HELLENIC REPUBLIC
National and Kapodistrian University of Athens

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Department of History and Philosophy of Science
&
Department of Informatics and Telecommunications

Interdepartmental Graduate Program:
Science, Technology, Society—Science and Technology Studies

MSc Thesis

Alternative Agro-food Network and Greenhouse infrastructures: towards a community-based system for urban greenhouse growers, with primary case studies from the Netherlands

Meilin Lyu
Registration Number: 15612020041

Thesis Advisory Committee:
Stathis Arapostathis, Associate Professor (Advisor)
Giorgos Gotsis, Professor (committee member)
Yannis Fotopoulos, Postdoctoral Researcher (committee member)

Athens 2022

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Supervisor
Prof. Stathis Arapostathis

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Abstract

Urbanisation, growing population pressure and extreme weather conditions could all contribute to food insecurity. In the context of greenhouse farming, vegetables are harvested in a controlled environment, resulting in high-quality production with minimum resources. Such green infrastructure has also become promising in urban areas and non-arable lands. In the thesis, we would focus primarily on vegetable greenhouse horticultural sector. The thesis chose to focus on the Netherlands since it has concentrated regions with specialised greenhouse knowledge, which means high spillover effects with high knowledge cumulativeness, higher degrees of opportunities and a wide variety of approaches (Malerba, 2002, p.260). The thesis argues that there is an existing gap between the high-tech precision, large-scale greenhouse farming industry and community-based, small-scale social initiatives. Large greenhouse industry can be more efficient with enabling technology, infrastructure and capital, however, it can also be monopolistic competing against the interests of traditional farming and further alienating people from food production. Hence, the thesis proposes community-based greenhouse as an alternative agro-food model to be integrated into the current food production regime, therefore contributing potentially to key societal challenges, such as food self-sufficiency, community democracy, knowledge transfer, and employment. The main part of our research involves conducting primary research studies, a mixed-method would be employed with the use of surveys, email responses, interviews, observational studies and site visits.

Keywords: Community-based, Greenhouse, Urban agriculture, Social initiatives, The Netherlands

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Background

The Netherlands has a leading position in the high-tech industry of greenhouse construction, whose horticultural industry is also an important economic sector for international export. However, throughout the years, lifestyle routines and cognitive perceptions about food production have evolved, and consumers desire local, nearby and organic vegetables. The innately emotional affiliation of humans with nature has also prompted urban agriculture in metropolitan settings. It is also widely accepted that restorative greening activities are mentally and physically healthy for socially and economically disadvantaged social groups, especially stay-at-home elderly, patients in hospitals and children at schools (Artmann & Sartison, 2018). As result, greenhouse installation is the outcome of interactions between nature, technology and society. Industrialised greenhouse agriculture believes in the economies of scale in food production by following established norms (Seyfang & Smith, 2007), it could harm nonetheless natural capital and social justice (Weissman, 2015). Consumers acting alone cannot alter the situations for unmet social needs and food choices, but grassroots initiatives can. Small-scale community projects may be insignificant on an individual basis, they could be seen as a major gateway to engaging in the politics of food with joint efforts. From taking everyday decisions about food to resident participation, community-based projects act as a contrast to re-think the mainstream practice, their ideological commitments have formed the basis to counter the hegemony of mass food production, reflecting on the quality of life and self-sufficiency instead of capitalist economic growth and unlimited consumption (Seyfang & Smith, 2007). At the same time, community-based initiatives need co-efforts of institutions, professional associations, and government policies to acknowledge their ideological motivations, expand in numbers and impact the wider society in aggregate form.

Conceptual Framework

Community-based initiatives (CBIs) have political meanings, they are a form of civic engagement where public service delivery is entrusted to community self-strength for societal problems. CBIs are increasingly emerging in Western corporatist countries, especially in the Netherlands, as result, a variety of institutional forms could be associated with CBIs, such as social enterprises, self-organisation, grassroots initiatives, volunteer associations, etc. Another factor that has prompted the rise of CBIs is the decline of traditional civil society, where economic globalisation has driven "glocalised" social liquefaction and gradually degenerating state-bound concept of civil society (Brandsen et al., 2017, pp. 687–688). CBIs are usually "small, low-profile, voluntary, citizen-led and community-driven groups" (Chanan, 2004, referenced by Seyfang & Smith, 2007, p. 591), with pluralistic grants and finances generated from limited commercial activity, voluntary donations, and exchanges (Igalla et al., 2019; Brandsen et al., 2017; Seyfang & Smith, 2007). CBIs can also be characterised as a form of durable cooperation with a hands-on approach and contextualised knowledge, knowing the best fit for their local communities and local people (Seyfang & Smith, 2007). According to the *welfare triangle* of Evers and Laville (2004), civil society is positioned in the centre between the spheres of the State (public agencies), market (private firms) and community (Brandsen et al., 2017). Civil society organisations are considered to be bordering between the civil society and communities, developed from the bottom-up and typically tackling problems such as urban agriculture, climate and clean energy before these issues are being formally regulated by the public sector. CBIs aim for autonomy and ownership, developing their business models to achieve financial stability but not focusing on profit-making (Igalla et al., 2019, pp. 1182–1183). They also desire to connect with formal institutions but government tends to give more room to the citizens and only act as a facilitating role since CBIs are alternatives to governmental public service delivery (p. 1177). As such, CBIs do not seek to forcefully connect with the mainstream socio-technical regime and therefore can be exclusive to some social actors (Seyfang & Smith, 2007).

The topic of this thesis explores *"community-based greenhouse"* which could be defined as a relatively big piece of land enclosed by glass panels, usually inherited from the previous commercial greenhouse, made available by the local authority and managed by a group of local people and volunteers. It is open to the public and maintains some level of commercial activities directly to end consumers, regional retail markets or the hospitality industry. Due to the expansion of urban spaces, conventional rural areas could also be extended and transformed to become *"peri-urban areas"*, the community-based greenhouse is a typical

example which it is normally situated on the verge, under the direct influence of the urban city (Van Veenhuizen & Danso, 2007, p. 13). Urban agriculture can also be related to a wide variety of terminology in literature, from an actor's perspective, it can be associated with home/private gardening, indoor farming, community allotments/greenhouses, etc. From the land usage perspective, it involves using areas of home spaces, vacant lands, residential areas and flat roofs, etc (Artmann & Sartison, 2018). Furthermore, urban agriculture could be equivalent to the term "localisation of food", which implies food being as close to the point of origin as possible (Seyfang, 2006, p. 386).

There are generally two types of urban agriculture: (1) in *land-sparing* urban agriculture which is relatively a new development, it is independent of weather, land security or climate change, with heightening levels of production, local processing distribution, and/or recycling technology (Van der Schans, 2014, p. 8). (2) In *land-sharing* urban agriculture, crops are grown in small and scattered spaces with more agro-ecological methods of production, typically involved with fewer pesticides and synthetic fertilisers, consequently increasing biodiversity and recreational values. However, being close to the city also has the potential complication that the soil might be contaminated (Nicholles et al., 2020). Urban agriculture could range from small-scale, non-for-profit organisations to larger-scale, commercial enterprises. Generally speaking, it should be considered an integrated part of the urban economy, utilising "urban resources such as land, labour, urban organic wastes, water and produces for urban citizens" (Van Veenhuizen & Danso, 2007, p. 6). Although it could potentially be in a competitive relationship with other urban spaces for economic or political functions, urban agriculture has the advantage of being in contact with nature, location-flexible, year-round production, and proximity to technical services and knowledge institutions. As such, it is inherently dynamic with multi-stakeholder interactions. In addition, urban growers also come from a diverse range of social backgrounds and motivations, where farming them is a secondary livelihood for non-professionals or it is for people with relatively weak traditional knowledge (Van Veenhuizen & Danso, 2007).

The following table identifies some possible forms of urban agriculture concerning their characteristics, level of control and relation type.

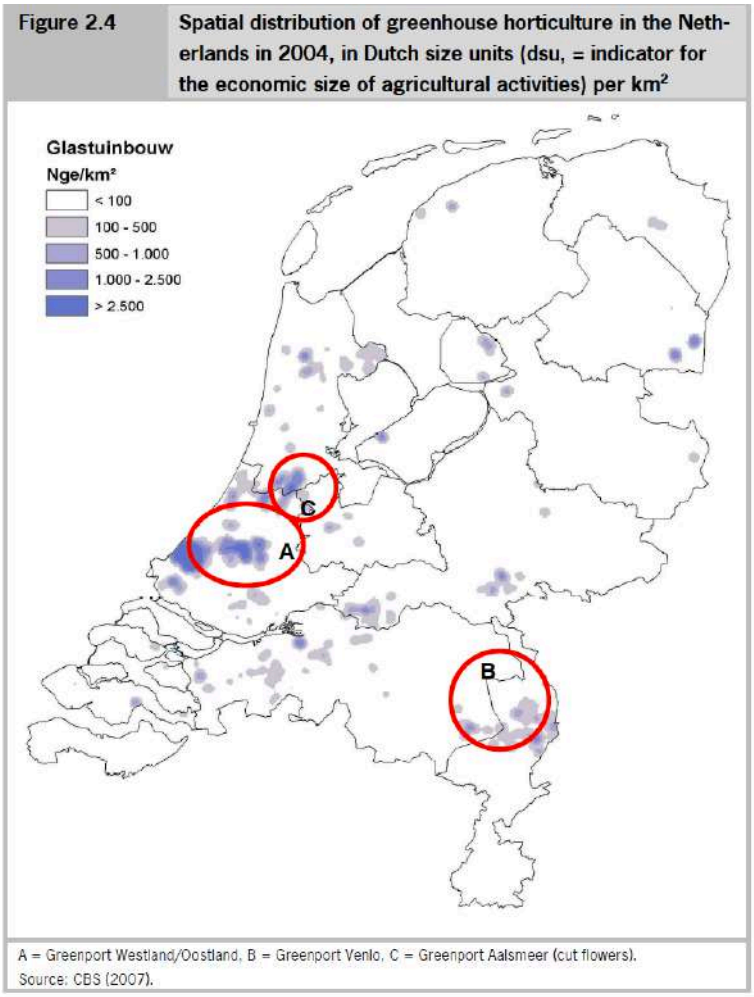
Table 1: Forms of urban agriculture (adapted from Nicholls et al., 2020; Van der Meulen and Verzandvoort, 2014; Van der Schans, 2014; Van de Vlasakker & Even, 2020; Cui & Smit, 1995; AlShrouf, 2017; Raji et al., 2015)

Forms of agriculture	Level of Control	Characteristics	Relation Type
Home gardens	open	Self cultivation in privately-owned backyard or window box	Consumer as (co-)producer
Community allotments	open	Rented small plot of land for hobby growers	Consumer as (co-)producer
Community-based greenhouses/gardens	controlled	A relatively big piece of land enclosed by glass panels, usually inherited from previous commercial greenhouses on the city fringe and made available by the local authority and managed by groups of local people and volunteers, open to public and maintain some levels of commercial activities directly to end consumers or to regional retail markets or hospitality industry	Consumer as (co-)producer/business-to-consumer/business-to-business
Community Supported Agriculture (CSA); Ethical Purchasing Groups (EPG)	mixed	Network of individual consumers supporting one or more local farms	Consumer-producer-partnership
Rooftop gardening	mixed	Utilises the flat or sloped roof in a building, requires different supportive layers to grow grass, herbs, shrubs and trees. It requires irrigation and permanent attention, it also has the potential to attenuate heavy surface runoffs and closed-loop recycling	Consumer as (co-)producer/business-to-consumer
Permaculture landscaping	open	Less about management and more about self-resistance of the ecosystem as whole. Food collection from edible shrubs, nuts, fruit trees or herbaceous plants that one does not maintain, acting as buffer zones in the neighbourhoods	Consumer as (co-)producer
Vertical farming	controlled	Environment-independent, with the use of LED lighting, usually grown on a commercial basis in stacked layers inside buildings	Consumer as (co-)producer/business-to-consumer/business-to-business
Aquaponics	controlled	A closed cycle without the need of cultivated land, it utilises fish excretions to enrich water with ammonia, which is then converted into nitrate by two types of bacteria. Nitrate—an essential nutrient for plants—is transferred by media beds or wicking beds to the plants (referenced from participant 15).	Consumer as (co-)producer/business-to-consumer/business-to-business
Hydroponics	controlled	From simple setup to complex models, it is space-saving with plants growing in nutrient or media solutions, without the need of soil and it is a highly efficient production method with higher nutrient and water efficiency	Consumer as (co-)producer/business-to-consumer/business-to-business
Indoor smart devices	controlled	Varied devices and designs, without the need of cultivated land, usually are for self-consumption and high efficiency in food production and continuity, it has the potential to improve indoor air quality and aesthetics of indoor space	Consumer as (co-)producer/business-to-consumer
Commercial	mixed	Solely for profits and provision of basic food sufficiency in urban setting	business-to-business

Image 1: Surplus or unwanted vegetables for compost (Kringsloop Community Garden, Dordrecht), photo taken by the author

Specifically, in the case of Holland, urban greenhouse farming is concentrated in Westland, Oostland and Venlo as "Greenports", these agglomerates are knowledge-intensive agribusinesses with strong global positions (Kasmire et al., 2013, p. 11), and their sizes could range from 1 to 25 hectares, usually are small family-owned companies and are connected to share information (Kasmire et al., 2013, p. 7; Pannekoek et al., 2005). In total, there are about 3,000 companies involved with vegetable production on approximately 4,000 hectares (Pannekoek et al., 2005, p. 42) in the Netherlands. The Greenports are close to port Rotterdam and neighbouring countries such as Belgium and Germany (ibid., p. 87) and the total production value of Dutch vegetable horticulture is approximately 1,3 billion euros, out of which, 90% of vegetable production are tomatoes, cucumbers and peppers (ibid., p. 24). As such, the Netherlands has the highest food export

Image 3: Spatial distribution of greenhouse horticulture in the Netherlands in 2004 (referenced from Breukers et al., 2008, p. 41)



value in the world, about 80% of food produced is exported (Breukers et al., 2008, pp.7–9).

The aim of this thesis explores "*Alternative Agro-food Networks (AAFNs)"*, which provide a different departure from mainstream economic values and beliefs about food production. In essence, AAFNs experiment with the social infrastructure of food supply and distribution, emphasising restructuring social formation. The theoretical basis of AAFNs is associated with a "new*"*, "humanistic*"* and "green*"* economy (Seyfang, 2006, p. 385), where the ecological economists have incorporated dependent qualitative factors such as air, water, soil, the ozone layer, biodiversity and healthy workforce, longevity and stability into conventional *quantitative economics perspective* (Hamstead & Quinn, 2005, pp. 149–150). Although responsible consumption behaviours are entirely voluntary, "non-territorial and non-contractual*"* (Seyfang, 2006, p. 388), they promote reflexive participation in social, environmental and political problems through everyday decision-making.

Several theoretical approaches would be drawn on aiming at producing in-depth analysis of community-based greenhouses as an alternative food network in the Netherlands, including Sectoral System of Innovation, Sustainability Transition Management, and Strategic Niche Management. Specifically, *the Sectoral System of Innovation (SIS)* (Malerba, 2002) is a useful tool to map out the descriptive analysis of the greenhouse sector and the current socio-technical landscape developments (ibid., p. 261) as the *first level* of analysis. Sectoral System of Innovation is defined as comprising "a knowledge base, technologies, inputs and an existing, emergent and potential demand" (ibid., p. 250). It is built on the belief that dynamics in a sector could change over time, emphasising cognitive dimensions and inter-dependent relationships of the actors. Also, knowledge is an important building block in a sectoral system, since firms have different degrees of accessibility relating to technological opportunities, suppliers or users opportunities (ibid., pp. 252–253). Further, the cumulative nature of knowledge could generate new technological developments which firms would rely on the intensity of university research to bridge the gap between science—industry. As such, SIS focuses on the "dynamic complementarities" among different types of agents which could affect the firm's overall competitiveness. Instead of merely assessing market competition and command, this conceptual framework explores more broadly the intertwining relationships of agents (universities, institutions, local authorities, etc) through their formal and informal interactions (ibid., p. 256). Additionally, SIS stresses the particular role of governmental institutions in shaping agents' behaviours, regulating the regime's standards and expectations, as well as supporting the diffusion of technologies. Nonetheless, such

communication is not necessarily one-way, behaviours of the sectoral level could also influence the institutional level (ibid., p. 257).

The *second level* of analysis would comprise an encompassing understanding of transitions with the theoretical framework of *Sustainability Transition Management (STM)*. STM is positioned at meso level unit of analysis in a particular national context. Such framework is significant to understanding the speed of diffusion and upscaling of innovation, focusing on four levels of policy-oriented analysis, namely institutional strategic vision development, tactical agenda to guide daily activities, operational and experimental transition projects, and finally, reflexive changes and adoption of the best-practices (Loorbach, 2010, referenced by Köhler et al., 2019). It is crucial to understand the dialectic relationship between change and stability in STM (ibid.) since incumbent regime actors can exert their power to resist transitions toward niche innovation to protect their interests. Moreover, concerning the scope of this thesis, there are several sub-fields of *sustainability transition* to be focused on in particular. Firstly, industries and business sustainability transition would discuss the social responsibility and sustainability concepts, as well as their roles with the newcomers (ibid., p. 12). Secondly, grassroots innovation, the role of social movements and local communities in food systems are another major sub-field concerning public support for alternative innovations and the selection of certain innovations in the regime. The question that remains for exploration in this thesis is how could grassroots innovation not only be predominantly "fit and conform" to the industrial system but also be involved in "deeper transitions" in terms of "stretch and transform" to avoid niche stasis (ibid., pp. 10-11). Thirdly, STM also considers the normative impacts of sustainability transition, such as ethical principles of justice and equity (ibid., p. 16). Such a transition framework, therefore, has a higher degree of reflexivity to emphasise social justice issues, which would otherwise go "below-the-radar" (ibid., p. 7).

The *third level* of analysis involves *Strategic Niche Management (SNM)* as a conceptual framework, where the emphasis would be on how niche innovation, with the development of alternatives and new entrants, might change the landscape development and consequently create windows of opportunity (Köhler et al., 2019). SNM is further built on two theories, first, the social construction of technology approach (SCOT), where the technological outcome is believed to be the result of social interactions among various actors, and ideological visions would be eventually stabilised through the articulation of expectations to guide other potential stakeholders involved in this social network (Verbong et al., 2008, p. 556). The second theory is

based on the perspective of evolutionary economics, which tends to focus on the protection of niche innovation from the mainstream market competition, where a group of stakeholders are willing to invest in its technological potential (Verbong et al., 2008). They would emphasise the implementation of pilot experimental projects, investing in the depth and breadth of the networking building, as well as "quality, specificity of robustness of expectations" (Köhler et al., 2019, p. 4).

Noticeably, all three levels of the conceptual framework have a strong social characteristic and equally focus on the multi-dimensionality and multi-actor processes. Also, they could all be grouped under the *processual theory*, which uses qualitative methodologies to study the complex process of interactions among entities (firms, policymakers, researchers, social organisations, etc) during participation in events (Verbong et al., 2008), taking in considerations of the dynamic framework conditions „in-the-making" (Köhler et al., 2019).

Aim of Thesis Research

While the current literature has paid some attention to community-based initiatives with traditional gardening practices in urban contexts, technological innovation in agriculture and community initiatives are scarcely related and linked. Albeit at a niche level, we would like to address the community-based greenhouse as a *socio-technical system*, since it shares the characteristics of dominant technological interventions of social relations, it also possesses the deep-rooted social nature of technological entities. As such, this thesis views the community-based greenhouse as a highly social and collective process, with multiple social actors interacting and negotiating in the system (Seyfang & Smith, 2007).

Further, we would like to address specifically three research questions:

1. How have visions and expectations emerged from relevant social groups?
2. What are the technological dimensions in giving a new legitimacy to the establishment of the community-based greenhouses?
3. What are actor-related interaction mechanisms contributing to the creation of community-based greenhouses?

Apart from the theoretical grounding, this thesis aims to have a practical contribution to the Dutch greenhouse systems by engaging with real-world situated actors, to have a dynamic view of their negotiations and uncertainties in the system innovation (Köhler et al., 2019, p. 19). Bearing in mind that social actors at various levels have "specific learning processes, competencies, organisational structure, beliefs, objectives and behaviours" (Malerba, 2002, p. 248), the aim of this thesis explores *three* different aspects of community-based greenhouses. Firstly, this thesis hopes to understand how visions about community-based greenhouses have emerged within the contexts of climate change and agro-ecological movements. Secondly, the thesis studies technological continuities and discontinuities with the dominant industrial greenhouse regime, to identify the material entanglements with community-based greenhouses and how it has created a new niche innovation market for the appropriation of smart technologies. Thirdly, this thesis is interested to investigate the communicative networks, to comprehend how discourses and visions about sustainable food are linked to the community-based greenhouses and to inform dimensions of their social identities.

To answer the three above-mentioned research themes, this thesis has further identified six design principles that can be used for empirical research analysis in the later stage. Namely, *Opportunities*, *Challenges*, *Inclusivity*, *Sustainability*, *Scalability,* and *Cultural sensitivity,* are independent dimensions but interconnect each other, forming jointly a complex analytical model.

OPPORTUNITIES

The major strength of community-based greenhouses lies within many different types of *community capitals*, which deviate from the economic paradigm, and are a social phenomenon representing the collective efforts to achieve shared community objectives. In particular, *financial capital* refers to the available monetary resources as external supports for community project development; *human capital* refers to individual capacity, skills and knowledge; *cultural capital* suggests the unique way individuals perceive the world, make their impacts on the community, and in return safeguarding the well-being of the community and allowing it to develop necessary capacities; further, *social capital* refers to the willingness to participate, even individuals acting alone could contribute collectively to community organisations and networks; *bonding capital* attributes to solidarity-building through social interactions to enhance group connections; finally, *linking capital* alludes to the ability to link vertically with higher authority and multiple networks of people, which is directly related to greater access to opportunities and resources (Magis, 2010). Another power of local communities in the context of urban cities lies in *community resilience*, which Magis (2010) has defined it as "existence, development, and engagement of community resources by community members to thrive in an environment characterised by change, uncertainty, unpredictability, and surprise" (p. 401).

