.e. higher stocks of social capital, environmental awareness and municipal government support). From this, conclusions were drawn on the importance of these macro-level characteristics rather than focusing on food forest characteristics.

3.2 Data collection and variables

Figure 1: Food forests data collection



To collect data on food forestry in the Netherlands the sequential steps were performed. First, a database by Roodhof (2024) was used. This database consisted of a list of 246 food forests with their general information (i.e. name, contact information, size) that is publicly available. The dependent variable consisted of the number of emerging food forests per municipality per year from the years 2010 - 2023. Therefore, in order to complete the dataset by Roodhof (2024) in a way that was relevant for this study, information on the year of first planting and the municipality in which the food forest is located was added to the dataset. This was done through web-based research, more specifically, by visiting their food forest's websites social media platforms or by reading local news articles. It was not always possible to access information on food forest location or year of first planting via web-based research. Therefore, the food forests of which this information was not available were contacted via E-mail or LinkedIn. In total 45 food forests generated no reply, or they replied that no first planting was executed yet. These food forests were excluded from the dataset. In a second step, the dataset was further supplemented through accessing databases of Dutch food forestry organizations, namely 'Green Deal Voedselbossen' and 'Voedsel uit het Bos', which added 40 more food forests to the dataset. As a final step, through a web search (in Dutch) on food forests per municipality ("Voedselbos Gemeente [municipality name]") 146 more food forests were discovered either through their own social media or websites or through local news articles (see Appendix A for an overview of sources). Although this is a large number of new food forests, it is not that surprising as Roodhof (2024) already pointed out that the actual number of food forests in the Netherlands may be much larger than the number of food forests she included in her research. In total, this generated 387 Dutch food forests in the dataset, 373 of which emerged from 2010 onwards. In order to create the depended variable, the data was structured as the number of new emerged food forests in a municipality per year from 2010 to 2023. See figure 1 for an overview of the data collection process.

As the first independent variable, social capital was measured by four indicators extracted from a dataset based on social media data from a Dutch social media platform called *Hyves* and adjusted by Corten (2012) and Norbutas & Corten (2018). Hyves was the most popular social media platform in the Netherlands at the time of data collection in 2010. At its peak it reached 10.4 million users, while the Dutch population size was 16.6 million people. Thus, the dataset covers a large portion of the social networks among the Dutch population. This is the only variable that is extracted at one point in time in this research, therefore the values will be used as a proxy for the following years. All indicators consist of a value between 0 and 1. The first indicator is *Network density*, which is the ratio of actual friendship connections within a municipality network to the maximum potential connections, based on the total number of Hyves users in that municipality. This is an indicator of bonding social capital (H1). The second indicator is *Network fragmentation* or *modularity* (Louvain), which refers to the division of a network in subcommunities. This is also an indicator of bonding social capital (H1). The third indicator is *Topological network diversity*, which refers to the spreading of one's friendship connections. This indicator reflects bridging social capital (H2). The final indicator is *Node locality* (distance), which is the geographic closeness of an individual's network in an undirected network. This is also an indicator for bridging social capital (H2), i.e. when the value is close to 1, there are high levels of bridging social capital.

Although social capital in research is more commonly measured by trust and membership in civic associations (e.g. Ahlerup et al., 2009; Hauser et al., 2007), using differences in network structure as a proxy for social capital is no novel approach. Corten (2012) and Norbutas and Corten (2018) already used this data as a proxy for both bonding and bridging social capital, while other research used data on friendship connections from other social media platforms to measure social capital (e.g. Chetty et al., 2022a; Chetty et al., 2022b). Thus, it is an established measure and aligns with existing literature.

The second independent variable, environmental awareness, was measured using data on plant observers in the Netherlands. This data is extracted from *Waarneming.nl*, which is the biggest Dutch nature platform. On the website, anyone is allowed to upload a nature observation of any kind of species, including date and location. It is publicly available and includes yearly municipality level data on the number of observers and observations. This study used data on plant observers on the municipality level from 2010 until 2023 in order to grasp how many people in a municipality are aware of their natural surroundings. This indicates that municipalities with a high level of environmental awareness will have more people engaged in reporting their observations. Using this type of citizen science data in scientific research is not uncommon. Previous research has shown that it contributes to global biodiversity data (Amano et al., 2016; Chandler et al., 2017), due to its ability to generate large amounts of data, while also fostering public engagement with the environment (McKinley et al., 2017). Moreover, research has shown that citizens that participate in citizen science programs of biodiversity monitoring have strong preexisting environmental attitudes and values (Chase & Levine, 2017; Davis et al., 2019), which is why it is a relevant measure to use when studying environmental awareness in this study.

For the final independent variable on institutional support, data on green party representation in municipal councils was used to determine whether Dutch municipalities play supportive roles in food forestry development. The data was extracted from *Kiesraad.nl*, a website that contains information on Dutch elections. In order to test whether a municipality is 'green', the amount of green party seats in the municipality council (based on the number of votes) was calculated as a percentage of total seats in the council. This research only considered the four biggest national green parties in the Netherlands, excluding local parties, because policy making of national parties is similar on the local level as on the national level, making it easily comparable across municipalities. The four biggest green parties are D66, GroenLinks, PvdD and ChristenUnie, which is determined based on the protection and promotion of green in their election programmes (Greenpeace, 2010; De Snoo, 2017). The most recent municipality elections in the Netherlands have been in March 2022, 2018, 2014 and 2010 hence the data was extracted from these four elections. However, in some cases there have been re-elections at different points in time, mostly due to municipalities merging. In these cases, the percentage of green party seats were calculated for the re-election and used in the year closest to the re-election. For example, Gooische Meren had elections in November 2015 due to a merge with municipalities Naarden, Bussum and Muiden in January 2016. In this case, the elections of 2015 were used to determine the percentage of green party seats for the years 2016 and 2017 (until the elections of March 2018). The percentage of green party seats in the council shows whether a greener local government will be linked with higher levels of food forest emergence, as they are expected to facilitate more green development in the municipality. In fact, previous research has shown that more green parties in national governments contribute to more pro-environmental policy making (Jensen & Spoon, 2011; Knill et al., 2010). This would suggest that more green parties in a municipality council could lead to more policies that facilitate food forest emergence.

In addition to the main independent variables, control variables were added in order to avoid omitted variable bias. Control variables assumed to be influential in determining the emergence of food forests in a municipality include prior food forests present, population, municipality size, level of education, household income and land use. The first control variable is the cumulative number of food forests present in the municipality every year. This variable includes the food forests present before 2010 and shows whether the presence of food forests in a municipality has an effect on the emergence of new food forests. This effect was expected to be positive, because new food forest initiatives in a municipality can leverage capabilities acquired by already existing initiatives, as was discovered in citizen initiative research (Fransen et al., 2021). Second, municipalities with a higher population were expected to have more food forests emerging, due to the higher likelihood of having diverse social groups or organizations interested in starting a food forest. Third, a larger municipality was expected to be positively correlated with a higher amount of food forest emergence, because a larger municipality has more available land for such projects, providing the space needed for establishing and maintaining food forests. Fourth, a higher education level of citizens in a municipality was expected to positively impact the capabilities of locals to start successful food forests and, thus, be positively correlated with food forest emergence, as it was discovered that most Dutch food forest practitioners are highly educated (Roodhof, 2024). Fifth, a higher average income in a municipality was expected to have a positive effect on the financial resources available to start food forests. Food forests require considerable start-up funds with no immediate returns, so it is more likely that food forests emerge in places with higher average incomes (Roodhof, 2024). Lastly, land use, measured by the percentage of built area of total municipality area, was expected to negatively impact food forest emergence, meaning that in municipalities with less built area more food forests were expected to emerge. This negative effect was expected as a higher percentage of built area means less open land available to start food forests. Data on control variables was extracted from the Dutch Central Bureau of Statistics (CBS) 'Regionale Kerncijfers Nederland' database. Both population and municipality size were available for each year from 2010 to 2023. Data on education was available from 2013 - 2022, data on income from 2011 – 2022 and data on land use for the years 2010, 2012, 2015 and 2017 (see table 1). To prevent the unavailable years from being dropped from the analysis because of the lack of data, data for these years were estimated using interpolation. For both variables education and income, the average growth rates of the known years per municipality were calculated and used to estimate the data for the missing years, because for these variables the numbers had been growing steadily over time. However, regressions were performed using both the interpolated data and the not-interpolated data in order to test whether the interpolated data significantly changed outcomes. In the case of variable land use interpolation was not possible because the variable was not growing steadily over time but rather fluctuating mildly, mostly within the one percent range. Instead, the rate was used closest to the year of data collection. So, the 2010 rate was used in 2011, the 2012 rate in 2013 and 2014 and so on.

Finally, in order to complete the data collection, all variables had to be adjusted to the same municipality division. Dutch municipalities have been merging at a high annual rate for financial and administrative reasons. Therefore, the total amount of municipalities has decreased from 438 to 342 between 2010 and 2023. In order to correct for this, the variables were adjusted to the municipality division of January 2023. For the variables environmental awareness, population and municipality size this consisted of simply adding up the data of the merging municipalities to the new municipality. For the variables social capital, institutional support, education, income and land use a weighted average was taken based on the population size of each municipality. The two food forest variables did not need correction as these were created based on the division of 2023. Social capital and education data were not available for two municipalities, Rozendaal and Schiermonnikoog, two out of the three smallest municipalities of the Netherlands (CBS, 2024b). These municipalities were excluded from the analysis.

The operationalization of the dependent, the independent and control variables are shown in table 1.

