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The Impact on Logistics when Using Hydroponics Technology in a Value Network

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ABSTRACT

Logistics of using hydroponics to support urban agriculture in a value network context is conceptualised through an empirically grounded model. This is developed employing a single case study that reveals hydroponics use in a value network, a local and transparent form of inter-organizational cooperation. Hydroponics use for urban farming in its networked context reveals this form of food supply as a local ecosystem, alternative to modernistic large scale geographically distant to consumption-type farming. The empirically grounded conceptual model reveals how this recent technology is only one of many factors that in combination provide understanding on how sustainable production of safe and quality foods may be achieved with focus on its impact on logistical operations. Hydroponics use as revealed in the case shortens logistics flows and greatly simplifies logistics operations since it is a local type of goods distribution. This model provides basis for further research on use of small-scale indoor urban farming technology from a logistics perspective highlighting features of using this technology economically to supply urban food consumption through loosely coupled food production.

***Keywords**: Hydroponics; Urban agriculture; Local food; Logistics; Value network; Disruptive innovation.*

1 Introduction

Hydroponics is a subset of hydroculture, which is a method of growing plants without soil, by using mineral nutrient solutions in a water solvent. Commonly, hydroponics is applied indoors, and facilitates therefore year-round horticulture production. This is especially advantageous in locations with relatively severe winter seasons. Our case concerns Bygartner 1, a company that applies hydroponics to produce a range of lettuce, spices and herbs located in Molde, Norway. Hydroponics technology is quite new in Norway, meaning little research has been done on the sustainability of the technology. Also, this technology is applied as a technological innovation in an existing food supply chain. It is still quite new in Norway and for now only best suited for the cultivation of lettuce and some microgreens. It is therefore relevant to investigate impacts of this technology on its use in food supply.

Figure 1. Tugushan Alp, the founder and entrepreneur of Bygartner 1 in his Hydroponics facility in Molde Norway.

Molde city is a location having a cold climate and distinct seasonal climatic variations. Agriculture in this farming area is therefore normally seasonal. Using hydroponics implies technology-driven potential to move production of horticulture destined for colder-climate markets to local foods production at such locations. This use also opens for growing such foods at urban location, even right inside the major population concentrations. Consequently, the provided case narrative aims to shed light on to what degree and how the applied hydroponics technology as described in this case can be considered as a disruptive technology from a logistics perspective.

'Disruptive innovation' was conceptualized in an article by Bower and Christensen (1995) to mean innovation when it creates a new market and organizational network, radically changing customer needs and thereby displacing established market leading firms, products, and alliances. If an innovation is disruptive, this means that the networked market agents will need to re-think how they produce and exchange in the networks of industrial relationships facilitating production and transaction exchanges. Old agents may die, and new ones may become important. Previously weak agents may become more powerful, or vice versa. Old processes of exchange and production may also change. Therefore, it is of importance to analyse to what degree this form of increasingly common production and exchange can be characterized as a disruptive innovation.

Logistics concerns how goods are transported, stored, and handled described as a "flow" (process). A disruptive innovation implies a major change in how logistics of the studied horticulture products is altered through use of hydroponics as a technology-driven innovation in relation to food supply logistics. This study takes a network perspective of the logistics in supply chains rooted in contingency theory (Thompson 1967) where customer value is regarded as the main functionality of such production (Holbrook 1994). Following Alderson (1965), this means that the logistics flow is mapped as a sequentially interdependent chain of actors from the ultimate perspective of *the hands* on the end user.

A logistics approach also implies in this flows perspective of production being fundamentally regarded as transformation in its value network context consisting of a context of production from a network perspective implies that the producers are influenced by and may also influence other supply chain actors. They are not faceless influencers to each other, and they have always some degree of reciprocal interdependency. Being divergent networked actors, they are viewed as fundamentally interdependent.

This study also brings up the issue on how hydroponics technology may be considered sustainable from of agricultural technology mainly form a logistics perspective. This implies also considering how the studied entrepreneurial company

provides value to his customers including social and environmental concerns. “Sustainability” is from this viewpoint tri-faceted involving considerations of (1) nature, (2) society and (3) economy.

The overall aim of this paper is to conceive the conceptual groundwork needed to found research in developing urban agriculture using hydroponics as a variation of local foods production. Such conceptual modelling creates basis for future more precise research on using this technology, specifically in colder-climate environments as a substitute for food imports. This modelling will enable considering to what degree this technology used in food production impacts on the logistics of food supply.

The first step of this paper is to elaborate on hydroponics technology followed by what constitutes “urban agriculture”. Secondly, the paper discusses supply chain issues of this type of farming based on this elaboration. After that, a concept of “urban agriculture” as a variation of local food production is developed and embedded in another concept, that of the “value network”. This implies considering networked local food production. Such a conceptualisation of “value network” may be considered as a variant of a “supply chain”, following Christopher (2022) where the chain is considered as a network and that value is the purpose of product transformation through logistics. The research issue concerns what is the impact on hydroponics technology use on logistical operation is what is considered as a value network. Thus, network is the context of logistics flows of goods. “Value” is normative, meaning customer needs are focal to the functioning and thus the appreciation of logistics.

2 Hydroponics

A hydroponics system is a system for growing plants in an aqueous solution including troughs for conducting a predetermined level of nutrient solution. This solution is supplied to each trough by a branch pipe extending the length of the trough and including a plurality of outlets spaced at uniform intervals Wong Jr (1972). Nutrients are dispersed evenly along the length of the trough. Each outlet has an associated aspirator or educator whereby air is entrained by the solution issuing from the outlet thereby providing substantially uniform aeration of nutrient solution. According to DeMitchell and Tarzian (2011), there are primarily two types of hydroponics systems: static solution culture and continuous flow solution culture. In static solution culture, plants are grown in containers of nutrient solution. The nutrient solution is either changed on a schedule such as once per week, or when the concentration drops below a certain level. Whenever the solution is depleted below a certain level, either water or fresh nutrient Solution is added to make the necessary adjustment. In continuous flow solution culture, the nutrient Solution constantly flows past the roots.

Hydroponic production has become a considerable commercial production system for vegetables, and that, in 2004, there were over 22,257.7 hectares of hydroponics greenhouse vegetable production worldwide, with more than 404.7 hectares in the United Sates, with the production of mainly tomato, cucumber, and pepper (Jones Jr, 2016). There exist various Hydroponics techniques with different range of complexities that can be customized. Farmers can adopt the technique that addresses their agricultural needs based on the type of product involved, material availability/cost and other factors.