CHALLENGES

However, we should not overly-romanticise the concept of "common purpose and common good" (Botes & Van Rensburg, 2000, p. 56), since success is always expressed more often than obstacles related to development initiatives. Concerning community-based greenhouses, this thesis categorises two types of obstacles, "*hard constraints"* refer to technological, financial, physical and material issues, such as changing practices to adapt to more economic technologies and tackling problems of low efficiency and low economic value of food self-production. It should be stressed that the potential opportunity lies in expert guidance provided by educational institutions, intermediate and regional entities, and local governments, by encouraging „practical learning through sharing experiences, analysis techniques, and practices" (Mfitumukiza et al., 2020, p. 12).

Further, "*soft constraints"* are *process-related* and often neglected but they are no less menial than „hard constraints", such as community involvement, decision-making procedures, organisational capacity building and empowerment (Botes & Van Rensburg, 2000, p. 47). In the process of promoting community participation, it is often underrated that the involvement of the community is an enormously time-consuming process and not cost-effective since it can produce uncertainties and circularise decision-making and developmental plans (ibid., p. 56). Each community is composed of a heterogenous network of social actors with different interests and perceptions of community-based initiatives, such as the newcomers versus the old-timers, old versus young, formally employed versus informally unemployed (ibid., p. 49).

INCLUSIVITY DIMENSION

Citizens are no longer passive receivers who are solely dependent on governmental implementations, instead, they have become the co-creator of public services (Edelenbos et al., 2020). The term "co-creation" concerns "innovation and value creation taking place as a collaborative process involving different types of actors" (Lund, 2018, p. 8). We can see that inclusive participation not only provides multi-dimensional benefits, such as the well-being of the public domain, social cohesion and empowerment, but it is also an interactive learning process that embeds social actors and considers the interests of others (Mylan et al., 2014; Malerba, 2002). Thus, this process has a deliberative democracy element as its basis for self-governance and ownership of public space (Artmann & Sartison, 2018), it is also considered a scalar concept that is further constituted by *three dimensions* of co-creation concerning the degree of citizen participation. Namely, *"co-implementers"* are citizens taking part in the process of making a workable service but they do not own the decisions in designing and initiating a project; *"co-designers*" have greater collaborative capabilities, where citizens are developing a service but not initiating it, one of the most popular forms is through living labs; finally, *"co-initiators*" is taking the most active role, which can be associated with social entrepreneurship that citizens innovate the process (Lund, 2018). Additionally, the co-creation process should be cautious avoiding the pitfalls of output legitimacy, where only people who have resources, knowledge, assets and competencies would be included (Lund, 2018). Further, different dimensions of co-creation need appropriate leadership and shared responsibility, to ensure inclusivity, maintain the functioning of collaborative processes, build trust, networks and mobilisation of participation (Ansell & Gash, 2012, referenced by Lund, 2018).

As stated by Lund (2018) “framing participation as co-creation has a profound effect on actor roles and democratic focus” (p. 12), CBIs can thus be potentially viewed as a leading democratic form of ownership and socially just innovation, if it could then be integrated into the existing regime with its moral criteria, it could then impose pressure to widespread the practice (Köhler et al., 2019). For social niches to abandon “the exclusive, power vanguard” and become “a source of innovative diversity“ for more sustainable futures (Seyfang & Smith, 2007, p. 590), it must be stressed again the caution against selective participation, CBIs should intentionally include the least-privileged people and even those have little interests to participate, who are representing the wider community. There have rarely been reports examining CBIs' impacts on the most vulnerable social groups, especially elderly people and uneducated women (Mfitumukiza et al., 2020). Communities are prone to “the most visible and vocal, wealthier, more articulated and educated groups“ (Botes & Van Rensburg, 2000, p. 46), therefore, the Inclusivity dimension should prevent gate-keeping by the elites who exclude low-income people and the most vulnerable in general (p. 51). Furthermore, residents are often viewed as “knowing less”, and the transference of expert knowledge and skills should not be disseminated as an “already assembled package” with ready-made solutions (p. 44), local people must take their own decisions in their ways.

SUSTAINABILITY DIMENSION

Sustainability implies the long-term operational ability to be “economically viable, environmentally sound, socially just and culturally acceptable” (Van Veenhuizen & Danso, 2007, p. 27). The broad umbrella term “sustainability” could then be sub-categorised into the followings: (1) *Biophysical environment sustainability* refers to the ecological context with the usage of natural resources. In urban agriculture, it is associated with productivity, sustainable yield, resource management, such as energy efficiency, urban water reuse, and life cycle assessments. It is also concerned with the preservation of biodiversity and genetic resources. Some of our current practices of heavy mechanisation accelerated demands of technological and artificial inputs, intensive tillage and cropping practices have already resulted in soil erosion and loss of nutrients in a vicious cycle (Cui & Smit, 1993, p. 302). (2) *Socio-political sustainability* corresponds to the cultural, social attitudes and traditions affecting people’s behaviours and demands, which to a large extent are influenced by governmental policies and supports. In developing countries, there are more urgent needs for basic food necessities to reduce hunger, whereas, in developed countries, different varieties and volumes of food production function are ways to manifest people’s social status and life quality. (3) *Techno-economic sustainability* is linked to market mechanisms, for example, consumers’ demand, supplies and technological

inputs could all directly influence the economic viability of social projects in the long-term. Additionally agricultural practices, it is also about economic diversification and self-reliance ability (Hamstead & Quinn, 2005). Currently, fresh produce is still more expensive than processed foods for low-income people, which has greatly influenced their purchasing behaviours (Waterlander et al., 2010, referenced by Van der Schans, 2010, p. 40). All three sustainability dimensions are *interlinked*, although economic efficiency and technological rationalisation remain a normative consensus in our society, regulated by national and regional economic paradigms to satisfy our capitalistic consumption and preferences (Spaargaren et al., 2012). In particular, the most decisive economic parameter in our society is the Gross Domestic Product (GDP) for measuring national economic productivity, without any consideration of a nation's well-being factors (Hamstead & Quinn, 2005, p. 144). Furthermore, Cui and Smit (1995) emphasise two overarching tenets of sustainability, which are "*intra-generational equity"* and "*inter-generational equity"*. The former is associated with "the fair and equitable distribution of benefits from resource use and agricultural activity among the between countries, regions or social groups" (p. 303), whereas the latter refers to the benefits that could be enjoyed by our future generations.

Table 2: General indicators and parameter for sustainability assessment (referenced from Van Veenhuizen & Danso, 2007, table 3)

Economic indicators	Environmental indicators
Yield trends	Bio-indicators (clean air, biodiversity)
Income per head and per ha	Pollution indicators
Modified GNP	Material and energy flows and balances
Value of total food produced	Heavy metals in crops
Value of land with UPA	Soil health (organic matter, etc.)
Productivity	Food miles: local food produced
Willingness to pay	Organic waste recycled
Local food production	Depletion
Hedonic price method	Pollution
Cost of depletion and pollution	
Social indicators	**Composite indicators**
Equity coefficients	Lists of indicators
Employment	Scoring systems
Disposable family income	Integrated system properties
Inclusion: no. of youth trained in life skills, patients, migrants or ex-convicts	
Participation, both men and women	
Property rights (tenure)	

Source: based on Becker, 1997; Danso *et al.*, 2003

SCALABILITY DIMENSION

According to Mfitumukiza et al. (2020), there are three different types of "scaling-up": "*vertical scale-up*" integrates CBIs into sectoral policies at a higher level of decision-making for wider impacts; "*horizontal scale-up*" reaches over a wider area by replicating the same initiative in numbers; and "*scaling deep*" refers

to the deep-rooted beliefs and values, which are further spread through participatory tools to enhance the concepts of ownership and capacity-building (ibid., p. 6). Empirically speaking, small-scale initiatives and their nature of geography rootedness have proven to be difficult for upscaling (Seyfang & Smith, 2007), for several reasons, including limited time available, financial instability, lack of serious ambition and long-term commitment. Further, not only they are dependent on external funding, skills in CBIs are tactical knowledge and therefore are particularly sensitive to volunteer turnovers, key figures leaving and shifts in government policies (Seyfang & Smith, 2007). The overemphasis on management issues of small-scale initiatives has also forced many to align with entrepreneurial strategic orientation (Igalla et al., 2019), posing the risk of forcing CBIs into commercialisation and competing with private firms (Brandsen et al., 2017).

CULTURAL SENSITIVITY DIMENSION

Oftentimes, the bonding capacity of CBIs is deep-rooted cultural issues where more diverse neighbourhoods are divided by "languages, tenure, income, gender, age or politics than in less diverse communities" (Botes and Van Rensburg, 2000, p. 49). Under the contexts of increasing globalisation and urbanisation, the challenge lies in how we could transfer a place-determined project to wider communities, where (social or technological) conditions, processes and pathways necessary to bring changes are difficult to realise in another cultural setting. In the context of greenhouses, the successful Dutch model has difficulties in transnational technology transfer when the major greenhouse manufacturers are clustered in Holland (Seyfang & Smith, 2007). Nonetheless, it has also been shown that companies located overseas are usually sources of important product innovations (Pannekoek et al., 2005, p. 47). Also, some governments may have a more open attitude towards CBIs than others, which could directly impact the providence of money and grants, networking, advisory services, and technical and managerial expertise (Edelenbos et al., 2020, p. 1694). Thus, the macro-level policy could function as a key facilitator or an obstacle to addressing local resolutions.

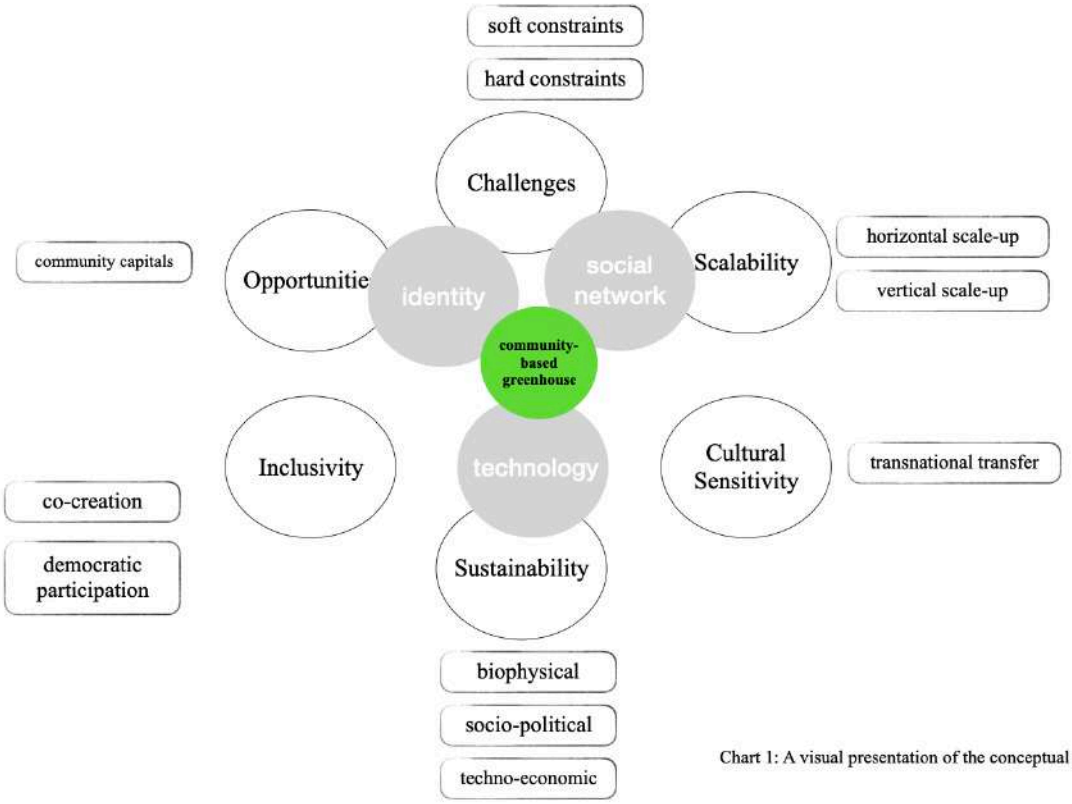


Chart 1: A visual presentation of the conceptual model of the thesis

Thesis Structure and Methodology

The first part of research is based on reviewing scholarly papers and reports, which focuses on understanding the existing Dutch greenhouse industry in terms of its historical development, expectation dynamics, social networking among dominant players and institutional policies, as well as its learning processes. As such, the first section aims to give an extensive analysis of the diversity and complexity of the Dutch greenhouse industry, and to reflect on its strengths and weaknesses. Further, in order to understand the contexts that configure the emergence of community-based greenhouses, it is also important to contextualise our research topic within two current important themes: *the Sustainable Development Goals* and *agro-ecological movements.*

The second part of research involves conducting primary research studies, a mixed-method would be employed with the use of surveys, email responses, interviews, observational studies and site visits. Several semi-structured interviews would aim to investigate opinions on the topic of community-based greenhouse model, which the interview questions were formulated to revolve around the six design principles previously outlined in the aim of thesis research. Furthermore, since many studies only describe the general outcomes of community-based initiatives without providing clear operationalisation details, four empirical case studies of community-based greenhouses would be examined through in-person site visits, interviews and surveys. Finally, the collected empirical data would be analysed and evaluated to answer the three initial research questions of this thesis. As such, the usage of both primary and secondary research would result in a more comprehensive understanding of the current social, institutional strategies and opinions from a diversified range of regime-actors. The thesis also explores the enabling technologies and how the usage of materiality could define different social practices, connect to concepts of sustainability and affect the quality of food.

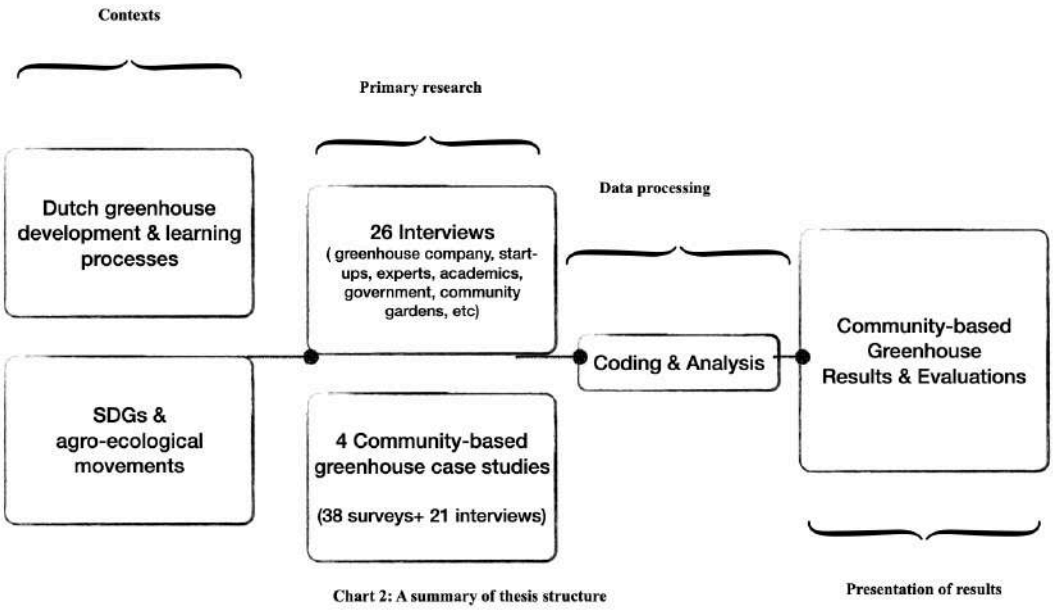


Chart 2: A summary of thesis structure

EXPECTATIONS DYNAMICS

This section has a technical-scientific focus, reviewing the step reconfigurations of the Dutch greenhouse industry from the early twentieth century to the present time. Specifically, this section would examine its "modular innovation", which refers to how "loose couplings" of multiple innovative parts where in a technical system, could work independently from each other and replace one without affecting other components in the system architecture (Berkers & Geels, 2011, p. 231). By adding on or replacing the existing components, the new combination of parts could then potentially transform into "radical innovation" (ibid.).

For a long time, early greenhouse farming was labour intensive and dependent on open-air horticulture and natural conditions (Berkers & Geels, 2011, p. 234). In the *1910s*, "Westland greenhouse" was originally from Guernsey, the British Channel Island, which refers to the largest Dutch horticultural area positioned between The Hague and Rotterdam. It had an improved greenhouse design with removable glass plates for better soil dehydration and removing salinity, but increased the exposure to plant diseases. Ever since, moderate and gradual enhancements have been made, such as adjusting the size of glass plates and the tilting angle to receive more sunlights, developing artificial light for plants by extending plant growth, and artificial heating generated by coal and oil which lengthened the growing season, which all contributed to *higher crop yield* annually. However, temperature fluctuation and heat generation had led to more frequent plant diseases, its technical bottlenecks resulted in limited diffusion into the greenhouse growers.

Between 1945 to 1960 after WWII, due to market liberalisation and foreign horticultural demand, there was a relaxation of growing permits and providence of financial funds by the government. Also, given the natural conditions of limited arable land and increased labour costs, Dutch farmers invested heavily into greenhouse technology to make efficient use of space. The growth of vegetable horticulture expanded most rapidly during this period (Buurma, 2001, p. 18) and the investments in *mechanisation* had made Dutch horticulture highly competitive in the European market for its productivity (Berkers & Geels, 2011, pp. 236–237). Consequently, greenhouse production has changed consumer preferences from inexpensive lettuce to more luxurious and tastier tomatoes in the domestic market.

Between *1960 and 1980*, greenhouses have been switched from unheated to heated ones, continuous *optimisations* were made on *cost-saving mechanisation*, such as climate control and ventilation system, automatic heating and temperature regulation device, which provided stability in temperature. Due to the increasing release of CO2 gases and soot deposits from the greenhouses, the heating method also shifted to natural gas and resulted in less pollution than transporting oil, the steam produced from artificial heating was utilised in soil disinfection (Berkers & Geels, 2011, p. 237). The development of artificial water systems that constantly flushed to prevent salt accumulation enabled the growers to plant a variety of crops. Despite higher fuel and equipment costs, less energy was spent with higher productivity, improved breeding for different seasons (ibid., p. 238), and higher-income for growers, causing economic growth in Western Europe.

Between 1980 to 1993, artificial lighting became widespread and *the application of computer technology* resulted in higher performance through enhanced data exchange and monitoring (Buurma, 2001, p. 33). Strong research has resulted in a change from heavy dependence on pesticides to biological control, there was also a change to substrate culture with a 15% increase in yield but faced with strong opposition from environmental interest groups (Buurma, 2001, p. 34). The physical yield of three major vegetables (tomatoes, peppers and cucumbers) had subsequently increased between 50% to 80% in just 16 years (p. 19). Furthermore, an environmental responsible guideline was introduced to reduce the negative impacts caused by the greenhouse industry (ibid.). *From 1993 to 2000*, *product quality and certifications* had become important factors for consumers, its economy also changed from supply-driven to demand-driven. With increasingly third-party inspections, the use of pesticides had also been reduced in half. Unheated greenhouses also sharply decreased from 2,000 ha in 1969 to only 300 ha in 2000 (ibid., p. 16).

From the year 2000 onwards, the Dutch government has made a Long-Term Agreement with the greenhouse industry, *GlaMi* (Greenhouse Horticulture and the Environment Agreement), with a maximum carbon emission between 6.5 and 7.1 million tonnes and using at least 4% of sustainable energy, with reduced use of pesticides by 88% and a reduction in nutrients such as phosphate and nitrogen emissions by 95% in 2010 compared to 1980. Concerning light pollution, the screening of artificial lighting had to be reduced by 100% by 2014. In fact, in 2012, the greenhouse industry has already produced more energy (10% of the national consumption) than the amount it has consumed (6% of the national consumption). Due to its high energy efficiency, the greenhouse growers could

generate additional income by selling the surplus (Van der Velde & Smit, 2012, referenced by Gerritsen et al., 2014, p. 11). Furthermore, a series of *food quality and safety standards* have been prominent (Breukers et al., 2008, pp. 7–8), although more than half of the Dutch greenhouse produce does not contain residues (p. 28), organic greenhouse produce is still at a small scale in the Netherlands, mainly for tomatoes, peppers and cucumbers.

Generally speaking, we could observe that modular innovations have provoked system reconfiguration in the greenhouse industry. A series of "innovation cascades" (Berkers & Geels, 2011, p. 244), such as greenhouse design, crop varieties, computerisation, controlled food safety and quality, and environmental agreements, has resulted in cumulative adoption of innovations on each other to develop "from craft-based farming to technical entrepreneurship" (p. 238).

Image 4: An example of greenhouse in 1900s
(Westland Museum, photo taken by the author)

SOCIAL NETWORK

Following the SIS approach described by Malerba (2002), this section focuses on the changing dynamics in the greenhouse sector through inter-dependent relationships among social actors. This section also emphasises analysing the knowledge-based greenhouse technological developments

and the involvement of governmental support to achieve its current competitive position in the global market.

In the 1930s, due to the economic crisis and decrease in the export of vegetables, a series of enormous governmental regulatory and financial supports had been made. Subsequently, the institutional goals *after the WWII* were (1) food security and sufficiency; (2) cheap food prices; (3) acceptable income for farmers to guarantee a living; (4) an increase in export for the national balance of payment (Van den Brink, 1990, referenced by Berkers & Geels, 2011, p. 243). During this period, the Dutch government invested in greenhouse infrastructure for the provision of good irrigation water and enforced low gas tariffs for greenhouse growers. Additionally, the government was active to realise shared commercial interests and goals, by organising advisory and technical services, coordinating, and implementing actions (Igalla et al., 2019, pp. 1186–1187).