Table 1: Operationalization of variables

Concept	Indicators	Calculation of scores	Available period	Source
FF Em	The total number of new food forest per year in the municipality		2010 - 2023	(Roodhof, 2024), Green Deal, Voedsel uit het Bos, Web search
SC - Dens	The ratio of actual friendship connections within a municipality network to the maximum potential connections, based on the total number of Hyves users in that municipality	A ratio between 0 and 1, where 0 is a completely unconnected network and 1 is a completely connected network.	2010	(Corten, 2012; Norbutas & Corten, 2018)
SC - Louv	The division of a network in subcommunities	A ratio between 0 and 1, where 0 reflects the lowest value of fragmentation, meaning the municipality is highly connected between all members and 1 refers to the highest value of fragmentation, indicating the presence of multiple subcommunities.	2010	(Corten, 2012; Norbutas & Corten, 2018)
SC - Div	The spreading of one's friendship connections	A ratio between 0 and 1, where 0 means no spreading of ties, meaning all connections of an individual are within the same municipality and 1 means all ties are completely spread out, meaning all connections of an individual are spread out equally across municipalities.	2010	(Corten, 2012; Norbutas & Corten, 2018)
SC - Dis	The geographic closeness of an individual's network in an undirected network.	A ratio between 0 and 1, where 0 reflects the highest value of closeness, meaning that one's friendship connections are geographically close and 1 reflects the lowest value of closeness, meaning that one's friendship connections are far.	2010	(Corten, 2012; Norbutas & Corten, 2018)

Env Awa	The total number of observers in a municipality		2010 - 2023	Waarneming.nl
Inst Supp	Percentage of seats from the four largest green parties (GroenLinks, PvdD, D66 & ChristenUnie), of total seats in the municipality council.	A ratio between 0 and 100%, where the higher the percentage, the greener a municipality council is.	2010 - 2023	Kiesraad.nl
FF Tot	The total number of food forests in a municipality for each year.		2010 - 2023	(Roodhof, 2024), Green Deal, Voedsel uit het Bos, Web search
Pop	The total number of inhabitants in a municipality.		2010 - 2023	Central Bureau of Statistics (CBS)
Mun Size	Square kilometre of land area of a municipality.		2010 - 2023	Central Bureau of Statistics (CBS)
Educ	Percentage of population in the municipality that is considered as 'highly educated'.	A ratio between 0 and 100%, where the higher the percentage, the higher educated a municipality is.	2013 - 2022	Central Bureau of Statistics (CBS)
Income	Average GDP per capita income in a municipality.	Measured by the sum of personal income of all persons in private households in a municipality, divided by the number of inhabitants of a municipality (in private households).	2011 - 2022	Central Bureau of Statistics (CBS)
Land Use	The percentage of built area of total municipality area.	A ratio between 0 and 100%, where the higher the percentage, the more urban a municipality is.	2010, 2012, 2015, 2017	Central Bureau of Statistics (CBS)

3.3 Analysis

As previously mentioned, this study takes on a quantitative approach. In order to estimate the effect of social capital, environmental awareness and institutional support on the emergence of food forests, a generalized linear regression model suited for count data was performed, due to the discrete nature of the dependent variable (food forests emergence). Specifically, a negative binomial regression model was selected for this analysis, because it is well-suited for modelling count data and it can accommodate overdispersion, which was detected in the data after conducting a test for overdispersion by Cameron and Trivedi (1990). Moreover, the negative binomial model was compared with the Poisson model by using a likelihood ratio test, which revealed that the negative binomial model provided a significantly better fit to the data, as was shown by a clear improvement in the model's log-likelihood. The analysis was performed using R Studio.

After running the final models, skewness in the residuals was discovered. In order to account for this, the skewness of all variables was analyzed. Population was found to have a significantly higher skewness (6.9) compared to the other variables (e.g. environmental awareness 3.89, municipality size 2.7, income 1.55), hence, the logarithm of population was taken to normalize its distribution and improve the model's accuracy.

The effects of the independent variables on the dependent variable were tested to see whether they influence the emergence of food forests positively or negatively. Therefore, first nested models were presented in order to test the effects separately. Thereafter, all main independent variables including the control variables were included in the model simultaneously, which is presented here:

$$FF\_Em_{it} = \beta_0 + \beta_1 SC\_Dens_{it} + \beta_2 SC\_Louv_{it} + \beta_3 SC\_Div_{it} + \beta_4 SC\_Dis_{it} + \beta_5 EnvAwa_{it} + \beta_6 InstSupp_{it} + \beta_7 FF\_Tot_{it} + \beta_8 Pop_{it} + \beta_9 MunSize_{it} + \beta_{10} Educ_{it} + \beta_{11} Income_{it} + \beta_{12} LandUse_{it} + \varepsilon_{it}$$

The coefficients β_1, $\beta_2, \beta_3, \beta_4, \beta_5$ and β_6 for the independent variables were all expected to be positive and significant. For the control variables $\beta_7, \beta_8, \beta_9, \beta_{10}$ and β_{11} were also expected to be significantly positive, while β_{12} was expected to be negative. The results of this analysis are presented in chapter 4.

3.4 Data quality

Data for this research was collected from a variety of sources. Data errors in the regression analysis could have impacted the model's predictive accuracy (Corrales et al., 2018). However, all data was retrieved from reliable sources ensuring validity of the research findings. First of all, the dependent variable was constructed through various different sources, namely an existing dataset of peer-reviewed article, databases of food forest organizations and web-based research. The existing dataset was compiled by an expert in the field, ensuring a reliable foundation. Moreover, the databases from food forest organizations provided verified and up-to-date information, reflecting an accurate status of food forest initiatives. Finally, the web-based research was conducted systematically, cross-referencing multiple reputable sources to minimize errors and omissions. Together, these sources ensure the robustness and credibility of the dependent variable. Additionally, the main independent variables were retrieved from verified sources. First, the social capital data has been validated in two prior peer-reviewed articles, demonstrating its acceptance and reliability in academic research. Second, the environmental awareness data was retrieved from *Waarneming.nl* which is part of *Observation.org*, an EU-based platform for biodiversity citizen science that ensures data quality through consoling over 1,000 species experts to continuously validate the data. Third, the institutional support data was retrieved from *Kiesraad.nl*, which is an independent administrative body that supervises elections and ensures a fair, transparent and verifiable electoral process. Finally, data for the control variables were retrieved from the CBS, which is a governmental organization.

The four quality criteria for quantitative analysis (i.e. replicability, internal validity, external validity and reliability (Bryman, 2016) are presented in table 2, in order to ensure the trustworthiness of this research.

Table 2: Trustworthiness of the research

Criteria	**Within this study**
Replicability	Documenting as much of the research process as possible allowed for a strong replicability for other researchers. Moreover, most data used is publicly available, so any researcher could conduct the same research at a different point in time.
Internal validity	A longitudinal design allowed for the ability to address causality. The inclusion of control variables captured other factors important in influencing food forest emergence beyond the main independent variables.
External validity	This study approached to use data on the entire population as it aimed to include all Dutch food forests and all municipalities ensuring strong external validity.
Reliability	Including the entire population ensured a strong reliability, as the same results should be produced when conducted again.

4. Results

Figure 2 shows the distribution of food forests across the Netherlands. In total, 211 out of 342 municipalities contain at least one planted food forest by 2023. The municipality with the most food forests (n=9) is Amsterdam, followed by Lochem (n=7) and Almere and Berkelland (n=6). The most common number of food forests present within a municipality is 1 (n=113) (see figure 3). As the right panel in figure 2 shows, most food forests are present in the east and southern parts of the Netherlands, namely in the provinces of Gelderland (80) and Noord-Brabant (79), which are two of the top three most forested provinces of the Netherlands (IVN, n.d.-b), while also the two provinces with the highest total number of agricultural companies present as of 2023 (CBS, 2023). Zeeland (8) and Friesland (9) have the least food forests present. This is somewhat surprising as Friesland has a relatively high total number of agricultural companies (CBS, 2024a). This indicates that there are other factors more important in determining the emergence of food forests than agriculture.

Figure 2: Number of food forests initiatives in Dutch municipalities and provinces