Hydroponics production is more prevalent in the United States than aquaponics. Aquaponics represents an ingenious technique may include multi-type food production, such as horticulture farming at one location in a facility using wastewater from aquaculture at another location in a closed water circulation loop. Intuitively, aquaponics is thus more sustainable, but also technologically more challenging. From a supply chain perspective, the logistical implication of using hydroponics compared to aquaponics is quite similar. The difference being that aquaponics involves two supply chains, one for the horticultures and one for the seafood while hydroponics produces and supplies mainly horticulture products.

3 Urban Agriculture

The main characteristic of urban agriculture is its location in or close to urban areas. It can also be considered being urban, as a variation of local foods production. By “urban” in the sense of farming, the location of this form of food production may lie within densely populated areas including an immediate urban proximity. The conceptual borderline in distance as well as location to classify food production as “urban agriculture” is not exact. It is natural to say that as urban agriculture increases in proportion to the common rural farming, some vague borderline should be drawn; where in the proximity of city suburbs does the “rural” landmass start”? In essence, urban farming entails local foods production with short supply chains (Engelseth 2015).

Urban agriculture can involve great variation in types of foods produced including animal husbandry, aquaculture, agroforestry, urban beekeeping, and horticulture. These types for foods differentiate also within each category; what type of foods is being produced. Within each of these categories food production techniques vary greatly. Also, the

degree of processing at the farm locations may vary. Some producers deliver fresh foods where the aim is to retain the most original state of the food at handover to the customer. In other cases, food is processed mainly to create products of high quality, in essence, following Engelseth (2016), based on traditional recipes or organic healthy products. The location of this small-scale production need not be at the same location as the farm. The technology used may vary greatly. Due to the scarcity of land. In urban areas, farming may involve layers of growing areas as well as farming in walls. Farming techniques may also avoid the use of soil, and urban farms may be done in closed environments using hydroponics technology. This is especially pertinent in cases of urban areas where water, soil and air may be polluted; farming may thus preferably be done in an artificially created closed environment. The characterizing features if an urban farm is suggested as follows: (1) location, (2) production scale, (3) ethics (degree of business idealism), (4), ecosystems (nature interwoven with society as context) and (5) technology. These factors may be applied to analyse and thereby characterize and differentiate an urban farm through a case study of hydroponics technology use. Given the limited availability of open spaces in cities, hydroponics technology, involving moving food production indoors, is well fit through locating food production in new or existing urban building structures.

When considering urban farms as small-scale farming organizations that are created on space not traditionally used for agricultural proposes, this increases conceptual clarity to differentiate “urban agriculture” from other types of food production practices. This, because rural farming is normally characterised by large-scale modernistic production techniques. An urban farmer may also cultivate many different plots that may disperse at different locations. Stone (2016) however, recommends that each farmer not have too many such plots and that they be located preferably in proximity to each other. The possibly best argument for urban farm is that the logistical distance to market is short meaning that transport is short. This is especially profitable in cases of fresh foods where durability is limited.

One of the key features of land in urban areas is that this normally is a scarce resource. This is a contributing reason to that urban agriculture is necessarily small-scale production since it is carried out on a very small plot of land, commonly less than an acre in size (Stone, 2016). Urban agriculture represents an organized economic *activity*, meaning that land ownership is not a requirement to carry out urban agriculture. The urban farmer is the key actor in this type of supply network and must somehow relate to making an economic profit. This farmer normally encompasses, given the small scale of organization, both administrative as well as labour functionality. The land can be leased or borrowed. In some cases, borrowing land may be facilitated for idealistic reasons by the landowners, or municipal lands are farmed as part of a wider city development policy. Support from government and municipality are key economic incentives motivating increases in urban agriculture.

Reasons to carry out urban agriculture vary greatly. Some urban farms are primarily organisations seeking to develop a local community feeling, especially in deprived urban locations. At the other extreme are urban farms that solely exist to create profit from their owners. Many urban farms in developed countries exist somewhere between these two forms of reasoning for producing; operations that need to be carried out profitably using sustainable production techniques where the producers are often motivated by ethical concerns regarding natural and social environment sustainability. Urban agriculture is therefore interwoven with intertwined societal and natural environment factors as reasoning for this form of production. The pattern of this intertwinement may vary. Economics is vital, but in varying ways and degrees influenced by production ethics.

4 Urban Farming in Value Networks

Urban farms are always part of some sort of supply chain since this form of production involves purchasing as well as sales and outbound logistics. Supply chain management (SCM) concerns management related to an entity commonly termed as a “supply chain” (Christopher 2022). This object of analysis may be considered from several perspectives, e.g. from a holistic perspective as an end-to-end entity consisting of a conglomerate of interacting resources and organizations, e.g. from “farm-to-fork” or “sea-to-plate” as a “transvection” (Alderson 1965). Value networks are a less systemic variation of “supply chains” indicting weaker rigor on system boundaries, common functionality and synergetic aims. Value networks may be considered in relation to their degree of systemic alignment. There may however be several competing functionalities in a “value network”, since this approach does not strictly adhere to systems thinking. Value networks are conceived here as a loosely coupled interorganizational context of food supply logistics.

Founded on the ground-breaking studies of Forrester (1961), the logistics in supply may be analysed as a systemic process of production and exchange in an inter-organizational structure where market actions downstream impact also on upstream activities, and not solely a visa-versa downstream sequentially interdependent production flow visualised as goods transforming operations. Focusing not on goods, but the supporting information exchange, in a supply chain downstream forces continuously interact with upstream flows. Supply is thus in SCM conceived as a *system*, it consists of several companies, has an overall conception of functionality, and a border that encompasses all these interacting companies. The bearing systems-founded approach in SCM is seeking out of synergies to develop production of goods and services through collaboration. SCM is accordingly a systemic normative managerial force in supply chains; it views

transparency and collaboration through developed integration as a core value. In this study SCM is considered an aspect of food supply organisation in a value network..

The first widespread dissemination of the term value chain is associated with Porter's (1985) studies. The fundamental view in the rather stringent value chain model is customer orientation and is influenced by Forrester's systemic view of supply involving sequentially interdependent supply chain actors. "Value", however, is never straightforward. Holbrook (1994) states that "…value is an interactive relativistic preference experience" (ibid. p. 27). Value is perception. This implies that when choosing to call the context of production a "value network" instead of a "supply chain" that the purpose of supply to create offerings that are valued by an end-user is a core management concern. In a "value network", this concern should be shared by all producers, meaning all companies involved in producing the goods and services, not only the owners. This also means that the value network is a collective of value perceptions, since it consists of tiers of product recipients, often organized in tiers along a logistics flow. The value network places at a conceptual level customer perceptions of product use in analytical focus. Logistics research, however, is rooted in a predominant cost focus (Christopher 2022) which is gradually changing to increased focus analytically of customer responsiveness as an interactive and iterative process. Value is a dynamic factor in the supply chain and given that achieving customer value is the main objective of a marketing supplier, "value" in the supply chain context is moving target. When managing supply the *value network* represents accordingly customer-oriented inter-organizational and systemic production structure. In urban farming value is more proximate between the producer and consumer. Engelseth (2016) indicates that local foods production is such short supply chains increases transparency and thereby facilitates a form of informal integration. This is supply chain integration and trust to secure food safety and quality is based on coincidental interaction and not on formal rules and rule-following.