Between 1965 to 1980, the reconfiguration pattern happened when the common policy objectives have caused the formation of a "three-tier distribution" between education infrastructures such as Wageningen Agricultural University, *Dienst Landbouwkundig Onderzoek* (agricultural research institution) and *Dienst Landbouw Voorlichting* (extension service) (Gerritsen et al., 2014, p. 14). Specifically, the education and research infrastructure developed the theoretical knowledge, which was further experimented with by the extension institution by monitoring soil quality, water salinity, pest control, etc. As result, its tested practical knowledge would be adopted by the growers based on contextualised greenhouse projects (Berkers & Geels, 2011, p. 242). Due to the common commercial interest, study clubs have been formed to invite university researchers and extension services to give lectures, site visits and experiments for the greenhouse growers. Such study clubs have enhanced the collective identity of farmers and the circulation of embodied knowledge among individuals. As such, there was a high level of trust and interaction between growers, researchers and advisers to disseminate horticultural knowledge since they saw themselves as a team (Buurma, 2001, p. 25). One of the biggest collaboration efforts was the *Denarkas* demonstration project with the Ministry, agricultural Rabobank, gas and oil companies, and regional government, investing in energy-saving and sustainable production (p. 30).

From 1980 to 2000, research was privatised and done on a contractual basis, the "three-tiered distribution" has ended and the national government has delegated more responsibilities to local

authorities. *Productschap Tuinbouw* (producer authority) as the major platform took the lead until 2014 in funding horticultural research, it had law-binding capabilities and integrated the EU market policies in the Netherlands (Gerritsen et al., 2014, p. 14).

It is important to stress that the successful adoption of greenhouse technologies by the Dutch farmers was not an individual effort, but due to heavy support from the favourable government policies (financial subsidisations and aiding legal frameworks), agricultural schools and extension services, as well as further knock-on effects among growers to increase in technological adoption scales (Berkers & Geels, 2011, p. 237). So far, the Dutch greenhouse industry has demonstrated a phenomenal coherence between research, production and marketing (Buurma, 2001, p. 42). Thus, it could be characterised as a typical supplier-dominant innovation pattern with an interconnected division of labour between university R&D, firms implementation and feedback provision to research (Berkers & Geels, 2011).

LEARNING PROCESSES

This section reflects on the strengths and weaknesses of the current Dutch greenhouse industry with a prospective outlook.

In a sectoral system, *product innovations* are "improvements of existing products and development and commercialisation of new products", whereas *process innovations* are "important changes and improvements on existing processes and the development and implementation of new process" (Pannekoek et al., 2005, p. 40). Continuous product or process superiority is the most crucial factor for a firm's success or failure, as such, innovations could be progressive or radical, having incremental or huge impacts on the products, processes or organisations of the company (Pannekoek et al., 2005). In recent years, the Dutch governmental subsidies have been actively supporting new and energy-efficient greenhouse technologies by collaborating with commercial parties, also, the government engages in the development of new greenhouse clusters (Gerritsen et al., 2014, pp. 18–19). Currently, there are already many options available. For example, electricity generated from renewable resources for heat and lighting in the greenhouses; solar heat stored in aquifers in the summer could be utilised during the winter; geothermal as an alternative energy source to reduce the usage of natural gas (Breukers et al., 2008, pp. 31–32).

Nonetheless, since the termination of *Productschap Tuinbouw* (producer authority), the greenhouse industry lacks a formalised, centralising governance authority to organise multilateral interactions and research for the growers (Gerritsen et al., 2014, p. 16). It is considered a weakening factor in the greenhouse industry since the network communication, flow of knowledge and information are crucial for an efficient rate of innovation diffusions (Kasmire et al., 2013, p. 4). For big dominant players, they could sponsor their private research to maintain their technological positions (Gerritsen et al., 2014). For small and medium-sized enterprises (SMEs), the decisive factors in conducting R&D are based on cost reduction strategies and operational license requirements (p. 17). As result, energy efficiency and CO2 emissions are hot topics in the greenhouse industry for cost reduction purposes. One of the biggest remaining challenges, water management, has been dealt with by the Platform Sustainable Greenhouse Horticulture, forming an agreement with the industry on zero emissions of minerals (N and P) to the water systems by 2027 (p. 11).

Due to the current economic and energy crisis worldwide, the stagnation of spatial development has also caused concerns about the management of clustered, obsolete greenhouses since they could be space-consuming and block the development of sustainable greenhouses (Gerritsen et al., 2014, p. 18). It is calculated that every 18 ha of greenhouses removed could build 44 houses in turn (Breukers et al., 2008, p. 47), further opportunities also lie in integrating greenhouses with the surrounding environment for recreational and touristic, even healthcare functions (p. 101).

Image 5: Peppers grown on substrate
(Floriada Expo Almere 2022, photo taken by the author)

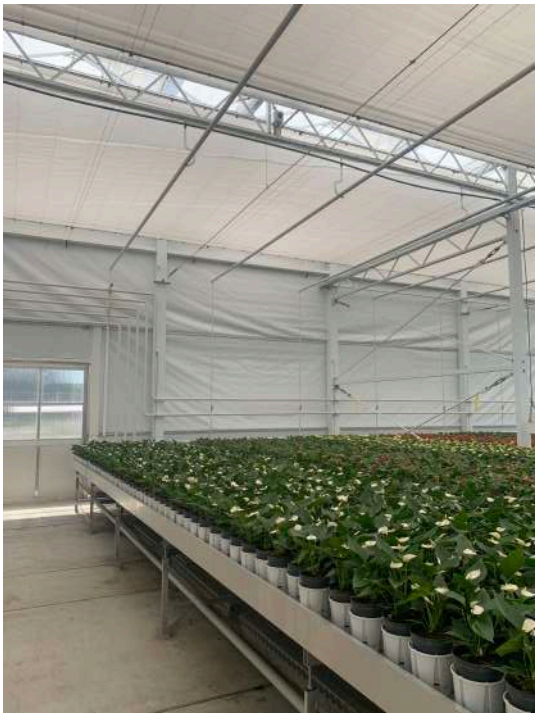


Image 6: Screens to reduce greenhouse light pollution
(Floriada Expo Almere 2022, photo taken by the author)

The following strengths and weaknesses of the current Dutch greenhouse industry have been identified concerning production and logistics, technology, and infrastructure.

Table 3: Strengths and Weaknesses of the Dutch Industrial Greenhouse Sector (adapted from Breukers et al., 2008; Kasmire et al.,

	Strength	Weakness
Production and Logistics	<u>Product Innovation</u> -More than half produce do not contain residue according to food quality and safety standards -new crop varieties (the shape, size and taste) for product differentiation -year-around production -continuous pest management and little pesticides -disinfestation of drain water and substrate -substrate culture (e.g. rockwool, perlite, coir) for growth precision -cold/heat storage -mechanisation and cultivation systems -automation of crop harvest and internal transport -cover materials with higher PAR (Photosynthetic Active Radiation) transmission <u>Process Innovation</u> -Sensors and climate control applications -closed loop of nutrient supply -collection of rainwater and recirculation of water -food certification	-Poor image in sustainability and environmental consciousness -Light nuisance and environment pollution -Organic greenhouse produce still at small scale -Supermarkets being the main outlet
Technology	-Knowledge-intensive infrastructure -3-10% of the companies being innovators to introduce new product or process innovations -Fast adoption rate for higher efficiency and sustainability -Governmental support of development of technology and innovation	-Major energy-consuming sector -Not contributing to labour market
Infrastructure	-Space provision made available by the government -Development of Greenports -Strong global market position and entrepreneurship -Strong organisational structure (vertically[short chain] and horizontally [e.g. grower's association]) -Finance support between grower and bank -Presence of a knitted communicative network among greenhouse associations and grower networks	-Space-consuming for alternative housing and obstruct the natural environment due to scarcity of land in Holland -A large number of obsolete greenhouses in the Westland area -Weak domestic market position -Causing congestion of roads -Lack of communication with local residents -Conflicts of interests with local communities (e.g. recreational spaces) -unattractive financial supports due to unrealistic requirements and uncertainties about availability -Not effective communicative network

Community-based Dutch Greenhouses and SDGs

From the previous evaluation of the Dutch greenhouse industry, we understand that innovations could be technological-intensive, involving various product and process innovations, or they could also be social, including new forms of practices, entrepreneurship and organisations, which usually attempt to re-establish ownership over certain societal problems (Van der Schans et al., 2014, pp. 3–5). In this context, the community-based greenhouse is regarded as a social innovation to re-establish our relationships with food and food security.

The Sustainable Development Goals (SDGs) were set out by the UN General Assembly in 2015 and are intended to be achieved by 2030. In this thesis, they are indicative as a heuristic tool to analyse the direct effects of community-based greenhouses on different societal goals. Nowadays, over a billion of the world's population are obese, especially in developing countries with cheap diets with high sugar and fat contents (Nicholles et al., 2020). By respecting local food production and its origin, and having face-to-face direct contact with crop production (Van der Meulen & Verzandvoort, 2014), community-based greenhouses could serve for subsistence food usage and have the ability to grow exotic and tropical plants in cold-weather countries and regions. By working in the field, growers would also exert physical labour with enhanced mental health by being in contact with nature and communal socialisations, which could contribute to *SDG 3 Good Health and Well-Being*. 70% of food in Africa and Asia is produced by small-scale farms (Lower et al., 2016, referenced by Nicholls et al., 2020), mostly due to a lack of stable access to food and a lack of purchasing power (Van Veenhuizen & Danso, 2007). Unlike in developing countries, growing individual food is not yet a basic necessity in developed countries (Van der Schans, 2010).

Further, the creation of green jobs contributing to *SDG 8 Decent Work and Economic Growth* could have a synergy effect with *SDG 1 No Poverty* via the sale of surplus. Its production value should not be overlooked since growers could sell through multiple outlets besides for personal use, such as streets, farmer’s markets, intermediaries and other market channels (Van Veenhuizen & Danso, 2007). Thus, it has the potential to grow from small-scale family production to entrepreneurial activity. In addition, such job opportunities usually are strongly social-oriented and are especially important for vulnerable social groups, for example, “HIV/AIDS-affected households, disabled people, female-headed households with children, elderly people without pensions, jobless youth” (p. 9). By transforming available cheap urban wastes into decentralised, productive resources, such

as biological compost and wastewater irrigation, there could be a wide diffusion of environmental management. In this respect, local authorities may also shift focus from high input agricultural production to sustainable and dynamic urban agriculture (Van Veenhuizen & Danso, 2007). The creation of a community-based greenhouse also functions as a green space with self-organising land management and recreational services, contributing to *SDG 12 Responsible Production and Consumption* and *SDG 15 Life on Land* with an increase in ecosystem services, such as pollination and pest control (Nicholles et al., 2020). However, we should not take for granted that many countries still do not have sufficient technical services, knowledge circles or responsible authorities to coordinate this type of low-tech urban food production (Van Veenhuizen & Danso, 2007).

Finally, communities and households are at the forefront of facing climate change, their flexibility to react to possible changes in hazard intensity and frequency is crucial (Mfitumukiza et al., 2020, p. 3). Community-based adaptation (CBA) to climate change emphasises the participatory process with vulnerable social groups living in poverty. It also focuses on a good relationship with the government to receive finance and adopt flexible and equitable solutions, changing communities from a passive social position to a developmental driver (ibid.). Specifically, community-based greenhouses reduce energy use for food production and food miles, since international food products cost 300 times more in transport costs than local foods, with 70% external transport costs for organic foods and 43% for conventional (Pretty, 2001, p. 7). However, it should be noticed that transport contributed to GHG emissions remains a small portion of the total GHG emissions from food production (Van der Meulen & Verzandvoort, 2014). In addition, by practising community-based greenhouse farming, the collection of rainwater runoff in barrels and water tanks helps to reduce the pressure of large surface runoffs on urban drainage systems; crop residues could also be used for bio-digestion and applied in soil fertilisations. Soil health related to crop productivity is characterised by physical, biological and chemical properties, through tilling and physical reconditioning, which would enhance soil structure and mitigate compaction; chemical and biological reconditioning could also be done through composting and tiling for optimal specifications (Van der Meulen & Verzandvoort, 2014). In general, we could observe that community-based greenhouses could mitigate intensive agricultural practices (Seyfang, 2006) with an increase in green spaces, contributing to *SDG 13 Climate Action*.

It is to be noticed that although greenhouses are land-based urban agriculture, they are not open-air and subsequently, the net increase in carbon budget, rainfall and surface runoff attenuation for urban ecosystems are minimal. Another disadvantage is that due to their building materials, greenhouses typically have the Urban Heat Island effect (UHI) designed for absorption of sunlight and reduced evaporation. At times, they could lead to decreased photosynthesis for plants and an increased need for ventilation, water and shades (Van der Meulen & Verzandvoort, 2014). Furthermore, since community-based greenhouses are usually inherited from previous commercial and industrial ones, other reducing factors include potential residue contamination affecting soil quality; metals from various sources such as batteries, electronics and glass sherds may have effects on plants and human health; animal manure contamination could also pollute local water sources (Van Veenhuizen & Danso, 2007).

The following illustrates a summary of the potential contributions of community-based greenhouse agriculture to SDGs in more detail.

Table 4: Summary of potential contributions of community-based greenhouse agriculture to SDGs (adapted from Nicholles et al., 2020)

Sustainable Development Goal (SDG)	Contribution of Community-based Greenhouse to target	Trade-offs with
1. End poverty in all its forms everywhere	-reduce extreme poverty through sale of crop produce -reduce vulnerability to climate-related extreme events, economic shocks	-possible need of starting capitals to purchase/take over a greenhouse
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	-access to nutritious and sufficient food all year round -with a higher level of agricultural productivity through sustainable food production system -strengthened capacity to adapt to climate change and improved soil quality -maintain diversity of seeds with associated traditional knowledge -promote mental and physical health and better socialisation	
3. Ensure healthy lives and promote well-being for all at all ages	-reduce the number of illnesses from hazardous chemicals, air, water and soil pollution and contamination	-possible hazardous chemicals, air, water and soil pollution
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	-achieve higher level of economic productivity through technical up-grading and innovation -decent job creation, entrepreneurship, creativity and innovation -job opportunities for all women and men, including young people and persons with disabilities -sustainable consumption and production pattern	
11. Make cities and human settlements inclusive, safe, resilient and sustainable	-improve inclusive and sustainable urbanisation -resilient to disasters, focus on protecting the poor and people in vulnerable situations -pay special attention to air quality and waste management -universal access to safe, inclusive and accessible green spaces	-potential competing with housing and other urban infrastructure (SDG 9)
12. Ensure sustainable consumption and production patterns	-reduce food waste at the retail and consumer levels and reduce food losses along production and supply chains by shortening the supply chain -improved soil quality related to crop productivity -reduce waste through reduction and recycling and reuse of water and organic waste.	-potential health (SDG 3) and environmental consequences (SDG 15) if waste not treated properly, spreading diseases
13. Take urgent action to combat climate change and its impacts	-reduce in energy-use for food production and food miles -improve education and awareness-raising on climate change mitigation and adaption -inclusion of women, youth, local and marginalised communities	-experiencing an increased Urban Heat Island effect (UHI) inside the greenhouse -Increased needs for ventilation, water and shades than open-air farming practices
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	-sustainable management and restoration of land and soil -promotion of biodiversity and conservation of ecosystem	-potential of lower productivity compared to commercial growing

Alternative Agrofood Networks (AAFNs)

Veen and Dagevos (2020) are proposing that in a post-industrial era, “consumption” would shift to “prosumption” as termed by Toffler (1980), merging the distinct lines of production and consumption together (p. 2). Although both terms are on a self-managing basis, they have created a sharp contrast that one is buying his/her food, and the other encourages “consumers produce consumption opportunities for their peers” (p. 4).

The decline of the horticultural auction system has led to the establishment of several dominant supermarket oligopolies in the Netherlands and consequently, farmers are receiving shrinking profit margins. The industrial image of agriculture is often associated with established chains of demand and supply, bulk produce, heavy on chemicals and genetically engineered, even though Dutch agricultural products are already considered the cheapest and best in the world, being affordable for most of its residents (Veen & Dagevos 2020, 17). However, the seemingly cheap food prices do not take into account social and environmental costs, too many unnecessary “food swaps” among countries with exactly the same products being imported and exported, raw vegetables are processed into varieties of products, wrapped in packaging and transport to distant countries and regions. On average, each food travels 2000 km from land to plate in the US (Pretty, 2001). Given the increasing amount of organic labelling, it is also difficult for consumers to identify the real quality assurance and certify food production methods (Pretty, 2001).

Alternative Agrofood Networks (AAFNs), as suggested by its terms, are alternatives to the conventional industrialised agro-food system which is held accountable for deskilling and alienation of food origin, preparation and quality (Psarikidou & Szerszynski, 2012, p. 31). There are many different typologies of AAFNs under the umbrella term “ethical foodscape” (Morgan 2010, p. 1853), including for example, ethical, organic, local and fair-trade food products. In terms of *the spatial dimension* of AAFNs, Psarikidou and Szerszynski (2012) have pointed out that they have a “social centrality“ (p. 35) where a range of spatialities such as restaurants, farmers' markets, allotments, public spaces, and even window boxes can take place based on a set of beliefs and skills. In terms of *temporal dimension*, AAFNs could co-evolve with the public, cultures and histories; the frequency of occurrence could correspond to individual free time, plant biological growth and seasonal change (p. 35). AAFNs seek to reverse the trend of high modernity and “knowledge-expropriating mechanisms of conventional food system” (p. 36), emphasising the

multi-faceted aspects of sustainability, social, and economic benefits to local communities. In fact, concerning its productivity, it is calculated that small-scale urban agriculture yields a higher output than commercial farming (except monoculture), out of the 570 million farms in the world, 84% have a size less than 2 ha (Lowder et al. 2016, referenced by Nicholls et. al, 2020). In addition, it overlaps with the social goals of "health, equity and social cohesion" through the means of "participation, empowerment, and accountability" (Psarikidou & Szerszynski 2012, p. 32). Thus, AAFNs place importance on the physical interactions with our environments, by offering something to smell, touch and see, they would revoke our old memories (Van de Vlasakker & Even, 2020, p. 15).

In the Netherlands, *Gezonde Gronden* (Health Soil) was one of the first citizen initiatives to grow locally produced food in their neighbourhood and it organised courses to educate local residents on *sustainable food production*, which is the growing method "to strengthen the natural productive capacity of the agro-ecosystem, without using chemical inputs, and by closing water and nutrient cycles" (Van der Schans 2010, 40). Another example is *Stedennetwerk Stadslandbouw* (The City Network) formed in 2014, with the help of Wageningen University and the Netherlands Rural Network, the association consisted of experienced members who have certain knowledge of urban agriculture from different municipalities. As a result of networking, The Urban Agriculture Charter was adopted by 25 city councils so far, aiming to "1) create space for experimenting; 2)support regional food chains; 3)facilitate quality improvements, and 4) connect local initiatives" (Jansma et al., 2014, p. 40). As such, we can see that micro-and meso-level activities could help "nurturing diverse niches, facilitating greater actor interaction, promoting social learning" (Seyfang & Smith, 2007, p. 590).

At a national level**,** the Dutch law *Omgevingswet* (Environment and Planning Act) recognises the importance that local government actively participate with citizens. In fact, the Dutch government already has realised the importance of reconnecting metropolitan residents with food production, albeit still as a symbolic function to create bridging dialogues between citizens and farmers (Van der Schans, 2010, p. 40). Another project that recently was piloted in the Netherlands is the *NU Spaarpas* loyal card, which awards points to redeem for public transport tickets in exchange for buying local, fair-trade products. Generally speaking, a change in top-down policy could also provide new opportunities with respect to higher capabilities and infrastructures for upscaling of

community-based initiatives (Seyfang & Smith, 2007). It is crucial for governmental institutions that local people can be directly consulted with, to respect communities' needs, and to take part to make their own decisions. In this context, CBIs concerning AAFNs need also to be compatible with governmental long-term visions to access higher-tier opportunities and they are especially important in reacting to systematic problems and social vulnerabilities (Mfitumukiza et al., 2020).