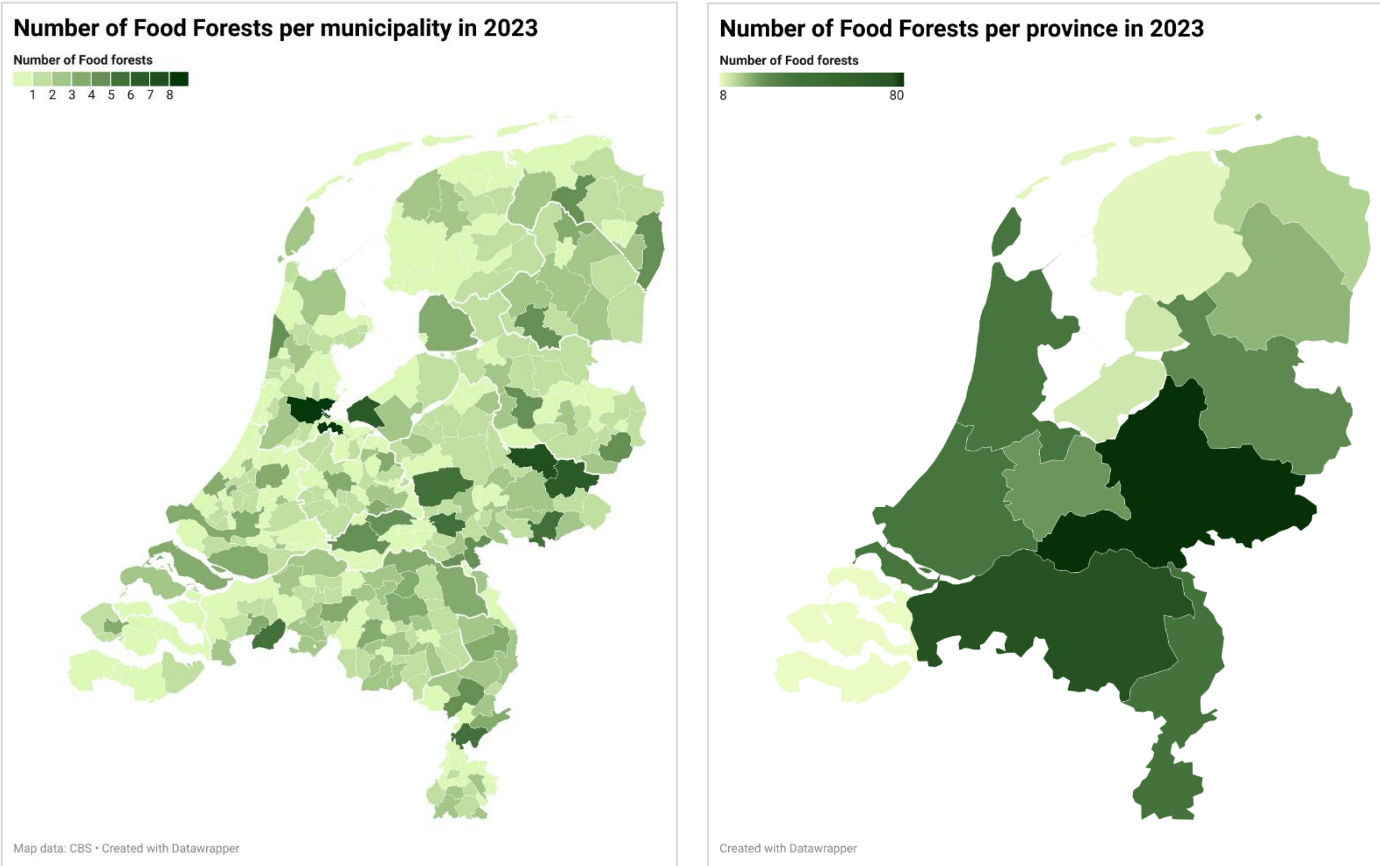
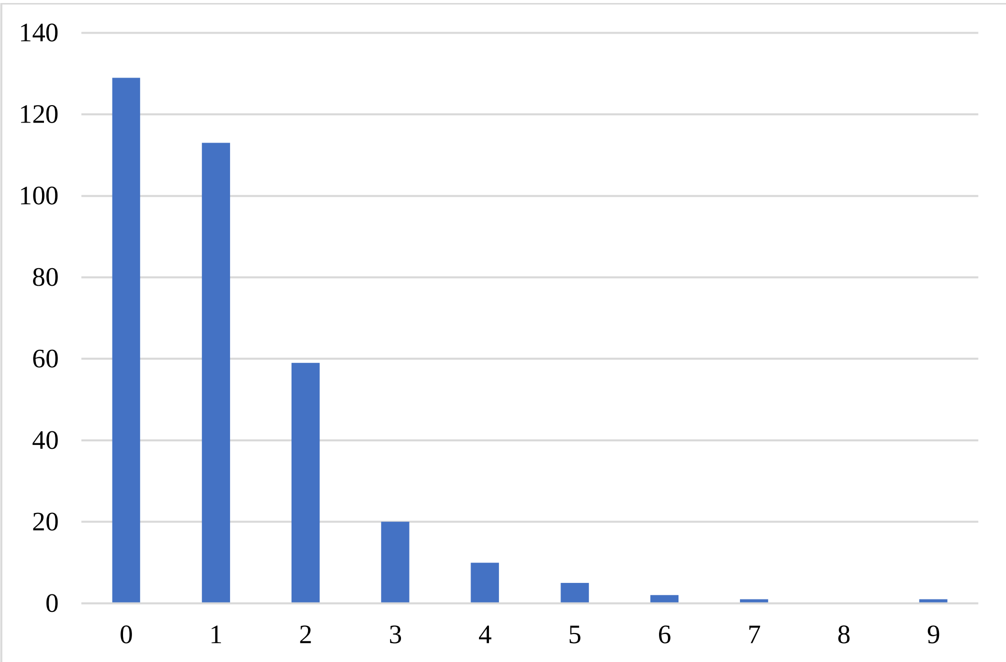
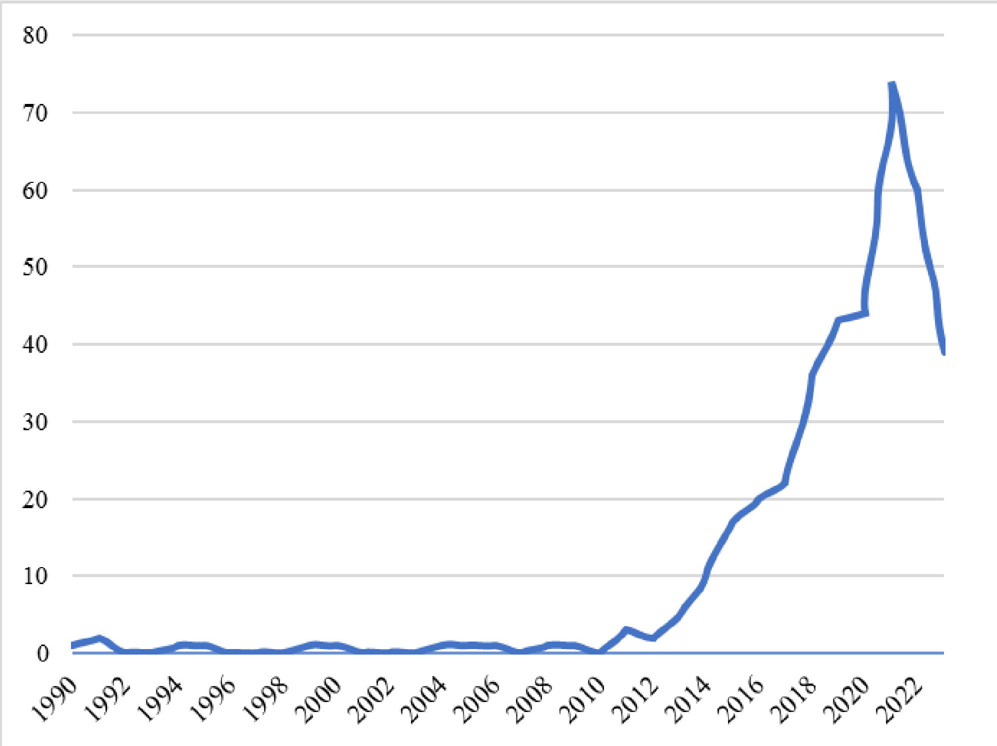


Figure 3: The distribution of total number of food forests per municipality



Although some food forests already started in the 1990s, from 2011 onwards food forest emergence in the Netherlands increased every year with a peak of 74 in 2021 (see figure 4). However, this number dropped to 60 in 2022 and 39 in 2023, indicating that food forests are emerging at a slower pace.

Figure 4: Number of Food Forest Started by Year, 1990–2023 (n=387)



4.1 Regression Models

The descriptive statistics and correlations of the variables used in the regression model are presented in table 3 and 4. The correlation between the dependent variable (number FF emerging) and the independent variables is low to moderate. The correlation between most of the independent variables is also low to moderate, except for the correlation between the social capital variables "Diversity" and "Distance" (0.793). Therefore, the diversity variable was excluded from the analysis. This correlation was expected as highly diverse social connections outside the own municipality are related to the distance of social network members, meaning that high diversity relates to a far distance of the social network. The social capital variable distance was opted for over diversity, because it directly reflects the extent to which individual's social connections reach beyond their immediate locality. Diversity captures the spreading of social connections across different municipalities, which may not reflect an individual's engagement with different communities or access to different resources as well as distance does, which are the key aspects of bridging social capital (Putnam, 2000).

Table 3: Descriptive Statistics

	N	Mean	Std. Dev	Min	Max
Dependent variable					
FF Em	4,759	0.078	0.303	0	3
Independent variables					
SC - Dens	4,759	0.007	0.006	0.0001	0.064
SC - Louv	4,759	0.442	0.048	0.256	0.583
SC - Div	4,759	0.309	0.025	0.168	0.374
SC - Dis	4,759	0.653	0.083	0.219	0.891
Env Awa	4,759	1.483	2.470	0	25.940
Inst Supp	4,759	0.190	0.113	0	0.578
Controls					
FF Tot	4,759	0.307	0.740	0	8
Pop	4,759	5.027	7.235	0.108	91.812
Mun Size	4,759	1.215	1.306	0.078	9.312
Educ	4,759	0.261	0.077	0.087	0.582
Income	4,759	30.729	5.281	16.190	78.220
Land Use	4,759	0.203	0.158	0.002	0.707

Table 5 presents the results of the negative binomial regression. The results of the first model indicate that all control variables except municipality size and education have a significant effect on food forest emergence in a municipality. The variable counting the total amount of food forests in the municipality is positive and significant, indicating that more food forests already present in a municipality correlates with more food forests emerging within the same municipality. The significant positive coefficient for population indicates that more food forests emerge when a municipality has a higher population. The effect for income is positive as well, meaning that municipalities with a higher average household income are more likely to be associated with food forest emergence.

Table 4: Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	FF Em	1	-0.030	0.064	-0.031	-0.038	0.189	0.041	0.149	0.126	0.051	0.073	0.113	-0.020
(2)	SC - Dens	-0.030	1	-0.425	0.136	0.063	-0.031	-0.388	-0.057	-0.335	0.114	-0.243	0.030	-0.452
(3)	SC - Louv	0.064	-0.425	1	0.204	0.295	0.110	0.245	0.125	0.208	0.039	0.303	0.121	0.051
(4)	SC - Div	-0.031	0.136	0.204	1	0.793	-0.052	0.151	-0.076	-0.215	-0.140	0.286	0.199	0.046
(5)	SC - Dis	-0.038	0.063	0.295	0.793	1	-0.047	0.118	-0.091	-0.239	-0.239	0.485	0.376	0.106
(6)	Env Awa	0.189	-0.031	0.110	-0.052	-0.047	1	0.176	0.445	0.234	0.186	0.306	0.426	-0.038
(7)	Inst Supp	0.041	-0.388	0.245	0.151	0.118	0.176	1	0.118	0.290	-0.084	0.495	0.133	0.317
(8)	FF Tot	0.149	-0.057	0.125	-0.076	-0.091	0.445	0.118	1	0.287	0.103	0.158	0.232	-0.038
(9)	Pop	0.126	-0.335	0.208	-0.215	-0.239	0.234	0.290	0.287	1	0.129	0.238	-0.136	0.371
(10)	Mun Size	0.051	0.114	0.039	-0.140	-0.239	0.186	-0.084	0.103	0.129	1	-0.252	-0.174	-0.450
(11)	Educ	0.073	-0.243	0.303	0.286	0.485	0.306	0.495	0.158	0.238	-0.252	1	0.539	0.363
(12)	Income	0.113	0.030	0.121	0.199	0.376	0.426	0.133	0.232	-0.136	-0.174	0.539	1	-0.036
(13)	Land Use	-0.020	-0.452	0.051	0.046	0.106	-0.038	0.317	-0.038	0.371	-0.450	0.363	-0.036	1

Lastly, the variable land use is significantly negative, indicating that a higher percentage of built area in the municipality correlates with a lower number of food forests emerging in that municipality. Hence, more food forests emerge in municipalities with a higher percentage of green area (i.e. recreational, agricultural, and natural). This makes it especially surprising that Amsterdam has the most food forests out of all Dutch municipalities, so there must be other reasons that explain this. These significant coefficients of all control variables behave as predicted. The total number of food forests, population, income and land use stay robust throughout all models (model 1 – model 7). The coefficients for municipality size and education are unexpectedly negative in the first model, although both insignificant. Municipality size remains insignificantly negative in most models except model 3. Education, on the other hand, turns positive in all subsequent models, excluding model 5, but remains insignificant throughout.