5 Urban Farming using Hydroponics as Variation of local Food Production

A fundamental assumption in this paper is that urban agriculture is conceptually a variation of "local food" production; local foods produced in urban locations. Hydroponics technology supports this form of food production in cities. Preceding studies have revealed a range of factors that distinguish this form of food production from the more common large-scale modernistic food production (Engelseth, 2016; Engelseth and Sandvik, 2017). Locally produced food is commonly supplied by producers that can be strategically classified as niche suppliers. They produce limited volumes of either organic foods or foods based on traditional recipes (Engelseth, 2015). This is a commonly held view. Further research has sought to elaborate in a more detailed manner on how sense making as grounds for decision-making in value networks in cases of local food production is influenced by inter-firm interdependencies (Engelseth, 2016). These interdependencies are different from that found in modernistic-type food production. This exposes that local food production, being smaller in production volume coupled with proximate distribution, implies rather than search for economies of scope or scale, a search for economies of small-scale. This concept of "small-scale" is shown similar by Engelseth (2016) to the logic found in services industries where complex resource combining through iterations is typical; this form of supply is characterised by short chains, like those found in services, and that in these short chains, interaction is intense as often is the case in services. These findings imply that managing local foods has more to learn from experiences and conceptual development in the services industry than from modernistic large -scale food production. Still, the same study revealed that local food producers were following patterns of production from modernistic food supply and trying to adapt then to a local food value network context.

Engelseth and Sandvik (2017) elaborate on these findings regarding a predominance of services logic in local foods networks through a case study of a local small-scale seafood distributor. This study considers how local foods may, founded upon understandings of (1) interdependencies (Thompson, 1967), (2) information technology (IT) enabled development (Engelseth 2017) and (3) traceability in end-to-end chains (Engelseth, 2009; Engelseth, 2011), be used to develop local foods production seeing it as complex and seeking efficiency, both embedded in an ecosystem's perspective. This study proposed that managing local foods clearly is embedded in important societal and natural environment concerns, but that these concerns are through management activity "filtered" as perceptions of economic performance. This study also returns to a start position in our research on local foods, highlighting the importance of local foods as geographical proximate production of organic or traditional foods in small scale through tight interaction within the market.

A critical issue regarding local food production is adapting to production in the context of a particular supply chain structure. Since the roots and business practices of local food production conceptually are found in developed economies of the world, adapting it as a framework for use in developing economies is according to Engelseth et al. (2017), called for. Since developing countries are keen on improving their food exports, this directs attention to the commercial need for applying hybrid supply chain structures where local upstream farm or fisheries production characterised by a local food networks community-like transparency and quality, may, as suggested by Engelseth et al. (2017) through their conceptual study, be a starting point of long-linked more modernistic mass export supply. This notion of export is not actual for urban agriculture, which intuitively is associated with local urban distribution. However,

this does not rule out potential for export of urban small-scale food production as exemptions from the rule if such foods are in export market demand.

Regarding the role of information in local food networks, Engelseth (2017b) elaborates on the importance of information systems development that is adapted to local foods production. This implies basically the IT investments are cheap and easy to use, mainly provided as low-cost off-the-self easily adapted solutions. This involves applying information standardization to support multiplex use of information resources (Engelseth, 2013) to enable traceability and information exchange in general to supply the food products. As Parenreng et al. (2016) point out; traceability is an important integrator in the supply chain, weaving the partners together though enhancing trust created by the development of such a system. This points to an aspect of information systems (IS) is associated with information efficiency, and not only its effectiveness; enhancing from an analytical viewpoint that "value" is composed of both cost and benefit sides perceived by producers and customers. Enhancing supply chain transparency through low-prices IT solution, as shown through the case study of IS development to support the traceability of organic foods in Thailand (Engelseth et al. 2014), provides IS solutions with high customer value from a complete supply chain perspective involving small-holder producers as source of the foods. Information integration in local foods supply chains is efficient because of the inherent transparency. This transparency is due to the limited number of actors networked through well-developed relationships characterised by knowledge in information sharing routines and trust. The Valldal strawberry case reveals such local integration using simple technologies to support traceability and quality (Engelseth, 2015b). However, as Engelseth (2017b) points out, increasing the use of electronic information exchange may be especially advantageous in connecting local food producers to their markets consisting in an often unmanageable in their perspective, number of customers. In local foods production, including urban agriculture, quality is inherent founded on the strength of its *community* characteristics. This reduces the need for control using IS in urban agriculture. The system is expectedly self-controlling founded on the strength of the value network's community-founded quality discourse.

In this study hydroponics technology's impact on logistics is considered in the context of a "value network". Given that hydroponics facilitates urban farming, a variation of local foods production in short supply chains, this obviously impacts on logistics. Through the case narrative how logistics is carried out is described and considered in relation to alternative supplies of comparable horticulture products. Alternative means of horticulture supply in this case are winter imports from southern Europe, and seasonal (spring to autumn) domestic production. Both these alternatives apply outdoor soil-based agricultural technology.

6 Methodology

This is a single case study of the company Bygartner 1. It takes a value network perspective of the use of hydroponics technology to facilitate local food production in a small location. A case study research strategy was chosen so that a real-life picture of the current use of hydroponics technology in a value network context could be described. This is clearly qualitative research where the aim is to derive practices-based conceptual understanding with limited potential for transferability to other business settings. A series of semi-structured interviews were carried out to provide the primary data for this investigation. Before conducting the interview, we articulated some problem and needs that had to be addressed for this process:

- We took ensured the place of interview be where our respondents feel comfortable. All of them agreed at their workplace.
- While booking the appointment for interview, we explained the purpose of interview to all our respondents so that they make their mind more ready for the interview.
- We also considered confidentiality of some data (during site visits) that had not to be shared in our research.
- At the time of booking the appointment we explained the format of interviews to our respondents and asked for their willingness to answer the interview questions.
- Timing, date, and length of the interviews were all decided while taking the appointment.
- At the end of these interviews, we asked each of our respondents for their telephone number or email address and the permission to contact in case of any confusion or need for further data.
- All interviews are recorded in mobile voice recorder app with the permission of our respondents.