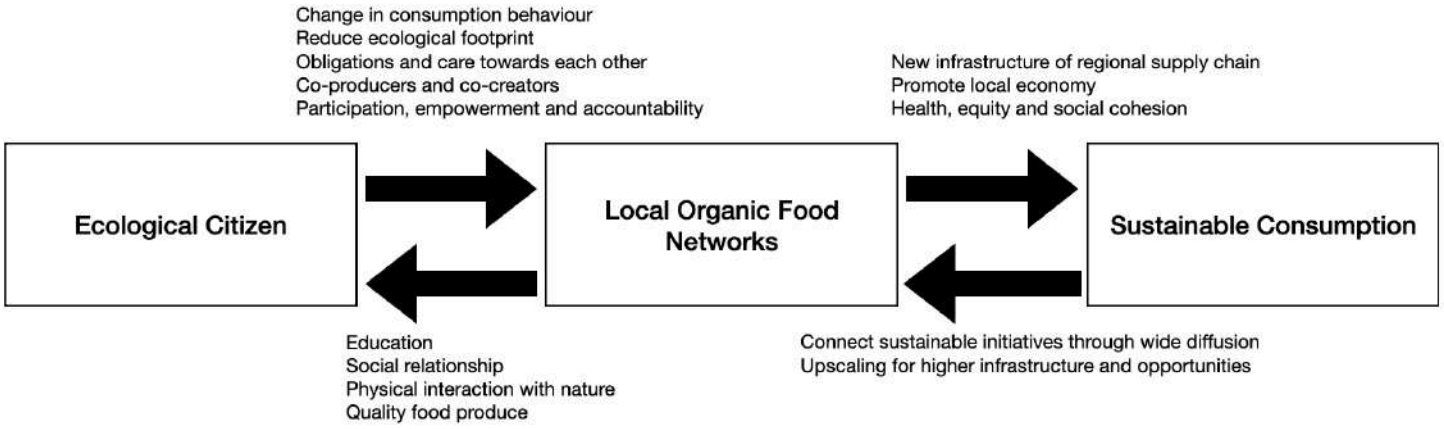


Chart 3: Relationship between ecological citizen, local food networks and sustainable consumption (adapted from Seyfang 2006)

Empirical Data Collection

Our empirical research has employed mixed methods of semi-structured interviews, surveys, case studies, and observational field studies. Specifically, *semi-structured interviews* seek to understand interviewees' own opinions, exploring their detailed descriptions based on the specific situations. As such, our interviews should be open to the spontaneity of interviewees, and increase sensitivities by engaging in two-way dialogues. Rather than fixated and presupposed categorisations, semi-structured interviews are guided by open-ended interview questions to focus on specific themes (Kvale, 2007, p. 29). At a later stage, coding would be performed thematically according to our conceptual frameworks. Further, *survey research* could map out "the extent, characteristics, impacts and outcomes of grassroots innovations" (Seyfang & Smith, 2007, p. 599). Since the author had only conducted her research for one (or two) specific day(s) in each organisation, this thesis has used random samplings which have the advantage of generalisability and simplicity in a limited time (Crowe et al., 2011). Although the disadvantage is that the surveys were unable to differentiate a large population by selective categories. Thirdly, this thesis has identified and selected four contrasting initiatives via internet search with "pre-defined boundaries" (Crowe et al., 2011, p. 5), such as its geographical area should be within Holland, its operational stability, attractiveness, scale, and the overall integrity to our theme "community-based greenhouse". The exact dates and time of the site visits were later confirmed via telephone and emails, also, the availability of the organisations was checked to confirm if the research could access the groups of volunteers and decision-makers for interviews and surveys. By comparing simultaneously in our data analysis section, *a collective case study* could provide an insightful, explanatory analysis of *why* and *how* one decision was adopted over others (Crowe et al., 2011, p. 2); it also offers naturalistic settings to study social actors through everyday events (p. 2). Finally, this thesis has utilised *observational study* as a supplement for personalised field research to gain a more holistic view of the social organisations. It facilitates the author to take notes of the surrounding environments, people's emotions and behaviours which are unable to be captured orally, to identify and formulate more clarified research questions (Angrosino, 2007).

SEMI-STRUCTURED INTERVIEWS

All interviews were conducted between March and May 2022, the participants were selected from dominant and SMEs greenhouse companies, innovative start-ups, as well as individual experts and technicians, academics and governmental policy-makers, who were being contacted through their emails and LinkedIn information from the websites. Their expertise and knowledge are based on

strong theoretical and empirical foundations. Due to spatial and Covid-19 pandemic restrictions, some respondents addressed their opinions with written emails, and the majority of semi-structured interviews were conducted through video and in-person meetings, each with a duration of 30-45 mins, and were transcribed by *Otter.ai* and later on checked for a full reading. In total, 18 semi-structured interviews have been conducted successfully, with an additional 8 short written email responses. All of the interviewees were briefed on the purpose of the study in detail with an electronic letter of invitation to participate; some of the interviewees were uncomfortable with audio-recording and the conservations were documented with note-takings.

CASE STUDY RESEARCH

The case study research took place in May 2022 in Holland, and consisted of semi-structured interviews with the organisers, growers and volunteers; site visits between three to six hours to each of the four different organisations, packing sites, market stalls and the local neighbourhoods; two forms of self-completed surveys, one with the organisations and the other with the customers. The surveys were given out to three organisations on the same day during the site visits, in total 30 organisation surveys and 8 customer surveys were returned.

Specifically, during the visits, all the organisers provided general information about their greenhouses, and observational notes were taken to contextualise later on the executed interviews and surveys. Permission to take photos was asked in advance as a way to illustrate the findings of this research. A total of 21 short semi-structured interviews were conducted with open-ended questions related to social identities and motivations, greenhouse technology and sustainability, institutional challenges and opportunities, and social networking. People were very busy with their agricultural activities and they did not have the luxury of time to reflect on what they were doing. As result, the interviews were conducted through opportunity samplings shortly during their breaks, with an average of 8 to 10 minutes long for volunteers and growers, the interviews were however complemented with a higher quantity. In general, people were very friendly and easy to approach and a large proportion of them were eloquent in English, only several were rather private and did not prefer to have any audios taken. All of the participants were briefed on the purpose of the study in detail, emphasising that participation was voluntary and their data would be kept safe for research purposes only.

Furthermore, the organisation survey was used to examine the competencies, motivations, and perspectives of employees and volunteers in three of the four community-based greenhouses. One of the case studies has individually-owned greenhouses in a community and therefore does not suit the survey design questions, it was considered more effective to conduct a higher number of interviews rather than surveys. The survey originally contained 26 questions, both multiple choices and one open question. One survey question was not analysed in this study since several participants preferred not to specify their countries of origin. Moreover, the consumer survey examined the customers' perceptions of food quality of community-based greenhouses and consumption patterns in two of the four case studies, since these two greenhouses have their market stalls with frequent visitors outside of the organisations. Because customers usually have very little time or interest in filling out a questionnaire, the survey comprises 15 questions. All surveys were handed directly to and back from the participants and analysis was performed using Google Forms and Numbers (MacBook software).

Table 5: Number of conducted case-study interviews

Types of semi-structured interview	ONZE	OudeBeer	BoereGoed	Oosterwold
Decision-maker *(40-60 mins)*	1	0	1	1
Volunteer/Grower *(8-15 mins)*	4	3	3	8
Total number	5	3	4	9
				21

CASE STUDIES

Onze

A family business leasing greenhouse allotment spaces to interested growers to produce their own food, with monthly rents, it provides growers with water taps and biological pest control agents, it is not allowed to use chemicals or pesticides in the greenhouse. Onze itself also produces crops for sale to its on-site food store and external outlets. The total space is divided into numerous allotments with a basic size of 3 by 4 meters. In the greenhouse, there is one main pathway approximately 2 m wide and side pathways are about 50 to 70 cm wide.

OudeBeer

OudeBeer social organisation is situated just outside the city of Dordrecht near the highway and some warehouses. It is run by volunteers and focuses on the natural relationships with organisms, OudeBeer does not use any fertilisers or pesticides. Its greenhouse facility is shared with a commercial grower.

BoereGoed

It is a social initiative largely run by volunteers, providing opportunities for people with difficulties to access the job market and people with disabilities. Fruits and vegetables are sold in its on-site store, several regional farm shops and online. In its greenhouse, there is also a relaxation booth, a small office and a packing station for delivery orders.

Oosterwold Food Cooperative

In the Almere Oosterwold region of 43 square kilometres, there are currently 1,500 living households and it is expected to have 15,000 households in 10 years, being the largest urban farming project in the world. The developmental strategy is that 59% of the total area is designed for urban agriculture, residents are free to design their housing, water management, waste management, as well as energy supply. It is estimated that in 10 years, based on an average Dutch person's daily diet, the Oosterwold food cooperative could provide 10% of the food baskets for the Almere city.

Table 6: Characteristics of community-based greenhouse case studies

	ONZE	OudeBeer	BoereGoed	Oosterwold Food Cooperative
Starting year and Location	2012 Almere	2013-14 Dordrecht	2017 Naaldwijk	2020-21 Almere
Type of greenhouse	commercial greenhouse	30-40 years old commercial greenhouse	30-40 years old commercial greenhouse	self-built/purchased new/second-hand materials
Size	unknown	4000m$_2$	7500m$_2$	43km$_2$
Organisational management	individual allotments for rent	run and managed by volunteers	run and managed by volunteers	decentralised production by residents
Business activities	on-site food store, external outlets	on-site food store, external outlets, webshop	on-site food store, webshop, regional stores, external outlets	external outlets




Group Image 1: ONZE Community-based greenhouse





Group Image 2: OudeBeer Community-based Greenhouse

Group Image 3: BoereGoed Community-based Greenhouse

Group Image 4: Oosterwold Community

Reflection on Methodology

Reflecting on our methodologies for empirical research, this thesis has included a considerably organised and coherent dataset with both qualitative and quantitative analysis. The data presentation has also been supported with considerably rich details, outlined by six key concepts. Further, our data analysis and discussion sections were based on scholarly literature and data coding, with a representation of comparatively coherent social actors from different disciplines. In addition, this thesis also has offered as many different case studies as possible, to gain a broad understanding of the field of the community-based greenhouse. Specifically, through cross-case comparisons, OudeBeer and BoereGoed could be viewed as *instrumental* case studies, typically managed by volunteers; Onze being the longest-standing, a relatively large-scale initiative among the four could be considered as a *mature* case; Oosterwold community, with its decentralised method of production, can be viewed as an *intrinsic* case by expanding our community-based greenhouse range due to its operational uniqueness (Crowe et al., 2011, p. 5).

However, it should be noted that the analysis of case studies has provided only a "screenshot" rather than an ongoing long-term investigation. The number of interviewees and the sample size of the surveys for both volunteers and customers was limited. On one hand, a greater number of quantitative and qualitative studies could increase our data diversity and reliability, enabling more in-depth statistical analysis. On the other hand, given the limited space and its voluminousness, this thesis has also encountered difficulties to analyse the whole aspects of raw data. During the interviews, (1) social actors associated with private companies and research institutes were difficult to reach out; (2) the interviews and surveys were carried out too abruptly, without establishing the trustworthiness of the researcher yet; (3) the Netherlands being a non-English speaking country, some participants' opinions could not be fully and explicitly conveyed, a few were unable to participate due to the language barrier. Finally, considering the ethical issue of conducting interviews, the thesis could be more considerable in anonymising participants and organisations, since some are easily recognisable (Crowe et al., 2011, p. 7).

Table 7: **A summary of socio-characteristics of case studies participants (% of respondents) (multiple choice possible)**

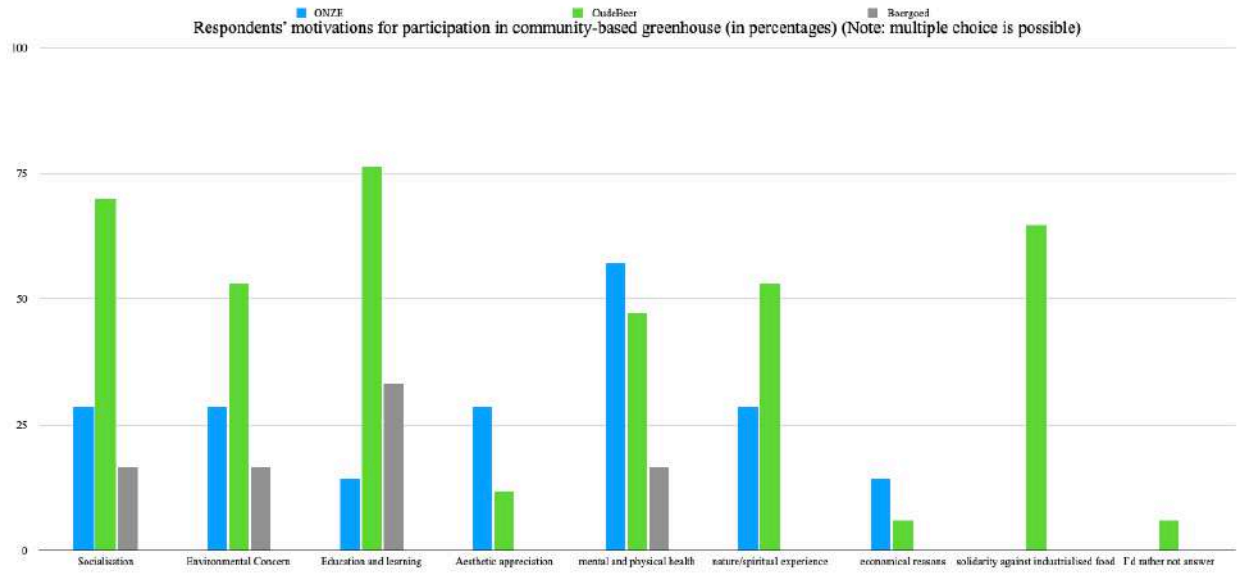
Factor	Category	ONZE	OudeBeer	Boergoed	Surveyed Sample
Gender	Female	28.6.	35.3	33.3	40
	Male	71.4	64.7	66.7	60
Age	<18	28.6.	0.0	0.0	6.7.
	18-35	28.6.	5.9.	33.3	16.7.
	35-50	0.0	23.5.	16.7.	16.7.
	50-70	28.6.	64.7	33.3	50
	Over 70	14.3.	5.9.	16.7.	10
Full-time Job	Student	42.9	5.8.	0.0	10
	Retired	42.9	17.6.	16.7.	26.7.
	At this organisation	0.0	0.0	33.3	6.7.
	IT	14.3.	0.0	0.0	3.3.
	Public Administration	0.0	23.6.	0.0	13.3.
	Unemployed	0.0	23.5.	33.3	20
	Recreational jobs	0.0	11.8.	0.0	6.7.
	Ecology-related	0.0	5.8.	16.7.	6.7.
	Other (e.g. nurse, self-employed)	0.0	11.6.	0.0	6.7.
Type of volunteer work	Online and marketing	0.0	23.5.	50	10
	Administration	42.9	17.6.	50	30
	Sale and delivery	28.6.	23.5.	66.7	33.3
	Field work	57.1	35.3	33.3	40
	Horticultural specialist	0.0	17.6.	33.3	16.7.
	Project coordination	0.0	5.9.	33.3	10
	Wherever needed	14.3.	52.9	50	43.3
Frequency for volunteer	Almost everyday	0.0	5.8.	33.3	10
	3-5 time per week	57.1	5.8.	33.3	23.3.
	At least once a week	42.9	70.6	33.3	56.7
	A few times a month	0.0	11.8.	0.0	6.7.
	When I am free	0.0	5.8.	0.0	3.3.
Future plan to volunteer	Yes	100.0	94.1	83.3	93.3
	No	0.0	0.0	16.7.	3.3.
	I am not sure	0.0	5.9	0.0	3.3.
Community support	Yes definitely	71.4	0.0	40	20
	Yes but more participation is better	0.0	70.6	40	46.7
	Not many are interested	0.0	11.8.	0.0	6.7.
	I am not sure	28.6.	17.6.	20	23.3.
Percentage of diet from the organisation	<20%	14.3.	41.2	50	36.7
	20-50%	42.9	47.1	16.7.	40
	50-80%	42.9	5.8.	16.7.	16.7.
	more than 80&	0.0	5.8.	16.7.	6.7.
	100 %	0.0	0.0	0.0	0.0
Farming skills learnt from	this organisation	42.9	52.9	66.7	53.3
	At school	0.0	17.6.	16.7.	13.3.
	From previous jobs	14.3.	23.5.	0.0	10
	Self-education	42.9	76.5	16.7.	60
	Family tradition	57.1	47.1	16.7.	43.3
	Expert workshops	14.3.	17.6.	16.7.	16.7.
Distribution of harvest	Self-consumption	100.0	76.5	50	76.7
	Gifts to friends/ neighbours	71.4	35.5	16.7.	40
	Occasionally sell through private outlets	14.3.	29.4.	16.7.	23.3.
	Sell from online through organisation	0.0	17.6.	66.7	23.3.
	Sold from organisation	0.0	41.2	50	30
	I do not get harvest	0.0	11.8.	0.0	6.7.
Sources of daily consumption	From our organisation	57.1	18.8.	66.7	36.7
	Grow my own elsewhere (e.g. backyard garden)	14.3.	37.5	16.7.	26.7.
	Local farmer's market	0.0	31.3.	0.0	16.7.
	Organic food store	14.3.	25	16.7.	20
	Large supermarket	71.4	56.3	50	56.7
	Wherever cheap	28.6.	25	16.7.	23.3.
Inclusivity dimension with vulnerable social groups	(average score)	80	83	88	83.7
International diversity dimension	(average score)	87	71	38	65.3
Sustainable practice	(average score)	72	78	56	68.7

Table 8: A summary of consumers' perceptions on selected community-based greenhouses (% of respondents) (Multiple choice is possible)

Factor	Category	OudeBeer	BoereGoed	Surveyed Sample
Gender	Female	66.7	60	50
	Male	33.3	40	50
Age	35-50	33.3	0	12.5.
	50-70	66.7	100	87.5
Frequency of visit	First time	33.3	0	12.5.
	Several times	66.7	40	50
	Regularly	0	20	12.5.
	Loyal customer	0	40	25
Living distance from the organisation	<1km	33.3	0	12.5.
	<5km	33.3	100	75
	5-20km	33.3	0	12.5.
Ways getting to know this organisation	Google	0	20	12.5.
	Social media	0	40	25
	Words of mouth	50	40	37.5
	Public event	50	20	25
	Passing by	0	20	12.5.
Did you visit before you bought vegetables	Yes	66.7	20	37.5
	No	33.3	80	62.5
Price reasonability	Yes	100	100	100
	No	0	0	0
Percentage of diet consumption	<20%	100	20	50
	20-50%	0	40	25
	50-80%	0	40	25
Sources of daily consumption	From this organisation	0	75	37.5
	Local farmer's market	66.7	0	25
	Large supermarket	100	100	100
	Wherever cheap	0	25	12.5.
Trust in this organisation	(average score)	90	88	89
Perception between greenhouse and outdoor farming	Yes, there is a difference	100	100	100
	No	0	0	0
Perception on safety of community greenhouse production (free from chemicals and fertilisers)	Yes, they are safe	100	60	75
	No	0	20	12.5.
	I am not sure	0	20	12.5.
Perception on healthiness and tastiness of community greenhouse	Yes, they taste better	100	40	62.5
	No	0	40	25
	There is no difference	0	20	12.5.
Experience with vegetables grown in substrate	Yes	66.7	80	75
	No	33.3	20	25

1) MOTIVATIONS

The most common reasons involved in community-based greenhouse farming for the respondents are (1) education and learning; (2)socialisation; (3) environmental concerns and climate change, although volunteers at OudeBeer were particularly driven by "solidarity against industrialised food". Besides, respondents also identified strongly with reasons for "mental and physical health" and "nature/spiritual experience".



We know that people usually are involved in CBIs in order to deal with a specific or a range of social crises (Glover et al., 2005, p. 80), Seyfang (2007) employs Mary Douglas' Cultural Theory to differentiate a range of behaviours and values on sustainable consumption as a simplified heuristic tool. She identifies three types of social actors: (1) *hierarchists*, who relate sustainable food with a higher social status symbol where high prices are associated with better quality, therefore promoting a divided social structure where elite culture is a way to exclude others. Among communities, there could also exist "defensive localism" (p. 111), preserving conservative values of local history and tradition; (2) *egalitarians***,** who perceive nature as a vulnerable entity would favour local products that respect the environment, participatory democracy for collective decisions, and more control in food production processes. As such, egalitarians would oppose mass produce in supermarkets and wish to form an intimate relationship between consumers and producers, encouraging social networking during economical transactions (p. 110). (3) *individualists* are hedonistic and market-driven. They are concerned about the apparent health benefits, better tastes, nutrition and food safety. They are however indifferent towards environmental benefits, promoting green economic growth only due to the competitive pricing (p. 112).

From our research, we could observe that respondents could be associated strongly with *egalitarians* in terms of relocalising the food chain, they have a high environmental consciousness and limit their environmental impacts through behaviour change.

> " *I was really inspired by Grow Your Own Veggies and do it in a natural way. Especially direct, close supply chain"*

" Those are really people that that care for the environment that only want to produce organic that really wants to use almost all of their gardens, not just 50%. All of the gardens for urban farming"
" But if I would put more effort in it. I think I could even buy less from supermarket that would that would go my personal dream would be to never need them again"
"When I was nine years old, I already had the dream to be self-sufficient"

In addition, these respondents valued the personal interactions with the consumers and green economic growth. They have expressed strong abomination towards industrialised mass produce, instead, they aimed to propagate food without toxic protection agents or artificial fertilisers, for a fair price with a fair reward for growers, and with as few intermediaries as possible (participant 43).

"I hope that changing narratives about valuable foods, we can also be that way is sustainable finances"
"I think that it is a bad cycle if they purchase extremely cheap vegetables from supermarkets, they put good money for bad use. People do not consider the environmental costs and social costs where so many people get cancers from the chemicals in those vegetables. The food narrative must change and the social system should support it, our society should not encourage consumerism"

Further, some respondents also appealed for the health benefits and climate conditions of community-based greenhouses. To some extent, they could be categorised as *individualists*, motivated largely by personal reasons and less by environmental awareness.

"Because everything here is organic"
"My father already had passed away, he had cancer, because of his cancer he searched for biological food"
"I chose to grow here because Surinamese vegetables don't grow outside"
"It's the only thing all I want to see or smell, feel, plant greens and meet people. I can only sit here and do nothing. It's so beautiful. We can take them when the vegetables are ready, we can take it at home. So I eat biologic. So what do I want more?"

Arguably, residents living in the Oosterwold community could be grouped under *hierarchists*. Although they may not necessarily perceive themselves to have a higher status symbol, they have the freedom to design their own living spaces, sewage and water systems, and control methods of food production which is mainly for self-consumption. As such, it differentiates from other communities in the Netherlands since such a social project is not possible elsewhere in the country.

"We wanted to go out out of the city, we wanted to be in the community, and to live really, really live together with the people around us and really connect and really share about things and still have nice, spacious house, big garden"
"I came here because there was more freedom here, that wasn't possible anywhere else in Holland. So it's a very unique project. And I always wanted to have a big garden for vegetables next to my house"

2) PARTICIPATION AND INCLUSIVITY

According to M.E. Warren (2001), voluntary associations have three impacts. Firstly, the *developmental effect* is associated with collective participation, cooperation is a necessary social process in a voluntary association for participants to share their crop cultivation success and organise recreational activities. Such effect is also related to the social justice aspect of improved access to information and effective participation (Hamstead & Quinn, 2005, p. 146). It could also indirectly enhance trust and social attachments, influencing the establishment of the social project. In return, participants could cultivate political capabilities, taking into consideration of civic values, such as social justice and the common good, public speaking skills, community membership and care towards others (Glover et al., 2005, p. 77).