The second model includes social capital density and social capital Louvain in the analysis, i.e. the variables measuring the first hypothesis. Both variables are positive when added in the model with the control variables, however, only social capital density is significant. This indicates that municipalities with citizens that have a high number of connections within the community are likely to have more food forests emerging. In model 3 the second hypothesis is tested by including social capital distance in the model with the control variables. Social capital distance is significant, though shows a negative coefficient. This suggests that the higher the average geographical distance of individuals' network ties, the lower the number of food forests emerging in that municipality. When the variables for bonding social capital (density and Louvain) and bridging social capital (distance) are both added into the model simultaneously (model 4) density and distance do not change. Louvain, on the other hand, turns significant, suggesting that more food forests emerge in municipalities where relatively many subcommunities exist. The coefficients of the three social capital indicators remain robust in the final model (model 7). Hypothesis 1 suggested that more bonding social capital present in a municipality should lead to more food forest emerging in that municipality. Thus, the positively significant coefficients for both social capital density as well as social capital Louvain confirm hypothesis 1. Hypothesis 2 suggested that bridging social capital should lead to more food forest emerging. However, a negative relationship of social capital distance on food forest emergence was found. Thus, the second hypothesis is rejected.

Model 5 includes environmental awareness with the control variables in order to test for the third hypothesis. As predicted, environmental awareness is positive and significant, indicating that more food forests are likely to emerge in municipalities with higher levels of environmental awareness. This result remains robust through all subsequent models. Thus, hypothesis 3, suggesting that more food forests emerge in municipalities with higher levels of environmental awareness, is confirmed.

The sixth model focuses on the final hypothesis and includes the variable for institutional support. The indicator is positive yet insignificant, indicating that the percentage of green parties in the municipal council is not associated with the emergence of food forests. This result remains robust in the final model, implying that hypothesis 4, more food forests emerge in municipalities with more supportive institutions, is rejected.

Model 7 is the final model and includes all independent variables and control variables. This final model is a significant improvement over the other models as was discovered with the Log-likelihood ratio test.

Table 5: Regression models 1-7 on the emergence of food forests

N = 4,759		Hyp	M1	M2	M3	M4	M5	M6	M7
	Intercept		-5.783*** (0.346)	-7.076*** (0.705)	-4.718*** (0.589)	-6.187*** (0.769)	-5.239*** (0.389)	-5.770*** (0.346)	-5.799*** (0.787)
Controls	Food Forests total		0.185*** (0.051)	0.165*** (0.052)	0.172*** (0.051)	0.143*** (0.052)	0.133** (0.055)	0.185*** (0.051)	0.105* (0.049)
	Log of Population (10,000s)		0.700*** (0.101)	0.810*** (0.115)	0.583*** (0.114)	0.647*** (0.131)	0.638*** (0.102)	0.714*** (0.102)	0.613*** (0.132)
	Municipality Size (10,000s)		-0.006 (0.053)	-0.025 (0.055)	0.009 (0.053)	-0.006 (0.055)	-0.039 (0.055)	-0.005 (0.053)	-0.035 (0.057)
	Education % highly educated		-0.160 (1.001)	0.498 (1.037)	1.089 (1.160)	0.804 (1.149)	-0.427 (1.007)	0.218 (1.131)	0.677 (1.271)
	Household Income (€1000s)		0.084*** (0.012)	0.086*** (0.012)	0.085*** (0.012)	0.088*** (0.012)	0.070*** (0.013)	0.083*** (0.012)	0.074*** (0.013)
	Land Use % of built environment		-2.305*** (0.610)	-2.064*** (0.617)	-2.148*** (0.619)	-1.798* (0.629)	-2.237*** (0.613)	-2.309*** (0.611)	-1.803*** (0.631)
Indep. vars	Social Capital Density	H1: +		37.710** (16.162)		37.788** (15.913)			31.491* (16.470)
	Social Capital Louvain	H1: +		2.064 (1.317)		3.431** (1.402)			3.339** (1.404)
	Social Capital Distance	H2: +			-2.045** (0.915)	-2.734*** (0.987)			-2.326** (1.011)
	Environmental Awareness (100s)	H3: +					0.061** (0.018)		0.052*** (0.019)
	% Institutional Support	H4: +						-0.453 (0.643)	-0.468 (0.648)
	Log-Likelihood		-1250	-1248	-1248	-1244	-1246	-1250	-1240
	AIC		2515	2513	2512	2508	2507	2516	2505

*p<0.1; **p<0.05; ***p<0.01

4.2 Post-hoc model

In order to investigate the unexpected negative effect of social capital distance on the emergence of food forests, a non-linear effect of distance was considered by including distance-squared into the model. The results are presented in model 8 of table 6, which shows a positive significant coefficient for social capital distance and a negative significant coefficient for distance squared. This is evidence of a significant inverted U-shape effect of social capital distance on food forest emergence, which means that initially, as the distance of connections people have outside the municipality increases, food forest emergence also increases up to a certain point. After this point, further increases in the geographical distance of network ties lead to a decrease in food forest emergence. The other coefficients remain relatively robust in this model, except for social capital density, which now turns insignificant. Model 8 that includes a non-linear effect is a significant improvement over Model 7 (Log-likelihood ratio test χ^2 (1) = 26.232, $p < 0.01$) This brings some nuance into the relationship between bridging social capital and food forest emergence, indicating that there is, in fact, a positive relationship, however, when the geographical distance of network ties reaches passed a certain point, this relationship turns negative. Besides bridging social capital, this model may also provide some nuance into the relationship between bonding social capital and food forest emergence, as social capital network density turns insignificant when including social capital distance squared. This may indicate that having many diverse subcommunities present in a municipality may be a more important determinator of food forest emergence compared to having a highly connected network within a municipality.

4.3 Robustness checks

As was mentioned in the section on data collection, data on education and income were not available for all years from 2010 – 2023 and therefore, interpolation was used to account for the missing years. To test whether this interpolation accurately reflects the factual empirical data, the models were run excluding 2010 – 2012 and 2023. Model 9 and 10 in table 6 show that all variables are robust except for social capital density, indicating that the results are largely the same when using solely factual empirical data.

A second robustness check was performed including province dummy variables in the regression model in order to control for unobserved, time-invariant characteristics of the Dutch provinces. The results are presented in model 11 and 12 of table 6. Social capital density and Louvain are robust when including province dummies. Social capital distance is negative and insignificant in model 11, while the inverted U-shape remains significant (see model 12). Environmental awareness is still positive and significant in model 11, although only at the 10% significance level. It turns insignificant in model 12, implying that the effect of environmental awareness may be influenced by how social capital distance is modeled. However, more importantly, the inclusion of province dummies appears to significantly influence the effect of environmental awareness on food forest emergence. This indicates that province-level factors play an important role, that may overshadow the direct effect of environmental awareness. Nonetheless, it is important to note that the inclusion of province dummies is a coarse measure and does not necessarily imply that environmental awareness is no longer relevant, although it does suggest that other results appear more resistant to the inclusion of province dummies. Control variables population and income remain robust throughout. These findings suggest that the indicators for bonding social capital and the inverted U-shape of bridging social capital are robust, strengthening the validity of these findings.

Table 6: Post Hoc model & Robustness checks

		Hyp	M8	M9	M10	M11	M12
	Intercept		-19.770*** (3.126)	-4.979*** (0.855)	-16.975*** (3.332)	-7.655*** (0.923)	-21.021*** (3.262)
Controls	Food Forests total		0.060 (0.056)	0.115* (0.062)	0.079 (0.062)	0.018 (0.057)	-0.026 (0.057)
	Log of Population (10,000s)		0.513*** (0.134)	0.554*** (0.142)	0.469*** (0.144)	0.872*** (0.154)	0.794*** (0.153)
	Municipality Size (10,000s)		-0.005 (0.057)	-0.054 (0.061)	-0.029 (0.061)	-0.029 (0.069)	-0.017 (0.069)
	Education % highly educated		1.438 (1.268)	0.658 (1.364)	1.349 (1.368)	-0.120 (1.325)	0.599 (1.316)
	Household Income (€1000s)		0.097*** (0.014)	0.051*** (0.015)	0.072*** (0.017)	0.106*** (0.014)	0.128*** (0.015)
	Land Use % of built environment		-1.419** (0.634)	-2.130*** (0.693)	-1.805*** (0.697)	-1.254* (0.677)	-0.866 (0.675)
Indep. vars	Social Capital Density	H1: +	26.094 (16.978)	25.508 (17.703)	21.242 (18.145)	50.101*** (18.777)	48.377** (19.331)
	Social Capital Louvain	H1: +	3.670*** (1.394)	4.018*** (1.477)	4.199*** (1.470)	3.185** (1.506)	3.675** (1.506)
	Social Capital Distance	H2: +	40.443*** (7.294)	-2.221** (1.087)	34.549*** (9.879)	-0.939 (1.155)	40.011*** (9.418)
	Social Capital Distance²		-34.595*** (7.294)		-29.878*** (7.884)		-33.172*** (7.445)
	Environmental Awareness (100s)	H3: +	0.035* (0.019)	0.074*** (0.023)	0.058** (0.023)	0.034* (0.020)	0.019 (0.020)
	% Institutional Support	H4: +	-0.362 (0.655)	-0.775 (0.679)	-0.643 (0.687)	-0.098 (0.712)	-0.127 (0.708)
	Province dummy		No	No	No	Yes	Yes
	N		4,759	3,400	3,400	4,759	4,759
	Log Likelihood		-1227	-1051	-1043	-1213	-1202
	AIC		2481	2126	2111	2472	2451

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

As a third robustness check a zero-inflated negative binomial (ZINB) regression model was performed to account for excessive zeros in the dependent variable. The results are presented in table 7 by model 13 and 14. The ZINB model distinguishes two processes, namely the **count process**, which models municipalities where food forests could emerge during the observation period (2010 to 2023) including years with zero food forests and years with non-zero counts, and the **structural zero process**, which accounts for municipalities with a consistent count of zero food forests across all years, reflecting those that are unlikely to ever establish food forests. The former is represented in the models as the 'count model part' and measures the effect of having more food forest emerging. The latter is represented as the 'zero-inflated part' and measures the effect of having zero food forests or not.