Tugushan Alp, the CEO of Bygartner 1 was interviewed twice, the manager and owner of a Restaurant, the manager of Rema 1000 supermarket and the manager of Den Gode Smak café in the Molde Torget shopping mall. The nature of

qualitative data makes it difficult for the researcher to separate himself from the data, but we tried to avoid biasness and achieve objectivity by following Labs (2018):

- Using multiple references to code the data and show consistency in our interpretation.
- Asking our supervisor and Bygartner 1's owner for the review of this study's conclusion.
- Using as many data sources to justify our interpretation as we could.
- Trying to establish the results of this study from the perspectives of our respondents because participants are the only ones who can legitimately judge the credibility of the results.

Respondents were decided with care through applying judgement sampling. Customers include restaurants and grocery shop to whom Bygartner 1 supply fresh vegetables. Interviews were conducted face-to-face, and responses were recorded through mobile voice recorder app. There were two different interview guides for customers (different for Rema 1000 because that is a grocery shops while other two are restaurants) and a semi-structured interview guide for the owner of the company was thus created for practical use. The interview guide was written as short as possible and carefully adapted to each informant. Questions concerned the informant, the company of the informant, the relationships and logistics. All the respondents were interviewed according to their respective interview guides to be able to compare the result and eventually analyse them. Main goal of the interviews was to get response from the respondents which could help to answer our research questions. The length of the interviews varied from 30 minutes to 1.30 hours depending upon the respondent.

This investigation included considering if the applied hydroponics technology is a sustainable means of farming compared to the traditional way of farming using soil. This implies also bearing in mind how the studied entrepreneurial company provides value to his customers. Hydroponics technology is quite new in Norway, meaning very little research has been done on the sustainability of the technology. This technology also encounters an existing food supply chain. It is thus pertinent to investigate the level of disruptiveness of this technology from an inter-organizational network perspective. The "value network" is such an inter-organizational setting.

7 The Bygartner 1 case

This case narrative aims to shed light on to what degree and how hydroponics technology as applied in the provided case narrative can be considered as a disruptive technology in the food value network. This is done by providing a text that only provides the story of this production free from interpretation other than those of the informants.

Figure 2. The Bygartner 1 facility is located in the garage area of the Grandfjæra industrial park in Molde

The entrepreneur that started and currently manages Bygartner 1 is originally from Turkey and is proficient in both Norwegian and English. He is actually a cook. This firm started production of horticulture in a closed environment applying hydroponics on November 2017. Bygartner 1 has the first commercialized growth chamber in all Nordic countries. Bygartner 1 uses efficient production system with minimum use of power to minimize pollution. Horticulture produces the least pollution compared to other agricultural innovations and almost half of the pollution that smart greenhouses produce. Company is aimed to further reduce the usage of electricity as less as possible.

According to the CEO of Bygartner 1, his company has as its mission to produce lettuce, micro greens and some selected plants in controlled areas as much as they can, limiting pollution, and bringing products as closer to the Customers as possible.

The CEO of Bygartner 1 went further and shared future vision of the company, he said:

"We are working with expanding first of all for the Møre og Romsdal here, we are working to open a nursery 10 times larger than this one to produce further here. It is going to be in Molde. It is first and after this BAMA (Norway's largest fruits and vegetables wholesaler) is going to advise us".

The CEO also said that:

"We give you the best taste and care for the environment at the same time".

Bygartner 1 supplies only fresh, nutritious, and environmentally friendly food such as different types of lettuce, Basil and parsley micro greens and herbs in Molde. The company for now is mainly producing lettuce. According to the CEO of Bygartner 1 (2019):

"95% of our products are tastier than traditionally grown vegetables except lettuce rockets which tastes much strong when grown this way".

Bygartner 1 produces following products:

Micro-Greens: These are small and edible green plants that are produced by herbs or other plants. Including stems and leaves, they vary in size from 2.5 cm to 5 cm long. Micro-Greens have single central stem that are cut just above supra line during harvesting. They have fully developed seed leaves called cotyledon leaves, usually one small pair (partially developed true leaves. The typical style and leaf configuration for microwaves is approx. 2 cm. to 5 cm. in height and 1 cm to 2.5 cm. in width across the top.

Figure 3. Micro-Greens

Micro-Greens despite their small size have quite intense taste. They are used for fresh flavour in restaurants in different dishes and salads. These restaurants also use micro-greens for creative presentation and tastier dishes. The micro, delicate, fresh look provides beauty and dimension combined with a variety of flavour elements.

Lettuce: it is among widely consumed vegetables all around the world and it is annual leaf vegetable of the aster family (Asteraceae). Lettuce is a rich source of vitamin A and K, but nutritional value also depends on the variety of it.

Figure 4. Growing lettuce in the Bygartner 1 facility in Molde

Parsley: it is another widely used vegetable that is indigenous to Mediterranean but now is cultivated throughout the world. Its scientific name is Petroselinum cripsum. They are up to 80 cm long with yellowish green colour. Entire plant is used in different salads and dishes which include leaves, fruits, and roots. Fruits

are sub globose or ovoid that is very aromatic with five equal ribs. Parsley is used as a rich source of vitamins and minerals. Parsley is used as a rich source of vitamins and minerals.

Figure 5. Parsley

Basils. It is a tender plant with strong, pungent, and sweet smell. The plant sizes differ depending on the variety ranging from 30 cm to 150 cm. basils are richly green and whole plant is edible. There are different types of basils, but sweet basils are commonly used for its sweet taste worldwide.

Figure 6. Basils

Coupled with the cultivation of Lettuce, Basil, Parsley and other micro greens, the company also distributes LED lights and Hydroponics systems built according to customer's specifications. For now, most of their distributions are in Molde since the company is still quite small. They intend to extend their products and services to other parts of Norway in the future.

According to the CEO, about 85% of everything in the growth chamber is imported from Turkey. While seeds are bought from Norway. Norgro and the Farmers Shop all based in Norway are the 2 shops that supply these seeds. The products are supplied either through the postal service or through other third-party Logistics companies depending on the type of the seed to be supplied. Seeds sent through truck are basically those that needs special care and must be transported in the presence of nitric acid. According to the CEO, Hydroponics systems require many components which at times cannot be found in Norway. In that case, some of the components are often ordered from other countries like Sweden, Denmark, and others. Company signs contracts with all his customers and suppliers for any sale and purchase.