In terms of interaction with the local community, De OudeBeer has organised many activities with the immigrants, who mostly come from the Middle East, some of the vegetables were also planted by these people. It offers a social space where immigrants can exchange ideas with the Dutch people and also increase their social status in Holland (participant 41). At De OudeBeer, its operating principle is going against the capitalistic values, instead, it focuses on the fun, slow, and healing effects of growing food. As such, the volunteers are developing their own ideological social ideas and individual autonomy (Glover et al., 2005).

> *"Our volunteers makes the tea break into a real party, often with homemade cakes or a soup made from our own greenhouse vegetables"*
>
> *"Many people experience an emptiness in their lives because we have to meet the hectic expectations of our performance- and money-oriented society. With vegetable gardening you go back to the basics of our existence"*

In fact, in the example of De OudeBeer, volunteers have become the *co-intiators* of services with many forms of cooperation being made possible, such as handicapped people working at a large market nearby could share allotments at OudeBeer free of charge to grow their food; OudeBeer horticultural specialist also has his vegetable business, he doesn't pay his own allotment but distributes knowledge and guidance to the organisation in return (participant 41).

> *"Somebody grows, cacti or mushrooms, or somebody else just wants to do the technical stuff like building furniture or so everybody can find something they want. There's a place for initiative and experiment"*
>
> *"I did organise a reading last week for the garden, people who wants to know everything about medicine and plants. There's a botanist here to tell everything about plants and their good things"*

Our survey responses show that more than half of the volunteers working among these four different organisations are over 50 years old; retired and unemployed respondents have occupied 46.7% of the survey group. By bridging with different social actors and especially including vulnerable social groups, the community-based greenhouse as a social niche could turn into an empowering source of innovative diversity for initiating different social activities.

> *"Customers come and purchase in our store are offered with special tours, so that they know where their vegetables are grown and people like that very much, especially children"*

"They also do that discussion and interaction with all the volunteers that work in the greenhouse. And we also ask people at the shop, what are people interested in, what do they want for life? And can we sell that? So that's how we make our choices"

We can observe that our studied organisations take into consideration of consumer interests, and offer interactive learning opportunities to the public. Since it is crucial that social organisations represent the interest of their wider communities and do not exist as exclusive, solitary entities.

However, from the results of our survey, only 10% of the respondents (including paid employees) commit almost daily, 80% have volunteered one to several times a week. As result, there is a lack of full-time commitments and available time between the project leader and volunteers, and also among each other. Although voluntary associations should not be fully market-driven, factors such as sharing information and transparency are the basis of inclusive participation and long-term operational ability. From the survey responses, a high percentage of respondents regarded "effective organisational leadership", "good relationship with colleagues", and "democratic management" as driving factors to influence the efficient performance of the greenhouse.

" I think it's, the whole project would maybe work better if there were more volunteers, that's to be more committed in taking more responsibility, or got someone with the whole week here to have a good overview over what is going on"

"We work with only volunteers. I think some professionals on payroll who lead the project would give the greenhouse more structure and would make it functioning more efficient"

"Communication between farmer, volunteers and markets. And evaluation right after harvesting"

Secondly, *public sphere impact* is when the social project offers a platform for citizens to get involved and get to know each others' motivations and opinions, thus providing an alternative social infrastructure outside the government and market socialisations (Glover et al., 2005, p. 78). CBIs are regarded as a "third place" (p. 79) for socialisation, which is outside the normal work and home circles of the volunteers.

At Onze for example, it has the highest score (*87 out of 100*) of international diversity rated by the respondents since the majority of growers have immigrating backgrounds.

"Contacts with different people, different cultures and having contact as you would normally not have in your own socialisation"

"I think this place is quite international here, different cultures like Dutch people of course, Suriname, Indian, and also Asians, we also saw some Turkish people"

Furthermore, we could observe in general there is a low level of hierarchy among the internal organisational structure in all of our four cases, allowing volunteers to directly participate in decision-making (Smith, 2000, referenced by Glover et al. 2005, p. 80).

"The members are the owner of the organisation. The members can advice the board, so the board will make proposals, and the members can vote on it. So that decides the direction of the cooperative"

"With the vegetables and herbs, that's very driven from our volunteers and the more standard way of growing crops, they learn from this"

It should be noticed that most of the respondents have learnt agricultural practices through self-education (60%) and families (43.3%), and only a few did professional training or worked in ecology-related fields (6.7%).

"*I think ninety percent of people here don't have no idea what they were doing when they started, but it is also important to figure out yourself, which is the best way to learn"*

"What we try to do is to take away the pressure by indicating that we are working with non-professionals. We're working with nature"

To some extent, several respondents viewed themselves and their organisations as "knowing less" with limited time and resources available. In the survey responses, they anticipated practical guidance and quantifiable data from the greenhouse experts, academic institutions and specialists concerning pest management, biodiversity and soil healthiness.

"We should increase vigilance on ecological processes and increase knowldege on ecological affairs. We should invite more experts on soil and ecology and make even more efforts to share our experience"

"But we have no data points, we can't measure anything really, except how acidic soil is we could measure that…Also, we won't have time, we also don't have the knowledge"

"If we would have some people here also, ecological experts who could tell us about the creatures, there's a lot happening simply that you don't know about and anything could be suddenly become a threat"

Thirdly, the *institutional effect* represents the political voice in a voluntary association, carried democratically. In BoereGoed, its organisation has strong social objectives where mainly handicapped people and volunteers support its daily operations. Subsequently, its moral criteria indirectly influence the local community to purchase its products because they can help people that are not able to work in normal work settings. Greenhouse companies are also attracted by BoereGoed's social agenda (participant 44). In addition, local governments have also visited De OudeBeer for advice in the surrounding local environment.

"There are a lot of support from big enterprises and big industries, also companies that are in the mainstream of growing, very intense way of growing, they're still thinking about well, what's in the future and they are sympathetic about our way of working and they are also interested in how we do it, they want to learn from us. So they are really supporters"

"Making connections between people and groups outside, that mainly my work, and telling the story over and over about our beliefs and our credos, what we believe in, we have to tell with the volunteers, also with the customers, with the governors coming in, so that's my job to make the best way in my role to support BoereGoed"

Regarding our case studies, one organisation has explicitly stated they have received financial support from the government to realise their strategic plans, another has received advice from the local authority.

"W*e have received subsidies funding for building the manual, the app that's around 50,000 euros. We also need a central place that we will we're discussing with the local authorities is that we want to have a cooling system there as well so we can extend our deliveries for certain for certain products, maybe even throughout the year"*

„But they are very sympathetic towards us and also for how to get permits etc, they are supportive"

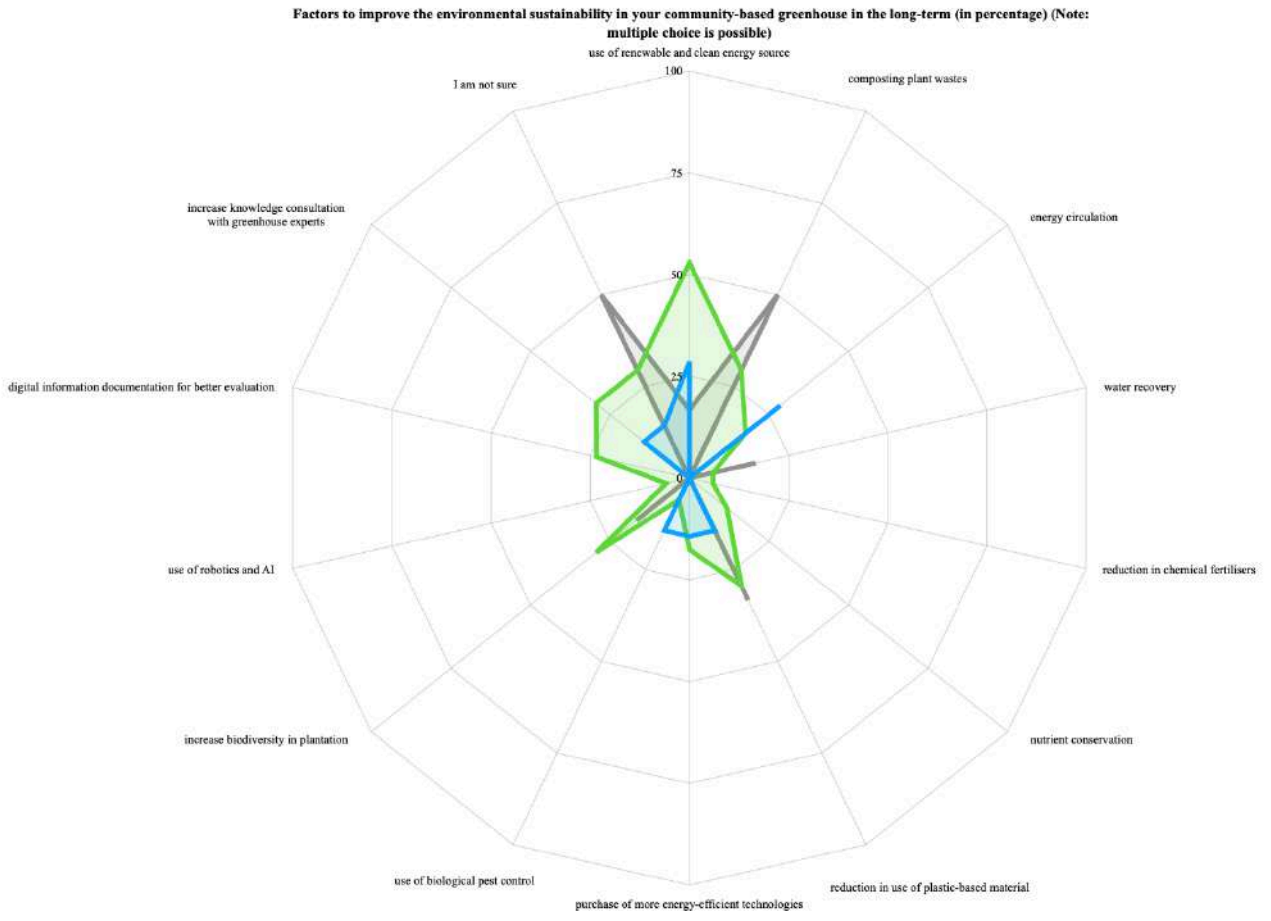
However, most of them do not attempt to become dependent on governmental funding, wishing more interactions and support instead.

"We will be able to sustain ourselves. So we don't need annual subsidies in order to continue, for example, over three, five to ten years"

"Promotion in general and more support and better facilities from local government"

3) SUSTAINABILITY AND TECHNOLOGY

Every community-based greenhouse has its own way of sustainable practices, in general, our study shows that they work with nature by maintaining a balance between biodiversity and volume, harvesting natural seasonal produce, creating a better micro-climate, and using biological compost.



Greenhouse Design

All of these three greenhouses are at least 30 years old, inherited from the previous commercial growers. Two of them have indicated that some of their mechanical parts are rusty and the glass panels are leaky at times. They also needed to clean their side panels from time to time. In the Oosterwold community, greenhouse growers have more freedom to select the type of greenhouse design, most were built from second-hand materials.

> *"A greenhouse, if you want to do it right. Like this greenhouse, I think it was about 25,000 euros. I couldn't pay it now"*
>
> *"I made this from PVC. And I bend it in boiling water, and then flatten it with an angle. And then you can screw it together"*
>
> *"It was relatively inexpensive, but it is still very expensive. It's all secondhand materials. So from the greenhouses that in our neighbourhoods in Rotterdam and they have really big greenhouses. They just use materials and build smaller greenhouses"*

Due to their "closed-air" nature, greenhouses are vulnerable to heat stress, more than 30% of the respondents have complained of the inner high temperature and ventilation problems in the summer. In wintertime, unheated greenhouses could be just as freezing as outside and lack of lighting.

> "I*n the winter because of the climate, we switch to more Dutch vegetables"*
>
> *"The biggest problem in the wintertime here is the lack of light. So no matter how cold or how warm it is, there's not enough light and then the plants won't grow"*
>
> *"If you are in the winter, you also need to water because there is no water inside of course. And if you don't water the ground, the ground will die"*

Another problem is the location of community-based greenhouses, especially at Oudebeer it expresses the concern that being close to the roads and traffic would damage its organisational image. A respondent from Oudebeer has suggested that "*I wish the greenhouse is more based in the community city"*.

> *"We had also customers that were not buying veggies from the farm a little bit further. Because of the cars and also the railway roads. The pollution is also coming on the roof and with rainwater is coming, at the end, it's also coming in. It's not perfect but it is what it is"*

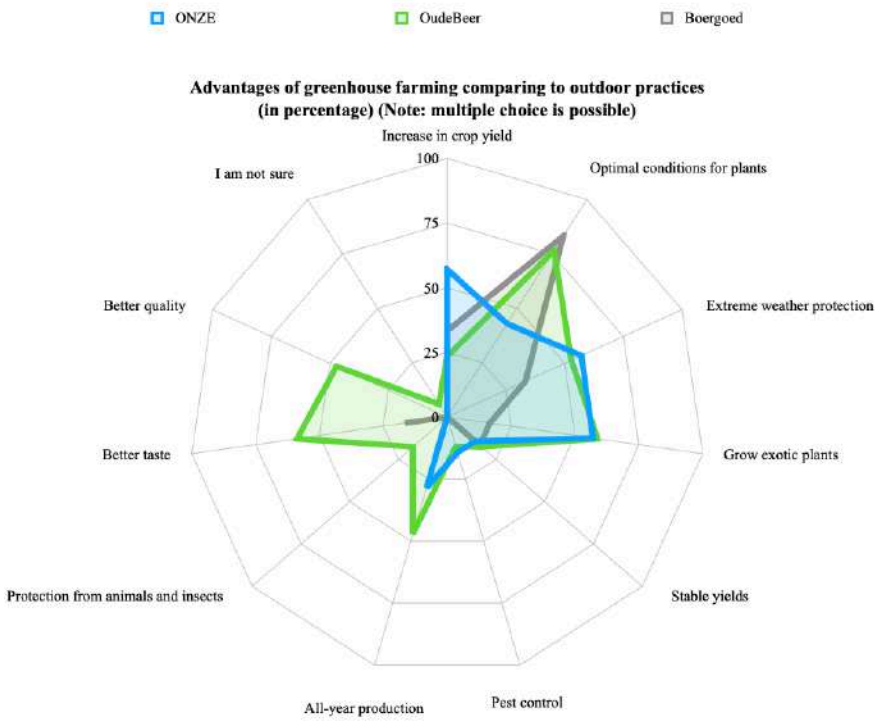
Pest Management

One of the biggest problems encountered by all four organisations is snails and occasionally mice invasions. Although at Onze and BoereGoed, biological agents have been introduced, snails are a really difficult problem to get in control of biologically, because they do not have small natural enemies. At Onze, it is mostly dependent on decisions taken by the individual growers, for example:

> *"Birds help problems like snails or a butterfly catches it and release them outside"*
>
> *"There's some eggshell here for the snails, because they don't like sharp things"*
>
> *"For the snails we use biological chemical from Ecostyle, where the snails would want to sleep and die somewhere else"*

At BoereGoed, with 66.7% of volunteers involved with packing, sales and delivery, it has the largest production amount among our case studies and takes a different approach:

"We try not to use chemical products, but sometimes we are forced to, when the predators are too heavy, we cannot control in biological ways, then we have to on a minimum scale using chemical"



In contrast, the founder of De OudeBeer was hoping that creatures would come inside by themselves to fix problems, where "*people are part of the life, the plants are. The insects are even the mice are, everything's part of life that's within these walls"* (participant 41). Consequently, OudeBeer does not use any biological control agents and instead, fixes a small pond in the field for amphibians to flourish which could predate slugs and insects.

> "*Another experimental example was that previously where butterflies ate our tomatoes, by integrating more flowers we have also attracted butterflies to drink from nectars instead"*

At Oosterwold, they accept the presence of pests and refer to them as "little neighbours":

> "Y*ou give a small percentage of what you do you give to the animals, to the environment, to our little neighbours"*
>
> *"And if I have them, it means something is not right in the biodiversity. So I tried to plant good neighbours. If you put another plant And next to it. They make each other stronger"*

Soil Management

A large percentage of respondents (especially at OudeBeer) related soil-based greenhouse production to better taste and better quality. A large pile of leaves was being collected from the public park in the autumn

for biological compost, which is good for worms to digest the organic matter and prevent calcification by sealing the ground. As result, the soil at OudeBeer has transformed into heavy clay, almost concrete-like. Although the disadvantage is that the soil needs constant attention otherwise it hardens. On the ground, they have also put wooden chips to keep the weeds out to be more space-efficient, they also inserted buckets on the ground. More importantly, at OudeBeer they did not want to create straight lines, but natural crooked pathways, which are better for the micro-climate.

At Onze and Oosterwold communities, they are mostly dependent on the self-management and environmental consciousness of individual growers. At Onze there is a central station where "*all the green waste we collect, we compost them and we hand back to the company that makes the compost"*. At Oosterwold, there is greater diversification of soil management: some residents would utilise pigs to digest the vegetable surplus; some utilised cotton where "*a nice lawn can be covered with cotton with some ground, some compost on it, even a small layer. After two months time you've got the best garden bed that you can imagine without any weeds, but very, very fertile"*; some have taken a more laissez-faire approach where "*nature take its course, we don't have any fungus problems. When human take over, there was dis-balance";* Others would "*just buy really big piles of bio approved compost for a good price"*.

At BoereGoed, approximately 30% of the respondents opinionated that the "health of soil" and "available space efficiency" could be improved in the future. It has been experimenting with crop rotation methods, "*now we make a lot of changes in growing our crops, so we do not go one big plot of cauliflower, that cauliflower changes with other crops and then another part of cauliflower"*.

Water and Energy Management

There has not been a specific *water recycling management* being implemented in these three community-based greenhouses, at BoereGoed and OudeBeer, lack of sufficient scale and technical facilities have deterred them from doing so. However, at the Oosterwold community, a large number of privately owned greenhouse growers collected rainwater or from nearby water resources.

> *"Because climate change in Holland is also happening a lot, for example there are more dry seasons like now. And if there is rain, there's a lot of rain. But drinking water we do not use"*
> *"Since last year we have the pond here now. So I can get water from here as well. And we have river near the road, they keep it a certain level. So I can get water from there as well"*

Concerning *energy consumption*, we should not only focus on food production, how foods are processed (packaged and delivered) is also an equally important assessment aspect (Veen & Dagevos, 2020, p. 7). At BoereGoed in particular, due to its logistics structure (individual customer routes, storage and cooling), "*the air-conditioning temperature is about 16 degree, and inner storeroom for strawberries and blueberries the temperature is about 6 degree"*. For delivery, the organisation "*[tried] to work with electronic vehicle. It's not 100% but we do in little steps, delivery by bike"*. At OudeBeer, its computer-controlled system was implemented by the next-door commercial grower, if the temperature goes below 4 degrees, the heater would pump natural gas to warm up the greenhouse. However, since to an extent it is dependent on the

neighbouring commercial grower, it has also created some frictions between the two parties regarding the usage of chemicals and soil management.

In addition, nearly a quarter of the respondents were concerned about the *use of plastic-based materials* in their greenhouses.

> *"We try to make it as low as possible, for example the boxes from our website, and we use paper wrapping as much as possible. On some products is more for the quality, better to have plastic, but we can try to use more sustainable packaging. But we need to pay attention for that, yes"*

Crop Management

From the author's observance, tomatoes, cucumbers, peppers and beans are the most common crops grown in the case studies.

> "*Tomatoes don't really grow in the Dutch climate most of the time, and here you have a controlled environment. Outside there are all kinds of animals, mice and birds that eat your seeds"*
> *"And in the summertime, tomatoes, they're not supposed to get wet because of the rain, then they will rot. So inside it's very hot can be like 50 degrees. It's very good for tomatoes"*
> *"With salads, It's possible to have whole-year production. And some beans*"

At Oudebeer, yacon (tuberous roots from Latin America) and chilli peppers are their identity crops; similarly, at BoereGoed, they also have been experimenting with "forgotten vegetables", those that "*supermarkets are not usually interested in supplying them even though they are really beneficial for your immune system"*; and at the Oosterwold community, a more diversified range of crops were cultivated due to growers' personal preferences. However, not all types of crops are grown in these greenhouses due to limited space and pest-control problems.

> *" And some vegetables I just won't grow because they take too much space like potatoes. And they are very sensitive for pests. So I better buy them in the organic supermarkets"*
> *"We have the potatoes, we have sunflower roots, and yacon. We have tried grains once. But it's not enough to get all the calories"*

Concerning its *consumption volumes,* our survey shows that 76.7% of the respondents' diets (<50% of his/her total consumption pattern) were based on greenhouse production. Similarly, in our consumers' survey, 75% of the customers' diets (<50% of his/her total consumption pattern) were based on the production. Noticeably, there has not yet been a single respondent that based his/her diet 100% on the production.