The first ZINB model (model 13) includes all main independent variables and controls. In the count model part, social capital Louvain and environmental awareness are positive and significant, indicating that municipalities with higher levels of social capital Louvain and greater environmental awareness tend to have more food forests emerging. The zero-inflated part of the model shows whether these variables impact the possibility of having zero food forests emerging in a municipality. The positively significant coefficient for social capital distance indicates that there is a higher probability of having zero food forests emerging when friendship connections are geographically far away. This positive coefficient confirms the previously found negative relationship between social capital distance and food forest emergence. In the case of environmental awareness, the negatively significant coefficient entails that there is a lower probability of zero food forests emerging when there are low levels of environmental awareness, confirming the previously found positive relationship.

Model 14 includes social capital distance squared. The results are very similar to model 13, however, social capital distance and social capital distance squared are now both significant in the count part of the model. This means that when there are food forest emerging in the municipality, an increase in the geographical distance of friendship connections increases the number of food forest emerging up until a certain point, after which an increase in geographical distance decreases the number of food forests emerging in a municipality. In the zero-inflated part of the model all social capital indicators turn insignificant, indicating that they do not significantly impact the probability of having zero food forests emerging in the municipality.

The results of the ZINB regression models mostly confirm the findings found in the previous models. While environmental awareness both positively impacts the number of food forests emerging and decreases the probability of having zero food forests emerging in both models, for social capital these effects are a bit more complex. The bonding social capital indicator Louvain has a positive effect on the number of food forests emerging, however, does not impact the probability of having zero food forests. On the other hand, the bridging social capital indicator distance increases the probability that a municipality will never have food forests emerging, confirming the negative relationship found in previous models. However, there is evidence again of an inverted U-shape relationship, which confirms the previously found nuance in the negative impact of bridging social capital on food forest emergence. Finally, a somewhat surprising finding is that control variable income is negatively associated with the number of food forests emerging and at the same time decreases the chances of having zero food forests emerging. Potentially, this could be due to the high start-up funds necessary to plant a food forest, as food forests require considerable seed capital (Roodhof, 2024). However, once food forests are present in a municipality, existing resources and knowledge on requiring funds may reduce the need for a higher personal income.

Table 7: Zero-Inflated Negative Binomial Models on the emergence of food forests

		Hyp	M13		M14	
			Count Model part	Zero-inflated part	Count Model part	Zero-inflated part
	Intercept		-3.344*** (1.076)	5.469* (3.222)	-10.716** (4.480)	15.737 (13.127)
Controls	Food Forests total		0.029 (0.057)	-0.502 (0.335)	0.012 (0.058)	-0.481 (0.342)
	Log of Population (10,000s)		0.473*** (0.159)	-0.272 (0.463)	0.405** (0.160)	-0.302 (0.479)
	Municipality Size (10,000s)		-0.103 (0.079)	0.009 (0.239)	-0.079 (0.078)	0.013 (0.240)
	Education % highly educated		-0.898 (1.553)	-2.740 (4.671)	-0.228 (1.580)	-3.269 (4.787)
	Household Income (€1000s)		-0.042* (0.021)	-0.362*** (0.070)	-0.029 (0.024)	- 0.368*** (0.071)
	Land Use % of built environment		-1.847** (0.821)	-0.558 (2.174)	-1.565* (0.823)	0.140 (2.217)
Indep. vars	Social Capital Density	H1: +	17.264 (21.430)	-0.970 (65.153)	12.813 (21.945)	-3.027 (67.338)
	Social Capital Louvain	H1: +	3.591** (1.706)	1.152 (4.594)	3.726** (1.696)	1.748 (4.663)
	Social Capital Distance	H2: +	2.112 (1.501)	11.990*** (4.164)	24.657* (13.289)	-20.912 (41.440)
	Social Capital Distance²				-18.457* (10.746)	25.952 (32.961)
	Environmental Awareness (100s)	H3: +	0.053*** (0.019)	-1.491** (0.665)	0.046** (0.019)	-1.457** (0.681)
	% Institutional Support	H4: +	-1.062 (0.836)	-0.619 (2.265)	-1.097 (0.828)	-0.987 (2.250)
	N		4,759		4,759	
	Log Likelihood		-1180		-1174	

*p<0.1; **p<0.05; ***p<0.01

5. Discussion

Previous research has shown the many benefits food forests can provide to the environment, social cohesion, food security and health (Young, 2017; Stoltz & Schäffer, 2018; Brito & Borelli, 2020; Nytofte & Henriksen, 2019). Moreover, the persistent issues of excessive emissions due to conventional agriculture (Horrigan et al., 2002) and the goals of the Dutch government to allocate 1,000 hectares of land to food forestry by 2030 (Ministry of Agriculture, Nature and Food Quality, 2020), has increased the relevancy of food forest emergence in the Netherlands. Therefore, the aim of this research was to investigate what influences the emergence of food forests in the Netherlands, by answering the following research question: *Which factors contribute to the emergence of food forest initiatives in Dutch municipalities?* Three macro-level factors were defined as important in the development of food forests by the literature, namely social capital, environmental awareness and institutional support. Data on food forest initiatives was collected through available data and web-based research. In order to answer the research question, a regression analysis was performed including variables reflecting social capital, environmental awareness and institutional support. Other variables that were expected to influence food forest emergence were included in the model as controls.

According to the results of the regression analysis, social capital had a partially positive effect on the emergence of food forests in Dutch municipalities. The different indicators for social capital based on Norbutas and Corten (2018) showed the importance of different forms of social capital on the emergence of food forests initiatives in the Netherlands. Network density and Louvain both considered ties between individuals within the same municipality, where network density reflected the level of connectedness of the community and Louvain reflected the fragmentation of a network in multiple connected sub-networks. The significantly positive relationship of both shows the importance of bonding social capital on the emergence of food forests. A municipality characterized with high bonding social capital measured by the connectedness of its municipality network and the presence of many, well-connected communities was found to have a higher emergence of food forests. This is in line with citizen science literature, where neighborhood attachment and interactions with neighbors have been found to be connected to higher citizen initiative emergence and participation (Wittenberg et al., 2023; Caferra et al., 2023). However, social capital density was not as robust as social capital Louvain, indicating that having many subcommunities present in a municipality may be more important in determining food forest emergence than having one highly connected network in a municipality. A potential reason for this could be that a bigger presence of different subcommunities could facilitate the emergence of more independent food forests.

The relationship of bridging social capital and the emergence of food forests, on the other hand, is not as straightforward. Contrary to theoretical expectations, bridging social capital measured by the geographical distance of individual's friendship connections, was found to have a significantly negative relationship with food forest emergence. This result is counter-intuitive, since findings in previous research have shown that having partnerships outside the community provides more opportunities to mobilize resources necessary for an initiative to be successful (Agranoff & McGuire, 2003; Shrestha, 2012). An explanation for this was found in a non-linear relationship between distance and food forest emergence, namely an inverted U-shape. This suggests that there is an optimal range of geographic distance for social connections that maximizes food forest emergence. This partially confirms the results of previous research, as having network ties beyond the immediate locality provides access to information, resources and support. However, as the distance of social network ties extend beyond a certain point, the benefits of bridging social capital may be outweighed by the challenges and limitations associated with long-distance relationships, such as logistical challenges in coordinating activities and maintaining communication or diminished local engagement and cohesion. Research has shown that geographically isolated individuals are less involved in collective dynamics compared to members in the locality closest to the cooperative (Pachoud et al., 2020). Since food forests are space bound, this could explain the non-linear relationship found in this study.

These different impacts of bonding and bridging social capital on food forest emergence are not uncommon. Previous research has shown that they do not always enhance each other, but rather can have opposite impacts. For example, in research on the impacts of bonding and bridging social capital on socio-economic outcomes, bridging social capital is considered beneficial as it increases the diversity of knowledge sources and therefore increases creativity, innovation and entrepreneurship (Florida, 2002; Crescenzi et al., 2013; Feldman et al., 2019). Bonding social capital, on the other hand, is seen as negative as members in a close-knit community prefer group loyalty over benefiting society (Portes, 1998). However, food forests are not focused on economic growth and innovation, as one of their primary purposes is to embed people in their communities and they usually do not have the incentive to grow beyond (Bauwens et al., 2022). Therefore, bonding social capital is crucial to their development, while bridging social capital may be rather subordinate. Therefore, the results of this study are relevant for other citizen initiative research, as they highlight a more nuanced relationship between bridging social capital and initiative emergence than discovered in previous research.

In line with theoretical expectations, environmental awareness was found to have a significant positive effect on the emergence of food forests. Previous research has shown that a high level of environmental awareness is linked to citizen initiative emergence (Boon & Dieperink, 2014), greater engagement within these initiatives (Bauwens, 2016) and is considered a main driver of food forests initiators (Roodhof, 2024). As was discovered in this research, more food forests emerge in municipalities with a high level of environmental awareness, measured by the total number of plant observers in the municipality. Using citizen science data on biodiversity monitoring is becoming more common in biodiversity research (Amano et al., 2016; Chandler et al., 2017). However, it is a new approach in measuring the link between environmental awareness and citizen initiative emergence, which is generally studied using survey-based measures that capture individuals' ideas and attitudes (e.g. Bauwens, 2016; Boon & Dieperink, 2014). These surveys focus more on self-reported environmental awareness rather than directly assessing actual environmental awareness, which can raise questions about their validity. This study is unique in capturing a more behavior-based insight into how environmental awareness influences emergence of citizen initiatives like food forests. Although the positive impact found may not be theoretically groundbreaking, methodologically, it offers a more exciting perspective as it highlights the potential value of incorporating citizen science data as a measure for environmental awareness in future citizen initiative research, which could potentially complement traditional survey data and provide a more comprehensive understanding of the factors driving initiative emergence.