Bygartner 1 uses the Hydroponics system with artificial lights. This system is quite different from the normal Hydroponics system which uses natural lights. A typical Hydroponics system with artificial lights constitutes the following components.

Growth Chamber: To grow anything, space is needed. A growth chamber is a designated and enclosed area used for the cultivation of crops in a Hydroponics system with artificial lights.

Growing racks: This is the shelves on which the crops are grown. The racks at Bygartner 1 are made up of several shelves. These shelves maximize available space by increasing growing capacity and avoiding new construction.

Lead light: Just like crops grown outside need natural light to grow, to grow Vegetables and Micro greens hydroponically in dark enclosures, the grower needs Lead lights. Bygartner 1 has Lead lights as one of the requirements for his hydroponics system.

Water Pumps: Plants in a hydroponics system requires water (nutrient solution) to grow. This water is supplied in the system by a water pump.

Rockwool: A Rockwool, also known as stone wool or mineral wool, is the most widely used substrate for the commercial production of hydroponics. Rockwool's need constant monitoring and irrigation to hold a high level of aeration and moisture at the same time.

Growth tray and Dome: A grow tray is a container designed to hold one or more plants in a hydroponic growing system. The rock wool is placed in a growth tray before the seeds in a hydroponics system can be nursed. When placed on a Rockwool, the tray is covered with a dome to enable seeds sprawl effectively.

Hydroponics Nutrient Solution A hydroponics nutrient solution is a liquid which contains all nutrients necessary for plants growth. Compared to soil, Hydroponic system makes it easier to measure and fill the exact amounts of nutrients in the water solutions.

Just as many plants require a certain temperature to grow well, so too do plants in grown hydroponically. The temperature in the growth chamber needs to be monitored and controlled for plants to grow effectively. This is done with the aid of a climate control equipment

Carbon dioxide (CO2) generator: A CO2 generator is a machine used to enhance carbon dioxide levels in a greenhouse or enclosed areas to promote plants growth.

Control device for Nutrition and PH: Every plant requires different quantities of different nutrients substances to grow. In a Hydroponics system, to provide plants with the appropriate quantity and type of nutrients, a control device is used.

Timer for Lights: Just like plants grown outside require varying periods of daylight and night, so too do Plants grow hydroponically. The lights used in the enclosed growth chamber need to be controlled. This job is done by a timer.

Lettuce, basils, parsley, and other green plants are produced in Bygartner 1. According to Tugushan Alp, the total surface area of production is 60m^2 and there are several processes taking place here. The main processes include:

Seedling

Every hydroponics growing begins with the seeding stage. At this stage, the rock wool is used as a substrate for the seeds and is placed on a tray, hand watered and covered with a dome. Afterwards, the seeds can sprawl, and this takes approximately 2-3 days depending on the season/period of the year.

Growing

After the seeds sprawl, they are then moved to the growth system where it stays till it is mature and ready for consumption. On the growth system, the control device for Nutrition constantly supplies the plant with the nutrients in their right PH necessary for plants growth while the Led light provides the plants with artificial light needed for growth. Also, CO2 generator helps the plants to generate CO2 required for growth. According to the CEO, the plants take approximately 4 weeks to be matured and ready for consumption.

Figure 7. Lettuce in the growth chamber with LED Lights in Bygartner 1

Figure 8. Parsley in the growth chambers with LED Light in Bygartner 1

The Harvesting process: After the growth comes the harvesting process. The plants are carefully harvested and ready for packaging and delivery to customers (Bygartner1 2019).

Bygartner 1 is a small company with 2 people managing the whole activities. Once the harvesting is done, the team manages to pack all the products in the company. Although the plastic used for packaging is not recyclable, but company has plans to use such plastics in future that could be recycled. For this purpose, company is doing a lot of research and negotiation with authorities that can be helpful to make this cause possible. Awareness of the people for separating the recyclable plastics and non-recyclable plastics is quite challenging. With the current world status of a changing climate, there is a need for us to adopt measure that minimize the earth pollution as much as possible.

Bygarner 1 has a harvesting period from 2-6 weeks of growing depending upon the type of the lettuce being harvested. Once the vegetables are harvested, they are packed and delivered to BARE, a distribution company, who distributes Bygartner 1's products to 46 Rema 1000 supermarkets outside Molde. In Molde, Bygartner 1 is responsible for its product's distribution and the products are distributed to the various customers immediately after harvest using their own van. The vegetables remain fresh for consumption about 5 days once harvested. The main customers of Bygartner 1 are found in the Molde city area. Products are received by a truck at 8pm every evening and supplied to the shops for sale the next day.

Bygartner 1 creates contracts with all its customers for vegetable supplies. The number of productions also depends upon these contracts. it supplies its products to Rema 1000, Bama Gruppen, and any major restaurants in Molde such as Medly Food, Linjebygg AS canteen etc. Customers prefer its vegetables because they are tastier and healthier. The CEO of Bygartner 1 says:

"My products are not cheap. Its 5 kroner expensive than another one but I am selling more than another one. It's because of the taste, because of the freshness. And, of course because there is no herbicides or pesticides on them"

The following will analyse Bygartner 1's customers and the range of products they order from Bygartner 1:

Rema 1000 AS is a Norwegian supermarket chain. REMA 1000 is the main customer to Bygartner 1 in Molde and this business has two locations in Molde (REMA 1000 Fuglset and REMA 1000 eknes). This company became a customer since January 2019 and according to (Farstad, 2020) they used to order 5 products from Bygartner 1 but today, they only order Crispy Salad due to the new Norwegian regulation which restricts small farmers to produce. Manager of REMA 1000 (Reknes Molde), Kristian Farstad says:

"We have crypsy salad from Bare but the main reason for choosing Bygartner because bygartner because it is selling more and more so we decreased our order from Bare and increase that of Bygartner".

Figure 10. Store displayed crispy salad at REMA 1000 in Molde

Den Gode Smak is a gourmet shop and café. It is situated in Molde Torget, a shopping mall. The cafe offers a large variety of coffee and tea, high quality olive oil and many other exciting products from Italy, France and New Zealand. They also offer food products from Trondheim and Geiranger like cheese, salmon, jam, mustard, and confectionary. It serves baked cakes, yeast baking, ice cream and various coffee types at this restaurant. It orders fresh vegetables from BAMA, ASKO and Bygarter 1 Herbs and crispy salad from Bygartner. Den Gode Smak get these supplies from Bygartner 1 once a week but in the season of high peek it plans to order the amount of salad.