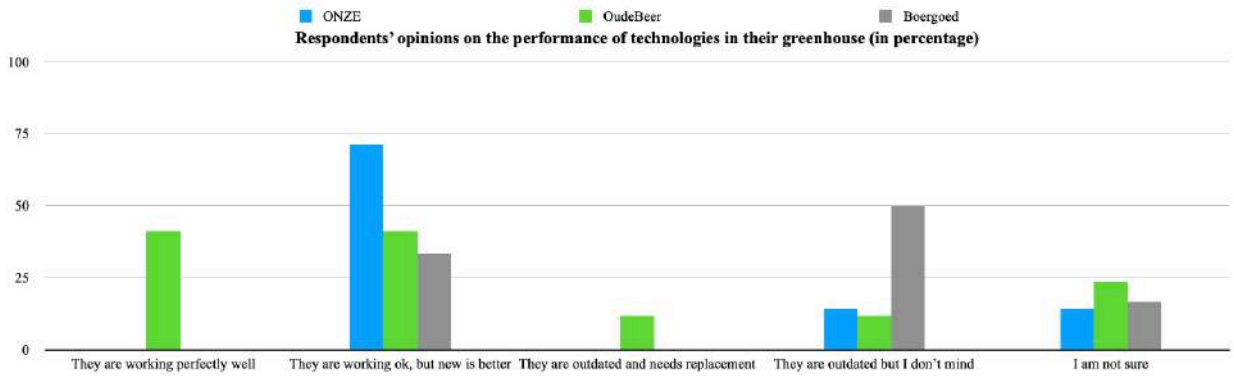
> *"Not much, because what's coming out of the ground is think for six persons for about two meals. It's just a hobby. It's not really meant to feed persons is just this a hobby and what comes up the ground, comes out the grounds"*
> *"This time in May, actually there's very little to eat from because most of the things are just too small, but from May on till October, we have really a lot of things"*

Generally speaking, this section focuses on *biophysical environment sustainability*. Snails and bugs are still a huge challenge for organic greenhouse production. Further, maintaining good soil structure is a challenge for

these greenhouses since it takes a relatively longer time to restructure. Although there are a great variety of crops already being cultivated, including rare species, there are limitations to growing staple foods. Another big obstacle is the use of energy-efficient, closed-loop technologies and materials, several respondents have indicated:

> *"I would like a closed waste cycle with compost processing; switch to vegetable fertilization; kitchen nearby to process products"*
>
> *"The use of plastic and water can also be greatly reduced, with a view to sustainability"*

The average sustainability score is relatively weak with 68.7 (*out of 100*) rated by our respondents, with more than a quarter suggesting to increase the "use of renewable and clean energy source". Recommendations to "increase biodiversity in plantation" also occupied a relatively high percentage. Further, 50% of respondents from BoereGoed hoped for "composting plant wastes" and nearly a quarter of respondents from OudeBeer wished to "increase knowledge consultation with greenhouse experts", as well as "digital information documentation for better evaluation". Interestingly, nearly no respondent aimed for the "use of AI/robots" since *"it's far out of reach, it's very expensive, and quite dependent on knowledge*" (participant 27).



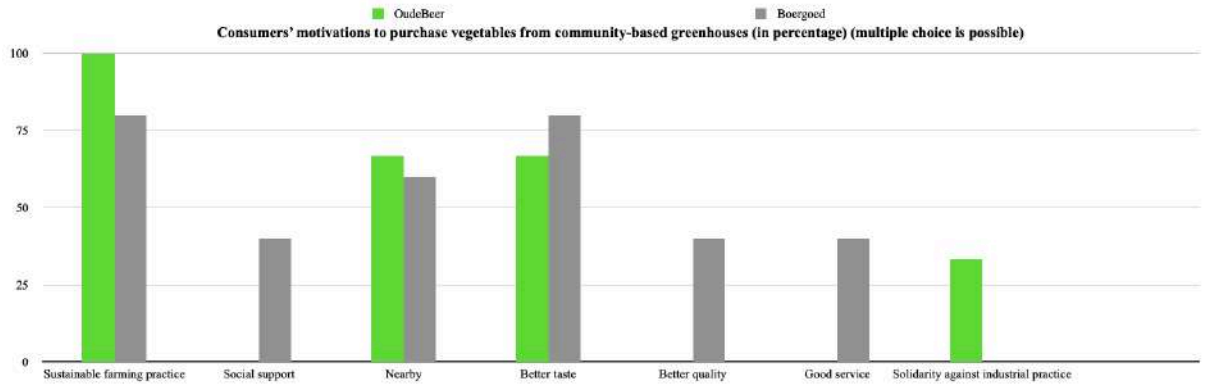
4) OPPORTUNITIES

Considering the current global pandemic and economic crisis, frequent natural disasters and even regional wars, community strength is becoming increasingly relevant with its capacity building and even ensuring *local food security*.

> "A *lot greenhouse companies are on the verge of bankruptcy that will make space for opportunities"*
>
> *"This year I'm trying to keep everything in the freezer because of the economics"*

As such, we could observe that our current global situation could potentially lead to spatial planning problems with an increased number of vacant commercial greenhouses. It is an opportunity to continuously maintain a sustainable level of productivity by leasing out to small community initiatives (Van Veenhuizen & Danso, 2007).

"*Mostly here (Westland) are SMEs growers and they do not make money like the large greenhouses, so they usually rent to others or plant pot plants and flowers here, there is also a rise in community-based greenhouses"*



Besides the most frequently discussed non-food benefits in CBIs, there is also a need to address the actual food benefits (Veen & Dagevos, 2020). In our research, 62.5% of consumers believed community-based greenhouse production tastes better and 75% believed it is safe to eat (free from chemicals). Among the volunteers and growers, quite a few commented on its *tastiness* and *safety*:

"Everyone told me the taste is stronger"

"So sometimes when I buy something in the supermarkets it feels more, for example, with tomatoes is more watery, and less tasty. I noticed. I think most of the normal veggies are tend to grow fast"

"Many diseases like Parkinson and cancers were caused by chemicals in our food. For example, the chemicals that they put in broccolis can destroy the weeds but the broccolis also become chemical-resistant"

In addition, a few respondents emphasised on its rich *nutritional benefits*, especially due to the ability of greenhouse to grow exotic plants:

"Especially if you had some wild plants, you would get a very rich nutrition bomb, it's very hard to buy in the store. Because you would need like for instance, with salad, you would need to buy a lot more salad to get the same amount in the store"

"So every herb has its own health working, you can eat them or you can make tea out of it for your body health"

The greenhouse was perceived by the respondents as "*a hostile environment"* where some varieties of crops could grow "*twenty times larger than their wild species"*. Given the *physical conditions* of the greenhouse, over half of our respondents agreed that it provides „optimal conditions for plants" where the season could start faster, growers could cultivate exotic species, and it offers a safe space to protect crops from extreme weather with a stable yield throughout the year.

"We don't go to Surinamese markets any more"

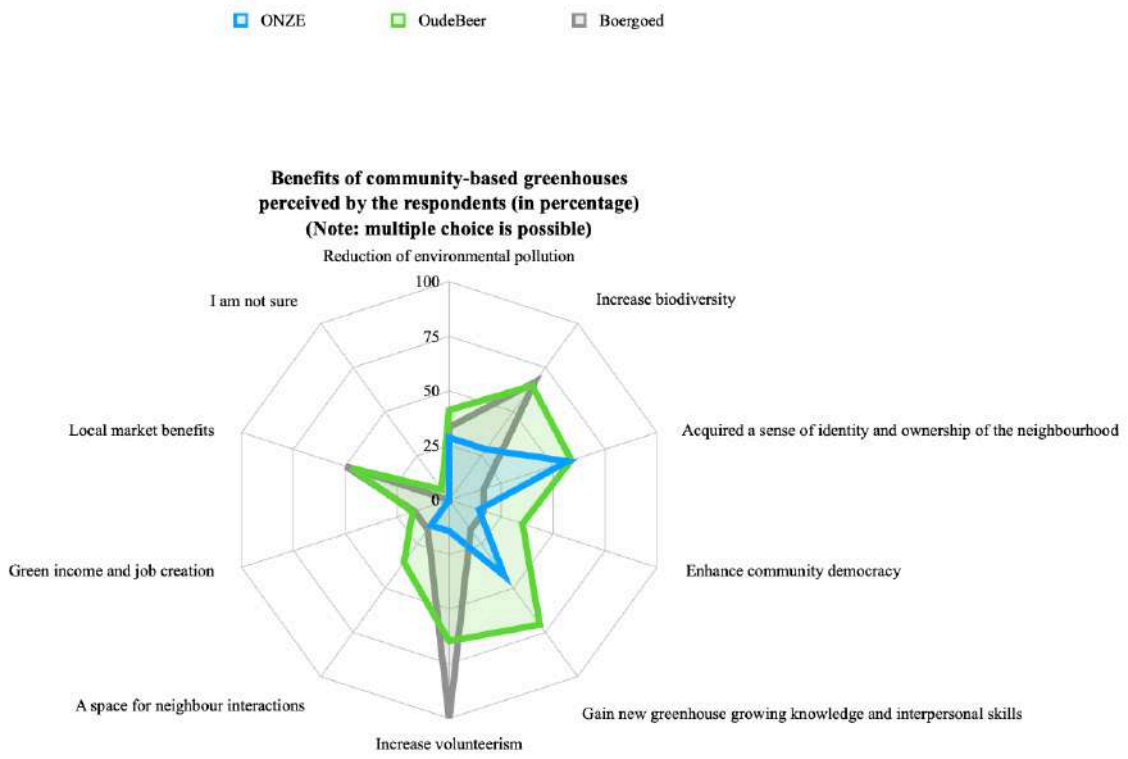
"So we can have exotic ones. We can have local ones. We can have old races, which are almost forgotten, which also try to incorporate the biodiversity basically"

Furthermore, another unique market opportunity is that the community-based greenhouse extensively shortens the *supply chain* through direct sales. Customers are more lenient on the end products and would like to pay higher, not necessarily because they would ask for it "*but people nowadays they really like production from their areas, instead of it was grown somewhere in the south of France and it was transported with a truck or maybe even flown from Morocco or whatever"*. Besides, 36.7% identified community-based greenhouse with "local market benefits", 26.7% of the respondents opinionated it could provide "a space for neighbour interactions" and 13.3% related it with "green income and job creation".

"And for my sister, it is therapy. She loves to see if she can create a product line"

"Maybe if we have some leftover, we sell it in a shop that we want to put here on the streets"

"I came up with the idea to make a garden here for this community. I mean, they are my neighbors and my friends and they pay me for it. And I just feel much more connected"



To sum up, in terms of different types of *community capital* this thesis has discussed, we could identify *cultural capital* where an individual contributes uniquely to the local communities, with 53.3% of the respondents "gained new greenhouse growing knowledge and interpersonal skills".

"*Like personally, I know I have changed a lot about my habits, but I also still have things to change"*

"Because more you learn, you know that you know nothing, it's so much it's so much information and every time you learn a little bit"

At Onze where Surinamese people have formed the majority, we can see that the inherent communal nature of these greenhouses, *"possible cultural diversity is really important to have it in this context"*. In terms of *social capital*, 60% of our respondents acknowledged that community-based greenhouses contribute to an increase in volunteerism. In return, community-based projects attribute to solidarity-building by enhancing *bonding capital*, 30% of the respondents have "acquired a sense of identity and ownership of the neighbourhood". Generally, we could see the respondents favoured an economic de-growth, especially at OudeBeer, over 64.7% of its respondents were motivated to participate due to "solidarity against industrialised food" and the capitalist system of power relation and exploitation. In this context, residents mutually enhance each other through group interactions and therefore regain the control of food production (Veen & Dagevos, 2020, p. 4).

> *"It doesn't have to be perfect right away, you can take time to learn and to do better and follow through crises and try things and other way. Instead of the corporate world where everything has to be perfect and efficient and right on target, and fast. I think things are a lot slower here"*

In terms of *financial capital,* there is potential to satisfy local demands with a high level of community support, but production volume may continuously be a concern.

> *"But if we have really a lot of vegetables, maybe we could do that"*

At Oosterwold, it was mentioned that urban farming could efficiently manage available space, for example, "*you can put things in between a normal farmer would never to do that. Because you have to drive with the tractor to it",* by paying higher attention per square meter of land, the community-based greenhouse has the potential to gain a competitive advantage than regular SMEs.

Nonetheless, there is still a needs to improve the *linking capital*, which is the ability to link vertically with higher authority and access to more resources and opportunities. Our respondents have recognised the particular urgency to collaborate with research facilities.

> *"I would like to know more about the chemistry of things…by inviting the experts who knows about food or about herbal medicine or that kind of thing"*

5) CHALLENGES

The first type of challenge is associated with *hard constraints*, such as technological, financial and physical limitations. In general, traditional land-based agricultural practices involve *intensive physical labor*, "*there are just too many works to do, plucking the weed, watering, leading the plant to grow on the vines",* which could deter volunteer long-term commitments and also poses a challenge for organisations to coordinate with limited resources and time.

> *"One project can involve many volunteers since there were high turnover rate, especially when in the beginning there was a lot of weeds and it was difficult to organise"*
>
> *"But I think there is not enough time for us to repair"*

Some of the bigger challenges for community-based greenhouses are *natural disasters*, such as storms or fires, it was said that previously at OudeBeer the whole greenhouse area was about 4000 square meters but 500 square meters were lost due to a fire accident.

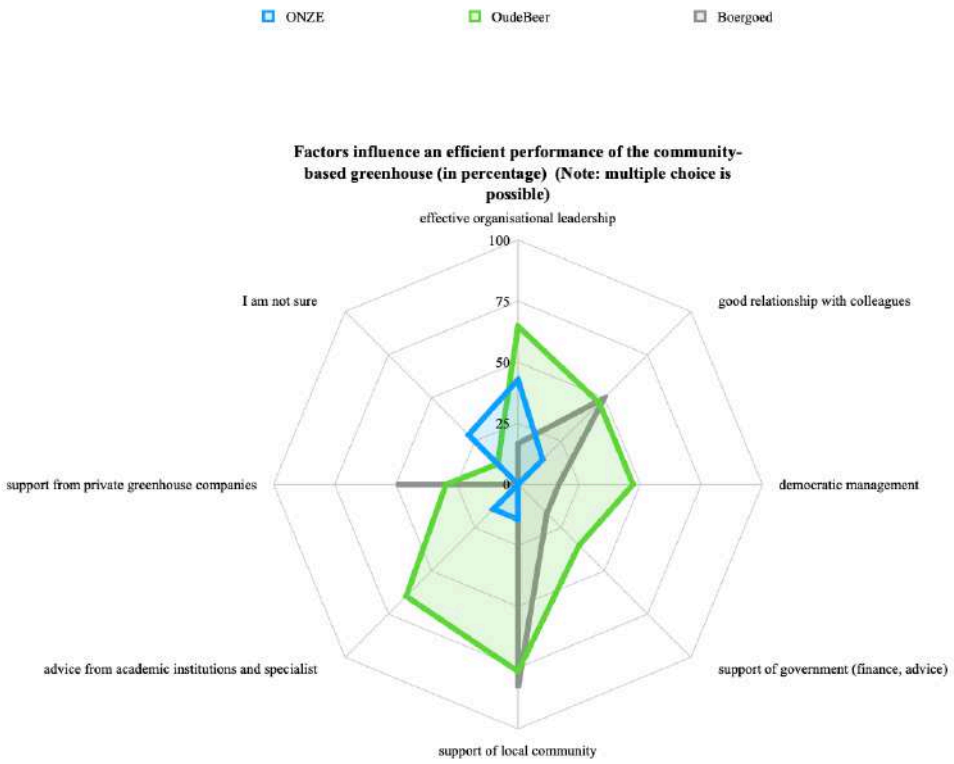
In terms of *technological developments*, there have been few connections between professional research and greenhouses in the communities. Several respondents have expressed the wish to cooperate with private greenhouse industries, expanding opportunities in the areas of low-cost adaptive facilities to further strengthen resource recycling management, as well as enterprise marketing strategies.

> "*People can buy via the internet, we did it half a year or something, but I think we didn't pay too much attention to it to make it work really good"*

Financially speaking, community-based greenhouses are not profit-oriented organisations, for example at BoereGoed, "*we are still making it breakeven*". In the Oosterwold community where residents grow vegetables as their part-time jobs for self-consumption purposes or the food cooperative, they have found it difficult to further develop as a full-time job due to economic inviability.

> "*I think I do want to make it my full-time job. But it's difficult because it doesn't pay much"*
>
> *"So much work. And the only benefit for me would be the price of crops would be sold at the supermarket for very low prices"*

However, the actual production values and costs in community-based greenhouses are difficult to measure quantitatively due to various factors: unwillingness to provide specific data, crop cultivation seasonality, and scattering methods of production (Van Veenhuizen & Danso, 2007, p. 29).



The second type of challenge is related to process-related *soft constraints*, such as community involvement, organisational management and governmental support. Specifically, 46.7% of our respondents acknowledged that there are *community support* but still lacks sufficient volunteers. One interviewee suggested that "*we are*

quite private as to all the things that we do in our households, so sharing a greenhouse facility will not be acceptable for older people" (participant 6). He also theorised that blue-collar workers might already be exhausted from their work and these initiatives are targeted more to "*a certain group of people who are into food and into health that sort of things"* (participant 6). Another respondent has remarked that in terms of *social-economic attitudes* of Dutch consumers, there have also not been enough social support for local products,

> "*The Netherlands are a more commercial society, trading, and not a country that's proud of their own products, maybe the sounds strange but I think it is"*

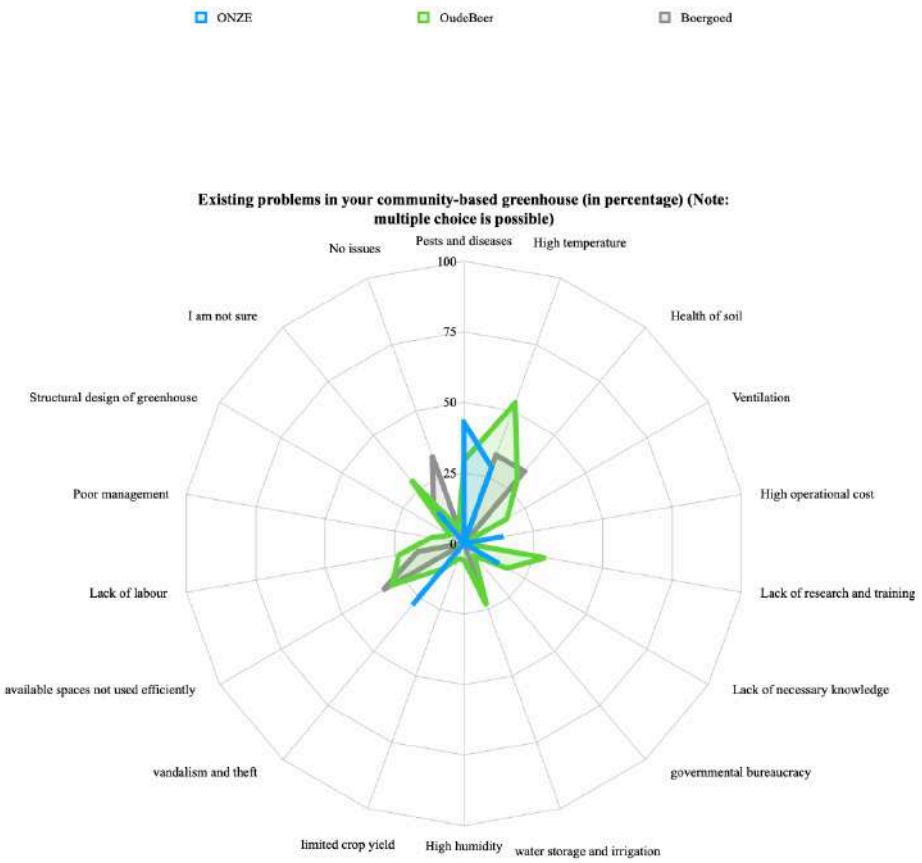
Another example could be seen at Oosterwold, where some of its residents lacked interest, information and time in producing their own agricultural products,

> "*About 10 to 20% just buys a plot of land, they do not want to have anything to do with it, just feels like I've got a nice place to build a big house fine with me; about 60-70%, they are interested, but it's also hard for them, they've got a job and they don't know how to do it, and they don't know how to where to bring the products and things like that"*

In terms of *organisational empowerment,* we could observe that our respondents have rated a relatively high score of 83.7 (*out of 100*) in terms of inclusion of vulnerable social groups and an intermediate score of 65.3 (*out of 100*) in terms of international diversity. As such, our case study communities are aware of diversifying race and/or class-based discrepancies (Artmann & Sartison, 2018) in participatory development. However, in terms of the daily operations of these greenhouses, two out of four case studies have pointed out *minor thefts and vandalism* problems where visitors took things without consent. At Onze, for example, most of the allotment gardens are fenced by wooden fences or metal wires, they are locked if the grower is not present, with the whole area being 24 hours monitored by security cameras.

Furthermore, the informal and incoherent legal status of urban agriculture has consequently created lots of insecurity and uncertainty of land tenure. An interviewee from the government sector has acknowledged that the primary goal of major Dutch cities is getting houses built (participant 6). So far, there has not been a legal definition by the government to specify the land category of "sustainable community" where people could "*initiate projects that create sustainable communities inside the cities and also immediately surrounding cities, that the connection between communities can start and the food and knowledge transfer can begin"* (participant 19). Since many community-based greenhouses are legally owned by the local governments, it may discourage or interrupt long-term voluntary commitments.

> *"So that's one of the objectives of when you develop city, it's not only buildings in particular but it's also agriculture"*



6) SCALABILITY

There is an emerging demand in the Global North, where consumers are paying more attention to the nutrition and qualities of food, as such, community-based greenhouses have offered a competitive product differentiation from industrial agricultural practices. In our case studies, each of them has projected special characteristics for different types of "scaling-up". At Oosterwold, its food cooperative decides the crop production quantity supplying to different outlets, individual responsible residents are in charge of growing a specific type of vegetable with an indicated quantity in the designated app the food cooperative has developed. By bridging the ties with Wageningen University, which made a report "Oosterwold residents are growing food for Almere", it has given the Oosterwold proof of concept that they can produce food for the supermarkets in Almere and that the Oosterwold cooperative is self-sustainable. As such, we could see the potential for Oosterwold food cooperative to *vertically* scale-up at a higher level of decision-making for wider impacts.