Contrary to the theory, institutional support, measured by the percentage of green party seats in a municipality council, was not found to have an impact on food forest emergence. This result was unexpected, as previous research has discovered that support from local institutions is crucial for the success and emergence of citizen initiatives (Hoppe et al., 2015; Wiseman, 2006; Roodhof, 2024). However, institutional support can take different forms, such as financial support through the provision of subsidies or by providing land or giving management advice (Mattijssen et al., 2017). The measure used in this study did not capture these types of support specifically, but rather aimed at capturing the interest of local institutions as an indicator of the types of policies the institution would implement. Although research has shown that the percentage of green party seats in national governments has significant impact on environmental results in the country (Jensen & Spoon, 2011; Knill et al., 2010), this does not seem to be the case for municipal governments and the emergence of food forests. Moreover, the aforementioned zoning plan of Dutch municipalities may have a more important impact on the emergence of food forests compared to the share of green parties in the council. Finally, using green party votes to measure the greenness of a municipality council may be another reflection of environmental awareness present in the municipality. In fact, some studies have used green party votes as a proxy for green attitudes while studying cooperative emergence (Punt et al., 2021; Liu & Guenther, 2022), so this may be the reason why a non-significant relationship was found. Potentially, when using a measure focusing on a specific type of institutional support, like subsidies or zoning plans, a different relationship could be found. This research did not use such measures as they were not available on the Dutch municipality level, though they would be interesting variables to use in future research on country level food forest emergence.

Another reason why this research may not have found a significant effect of institutional support on the emergence of food forests could be that institutional support may primarily occur at the provincial rather than municipal level. Roodhof (2024) found that supportive provincial policies were linked to more food forests present in the province. This highlights that provincial level institutional support could be an important determinant of where food forests emerge, potentially more important than municipal institutional support. Some evidence of the importance of provincial level factors on the emergence of food forests was found in this research in model 11 and 12, including province dummies. However, more research is necessary to better understand the dynamics at different governance levels and their impact on food forest emergence.

Finally, using the percentage of green parties in the municipality council as a measure of how supportive local governments are has its limitations, which could have influenced the outcome of this study. Most importantly, it does not capture the bureaucratic hurdles, budget constraints or competing priorities local governments face in policy making, as it focuses on government ideals rather than practice. Moreover, it neglects the contributions of non-green parties that may also support sustainable practices. However, political party affiliation is a practical and accessible metric for research purposes due to its availability, and therefore a good baseline measure for comparing between municipalities.

Besides the indicator used for institutional support, some other limitations could have affected the validity of this research. First of all, in order to measure food forest emergence in the Netherlands, a dataset was created aiming to include all Dutch food forests planted up to and including the year 2023. The use of web-based research in the creation of this variable could have led to an over- or underestimation of the exact number of food forests due to the availability of online information. For example, information on the location of the food forest or the year of first planting was not always accessible. Moreover, some food forests may not have emerged in the search results because they are socially inactive, i.e. they do not have websites or social media. Besides, searching per municipality may have excluded some food forests that could emerge when searching for specific towns or villages within those municipalities. However, by using existing databases and by doing web-based research on all Dutch municipalities, this underestimation should be low. On the other hand, some overestimation could have occurred through including food forests that do not conform to the official food forest definition, defined by the Green Deal (Green Deal, n.d.). This definition requires a size of a minimum of 0.5 ha for a food forest to be functional, though most food forests do not provide their size online. Food forests that were clearly very small (e.g. a food forest on a school playground) were excluded from the analysis. However, all other self-identified food forests were included in the analysis, as this study aimed to examine all Dutch food forests. This was especially relevant for food forests in larger cities, as these tend to have less space available for agriculture. Moreover, Roodhof (2024) discovered that 16.7% of food forests in here research were smaller than 0.5 ha. Thus, excluding these smaller food forests could have led to an incomplete understanding of the diversity and distribution of food forests in the Netherlands.

In addition to this, the data used does not distinguish between different types of food forests. Some food forests have clear involvement of governments or other institutions (e.g. NGOs or universities) while others do not, which means they may not all be considered equally 'bottom-up'. Consequently, the effect of social capital, environmental awareness and institutional support may differ depending on the type of food forests and the type of involvement. However, including these differences was not within the scope of this research.

Another limitation is the use of social capital data from 2010 as a proxy for the following years. This could have influenced the outcome of this study, as the social networks may have changed over time. However, the social media data used is unique in capturing the social networks of most of the Dutch population (10.4 million out of 16.6). This makes it a very accurate measure in reflecting network structures, especially compared to civic participation or ego-network ties frequently used to measure social capital (e.g. Hauser et al., 2007; Sabatini, 2008), since these only account for a small fraction of all relationships (Westlund & Adam, 2010). Additionally, the longitudinal design of this study starts at the period of extraction (2010), providing a relevant baseline for observing changes and trends in food forest emergence over time. The initial measurement of social capital accurately reflects the social network landscape at the start of the study, which allows for a reliable analysis of its impact on food forest emergence over the subsequent years. Moreover, food forests have been found to enhance community building and social cohesion which could, in turn, increase stocks of social capital (Riolo, 2019; Firth et al., 2011; Hale et al., 2011). Therefore, using data from 2010, before food forest emergence started to significantly increase, prevents the issue of reverse causality and ensures solely the impact of social capital on food forest emergence is measured. However, in future research it could be relevant to test the robustness of this data by including other measures for social capital in the analysis or by using other types of social media network data that is available over time.

As previously argued, using citizen science observation data as a proxy for environmental awareness gives a good behavior-based insight on its relationship with food forest emergence. However, this measure fails to capture how 'green' the municipality actually is. Initially, this research aimed to include vegetation data as an additional measure for environmental awareness in order to test whether more food forests emerge in more green areas, as people who frequently encounter greenery could be more concerned with conservation than those who do not. However, due to the lack of availability of vegetation data on the municipality level and due to time constraints, this variable was not included in the analysis. Nonetheless, as this research aimed to test the relationship between citizen's environmental awareness and the emergence of food forests rather than its relationship with the greenness of an area, the observation data can be considered a more relevant variable for this study. Moreover, the greenness of an area was partially captured in the control variable land use, as it measured the % of built area of total land area and it was discovered that in municipalities with more built area, i.e. less green area, less food forests emerge. This does provide some indication that a greener municipality could foster more food forest emergence. Thus, it would be interesting to test this relationship more thoroughly in future research.

A final limitation is that the negative binomial regression model does not capture the geographic factors that could potentially influence food forest emergence. Spatial models like Spatial Autoregressive Models or Spatial Lag Models, capture spatial dependencies in the dependent variable and residuals. This research did not use such models as it was not within its scope. However, the main focus of this study was to assess the impacts of social capital, environmental awareness and institutional support on food forest emergence. A negative binomial model directly examines these relationships, providing clear insights into these key factors, while also managing overdispersion found in the dependent variable. Moreover, including province dummies as a robustness check helped to account for regional differences. Although this does not fully capture all spatial dependencies, it does offer a practical and valid method within the scope of this research. Future research could enhance the analysis of this study by using spatial models in order to better understand geographic factors influencing food forest emergence.

Besides the aforementioned suggestions, future research could conduct a comparative analysis between different countries in order to help identify whether the factors influencing food forest emergence in the Netherlands are consistent across other contexts. This could highlight the role of different national policies, cultural attitudes, and environmental conditions in shaping food forest initiatives. Moreover, research on how demographic variables, such as age, gender or education level within municipalities affect food forest emergence could help identify specific demographic groups that are more likely to initiate or support food forest initiatives. Finally, a more comprehensive spatial analysis could provide deeper insights into the patterns, drivers, and impacts of food forest emergence.

As this is the first study measuring food forest emergence on a country level, policymakers could use the results when aiming to increase the number of food forest initiatives. In the Netherlands this is especially relevant, not only because of the persistent issues with nitrogen emissions due to conventional agricultural practices, but also in order to reach the goal of obtaining 1,000 ha of food forest cover by 2030. Supporting the development of social capital through investing in community building initiatives and developing educational programs to increase environmental awareness could help achieve this objective. This may also be relevant in other countries that aim to increase food forest emergence.

Moreover, these results are also applicable for the umbrella organizations currently aiming to scale food forest initiatives in the Netherlands. As previously mentioned, food forests are embedded in local interests and settings and thus, generally not concerned with upscaling. Therefore, umbrella organizations are crucial in the scaling process as they facilitate the sharing of capabilities, information and resources while at the same time guarding the community's boundaries and goals (Bauwens et al., 2022). The results found in this research will help umbrella organizations locate both current initiatives as well as potential places for new initiatives, while also showcasing that improving social capital and environmental awareness may help increase food forest emergence. This could help scale up food forests successfully.

6. Conclusion

The emergence of food forests in the Netherlands is an important development towards more sustainable agricultural practices and can contribute to decreasing the negative impacts caused by conventional farming methods. Different factors can be considered important in determining where food forests emerge, namely social capital, environmental awareness and institutional support. Therefore, this research aimed to investigate whether these factors significantly contribute to food forest emergence by conducting a quantitative, country-level analysis.

The results showed that network density and network fragmentation of subcommunities have a positive effect on the emergence of food forests in the Netherlands. Therefore, bonding social capital appeared to be relevant for the development of food forests. In addition, network distance has a positive impact on food forest emergence up until a certain point, after which it has a negative impact. This indicates that bridging social capital is, in fact, important for food forests to emerge, however, not when social connections reach too far. Moreover, environmental awareness was found to positively impact food forest emergence. Institutional support, on the other hand, is not significantly associated with the emergence of food forests. Thus, social capital, both bonding and bridging, and environmental awareness contribute to the emergence of food forest initiatives in Dutch municipalities.

National and local governments can use the drivers explored in this research for implementing appropriate policy to contribute to the development of food forests. More specifically, implementing policies aimed at building social capital and increasing environmental awareness, as these are considered more important for food forest emergence compared to institutional support. Besides, Dutch umbrella organizations may use the results of this study to improve connection between food forests initiatives, facilitating the sharing of knowledge, information and resources, which can help achieve the scaling of food forests these organizations are striving for. This would contribute to decreasing the negative impacts related to intensive agriculture and will help the Dutch government to achieve their goal of having 1,000 hectares of food forest cover by 2030.

