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Research Article

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Digitalisation in a local food system: Emphasis on Finnish Lapland

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Abstract: The positive adoption of digital technology within the food sector can boost sustainable development in Finnish Lapland. There is a need for a food system in the region to respond to current trends from consumers and ensure a better supply of local foods that are processed efficiently with minimal waste. In this article, a review of the literature on the benefits of digitalisation as a tool amongst food processors was carried out. The opportunities offered by digital technology are expected to make local food business operators more transparent, efficient and sustainable. Digitalisation can help to minimise the environmental impacts of food processing and ultimately improve sustainability. In meeting the demand of local consumers, distributed and localised manufacturing will help to add value to local food crops, lower transportation and storage costs. The adoption of food digitalisation will open up market accessibility for the locally produced food products in local communities. In the future, digitalisation is likely to have major impacts in the local food system of the Lapland region.

Keywords: distributed manufacturing, local food, personalised nutrition, sustainability

1 Introduction

Northern people in the circumpolar Arctic region have relied for millennia upon the landscape for their food through hunting, reindeer herding, gathering, fishing and small-scale gardening (Gjertsen and Halseth 2015). Agriculture, rural livelihoods, sustainable management of natural resources and food security are inextricably linked to climate change and other development challenges of the 21st century.

The Finnish Lapland as an European Arctic region presents a unique social, economic and environmental setting in Europe. With a sparse population spread across a vast land area, the natural conditions of Lapland with wealth of natural resources, and a distinct challenge, in long geographical distances between sparsely-populated communities offer both opportunities and challenges (Teräs et al. 2018). In the high-latitude North, rural livelihoods are tightly connected to climate, weather and ecosystems. It includes food and agriculture that contribute significantly to and are heavily impacted by the climate change, while also offering a range of opportunities for mitigating greenhouse gases through their role in emission reductions and carbon sequestration (Vermeulen et al. 2012). The climate change has a decisive and stronger consequence on the natural conditions in the Arctic region than elsewhere, which presents the region of almost four million people with an additional challenge and a need to adapt (ACIA 2004). It is estimated that 25% of the total global greenhouse gas emissions are directly caused by crop and animal production and forestry, especially deforestation, including 2% of emissions accounted in other sectors, from the production of fertilisers, herbicides, pesticides, and from the energy consumption for tillage, irrigation, fertilisation and harvest (IPCC 2014).

The conversion of natural ecosystems to agriculture causes losses of soil organic carbon up to 80 tonnes per hectare, most of which are emitted into the atmosphere (Lal 2004). Agriculture also suffers from the consequences of climate change such as rising temperatures, pests and diseases, water shortages, extreme weather events, loss of biodiversity and other impacts. It is important that sensors to monitor the related activities within a local system will improve efficiency and help to create a more sustainable food system.

Food system digitalisation refers to the application of innovative technology to enhance harvesting, processing, distribution and storage operations along the agri-food value chain (Raheem et al. 2019). As the European Arctic is particularly vulnerable to climate change, there is a need to promote business innovation that will

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respond to climate change and associated weather risks that build resilience to them.

It was suggested that the food systems have cumulative impacts on climate change and *vice versa* with consequences on the viability of individual and community health (Gerlach et al. 2011). In considering the future of food and agriculture in Finnish Lapland, which may bring new opportunities for new crops to grow in the region, it will be necessary to seek a sustainable food system. However, there are challenges for the introduction of new pests that will make their way into the region and will need to be planned adequately.

This article reviews the literature on the need to transform the food system holistically by encouraging local participation along the value chains. The need for a sustainable local food system through smart specialisation is highlighted in Section 2, while Section 3 discusses the future possibilities in Finnish Lapland concerning value addition to local foods and the relevance of distributed, localised manufacturing. Section 4 discusses personalised nutrition as a growing trend. Finally, Section 5 includes conclusions.

2 Smart specialisation concept to promote a sustainable food system

According to the Finnish Bioeconomy Strategy (2014), rural development has been seen as an important driver of the bioeconomy due to the increasing demand for biomass from rural areas in relation to the development of these rural areas. The strategy encourages smart specialisation with low carbon emissions that promote the green economy. However, it was observed that the amount, quality and scalability of the indicators that measure the green economy are rather narrow and novel (Timonen et al. 2018a). As the agricultural and food production involves the transformation of natural resources into products for human benefit, it is important to improve their operational efficiency and sustainability. Such a transformation will require technologies, knowledge, external inputs and management that consider the variation of their importance and mix across the production systems (FAO 2015). The level and mix of these inputs, the type of technologies and management systems used will have major implications for the level of productivity as well as the impact of production on natural resources and the environment. It will be

essential for the production system to be sustainable by having the “right mix” of inputs, through a smart specialisation concept that reflects the value of natural resources and the real costs of environmental impacts.

The Lapland’s Arctic Specialisation Programme 2014–2020 envisaged that Lapland’s forest and farmland resources will benefit from value addition. It is also hoped that natural products are processed within the region (Liitto Lapin 2013). The smart specialisation concept is designed to ensure that the Arctic natural environment is turned into an opportunity in the form of natural-resource utilisation, from which new and innovative business areas and networks are emerging alongside and within the traditional industries (Teräs et al. 2018).