Figure 11. Den Gode Smak café

The cafe now has nine employees. It is no more just selling smoothies and coffee, but also serving hot lunch. For this purpose, they are seeking one chef in a full-time position, two weekly cleaning assistants and one extra assistant. In an interview with RB-nett (local newspaper), Managing Director Nanna Kristine Jensen said that:

"*It will be exciting to develop our concept further. We will focus more on the smoothie and focus on the coffee shop concept. We also serve food for everyone, so that those with allergies and intolerances can also come and eat with us*"

Bygartner 1 is a major supplier of fresh salad to Den Gode Smak. They supply Herbs (Basilica) and crispy salad (lettuce) to them. They also used to supply micro-greens but due to some governmental regulations, they had to stop its production. Nana Kristine Jensen, manager of Den Gode smak in an answer to a question that are they willing to buy more from Bygartner 1 if Bygartner 1 increases its production capacity, she replied:

"We actually don't know yet. If he grows different things, I will order from him instead of Bama, but the amount I am not sure since we have to adjust to the number customers"

She further said that:

"We support Bygartner 1 because he is a local producer and that is very important to us and also to support the local community which is important"

Medly is a small local restaurant started as Molde's first food truck for spring 2017. The restaurant is owned by Alejandro Alvarez. Due to formidable response from customers, he took over the premises at ferry quay where Skippy's served fast food for years. Medly offers specialty burgers, grilled on real charcoal grill. Apart from burger the restaurant also

offers exciting variety with the salad of the week and the taco of the week, made in a real Mexican way, BBQ spareribs, fish, and chips and much more.

Figure 12. Medly Food is located at the Molde ferry terminal

Medly food uses different vegetables in their salad and dishes including onions, carrots, chillies, herbs from rosemary, green onions, chives, tomatoes. They order these vegetables from BAMA. Medly food also order Bygartner 1 lettuce (mostly), micro-green and basils. As per Alejandro Alvarez, they order salad from Bygartner 1 because:

"Yeah, the fact its local company that is growing a salad a 150m from us. I think that's is very positive because we are using very little gasoline to move salad from there here. I think it a luxury that I can afford to buy a salad that is made so close from where we are serving it. And also it help those small companies to help each other. Kind of to promote the economy between small companies and yeah that's positive".

We asked Alejandro Alvarez if he feels any difference between the salad from Bygartner 1 and other companies, he replied:

"*The salad from Bygartner 1 is super fresh. He is cutting them the day before delivering to me. And he is packing them himself and it's the salad that can stay in fridge for the whole week with no problem. If I order salads from BAMA, these are salads that have been travelling already for days and it might be the case that I get the box of salad and there is already a couple of salad that are starting to look bad or suffocated. They have been closed in the bag for long time. Totally, I mean the quality of product that I get can't be better. There is no company in Norway that is going to bring a better salad than what he is bringing me*".

The demand for these salads varies depending on the season and number of customers. Medly food get the supplies of these vegetables twice a week and the owner of the restaurant is willing to order more if there is an increase in demand coupled with increase in production of these vegetables by Bygartner 1.

According to (Tugushan, 2020), due to the cold climate, most fruits and vegetables consumed in Norway is mostly imported and this is done by two large importers BAMA and ASKO controlling two different food supply chains. There are a few local producers of vegetables in Norway, but they mostly produce in summer due to the cold weather. In this study, we can consider BAMA and ASKO competitors since they import fresh vegetable products like lettuce and microgreens from other countries which can as well be produced locally. However, as mentioned, there is a coopetition prevalent in the relationship with BAMA, since BARE, a subsidiary of BAMA, distributes the products of Bygarner 1 locally. Furthermore, ASKO and BAMA have a mutual agreement where BAMA is the chosen supplier fresh fruits and vegetable for this wholesaler. Therefore the prime characteristic of Bygartener 1 relationship with ASKO and BAMA is a constructive form of coopetition.

ASKO is a Norwegian company with 3300 employees. It is Norway's largest grocery wholesaler and is part of NorgesGruppen. NorgesGruppen is a grocery wholesaling group with various retail outlets covering all parts of Norway and had a market share of 43.2% in 2018. NorgesGruppen has 1200 suppliers throughout the country for its different product range. It runs its own private labels which include First Price, Eldorado, Folkets and 6 more. ASKO serves 25 thousand products to 14 thousand clients all over the country. ASKO has four retailers throughout Norway which are KIWI, MENY, SPAR and Joker.

BAMA is one of Norway's oldest privately owned retail company and has been in operation for 133 years (B. A. Report, 2018). BAMA HoReCa is a market leader in the marketing and distribution of fruit and vegetables. In recent years other product groups such as fresh meat, chicken and above all seafood and game have contributed a rising share of sales.

The HoReCa market covers hotels, restaurants, catering, the public sector and the business market (B. A. Report, 2016). Today, Bama is not only Norway's leading fruit and vegetable Supplier but also has a very strong position in fresh processed products. According to BAMA (2020) this company is the Norwegian Company with the highest number of Suppliers worldwide with over 1400 (on all continents) and their company alone supplies over 17,000 Norwegians with over 500,000 tonnes of products ordered worldwide. These products are handled through their terminals and some of the products are short lived hence, Bama has developed an advanced logistics system that allows fresh and high-quality products to be delivered to customers. In 2018, 506,000 tonnes of fresh products has been supplied by BAMA out of which 34% were from Norwegian producers. They were taken at 300 different loading points from 1,163 suppliers while 66% were international producers and these products are loaded at 220 different loading points from total of 234 suppliers.

Fruit and vegetables are live products whose quality must be maintained, regardless of distance, and well-thought-out logistics solutions play a crucial role in ensuring that fresh and pristine products reach our customers and the consumer as quickly as possible. Reducing the distance from field to fork is an ever-present aim in this context, and the products are refrigerated during their entire transport, regardless of origin.

Bama takes upon itself not only to offer fresh products but also takes the health of their clients, the nutritional value of their products and the environment into consideration. Bama in order to ensure that they offer high quality products, they engage into all aspects of production and distribution from farm to fork. Bama controls and monitors their crop producers to ensure awareness on Hygiene, plant protection, and cooling chain amongst others.

This company being a food company owning several production units all over Norway is subject to some regulations pertaining to food safety. This regulation is to ensure that food produced, packaged, stored and transported in these units adhere to the regulations. Furthermore, with research being an important tool for value creation, works closely with work closely with Gartnerhallen, Nibio (agriculture research institute), Nofima (seafood related research institiute) and other national and international research institutions as needed to increase production and value creation of Norwegian fruit and vegetables and also to increase their understanding of virus and bacteria activity and growth conditions.