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Appendix A: Food Forests discovered with web-based research

	Food Forest name	Url
1.	Voedselbos Klein Renneborg	https://voedselboskleinrenneborg.nl/
2.	Voedselbos Kudelstaart de Smikkeltuin	https://voedselboskudelstaart.nl/
3.	Nieuwe Bodem	https://www.nieuwebodem.nl/voedselbos/
4.	Voedselbos Alblasserdam	https://www.facebook.com/voedselbos.alblasserdam/
5.	Voedselbos Valckesteyn	https://voedselbosvalckesteyn.nl/
6.	Doepark de Hagen	https://www.natuurhusalmelo.nl/doepark-de-hagen/doepark-nu-en-straks/
7.	Voedselbos Bouwmeesterbuurt	https://bouwmeesterbuurt.nl/nws_1705_klusdag.php
8.	Voedselbos Groene Hart	https://voedselbosgroenehart.nl/
9.	Robijnsbos	https://keke46.nl/
10.	Spoortuin de Enk	https://www.prorail.nl/nieuws/eerste-bomen-voor-voedselbos-in-nieuwe-spoortuin-de-enk
11.	Voedselbos Amsterdamse Bos	https://www.amsterdamsebos.nl/voedselbos/
12.	Voedselbos het Landje	https://www.facebook.com/people/Voedselbos-het-Landje/100087622891007/
13.	Stadstuin Kweekland	https://stadstuinkweekland.nl/voedselbos/
14.	Voedselbos Berk en Boom	https://www.peelbelangonline.nl/nieuws/algemeen/41206/grasland-wordt-voedselbossysteem
15.	Frits en Fruitig	https://www.bndestem.nl/baarle-nassau/ochtendje-schoffelen-bij-dagbesteding-frits-en-fruitig-heel-gezond-br~a13e79a2/
16.	Voedselbos de Kleine Duiker	https://dekleineduiker.nl/voedselbos/
17.	‘t Lage Veld	http://www.paardenvakantielunteren.nl/
18.	Voedselpark Beek	https://www.facebook.com/voedselparkbeek/?locale=nl_NL
19.	Voedselbos Beesel	https://www.voedselbosbeesel.nl/
20.	Ecodorp Bergen	https://www.ecodorpbergen.nl/over-ons/
21.	Voedselbos Hoogerheide	https://www.bndestem.nl/bergen-op-zoom/bos-waar-mens-en-dier-kunnen-eten-aanplanten-voedselbos-hoogerheide-begonnen~a91c0dca/
22.	Voedselbos Nistelrode	https://www.mooibernheze.nl/nieuws/algemeen/35532/voedsel-telen-in-ecologisch-evenwicht
23.	Spinsteen	https://www.ijmondnieuws.nl/2023/11/15/buren-planten-met-elkaar-voedselbos-aan-de-spinsteen-op-18-november/
24.	Wildernest	https://www.wildernest.nl/voedselbos/
25.	Insectenvoedselbos Steegland	https://www.imkersgooieneemland.nl/index.php/drachtplanten/voedselbos

26.	Voedselbos de Groene Ladder (Ecodorp Boekel)	https://www.ecodorpboekel.nl/steun-voedselbos-in-ecodorp-boekel/
27.	Voedselbos Wageler	https://www.tubantia.nl/enschede/voedselbos-op-landgoed-het-wageler-daar-kan-straks-iedereen-de-vruchten-van-plukken~a739b707/?referrer=https%3A%2F%2Fwww.google.com%2F#:~:text=%C2%A9%20Cees%20Elzenga-,Voedselbos%20op%20landgoed%20Het%20Wageler%3A%20daar%20kan%20straks%20iedereen%20de,grond%20van%20zorgboerderij%20De%20Viermarken.
28.	De Kleine Aarde	https://dekleineaarde.nl/nieuws/voedselbos-steeds-gevarieerder-en-eetbaarder
29.	Voor Polderevents Brabant	https://www.polderevents.com/wij-hebben-een-voedselbos/
30.	(geen naam)	https://pdc.buren.nl/wp-content/uploads/2017/09/Brochure-Landschapstypen.pdf
31.	Hof van Kijk-uit	https://hofvankijkuit.nl/aanplant-meer-bomen-in-voedselbos/
32.	Voedselbos Drenthe	https://voedselbosdrenthe.nl/contact/
33.	De Voedselhof	https://www.facebook.com/devoedselhof/
34	Yogafarm	http://www.yogafarm.nl/
35.	Zenbos	https://www.zen.nl/delft/zenbos/#:~:text=Het%20is%20een%20wilgenbos%20geworden,Samen%20de%20klus%20geklaard!
36.	Beweegpark Dinkelloo	https://www.tubantia.nl/dinkelland/bomen-planten-voor-het-nieuwe-beweegpark-in-denekamp~a7077a2d/
37.	Houtwalhalla	http://www.houtwalhalla.nl/Over-ons/#:~:text=Op%20dit%20stuk%20hebben%20we,zo'n%20geweldige%20plek%20vertoeft.
38.	Houts Voedselbos	https://www.facebook.com/Houtsvoedselbos/
39.	Voedselbos de Buitensingel	https://www.duiven-post.nl/nieuws/algemeen/161580/voedselbos-de-buitensingel-geopend
40.	Voedselbos Kievietsnest	https://voedseluithetbos.nl/projecten/voedselbos-kievietsnest/#:~:text=Beschrijving,en%20andere%20bomen%20en%20struiken.
41.	Maanbos	https://www.oozo.nl/bedrijven/echt-susteren/peij/schilberg/2899485/voedselbos-maanbos
42.	Zonnepark Maasbrachterweg	https://www.limburger.nl/cnt/dmf20231101_95793707
43.	Voedselbos Enka	https://www.ededoet.nl/initiatief/3724
44.	Voedselbos Ter Wupping	https://www.visitgroningen.nl/nl/locaties/444804297/voedselbos-ter-wupping
45.	Voedselbos Henri Dunantpark	https://www.ed.nl/eindhoven/samen-wroeten-in-de-aarde-in-voedselbos-henri-dunantpark~ab4b833e/?referrer=https%3A%2F%2Fwww.google.com%2F
46.	Kasteel Voedselbos	https://www.ivn.nl/afdeling/geldrop/werkgroepen/kasteel-voedselbos/

47.	Voedselbos Struinpad	https://www.stichtingveen-depeel.nl/educatie-en-recreatie/voedselbos
48.	Voedselbos Gilze	https://barbararoozen.nl/2024/03/schoolmoestuin-riel-2/#:~:text=In%20Gilze%20ontstaat%20een%20voedselbos,dit%20voedselbos%20uit%20te%20werken.
49.	Voedselbos BI-JOVIRA	https://vooruitboeren.com/over-bi-jovira/omschakelen-2018-2022
50.	Voedselbostuin Plan B	https://keuzevrijbijmij.nl/aanbieders/voedselbostuin-plan-b
51.	Voedselbos Klein Renneborg	https://voedselboskleinrenneborg.nl/
52.	Levensritme	https://www.dorpsbelangenschipborg.nl/news-item/voedselbos-in-schipborg
53.	Voedselbos de Blaak	https://crowdfundingvoornatuur.nl/nl/initiatives/activities/details/funding/265/realisatie-voedselbos-de-blaak
54.	Belevingstuin Sonderenstraat	https://www.facebook.com/vandenatuurtafelhaaksbergen/
55.	Kruidenhof te Mallum	https://kruidenhof-te-mallum.nl/wat-is-er-te-beleven/
56.	Park21	https://www.parklanden.nl/voedselbos/
57.	Halderberge Groen	https://www.facebook.com/profile/100076204281601/search/?q=voedselbos
58.	Harderwijks Voedselbos	https://www.destentor.nl/harderwijk/vaarwel-letterzetter-welkom-eekhoorntje-kinderen-planten-bomen-in-harderwijks-voedselbos~aa2d7908/?referrer=https%3A%2F%2Fwww.google.com%2F
60.	Het Lekkere Bos	https://www.oozo.nl/bedrijven/zederik/tienhoven/tienhoven-polder/2879479/het-lekkere-bos
61.	Dorpstuin Hurdegaryp	https://www.dorpstuinhurdegaryp.nl/
62.	Voedselbos Schellerdriehoek	https://zwolle.nieuws.nl/nieuws/47590/montessorischool-en-voedselbos-schellerdriehoek-meer-natuurbeleving-voor-schoolkinderen/#:~:text=Een%20voedselbos%20zijn%20struiken%20en,zodra%20de%20planten%20vrucht%20dragen
63.	Heerdeberg	https://www.heerdeberg.nl/blog/voedselbosrand-landgoed-heerdeberg/
64.	Caroline’s Tuinen	https://www.carolinestuinen.nl/over-caroline/
65.	Voedselbos Leende	https://www.ad.nl/heeze-leende/uit-dit-bos-in-leende-komt-straks-voedsel-dat-rechtstreeks-zijn-weg-kan-vinden-naar-hello-fresh-en-picnic~a7231d04/?referrer=https%3A%2F%2Fwww.google.com%2F
66.	Beleefbos Noorderhaven	https://www.mnh.nl/nieuws/beleefbos-noorderhaven-geopend/
67.	Johanna’s Bos	https://www.johannasbos.nl/mini-camping-johannas-bos/#verblijf
68.	Voedselbos de Oude Beek	https://deoudebeek.nl/