> "*It's taken me approximately two years to convince the local authority again, of the possibilities and the uniqueness of our area that they're really this is the what we're doing here has never been done anywhere in the world"*
>
> *"I'm quite convinced that we have the potential to compete with like, greenhouse industrial actors. With smaller quantities, which means that we know exactly the amount every week, we can deliver throughout the year throughout the season, at least not 12 times a year but 12 times a season"*

Further, we could observe that Oosterwold food cooperative actively mobilises its residents and resources, by connecting with external outlets outside the community and maintaining conductive relationships both with its residents and the supply chain.

"*What we do is we build up a good relationship, we keep you informed on what we're doing…are we able to deliver and we will let you know in time. If that's not sufficient, then we are not the right partners"*

"And if the price is not good enough, still good friends, you sell it to somebody else, because, you know, that's better for you"

Nonetheless, one researcher has raised concerns about the scalability of such a decentralised model, he questioned the reliability of vegetable quality, since one minor problem (e.g. one grower cheating with pesticides) could ruin the reputation of outlets at large (participant 7).

At Onze, it provides individual allotments and rents out to growers according to their plantation interests. Onze is especially internationally diversified with different ethnic groups by offering a protected environment to grow exotic plant species. Onze has a good relationship with its growers by providing direct expert feedback, workshops (twice a month on Saturdays), walking tours and equipment. Thus, Onze has the potential to scale up *horizontally* to reach wider areas by replicating the same initiative in numbers.

"*A colleague of mine has a garden (allotment) now, and family of my nephew is also has a garden (allotment) "*

"I think it's the only farm house in the Netherlands that you can grow at this scale"

At OudeBeer and BoereGoed, both have deep-rooted beliefs and values, which the former emphasises sustainable farming practices and the latter focuses on the provision of social care for vulnerable populations. They have the potential to scale up *deep* and further populate through participatory tools to enhance community trust and networking.

"After several years of operation, with more organic matters deposited at ground, it has fast consequences by enabling the organisation to make more executive choices, some volunteers are more regular and specific delegations can be given or initiated" (OudeBeer)

"This is a level of words by mouth and storytelling. The customers and civilians I think and also because of the social goals, we see that more and more people, maybe also their choices are influenced by what we do" (BoereGoed)

Furthermore, it is also an opportunity as a mode of "lead user innovation" (Von Hippel, 2005, referenced by Van der Schans, 2014, p. 4), by encouraging small-scale professional farmers to adopt this form of community-based practices, since they know the best about agriculture and its specific needs, compared to non-professional amateurs in our case studies.

"[by being] a bit more professional and it also attracts some other people"

Another leading opportunity for wider scalability of community-based greenhouses lies with *niche crop produce*. From our case studies, it could be observed that a majority of them produce the same crops as large-scale commercial greenhouses: tomatoes, cucumbers and peppers. Nonetheless, they have also differentiated themselves by planting medicinal herbs and rare, exotic species. In the example of Onze, Surinamese crops have gradually become its brand identity since the imported Surinamese vegetables are usually of poor quality and transported by containers, with no supervision inspected on the use of pesticides (participant 7). Additionally, Onze also sells Surinamese-recipe dried banana chips in its store as a value-added product.

"And we are inter-ethnic groups, or I think we tend to search for the people that we know that the habits that we know" (participant 6)

"I think we have more than 150 cultures in the city. And a lot of these groups want to produce food that comes from the origin, but then certain ingredients are not for sale during the whole year what we observe is that people would like to get involved to produce it themselves" (participant 7)

Table 9: Types of crops observed in the case studies (note: this list is not exhaustive)

ONZE	Oosterwold	Oudebeer	BoereGoed
tomato	**tomato**	Yacon	edible flowers
cucumber	**cucumber**	chili peppers	strawberries
onion	**onion**	sichuan peppers	cauliflowers
lettuce	aubergine	Japanese wine berry	broccoli
bitter gourd	raddish	**beans**	**peppers**
peppers	chilli	celery	celery
Surinamese cabbage	melon	Egyptian onion	aubergine
aubergine	salads	lavender	**cucumbers**
beans	**peppers**	aloe vera	rhubarb
strawberries	herbs (tea, parsley, oregano, cilantro)	snow peas	root ball
	figs	cabbage	**broad bean**
	citrus fruits	white radish	potato
	beans	oregano	Other herbs
	coriander	sage	
	Pok Choy	fennel	
	spinach	red sorrel	
	beetroot	cardoon	
	grapes	Other herbs	
	edible flowers		
	cabbage		
	white sage		
	strawberries		
	carrots		
	rhubarb		
	zucchini		
	cherry tomatoes		

On one hand, one of the major obstacles to the wider scalability of CBIs outlined by our interviewees is *the legislative frameworks.* Several interviewees working in community-based gardens and permaculture complained about the layered governmental structure and the high payment for legal permissions,

"We make sure that we do not cease to exist…the money we get is not sufficient and incidental, we work hard to get the money from the government, then it will be gone already. They are very small amounts, and we receive on average one to two times a year" (participant 10)

"This is very basic measure of greenhouse and they had to pay for the fee for permission only without the cost of the greenhouse" (participant 19)

On the other hand, we could observe that CBIs for urban agriculture have impacted the government at the landscape level where "*the commissioners would like to learn the self-management and self-sustainable aspects of this neighbourhood"* (participant 18), and the Minister also does hold regular meetings to hear representative voices in the neighbourhoods (participant 10). As such, we could acknowledge that CBIs for urban agriculture are becoming a symbol of what is possible and attracting more attention at the governmental level.

Further, one of the most frequently discussed topics during the interviews was about meeting *food security* by community-based greenhouses. To some extent, their organic, high-quality produce is of higher price and could be demanded by restaurants to serve high-quality meals (participant 16), pessimist interviewee has critiqued these initiatives as "*rich people's toys and greenwashing, local community should not grow their own food"* (participant 12), where they could raise the food prices dramatically and affecting food equity to feed the world. Other interviewees suggested that community-based greenhouses could be viewed as a parallel development next to commercial agriculture to satisfy cities' food needs (participant 8). Most of the interviewees agreed that these social initiatives are important in raising awareness about the way food is produced and in providing contact with the nature as an alternative system of food network, "*for instance having schools into the farm…also for where people can enjoy in the front"* (participant 8).

7) CULTURAL SENSITIVITIES

It is important to transfer models with a degree of flexibility and allow communities to build their own local capacities (Forsyth, 2014), therefore, the future direction of CBIs would also need to examine going beyond the place-specific view of sustainability (Köhler et al., 2019).

Firstly, most countries have different *climates* from the Netherlands, one greenhouse expert remarked that "*90% it's not the same solution as we do in Holland, so we can't make a copy to Asia or to Africa"*, even in America where the climate is similar, „*they have snow but we don't in Holland, the construction we also have to cope with that"* (participant 9). Further, another architect has contrasted Mediterranean regions with the Netherlands, the former has more sunlights and subsequently uses higher amounts of solar energy as well as cooling devices for ventilation purposes, which are affecting the cost of production; the latter could cool down the greenhouse temperature by natural ventilation. Thus, *greenhouse designs* also need to accommodate appropriate climate systems (participant 8).

Besides climate conditions, cross-country greenhouse models must also consider *socio-economic differences,* for example, Dutch people mainly consume tomatoes, cucumbers and peppers without much variation in their diets; in other places, the *diet habits* of the people could change drastically and be more varied (participant 8). Another discrepancy is the *social purpose* of community-based greenhouses, in the Netherlands, most of our respondents are involved for hobby and well-being purposes:

> *"I walk outside and also there I look. What's that? And how can I use it? Can I eat it? …But when you learn about it, you look at them with another eyes. And then you see a lot of edible plants"*

Whereas in Africa, for example, its governments are supporting greenhouse projects to feed more people by having "*more kilograms per square meter to feed everyone"* (participant 9). As such, the focus is on production efficiency and food security.

Another barrier to transferring Dutch greenhouse (commercial/community-based) models is *technological availability*. Although some Dutch greenhouse consultancy companies are readily involved in knowledge transfer overseas, "*we visit one or two growers in the afternoon, teach in a subject. And then next time we do the same thing with other subjects. We explained it over there. So it's practical, theoretical, that's what we do"* (participant 9). However in developing countries, it is argued that greenhouse "*would be really not necessary and it will be more energy-consuming than being really beneficial for the people"* (participant 8). For example in Africa, people are using plastic tunnels as a cheaper alternative instead of constructing a new greenhouse with steel and aluminium glass. "*In a period like now, where the steel the prices are sky high, in the buildings that you're constructing, it will account for five to 10% more expected spend on your building. So this is an economical constraint"* (participant 8). Nonetheless, it would still be an opportunity if the structural design of the greenhouse could be dismantled easily by mechanical parts and reconstructed in developing countries with zero waste for construction (participant 8).

Synthesis and Discussion

From an STS perspective, we recognise that our current foodscape is a process in the making, a contested space with multi-actor interactions, and uncertainties are filled with new opportunities and challenges at the same time (Spaargaren et al., 2012). In this section, we are going to discuss our data findings in response to the original *research questions*.

Firstly, concerning the visions and expectations of the relevant social groups, volunteers/growers involved have high environmental consciousness, seek social justice and democratic organisational structures, and appeal for the health benefits of organic agricultural produce. Specifically, this research has demonstrated that contrary to supporting the globalisation of food production, which travels over huge temporal-spatial dimensions, community-based greenhouse growers/volunteers seek to re-connect social relationships through participating in traditional land-based agricultural practices. We must also accept the fact that Earth is an enclosed system where unlimited economic growth should be regarded as the "antithesis of success" in our finite ecological system (Cui & Smit, 1993, pp. 143–144). Most people hoped to limit their impacts through behaviour change in consumption and achieve food self-sufficiency through physical labour. Several also have expressed strong opinions against artificial fertilisers and chemical pesticides, and were aspired to consume better quality products in terms of aroma, taste, safety, nutrition, etc. Further, social objectives were also paramount to community-based agricultural organisations, most of them treated agricultural practice as a "serious" hobby which can also be educational and for socialisation. Our research has manifested that democratic structure acting as the basis of the inclusivity dimension concerns the nature of representation, information sharing and transparency within the internal matters of CBIs (Igalla et al., 2019). All of our studied initiatives have a very low level of the organisational hierarchy; people who have difficulties in accessing job markets, people with disabilities and retired elderly have formed the larger parts of the organisations.

Given the multiplicity of identities and narratives of our respondents, the second research question is connected to the *actor-related interaction mechanisms* contributing to the creation of community-based greenhouses. *This thesis argues that through everyday practices, social initiatives are departing from the obsolete system of industrialised mass produce and are provoking a systematic change by embracing sustainable agricultural practices. Further, the thesis also identifies an existing epistemological gap between CBIs and incumbent social actors.* In our studies, a range of

exchange and gift practices was taking place, embedded with personalised social relations between vendors and consumers, where food and products can be given regularly without the expectations of financial rewards. According to Shove and Walker (2010), the everyday practices, including planting, harvesting, composting, and circulating ideologies, have formed the constitutive elements for wider social diffusion. The positive attitudes our respondents have projected toward prosumption suggest that growing food has already become a rewarding experience itself and the people do not need to be consciously aware of their social responsibilities to make the "right choice" (p. 18). Although voluntary labour does not justify the traditional understanding of the cost of labour, our case of community-based greenhouse demonstrates "a normative surplus in their relation to the desire for a just and sustainable food system" (Psarikidou & Szerszynski, 2012, p. 36). In terms of interactions with the external social actors, our study has shown that private industrial actors are generally not interested in such developments, at least they have not yet effort to project any collaborative intentions, "*I am not in a position to comment"* (participant 14). The discrepancy between social initiatives and the government is also quite big, with the governments being overburdened by their legislative frameworks. To an extent, these community-based initiatives are largely managed on their own, the local and municipal governments should have played more active roles in responding to specific CBIs demands and promoting multi-stakeholder dialogues (Van Veenhuizen & Danso, 2007, p. 60).

Further, as we know, the "technical fix" perspective is usually employed in solving food problems, in our socio-technical framework, our research also attempts to answer the *technological dimensions* by giving a new legitimacy to the establishment of the community-based greenhouses. *The thesis argues that CBIs are prone to implement circular, low-tech solutions due to their traditional agricultural practices and financial constraints. High-tech solutions for them cannot intrinsically solve sustainability issues.* From our empirical study, all of the initiatives are practising sustainable land-based agriculture, despite one is still minimally employing chemicals for its production. As such, these initiatives are cooperating with nature and sustaining themselves based on the planetary rules. Instead, our respondents have hoped for circular and energy-efficient low-tech solutions, with the use of renewable and clean energy sources. By diffusing the existing technology, it has equally opened up new possibilities for sustainable food production and new social ideas (Seyfang & Smith, 2007). Some of the more radical community-based agricultural initiatives have viewed technology as being related to how the natural systems work. It would be

their objectives to create regenerative landscaping that is sustainable by itself without human interventions. Moreover, another reason community-based agricultural initiatives are prone to low-tech solutions is that high-end technology usually takes years and large volumes to integrate into the current system for cheaper prices, which social initiatives are usually lacking the financial means to implement.

Moreover, relating to our three-levelled theoretical approach, *sectoral system innovation (SIS)* as the first level of analysis has helped us to display the current socio-technical greenhouse landscape developments as a result of intertwining relationships among social agents. *We argue that in the mainstream, well-established Dutch greenhouse practices, there are comparative openness as well as existing lock-in mechanisms in its system*. SIS focuses on integrating "complementarities in knowledge, capabilities, and specialisation" (Malerba, 2002, p. 256). From the previous section, the review of the Dutch greenhouse industry, we have comprehended that at the regime level, the use of energy-efficient technologies have caused a drastic change through collaborations with universities and private research sectors. With the emergence of new research and agents contributing new approaches in the innovation systems, users and applications are progressing subsequently towards new sustainable demands, adding to the dynamics of the sectoral system (Spaargaren et al., 2012, p. 11).

The second level of analysis—*Sustainability transition management (STM)*—balances change with stability. *The thesis contends that currently there are three levels of social power influencing the directionality of sustainability transition in the greenhouse industry, namely: regime power, dispositional power and niche power*. Agriculture sustainability has also to be compatible with the socio-political environment, which is related to concepts of education, security, equity, employment, recreation, etc (Cui & Smit, 1993, pp. 301–303). Consumers and strong regulations from the government have influenced the Dutch food practices at the regime level (participant 23), specifically, *the regime level* represents the most "anchored" (Spaargaren et al., 2012, p. 12) principles affecting all institutions in a society. When we talk about urban agriculture in the coming days, the society is taking in account of the hidden social and environmental costs enclosed in the industrial mass production. With large food retailers (e.g. Albert Heijn) being remarkably powerful actors determining the value chains *van grond tot mond* (from farm to fork), they could also influence the tactical strategies for daily activities of the greenhouse industry with their

dispositional power. From our interviewees of the greenhouse industry, they have described the current transitions toward sustainability concepts:

> *"A Dutch tomato in a greenhouse, one kilo tomato needs five litres of water. And in Spain, they need 50 litres for traditional farming…60% of the water that is being used is from the rain" (participant 23)*
>
> *"Now it's also saving-energy, evidence of trials in Bleiswijk that normally when I started we used 45 cubic square per year of gas, I think now the average is 22 cubic square meter. And there are also other crops which have a positive so we have more energy. So we can keep the energy to other crops. It's a hot topic" (participant 9)*

On one hand, community-based greenhouses do not share the same problems as commercial ones considering sustainability issues. For example, commercial growers need to limit nutrient leeching, they need to maintain certain water quality of their drains, and they have issues with freshwater supply during droughts and energy costs for daily operations (participant 11). On the other hand, through technological diffusion, we could also envision that the opportunity for community-based niches lies in circular solutions, where cities produce a lot of waste in terms of organic waste, heat, CO_2, wastewater, etc. These forms of wastes could be further integrated for agricultural production.

It is also to be noticed that transition theories focus less on analysing materials and technological infrastructures in a socio-technical innovation, but more on the roles of social actors and their values. *As such, the thesis further argues that community-based greenhouses could act as a parallel trajectory alongside the mainstream food network to promote ethical food practices and concepts of social responsibility*. Specifically, commercial greenhouse farmers hardly contribute to the social welfare of citizens, unlike community-based greenhouses, whose whole production processes are opaque to consumers, partly due to sanitation protocols (participant 23). Acting as a parallel pathway, CBIs could demonstrate their natural ways of production, by growing rare vegetable species, projecting differences in food quality, educating ethical social principles, enhancing community socialisations, and adapting sustainable technologies. Through "stretch and transform", our social initiatives could cause deeper transition with a higher degree of reflexivity in agricultural practices. As such, the relational power at the niche level could be viewed as a collective network bringing wider cultural changes into the society.

Moreover, recognising that CBIs as AAFNs, the thesis contends that although the current food practices are to a large extent institutionalised for the social actors, CBIs could still bring new modes of production and consumption by embedding ethical capitals and social capitals in the

economy. In a market innovation perspective community-based greenhouses are being perceived as "backward" development, with direct producer-consumer relationships, short supply chains, high labour and operating costs, and high personnel costs. In particular, several literatures have mentioned that the majority of the time CBIs are struggling for niche survival, instead of developing further activities and improving community infrastructures, including "basic social services, access to infrastructure, community enterprise facilities, and infrastructure related to environmental management" (Mfitumukiza et al., 2020, p. 9). Several of our interviewees working in research and greenhouse companies have also questioned the social effectiveness, real quality difference, and productivity aspects of community-based greenhouses.

> *"I'm not against it. But you know, a greenhouse, this size is too small anyway" (participant 23)*
> *"But the major differences is in varieties, and not with greenhouse or not greenhouse, or organic or not organic" (participant 23)*
> *" It is very difficult for community-based greenhouses to have transformative impacts, because it is very difficult to have a large variety of crops, mostly they can only focused on one or two crops in greenhouse production" (participant 17)*

However, Van der Schans (2014) suggested that we should see this form of "old-fashioned" community-based relationship as a "sophisticated strategy" (p. 9). Currently, our social system is encouraging a monetary-based economy where "*we need to sell it to each other, we need to create services…that the money can circulate"* (participant 19), however, we must look at the sustainable direction as well where "*we as a human species don't bring ourselves into kills, either by disease, by war, or by general natural-related reactions"* (participant 19). Especially during the pandemic times, the general level of environmental and social awareness has increased. In the example of greenhouses as a form of CBIs, during the last 20–25 years, they are much more integrated into office spaces, art rooms and even residential buildings where people could gather for coffee and food, with it being part of the climate concept of the building for refreshing air and used for solar energy (participant 18). It has also been experimented with older people with dementia, where they could work in the garden to improve their mental and physical health (participant 18).

At the moment, we can see that community-based greenhouses are on the rise, and actor-technology and organisational activities can be easily organised. Nonetheless, these initiatives still necessitate good scientific knowledge to guide the transition effectively in the long term (Spaargaren et al., 2012, p. 5, 10). Moreover, we should keep in mind that the Dutch greenhouse industry is mainly commercial-driven for an increase in export values and reducing energy remains a major technical

challenge. In addition, from the greenhouse-related systems in terms of the roads and piped natural gas for energy supply, the interests of key stakeholders such as supermarket chains and greenhouse consortia, and to the end-users—consumers—who purchase cheap and imported groceries for convenience (pp. 6–7), we could acknowledge that these "lock-in" mechanisms are not easy to change. The whole food system is very much addictive for social actors.

Finally, in the processes of niche-regime interactions from the theory of *Strategic Niche Management (SNM)*, *the thesis contends that community-based greenhouses are no longer fragmented initiatives in the Netherlands, despite their power relations and interaction networks are not yet stabilised or interconnecting consistently to other incumbent social actors. Governments and knowledge institutions must step in to help*. These community-based greenhouse growers could be seen as "small-holders", although they are less commercially-oriented than large-scale farmers, they have the intention to generate some financial income, rather than managing them merely as a lifestyle hobby choice (Sutherland et al., 2019, p. 476). Further, small greenhouses have created a competitive advantage from the professional, large-scale growers, with them being close to the cities and taking advantage of volunteer labour. Additionally, we have seen that these initiatives are useful "localism" governance practices and are becoming embedded in the sustainability policies (Brandsen et al., 2017; Seyfang & Smith, 2007). They could serve as external pressure or resistance to the current political agenda, aiming to increase the responsiveness of governmental and corporate policies (Glover et al., 2005, p. 78). However, CBIs have not yet reached a critical mass to achieve "bottom-up" social changes (Spaargaren et al., 2012, p. 7). For further developments, university institutions which have a fundamental role in knowledge dissemination should also be in strong partnerships with the communities for long-term impacts, where communities could validate and adapt new technologies, instead of outsourcing to external actors or ad-hoc solutions to existing problems (Mfitumukiza et al., 2020). Vice versa, CBIs should also actively reach out for expert advice which is made available and free by some consultancy agencies (participant 12). Finally, land availability, accessibility and suitability are particularly essential to realise soil-based agricultural initiatives (Van Veenhuizen & Danso, 2007, p. 62), *regulative frameworks* should create enabling policy instruments to recognise CBIs as a form of permanent land use in city planning. As such, governmental legal land permissions could also unite scattered community-based initiatives for stronger social representation and participation in urban policy.

In the discourse of food production and consumption, “glocalization” is the phenomenon nowadays (Spaargaren et al., 2012, p. 15). In the global North, CBIs as a niche development should be aware of the “local trap” by over-emphasising locally produced food, and subsequently alienating and rejecting globalisation. Rather than defending self *versus* others, sustainable food production should represent a “hybrid and cosmopolitan spatial character” (Morgan, 2010, p. 1858). By recognising that we live “in an ecologically interdependent world” (p. 1863) where we have obligations to care towards each other, such as helping farmers from the global South in international trade, one could truly transform from being an “ethical consumer” to “ecological citizen” (p. 1861).

Concluding Remark and Future Implications

So far, this thesis has discussed different types of community-based initiatives and specifically investigated the topic of greenhouses in the Netherlands. It has outlined a brief evolution of the Dutch greenhouse horticulture sector over time, further relating it to the context of community-based initiatives with SDGs and alternative agro-food networks. Our empirical research has further attempted to answer the proposed research questions guided by six design principles.