BAMA also aims to reduce CO2 emission and to achieve this goal they require to choose appropriate transport means. As a cost-efficient and environmentally friendly option, Shortsea is a good choice. BAMA aims to use more direct transport and make less use of central warehouses. Shortsea solutions are competitive and satisfy their requirements for both emissions and quality. Several harbours in Norway could potentially be of interest in this context. They are working to replace fossil resources with renewable resources. For while BAMA's actual products are renewable, they still use fossil resources in packing, packaging, transport and processing. they are striving to reduce emissions by making more stringent requirements for transport service procurements, increasing the share of sea and rail freight and optimising packaging that increases utilisation rates for each transport.

Bama is the main distributor of the products of Bygartner 1. Bama has been a distributor of Bygartner 1's products since 2019 and distributes to over 46 other shops out of Molde. According to the CEO of Byagartner 1, Bama became a distributor of their products in 2019 and since then, sales has been increasing gradually.

According to the CEO of Bygartner 1, they have plans to increase the production, but this mainly depends on the number of contracts it receives from its customers. All the work has already been done in this regard and they are waiting to receive the contracts from their customers. In an interview with the CEO of the company, he said:

"The vision of this company is of course this is pilot we are talking about, similar of this one but much bigger size and at different places in Norway, where they need, where they have no production because climate doesn't allow them to produce".

The company expects to increase its production to 25000-30000 lettuce each month depending on contract. For now since the production is not much on a bigger scale that is why the CEO himself has the responsibility to distribute the products in Molde but once they increase the production on a larger scale, they will handover this responsibility to the third party company and solely focus on production of these vegetables. The company also anticipates to expand in other parts of Norway as well. In this regard CEO of Bygartner 1says that:

"We are working with expanding first for the Møre og Romsdal (county) here, we are working to open a gartneri 10 sizes this one to produce further in Høgre Romsdal, it's going to be in Molde. It is first and after this BAMA is going to advise us but it's mostly north not south"

In an answer to a question regarding his views about future of hydroponics system with artificial lights in controlled growth chambers, he said:

"It will come to those countries which doesn't have the climate to grow those things. I don't say everywhere. It will come to Nordic countries, it will come to Arabic countries, Africa will use it but not with artificial light because they do not need it. It will come to places where there is extremely much population like in the middle of Shanghai an industrial

area, New York, London has already started it in their tunnels. All those countries will do it. Will it come to Mediterranean? Yeah, after verse when we have even less water because we don't have water".

Considering the current issues faced due to sudden climate change, Bygartner 1's future goal is to use plastic that could be recycled contributing for a cleaner environment as much as possible. It also has plans to use a system that would minimize use of power as much as possible because that would be more environmentally friendly. Bygartner 1 is already working as an agent for the distribution of LED lights and Hydroponics system in Norway and is also ready to provide training and mentor those who wants to establish hydroponics system so, that they have great start.

8 Modelling Hydroponics Use to support Urban Agriculture in a Value Network

The preceding narrative provides foundation for considering the change in logistics due to actual use of hydroponics technology. The case reveals how the logistics of Bygarner 1 is very simple. This is understandable and revealed in previous studies of local foods supplies (Engelseth 2015, Engelseth 206, Engelseth and Sandvik 2017). They outsource logistics activities for their main bulk of supplies to one supermarket chain for local distribution. What remains of the daily harvested supplies are going to other customers that retail supermarkets and is services by Bygartner 1 themselves. The disruptiveness of such a change in food production may seem paradoxical. New technology greatly simplifies the logistics. This is clearly a change in how comparable products are distributed. As of now, such production in Norway is rare. However, if more locations produce horticulture, similarly, meaning increased presence of economically feasible urban agriculture, how foods are supplied, and not the least how this shortened logistics impacts on food quality, the impact on food product logistics will be great. The next step is to conceptually model the impact on horticulture food supplies in a value network context. The economic feasibility of such change in production presupposed a colder climate context with seasonal food production.

This modelling effort is founded on considerations regarding hydroponics use to support urban agriculture involving the following previously discussed features: (1) location, (2) production scale, (3) ethics, (4), ecosystems and (5) technology. Location is seemingly an absolute demand since urban agriculture is conceptually bound to be located in an urban setting. However, there remains a fuzzy proximity-associated borderline between what may be considered urban and what may be considered rural farming. By bringing in production scale, that urban agriculture is small scale much due to the scarcity of land in cities, an important distinguishing factor is achieved. All three cases are clear examples of such small-scale farming. In our case, Bygartner 1 is in Molde, which can hardly be considered a big city. Still, it is in our case classified as an urban location. Its location is therefore of the borderlines of what may be considered as "urban". The ethical aspect is associated in the case mainly with food quality. The products produced by Bygartner 1 are fresh and produced close to the consumer ensuring short transport distance. These are factors that substantiate the sustainability of this production. Hydroponics represents a technology. Alternatively, aquaponics could also provide similar features of urban farming in indoor facilities which are abundant in urban settings. Hydroponics is a well-established technology. It is simple and cheap. What is lacking is its diffusion as an innovation. Finally, as a technology, it is always susceptible to technological change. An example is that new lighting technology using LED implied a reduction in energy costs making hydroponics a much more competitive way to produce foods. Previously, hydroponics was known mainly for horticulture production in obscurity, in essence, illegal forms of production. The case is about food distributed in the context of an inter-organisational network structure. These networked value networks are characterized by repeated transactions meaning they are carried out in developed business relationships. Regarding the "value" concept, this implies a normative placement by the supplier of customer needs as the ultimate production objective. The cases reveal that this is certainly the case. Production is clearly not limited to simplistic "setting the customer first" type objectives commonplace in marketing literature. Production, supply and consumption may be characterised as an ecosystem. This implies that the suppliers value customer needs but in a wider intertwined societal and natural environment context. The urban farmer may be considered as part of a value network, but this value network needs to be interpreted and analysed as an ecosystem that includes the often-opposing forces of profitability, ethics, technology, society and nature. This implies that economics is also a distinguishing factor when seeking to study urban agriculture in a value network context and that this context is recommended considered as an ecosystem.