69.	Buitenplaats de Hoorneboeg	https://www.dehoorneboeg.nl/wp-content/uploads/2020/02/Voedselbos-op-De-Hoorneboeg.pdf
70.	Nabij het Oudeland	https://www.oozo.nl/bedrijven/strijen/strijen-en-buitengebied/noord/3097392/stichting-het-voedselbos-nabij-het-oudeland
71.	Hof van Espelo	https://www.landschapoverijssel.nl/voedselbos-hofespelo
72.	Voedselbos Hoorn	https://crowdfundingvoornatuur.nl/nl/initiatives/details/198/hoorn-zien-en-proeven/story
73.	Voedselbos de Haling	https://www.ivn.nl/afdeling/west-friesland/ivn-voedselbos-de-haling/
74.	Voedselbos de Rozahof	https://omroephorstaandemaas.nl/nieuws/artikel/voedselbos-de-rozahof-grubbenvorst-doet-mee-aan-crowdfunding-treevember
75.	Voedselbos Makeblijde	https://www.voedselanders.nl/placemarks/voedselbos-makeblijde/
76.	Voedselbron de Graauw	https://www.voedselbrongraauw.nl/
77.	Kiemkracht 64	https://www.kiemkracht64.com/map/voedselbos/
78.	Natuurspeelplaats en Voedselbos Kampen	https://www.facebook.com/voedselbosnatuurspeelplaatskampen/?locale=nl_NL
79.	Natuurtuin de Bimd	https://www.ivn.nl/afdeling/laarbeek/natuur-werkgroep-de-bimd/
80.	Janmiekes Hoeve	https://treesforall.nl/projecten/voedselbos-janmiekeshoeve/
81.	Voedselbos de Zoete Geest	https://www.facebook.com/p/Voedselbos-De-Zoete-Geest-100067848600453/
82.	Voedselbos Sibbe	https://kernoverlegsibbe-ijzeren.nl/category/werkgroepen/voedselbos-natuurspeeltuin/
83.	Voedselbos de Groene Boerderij	https://www.degroeneboerderij.nl/over-ons/voedselbos/
84.	Voedselbos de Schiebroekse Polder	https://www.natuurmonumenten.nl/natuurgebieden/zuidpolder/nieuws/eerste-honderden-bomen-geplant-voor-voedselbos-schiebroekse-polder
85.	De Warf	https://www.dewarf.nl/eetbare-tuin/
86.	Hof van Matilo	https://hofvanmatilo.nl/Over-het-voedselbos
87.	Nehalennia Tuin	https://voorburgsdagblad.nl/Lokaal/aanleg-eerste-voedselbos-in-voorburg-gestart
88.	Voedselbos de Cidergaard	https://uwecider.nl/groot-merm/
89.	Voedselbos de Weij	https://www.maassluis.nu/milieunatuur/maassluis-krijgt-eigen-voedselbos/
90.	Voedselbos Veghels Buiten	https://www.omroepmeierij.nl/omroepmeierij/voedselbos-verbindt-oude-en-nieuwe-wijk-in-veghel
91.	Voedselbos Meppel	https://lbdrenthe.nl/permacultuurtuin-en-voedselbos-meppel#:~:text=Langs%20het%20fietspad%20een%20brede,Dat%20is%20ons%20'voedselbos.
92.	Voedselbos Spenckweide	https://www.klarenbeekveersepoort.nl/activiteiten/%EF%BF%BCvoedselbos-sprenckweide-aanplanten/

93.	CitySeeds Middelburg	https://cityseeds-middelburg.nl/dit-doen-wij/wil-je-in-het-voedselbos-werken/
94.	Voedselbos van Jaarsveld	https://www.oogst.shop/boeren/voedselbos-van-jaarsveld
95.	Voedselbos Leveroy	https://www.nederweert.nl/voedselbos-leveroy
96.	Voedselbos ‘t Eind	https://www.nederweert24.nl/2022/03/24/arjan-en-gipke-starten-met-voedselbos-t-eind/#:~:text=Arjan%20en%20Gipke%20van%20der,de%20natuur%20mee%20kunt%20werken.
97.	Voedselbos de Middengaarde	https://www.pen.nl/artikel/aanleg-voedselbos-de-middengaarde-een-feit
98.	Voedselbos School Holk	https://nijkerk.nieuws.nl/nieuws/176583/school-holk-heeft-een-voedselbos/
99.	Weverkerkershof	https://weverkeshof.nl/site/voedselbos/
100.	Wessingboerbos	https://westerwoldsgoud.nl/het-wessingboerbos/
101.	Groene Doen Voedselbos	https://eetbaarolstwijhe.nl/elementor-538/#:~:text=In%20groene%20doen&text=De%20bodem%20van%20zware%20komklei,dat%20de%20bodem%20goed%20doorwortelt.
102.	Voedselbos Beesterzwaag	https://www.actiefonline.nl/nieuws/algemeen/47446/eerste-zes-perenbomen-geplant-in-voedselbos-beetsterzwaag
103.	Voedselbos Het Laar	https://www.geldersepost.nl/nieuws/natuur/428530/aanleg-groot-natuurgebied-en-klein-zonnepark-in-vethuizen-gaat-
104.	Voedselbos de Amstelaar	https://www.amstelaar.nl/
105.	Voedselbos Papendrecht	https://www.facebook.com/koningsspil.nl/
106.	De Tuinen van Hier	https://detuinenvanhier.nl/voedselbos/
107.	Vogelaar Vredehof	https://www.vogelaar.com/voedselbos/
108.	Greun Hooltn	https://www.greunhooltn.nl/projecten
109.	Voedselbos Kralingen	https://voedselboskralingen.wordpress.com/
110.	‘t Beleef en Bewonder Bos	https://www.facebook.com/p/t-Beleef-Bewonder-Bos-100067758212813/?paipv=0&eav=Afb1Edh_Z00SjNvldFbYuDrDjBn9XfiBjsII-agaLYSLXzPIHArg1VOjlhVl32rKtO4&_rdr
111.	Voedselbos Schouwen	https://www.voedselbosschouwen.nl/
112.	Voedselbos Sonse Weelde	https://www.facebook.com/people/Voedselbos-Sonse-Weelde/100076324590521/?locale=en_GB&paipv=0&eav=AfYX1k0ApkPQbOJkcvcbLKlFTVdrClH7DVW8b2cQe2jxp8iQzKtDSlEX6Wx-cOZpBr8&_rdr
113.	Voedselbos Musselkanaal	https://www.facebook.com/p/Voedselbos-Musselkanaal-100066536065926/?locale=uk_UA
114.	Linges Landje	https://lingeslandje.nl/
115.	Stadsbos013	https://stadsbos013.nl/initiatieven/voedselbos/
116.	Voedselbos Sana Terrae Kuilpad Udenhout	https://www.facebook.com/p/Voedselbos-Sana-Terrae-Kuilpad-Udenhout-100076398690408/?paipv=0&eav=AfZw03jQBj8t86IqTrN

		ECckWY8fSiZr7bNtthwycewJYPHqIdXWS041jEwzXyzkqBJg&_rdr
117.	Buurderij van Dam	https://buurderijvandam.nl/dagbesteding-voor-volwassenen/
118.	De Wij	https://dewij.nl/
119.	Voedselbos Lemiers	https://www.facebook.com/100069111344115/posts/288397673473942/?locale=ms_MY&paipv=0&eav=AfZjijWkWCf2H2PMDeeEZ4zJRp3kf-NAVj-WBUXWcP1YjkB2aFuSqhyNBMBQvgkRsvQ&_rdr
120.	Voedselbos de Groene Borg	https://www.facebook.com/profile.php?id=100064403753875&paipv=0&eav=AfY_Gv1fdwbmI7vx2VfV2oMWlfOnh1JG2uhDHs-aH48sA62XQ3Ye6oDSvuxcwVydcIQ
121.	De Zonnehoeve	https://www.campingzonnehoeve.nl/voedselbos/#:~:text=In%20ons%20voedselbos%20combineren%20we,grote%20variatie%20aan%20beplanting%20mogelijk.
122.	Bosk en Iepen Fjild	https://frieschdagblad.nl/duurzaamheid/Menaam-wordt-groen-door-Bosk-en-Iepen-Fjild-26804516.html
123.	(no name)	https://www.ad.nl/gouda/wiro-heeft-voedselbos-van-6000-vierkante-meter-dit-soort-notenbomen-bestond-al-in-tijd-van-de-dinos~a31c8308/
124.	Maargies Hoeve	https://www.maargieshoeve.nl/over-ons/nieuws/voedselbos-krijgt-vorm/
125.	Voedselbos Hoge Hexel	https://www.tubantia.nl/wierden/in-hoge-hexel-vind-je-een-bos-vol-eten-we-kweken-wel-150-verschillende-soorten-groente-kruiden-en-fruit~a7430cab/
126.	Voedselbos de Hagert	https://www.dehagert.nl/op-weg-naar-duurzaam-terreinbeheer-een-voedselbos-op-de-hagert/
127.	Aarde Werk de Stegge	https://aarde-werkdestegge.nl/voedselbos/show
128.	Sama Sangha	https://www.samasangha.nl/locatie/
129.	Voedselbos ‘t Wemmenholt	https://voedselbos.holtmaat.eu/over-ons/
130.	Rosarium Vriendentuin	http://dezuidkanter.nl/nieuws/2624-er-staat-een-bos-in-krommenie
131.	‘t Geertje	https://hetgeertje.nl/informatie/natuur/natuurbeheer/#:~:text=Op%20de%20lege%20plekken%20hebben,een%20bakje%20nootjes%20of%20bessen.
132.	Walburgisbosje	https://www.destentor.nl/zutphen/initiatiefnemers-walburgisbos-zoeken-mensen-met-wie-ze-samen-voedselbos-in-zutphens-emerpark-kunnen-verwezenlijken~a23d822b/
133.	Wonder Woods	https://wonder-woods.nl/
134.	Klein Groenrijk	https://kleingroenrijk.nl/voedselbos/
135.	De Kleine Ham	https://eetbaarede.nl/voedselbosje-de-kleine-ham/
136.	Urbania Hoeve Demo Tuin Noord	http://www.urbaniahoeve.nl/
137.	Natuurlijk Berghof	https://www.natuurlijkberghof.nl/
138.	Abdijtuin Egmond	https://www.abdijvanegmond.nl/abdijtuin/
139.	Loebroek Voedselbos	https://www.nmflimburg.nl/project/platform-voedselbossen-limburg/

140.	Haverland	https://stichtinghaverland.nl/voedselbos-haverland/
141.	Natuurgaard Korte Vonck	https://www.deltalimburg.nl/article/735/Aanplant+voedselbos+Natuurgaard+Korte+Vonck+Heythuysen
142.	Flinke Ven	https://voedselbosroerdalen.nl/gebiedsontwikkeling-flinke-ven/
143.	Tuinderij de Veldhof	https://www.tuinderijdeveldhof.nl/agenda/
144.	Voedselbos Tussen de Bomen	https://www.puttensezaken.nl/nieuws/meedoen-in-putten-bij-voedselbos-tussen-de-bomen
145.	Philavoedselbos	https://www.veluwefonds.nl/philavoedselbos/
146.	Voedselbos Eetlust	https://www.voedselboskabouters.nl/project/voedselboseetlust