In terms of the conceptual added value, our research is one of the first studying greenhouses as a socio-technical innovation in community-based initiatives in the Netherlands. It has also bridged an existing research gap in empirical research to assess the specific performance of community-based initiatives (Edelenbos et al., 2020; Igalla et al., 2019). Considering the current global economic crisis and high unemployment rate, the application of this thesis is very relevant in today's contexts: how to create better food chains in terms of quality, diversity, proximity and price, how to enhance social solidarity, and how to provide sustainable agricultural practices in communities, etc.

For future developments of our research, there are opportunities to study community-based greenhouse actors more systematically. Their behaviours, which include a series of "de- and re-routinisation of social practices in everyday life" (Spaargaren et al., 2012, p. 9), may not always be consciously enacted and therefore require a longer period of observations and interactions. Besides food production which our research has primarily focused on, food distribution and food consumption are also important interdependent concepts further research would be investigating (p. 16). Further, producers are situated in the "upstream" of the food chain and consumers are in the "downstream" where normally the point of change is initiated for food safety, climate change, health, etc. As such, our research could investigate more in the direction of how consumers as guiding social actors could redesign the food networks, thereby reversing the process *van mond tot grond* (from fork to farm) (p. 19).

Finally, this thesis hopes to alter the perception of the term "greenhouse", it should not only be associated with the industrial image of technological disturbance to our natural environment but also about "greenery" being truly integrated into our communities and everyday life.

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Appendixes

APPENDIX 1. SEMI-STRUCTURED INTERVIEW QUESTIONS

Note: The conducted interviews were not only based on the pre-structured questions written below, but also depended on the context of participated organisation from its websites, promotional videos, publications and news, as well as the designated role of the respondent.

Self-Introduction: Hello, Welcome and thank you very much for accepting the invitation to participate and thank you for your time. First, let me introduce myself and the project a bit: I am a postgraduate student of the European program of Science, Technology, Society studies program at University of Athens. My research project is about greenhouse and alternative agrofood network, especially towards community-based greenhouses in the Netherlands.

Visions and Expectations:
What are some important visions that your organisation is aspired to?
What is the motivation to grow these types of vegetables?

[A] Alternative Agrofood Network
How do you think community-based greenhouse is currently perceived and developed in the Netherlands?
How is your organisation differentiated from other commercial greenhouse growers?
What does the offering of such as greenhouse/gardening space, mean for the local people, their culture and their ideological inclinations?
In terms of the normative impacts at your organzation, does your company also take in considerations of sustainability transitions, ethical principles such as food justice and equity?

Inclusivity Dimension:
[A] Co-creation
Do you think local residents are interested in becoming involved? What do you think are the reasons behind that?
In terms of daily operational activities, would you like to elaborate more on how you have envisaged an urban greenhouse space that involves direct community participation in crop production?
In what aspects are your organisation interacting with the local community, government, university and private companies?
In what ways do you think your organisation has influenced your local community and local residents, also the local government in terms of policy-making?
From a top-down level, how has local government supported the development of your organisation?

[B] Knowledge dissemination
What kind of agricultural trainings does your organisation provide and who are the targeted trainees?
Does community-based greenhouse growers seek for consultation, what type?
Predominantly, what kind of consultancy do community residents reach out for? e.g. technical part on reducing energy, pesticides problem, etc?
How is the process of consultancy of community residents different from industrial actors, and also from Small and Medium-sized businesses? (in terms of technical difficulties, know-how knowledge)

[C] Organisational management
Could you elaborate on the types of activities involved in your organisation?
Does your organisation promote organisational democracy among the members? For example, do the experts prioritise the decisions made by local residents? Or the instructions are an already assembled package?
Since leadership is very important to navigate in conditions of voluntary engagement, what are your roles in facilitating this collaborative process?

[D] Social democracy
In what ways could your organisation potentially benefit low-income or less-privileged residents, but wider community to achieve food security?

Technological Dimension:

What kind of greenhouse technology do you use? Could you explain the reason behind it? Why do you choose this piece of technology over the others?
Why does your organisation choose traditional farming practice, instead of developing greenhouses (inclusion of smart technologies)?
How does your organisation maintain technical control for different plant requirements?
What kind of technological continuities and discontinuities with the dominant industrial greenhouses regime? In what ways would your organisation posit itself in the greenhouse industry?
In terms of the architectural feasibility of community-based greenhouses, what are the constraints and opportunities you would perceive?

Sustainability Dimension:
[A] Contamination/pollution
Do you think there are risks of metal contamination or pollution problems when selecting plots of land in urban agriculture?

[B] Agriculture/planation
How difficult to grow this particular type of vegetable in greenhouse and why?
How to make sure individual community member meet a sufficient quality and quantity level for the sale of the products? Is this imperative of delivery product an excessive pressure, which may discourage local community participation?
Has your organisation been considering to help members to set up small-scale greenhouses in order to achieve higher quantity harvest? Why or Why not?
Are all pests and diseases in your greenhouse vegetables controlled by biological agents? Any use of pesticides?
In terms of seeds management, do you use traditional landraces or purchase from the seeding company?
What percentage of crops are grown on substrates? What kind of substrates (rock wool, perlite, coir, etc)? What is the reason behind it?
How well-functioning is your greenhouse covers for light transmission and insulation capacity? Does your organisation hope to replace to more efficient ones?
Have your organisation thought about new production system to have full control of the production process? e.g. vertical farming
What about use of robots and artificial intelligence to increase efficiency of production process and have a better overview of the production process?

[C] Circularity
There are still environmental and economical challenges involved, what are the next steps of your organisation in becoming more sustainable and circular?
How to improve the current energy efficiency in your greenhouse?
How is the water irrigation process being managed? How much litre of water is needed per square meter of land everyday? Is there also a concept of circularity involved?
Does your greenhouse use compost? Why and what do you think are some advantages to vegetable production (e.g. lower land disease, rich minerals)?
Where does the supply of carbon dioxide come from in your greenhouse? (e.g. produced by the heating system or by industry)

Scalability Dimension:
In Holland, there are some small-scale greenhouses implemented at cafe, and residential buildings, promoting community participation and contact with nature, what are your thoughts on feasibility of such social projects?
Nowadays, we can see that people generally have more leisure time, pursuing more individualised services, do you think the models of greenhouse farming can be adapted at home-level?
Do you think the residential greenhouse installations have created a new niche innovation market or consultancy pathway for the appropriation of smart technologies and their adaptation for greenhouse installations?
Do you think if the technicality aspect of greenhouse farming is matured enough, can it be brought and diffused into communities?
There are many Dutch local start-ups or individual technicians and architects, who have been building home-based greenhouse appliances, we can see for examples, smart indoor greenhouse device allowing you to plant your own herbs; or energy-neutral households growing vegetables utilising Co2 from his own home.

Simple inspiration that people want to bring garden and nature into their homes. As a greenhouse specialist, do you think these niche innovations are feasible, or have the potential to be scaling-up in the future?

Cultural Sensitivity Dimension:
Under this global context of urbanisation, do you think there are some cultural sensitivities when designing each greenhouse project in a place?
How do you modify this Dutch greenhouse model to other places in the world, in order to have wider scope of application?

Opportunities:
Do they offer a higher economical compensation for this particular type of production method?
Does your organisation receive funding and support from the local government and elsewhere? And are they sufficient for the daily operation?
What do you think are some future opportunity you see for your organisation?
Large private industrial actors are usually focusing on the efficiency of crops harvest, efficiency of energy consumption, economies of scale in general. They are doubtful about community-based greenhouse as a business model. From another perspective, community-based greenhouse growers want people to participate in agriculture, or are aspired to achieve community democracy, therapeutic purposes. How would you suggest can these two regime actors be connected together?

Challenges:
What are some specific challenges your organisation has faced transforming garden spaces/empty spaces into actual urban agriculture?
Has your organisation already fulfilled the food production target? What is the next step, can it have the potential to compete with large greenhouse industrial actor?

APPENDIX 2. LETTER OF INVITATION TO PARTICIPATE

HELLENIC REPUBLIC
National and Kapodistrian University of Athens
EST. 1837

ESST
EUROPEAN INTER-UNIVERSITY ASSOCIATION ON SOCIETY, SCIENCE & TECHNOLOGY

Dear Sir/Madam,

We are conducting interviews as part of a research study to increase our understanding of greenhouse transition management in the Netherlands. We are associated with the European Master's programme on Society, Science and Technology (ESST) in Athens, Greece and currently we are researching on the topic of „Alternative Agro-food Network and Greenhouse infrastructures: towards a community-based system for urban greenhouse growers, with primary case studies from the Netherlands" under the supervision of Prof. Dr. Stathis Arapostathis. As a greenhouse-related specialist, you are in an ideal position to give us valuable first hand information from your own perspective.

We are interested in understanding the current social-technical developments of greenhouse industry in the Netherlands and how you think community-based urban greenhouse might be integrated as a niche innovation in the Dutch greenhouse regime. The interview takes maximum 30 minutes and is very informal. We are simply trying to capture your thoughts and perspectives on our research questions. Your responses to the questions will be kept confidential, each interview will be assigned to a number code to help ensure that personal identifiers are not revealed during the analysis and write up of findings.

If you are willing to participate please suggest a day and time that suits you and we can meet over Zoom digitally. If you may have any concerns please do not hesitate to ask. Further, if you have more interests in this topic, please help us indicate whether you might be available for a webinar focus group to exchange ideas with academic researchers, local communities and greenhouse start-ups.

Thanks! We look forward to your participation!

Meilin Lyu

sarameilin1712@gmail.com meilin@arch.uoa.gr

APPENDIX 3. DOCUMENTATION OF THE DETAILS OF SEMI-STRUCTURED INTERVIEW RESPONDENTS

	Type of Organisation	Organisation	Interview Details
1	Research	Wageningen University	Email Response
2	Greenhouse Industry	Artechno Growsystems	Workshop Response
3	Circular Sustainability Industry	Closing the Loop	Email Response
4	Greenhouse Industry	BOAL	Email Response
5	Individual Technical Engineer	-	Email Response
6	Government	Municipality of The Hague	Interview
7	Research	AMS Institute	Interview
8	Research	Wageningen University and University of Bologna	Interview
9	Greenhouse Consultancy Company	Delphy	Interview
10	Community-based garden project	MijnStadtuin	Interview
11	Non-Profit Organisation for Water Solutions	Aqua for All	Email Response
12	Greenhouse Industry	GrowX Vertical Farming	Interview
13	Home-based Greenhouse Industry	Plantui	Email Response
14	Greenhouse Industry	Food Venture	Email Response
15	Community-based Greenhouse	Metabolic	Interview
16	Small Greenhouse and Garden Grower	Wij Bijma	Interview
17	Research	Wageningen University	Interview note-taking
18	Greenhouse Residence	City of Culemborg	Interview
19	Permaculture and garden Consultancy	Towards Nature	Interview
20	Greenhouse social cooperative	Das Kas Kantine	Interview note-taking
21	Greenhouse social cooperative	Das Kas Kantine	Interview note-taking
22	Seeding company	Bejo	Interview note-taking
23	Greenhouse Industry	Floriada Expo	Interview
24	Community-based Greenhouse and Garden	Volkstuinvereniging Klein Grondbezit	Interview note-taking
25	Community-based Garden	de Rijke Sterrentuin	Interview note-taking
26	Community-based Greenhouse and Garden	Tuincomplex Tuinvereniging Kringloop	Interview note-taking

APPENDIX 4. DOCUMENTATION OF THE DETAILS OF CASE-STUDY INTERVIEW RESPONDENTS

	Community-based greenhouse	Respondent	Interview details
27	Onze	Owner's son/main staff	Interview
28		Grower (Surinamese origin)	Interview
29		Grower (Surinamese origin)	Interview note-taking
30		Grower (Dutch)	Interview
31		Grower (Surinamese origin)	Interview
32	Oosterwold community and Oosterwold food cooperative	Food cooperative chairman	Interview (2 sessions)
33		Greenhouse owner (size about 7x2m)	Interview note-taking
34		Greenhouse owner (size about 3x1m)	Interview
35		Greenhouse owner (size about 3x5m for nine families)	Interview
36		Greenhouse owner (full-time profession, size about 2x7m and 4x8m)	Interview
37		Greenhouse owner (size about 3x4m)	Interview
38		Greenhouse owner (size about 12 square meters)	Interview
39		Greenhouse owner (size about 7 square meters)	Interview
40		Community staff (greenhouse size about 6x8m for a community of 81 people)	Interview
41	OudeBeer	Volunteer (six years experience with OudeBeer)	Interview note-taking and interview (2 sessions)
42		Volunteer (seven years experience with OudeBeer)	Interview
43		Volunteer	Self-reflection written response
44	BoereGoed	Chairman	Interview note-taking and interview (2 sessions)
45		Volunteer	Interview note-taking
46		Volunteer (two years experience with Boergoed)	Interview

APPENDIX 5. A SAMPLE OF ORGANISATION SURVEY QUESTIONS

Note: All survey response would be analysed anonymously for research purpose only, the responses would be kept safe and participation is voluntary.

Gender
□ female
□ male
□ other

Nationality
□ Dutch
□ Non-Dutch:_____

Age
□ Under 18
□ 18—35
□ 35—50
□ 50—70
□ 70 and up

What is your societal role? (multiple choice is possible)

□ student
□ full-time employee at this organisation
□ farmer/gardener
□ retired
□ currently unemployed
□ immigrant
□ researcher
□ policy-maker
□ greenhouse company
□ other (please indicate a discipline)

_____

How often do you come for volunteer/work?
□ Almost everyday
□ 3-5 time a week
□ at least once a week
□ a few times a month
□ whenever I am free

Do you plan in the future to continue regularly?
□ Yes, for sure
□ No, because_____
□ I am not sure, because _____

Do you think in your neighbourhood area, there has been enough residents supporting this project/organisation?
□ Yes, definitely
□ Yes but there could be more participations
□ No, I don't think many are interested
□ No, they do not care at all

□I am not sure

From 1 to 10, how inclusive do you think this greenhouse allotment project is towards vulnerable social groups (e.g. elderly, unemployed, children, etc)?
(not inclusive at all) 1 2 3 4 5 6 7 8 9 10 (excellent inclusiveness)

From 1 to 10, how diversified/international are people inside this allotment project?
(no foreigners) 1 2 3 4 5 6 7 8 9 10 (many foreigners)

In what ways could this greenhouse allotment project reach wider members and disseminate knowledge? (multiple choice is possible)
□distribution of newsletters
□words of mouth through good social practices
□improve on website information
□online media promotion
□workshops and events
□collaborations with universities and academic institutions in research and education
□Other_____
□I am not sure

Why have you engaged in this community-based agriculture initiative? (multiple choice is possible)

□socialisation
□environmental concern/climate change
□education and learning
□aesthetic appreciation
□mental and physical health
□nature experience/spiritual experience
□economical reasons
□solidarity against industrialised food production
□I'd rather not answer
□Other_____

What kind of work are you involved?
□online media and marketing
□administration
□project coordination
□field work_____(type of work)
□sale and delivery
□wherever needed
□specialist _____(discipline)
□Other_____

Where did you learn your farming skills? (multiple choice is possible)
□At this initiative
□At school
□From previous jobs
□Self-education
□family tradition
□Expert workshops
□Other_____

What do you think are some advantages of greenhouse farming, in comparison to traditional outdoor farming practices? (multiple choice is possible)

☐increase in crop yield
☐stable yield
☐optimal conditions for plants
☐pest control
☐protection from extreme weather
☐production of crops all year long
☐ability to grow exotic plants
☐protection from animals and invasive plant species
☐Other_____
☐better taste
☐I am not sure
☐better quality

What do you think are positive benefits of community-based greenhouse? (multiple choice is possible)
☐reduction of environmental pollution
☐increase biodiversity
☐acquired a sense of identity and ownership of the neighbourhood
☐enhance community democracy
☐gain new greenhouse growing knowledge and interpersonal skills
☐increase volunteerism
☐a space for neighbour interactions
☐green income and job creation
☐local market benefits
☐Other_____
☐I am not sure

How do you distribute your vegetable harvest? (multiple choice is possible)
☐for self-consumption
☐gifts to neighbours and friends
☐occasionally sell through private outlets
☐sell through online platforms
☐collected and sold through organization/project
☐full-time living
☐I do not get any harvest

In your everyday diet, how much vegetable consumption is from your community-based greenhouse harvest?
☐less than 20%
☐20-50%
☐50-80%
☐more than 80%
☐100%

Where do you purchase your vegetables for daily consumption? (multiple choice is possible)
☐all from our greenhouse allotment harvest
☐I grow my own vegetables elsewhere (e.g. backyard garden)
☐local farmer's market
☐organic food store
☐large supermarkets
☐wherever it is cheap

□Other_____

Do you think working/volunteering at this project increased your awareness in food consumption? (multiple choice is possible)

□Yes, I prefer now more local, fresh vegetables
□Yes, I rarely buy from large supermarkets any more
□Yes, I start to eat more vegetables
□Yes, I am more aware of the production process and origin of vegetables that I purchase
□Yes, this experience has allowed me to _____
□No, I was aware in food consumption before I work/volunteer here
□No, it does not change my food consumption habit
□No, because _____

What factors do you think would influence an efficient performativity of your organisation? (multiple choice is possible)

□effective organisational leadership
□good relationship with colleagues
□democratic management
□support of government (finance, advice)
□Other_____
□support of local community
□advice from academic institutions and specialist
□support from private greenhouse companies
□I am not sure

What do you think about the performance of technologies in this greenhouse?

□They are working perfectly well
□They are working ok, but new technology could function better
□They are outdated and need replacement
□They are outdated but I don't mind
□I am not sure

What kind of problems have you encountered in this greenhouse? (multiple choice is possible)

□pests and diseases
□high temperatures
□ventilation
□water storage and irrigation
□high humidity
□structural design of greenhouse not suitable to local environment
□No issues
□health of soil
□pollination issues
□high operational cost
□limited crop yield
□available space not used efficiently
□lack of labour
□governmental bureaucracy
□poor management
□lack of research and training
□vandalism and theft
□lack of necessary knowledge to run a greenhouse
□I am not sure

If encountered a problem, where would you normally seek help or advice? (multiple choice is possible)

□from your own experience

☐internal help from the colleagues in the same organization
☐through information sharing from other greenhouses
☐expert consultancy
☐technological companies
☐governments
☐university
☐other_____
☐I am not sure

From 1 to 10, how satisfied are you with the <u>sustainable practices</u> in this greenhouse?
(not satisfied at all) 1 2 3 4 5 6 7 8 9 10 (perfectly satisfied)

In the future, how do you think this greenhouse could be more <u>sustainable</u> in long-term?
(multiple choice is possible)

☐ use of renewable and clean energy source

☐ energy circulation

☐ reduction in chemical fertilisers

☐ reduction in use of plastic-based material

☐ use of biological pest control

☐ use of robotics and AI

☐increase knowledge consultation with greenhouse experts

☐I am not sure

☐ composting plant wastes

☐ water recovery

☐ nutrient conservation

☐ purchase of more energy-efficient technologies

☐increase biodiversity in plantation

☐digital information documentation for better evaluation

☐Other_____

Finally, what aspects of this community-based greenhouse do you wish to improve, any further thoughts or suggestions?

_____

_____

Thank you for your participation!

APPENDIX 6. A SAMPLE OF CONSUMER SURVEY QUESTIONS

Note: All survey responses are analyzed anonymously for research purposes, responses are held securely and participation is voluntary.

Sex
□ feminine
□ masculine
□ other

Age
□ Under 18
□ 18—35
□ 35-50
□ 50-70
□ 70 and above

What is your social role? (multiple choice is possible)
□ student
□ immigrant
□ researcher
□ farmer/gardener
□ policymaker
□ retired
□ currently unemployed
□ other (please specify discipline)_____

How often do you buy vegetables from this organization?
□ first time
□ several times
□ regularly
□ loyal customer
□ Other_____

How far do you live from here?
□ less at 1km
□ within 5km
□ 5 to 20km
□ 20km and more

How did you hear about this organization?
□ google
□ social media
□ through a friend
□ public event
□ passing through
□ Other_____

Did you come to visit this greenhouse before you bought vegetables?
□ Yes
□ No
□ No, but I wanted to

What are some reasons you buy vegetables from this organization? (Multiple choice is possible)
□ ethical production
□ sustainable farming practice
□ social support
□ economical
□ nearby
□ better taste
□ better quality
□ solidarity against industrialized food production
□ good service
□ Other_____

Do you think they have a good price?
□ Yes, it is a reasonable price!
□ Yes, but it can be cheaper
□ No
□ I don't care

How many vegetables does this organization consume in your daily diet?
□ less than 20%
□ 20-50%
□ 50-80%
□ more than 80%
□ 100%

Where do you buy your vegetables for daily consumption? (multiple choice is possible)
□ this organization
□ I grow my own vegetables elsewhere (e.g. backyard)
□ local farmers market
□ organic food store
□ large supermarkets
□ Wherever it's cheap
□ Other_____

From 1 to 10, how much do you trust vegetable production with this organization?
(not at all reliable) 1 2 3 4 5 6 7 8 9 10 (excellent reliability)

Do you think there is a difference between vegetables grown in greenhouses and outdoors?
□ Yes
□ No
□ There is no difference
□ I'm not sure

Do you think vegetables produced in local greenhouses are safe to eat (free from pollution and chemicals)?
□ Yes
□ No
□ There is no difference
□ I'm not sure

Do you think vegetables produced in local greenhouses are healthier and taste better?
□ Yes
□ No
□ There is no difference

Do you rely on eating vegetables and herbs grown in substrates, rather than soil? (multiple choice is possible)
□ Yes
□ No
□ There is no difference

Finally, do you have any wishes/suggestions about the vegetables grown in this organization?

_____

_____