Since small-scale is a main distinguishing factor of urban agriculture, it is clearly a variation of local food production. Some lessons for conceptualising this form of farming may therefore be applied when developing urban farms as organizational entities in their value network context. This implies that urban agriculture as type of industry is carried out in short supply chains resembling activities in the services industry. This means people are *subjects* rather than faceless objects in such value networks. The case reveals how Bygartner 1, a small one-man firm, has developed heterogeneous personal relationships to his customers and suppliers. Interdependencies are mainly reciprocal and pooled. In cases of weak standardization of production and the information flow, the value network is necessarily characterized by reciprocal interdependencies implying need for intensive mutual adjustment processes. To the degree the value network is simplified, pooled interdependency increases opening the door for increasingly automating the information flow. Herein lies potential for economizing urban faring by both making supply processes including

transactions more efficient as well as potentially increasing sales volume through better market impact using IT. Finally, local food quality is secured through quality founded in a sense of community by the growers. This implies reduced need for quality control including traceability. The self-governance based on the values of urban agriculture as community sufficiently secures safe and quality foods. The value network is transparent complemented with a deeply rooted understanding of ethics among the producers. Herein also lies potential for reaping what may be termed as "economies of small scale". This further substantiates that urban agriculture be considered as an ecosystem, a systemic intertwinement of nature and the social, and that the study of norms embedded in this system are of key importance in securing the economics of this production. Based on the preceding discussion the following conceptual model of what constitutes urban agriculture in a value network context is proposed:

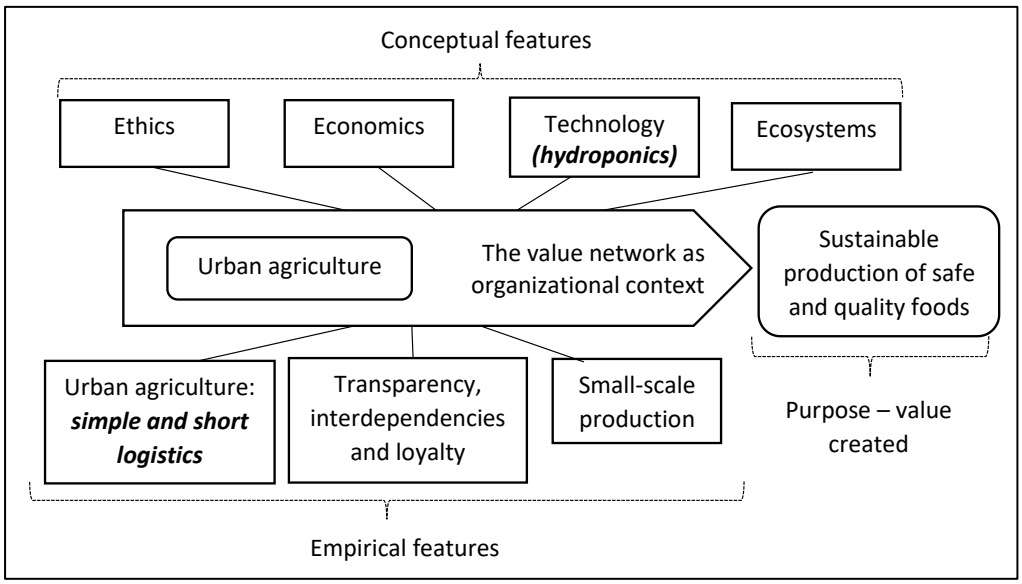

Figure 13. Conceptual model of urban agriculture in a value network context

As we can see, logistics is modelled as an empirical factor. The model depicts urban agriculture as sandwiched between the defining factors helping to determine whether a case at hand is "urban agriculture", and analytical factor helping to revel how such farming may be carried out in diverse ways. The model also directs hydroponics as a supporting factor in the system. This implies that monument should focus on hydroponics as an enabler resource, one factor of many when considering how to produce foods in an urban location. Choosing the "value network" as concept is a choice of analytic approach. This approach is predominately economic, but as previously discussed needs to be modified by ecosystems thinking. As context of urban agriculture, the value network is inherently characterised by variation in transparency, interdependencies and loyalty, all factors contributing to the sustainability of this form of production. "Purpose", or since production is fundamentally an economic activity using technology, in this case hydroponics, is associated with value created through customer perceptions of sustainable production of safe and quality foods. Note that "safe" is a societal aim associated with human well-being (ethics), while "quality" is an economic aim associated with *customer* perception. These terms are clearly overlapping in meaning. Hydroponics is in the model regarded more as an empirical factor than a conceptual one.

9 Conclusion

"Our world is dying for good news, and urban farming is some of the most exciting news there is in the world of sustainable agriculture" (Stone, 2014: 249). Hydroponics enables urban farming. It is proposed as not the key feature of a local foods network. It is instead considered as a part of the conglomerate of factors that makes urban farming work. Urban agriculture involves more than creating the foods at small farms close to city-dwellers. To succeed, the urban farmers need to develop competence in managing their value network. Logistics is just one of many features of using hydroponics technology. The change in logistics is immense. It is only not disruptive because such production still limited. Therefore, it has a potential for being considered a disruptive innovation in logistics. This, in turn, impacts on the value network structures since distribution is local organised in a short supply chain. Local foods distribution implies simple and short transport routs and limited need for storage. This logistics is embedded in value network characteristics of urban farming which differs for than of traditional soil-based outdoor farming.

Value is inherently focal to the chain due to its features as an ecosystem grounded on commonly shared values related to food safety and quality as well as ensuring human well-being through the farming itself. It is a self-controlling production human-focused system ensured by its transparency creating an economy of small-scale food production. As a variation of local foods production, urban agriculture sets this food production in proximity of consumers. The value network of urban farms is simple, short, and therefore also naturally transparent. Value is not dictated by the customer; it is a natural component shared by consumers and producers; it is continuously negotiated. SCM in urban agriculture takes there on a completely different picture than in modernistic industrialized food production. This indicates that the disruptiveness of using hydroponics technology is not limited to features of logistics. It overall greatly changes the value network since it also changes the rules of competition in the distribution of horticulture products.

Further research needs to ground these findings which still must be considered assumptions. These studies may apply model in figure 1 as foundation and potentially refine this conceptualization of urban agriculture trying to develop a theory of managing value in chains of agents in involved in urban food production. Studies may also focus on more specific topics such as transparency and quality assurance, the self-controlling system that is hypothesized. The use of information technology and artificial intelligence to support the logistics of urban farming for small scale producers may be further researched. Studies may also consider the role of motivation and idealism, the people and ethics of urban food production. Finally, the use of variations of technology implies several viable paths of research including high tech urban agriculture, the degree of manual labour, and whether there is a conflict between the ethics of urban agriculture and use of high-tech farming. This includes importantly investigating aquaponics use in value networks. Further studies of urban agriculture will naturally involve case studies at a first stage, but gradually more refined methods adapted to the specific research issues that have emerged may be applied. The case studies should be single case studies of a particular urban farm in its value network context. These studies should seek to reveal details in accordance with the model shown in figure 1. As several case studies are completed, these different case narratives may be compared. Furthermore, this may provide ample grounds for refining the conceptual model provided in figure 13.

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