This approach is in line with the European Union’s Joint Research Council’s (JRC) Vision 2030 on food security, which calls for concrete actions to build and promote a more balanced mix between local and global food systems as they will become increasingly demand-driven in the future. A largely demand-driven food system where responsible consumer behaviour is shaped by sustainable objectives was envisaged by the Food and Agriculture Organization (FAO) as a food system of the future (FAO 2015). By digitally empowering consumers who are eager to have a better control on the nutritional aspects of what they eat while contributing to sustainability issues worldwide can be a way to engage with them in realising this vision (JRC 2015). The JRC 2030 food system vision is based on a balance between the local and global level of food production and consumption, and it aims to move the traditional system beyond self-sufficiency and subsistence towards better productivity and integration into local, regional and global markets.

Sustainable development is defined by the FAO as the management and conservation of the natural resource base, and the orientation of technological and institutional change that ensures the attainment and continued satisfaction of human needs both for the present and future generations (FAO 2014).

In order to ensure that the future generation has access to adequate natural resources for food, every region of the world will require a more holistic approach that is sustainable within the food system at local, regional and global levels. For the local food system to be sustainable, its development needs to generate positive values along the economic, social and environmental dimensions simultaneously (FAO 2014). Such a food system needs to ensure sustainable development in the agriculture, forestry and fisheries sectors by conserving land, water, plant and animal genetic resources through digitalisation (Holden et al. 2018). In addition, it

should also be economically viable, socially acceptable, technically appropriate and not degrade the environment (Gennari and Navarro 2019).

In advancing the Sustainable Development Goals (SDGs), the UN Global Compact presented a vision that incorporates digital technology as a tool. The United Nations have set goals and targets for sustainable development towards 2030 (UN 2015). SDG 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) and Goal 12 (ensure sustainable consumption and production patterns) are related to food production systems (UN 2015). Adopting a food system perspective will be critical to addressing climate change and achieve the SDGs, which span multiple sectors that are linked by food (TEEB 2015).

Due to the complexity of the food system, it is necessary that different stages of pre- and post-harvest operations benefit from digitalisation by improving their efficiency. For example, digitalisation can be employed to reduce food waste, which has been shown to occur at the consumption stage where at least half of food losses and waste occur in developed countries (Gustavsson et al. 2011). These losses can be reduced drastically with innovative sensors that can monitor the shelf life of these products and alert consumers when they are likely to become inedible. There are initiatives that encourage the use of digitalisation at local levels to better promote and match those who may benefit from food products that may likely be wasted, e.g., low-income earners, students and the unemployed in local communities.

Investigations into further processing opportunities available to small- and medium-sized enterprises (SMEs) and the commercialisation of innovations will lead to the launch of further processing activities in the food sector. Challenges with such activities will be develop a production technology and logistics that are sustainable to meet the needs of SMEs. In order to strengthen their business expertise support measures for product development and the development of expertise will need to be considered. As there are concerns of migration from rural to urban cities, there are discussions on how to reverse this trend and make rural communities more attractive for young people.

2.1 Food sovereignty and rural-urban migration

Food sovereignty can be defined as the ability and the right of people to define their own policies and strategies

for the sustainable production, distribution and consumption of food that guarantee the right to food for the entire population, on the basis of small- and medium-sized production, respecting their own cultures and the diversity of peasant, fishing and indigenous forms of agricultural production, marketing and management of rural areas, in which women play a fundamental role (Raheem 2018). A distinction was made between food security and food sovereignty in 2001 at the World Forum on Food Sovereignty, and since then, it has gained a popular momentum for putting the people first. Nilsson and Evengård (2015) highlighted the relevance of food sovereignty from an Arctic perspective where local peoples are in control of the processes that lead to food security.

2.2 Examples of digitalisation in a local food system outside the Finnish Lapland region

As the global food system is gradually embracing digitalisation, there are several novel innovations mostly from start-up companies. A few examples outside Finnish Lapland are briefly described below.

Robotic machinery is used to harvest apples and other crops. A mobile robot is able to examine crops for their health and conduct simple operations like pruning, and observing and controlling ripening profiles so that a robot can cultivate crops like tomatoes continually and more efficiently than people (Golombek 2019). Robotic harvesting vehicles are being tested to pick strawberries and perform labor-intensive tasks normally performed by dozens of farm workers. Berries represent one of the most difficult challenges faced by the farm technology. Harvesting a soft fruit like berry mechanically is not an easy task. Each berry needs to be located, even if it is behind a leaf, assessed for ripeness and then harvested and boxed with enormous care to avoid bruising. Recent developments in the visual sensor technologies, machine leverage and autonomous propulsion have brought the goal of harvesting in California and Florida within reach (Golombek 2019).

Blockchain technology as an open and secure digital ledger provides transparency to inefficient and corrupt business practices by enabling equitable participation for farmers and other stakeholders on the global food value chain (Townsend et al. 2018). Since most SMEs in the food sector are slow to adopt digital solutions,

researchers from the Technical University of Denmark's Food Institute, together with the university's Compute and Skylab departments, designed blockchain solutions for small- and medium-sized food producers (Southey 2019). The permanent record of transactions in blockchain technology will help to prevent food fraud in quality food products.

There is also work being conducted to develop small agricultural field products to attack weeds and perform other farm chores. In this context, the low-cost flexible automation provided with robots can be an ideal solution for SMEs to improve their flexibility, productivity and product quality (Cederfeldt and Elgh 2005).

3 Future possibilities in Finnish Lapland

The Finnish Lapland has an area of 1,00,366 km², of which 7,699 km² is water, and a population of 1,80,200 inhabitants (Liitto Lapin 2018). In Lapland, 99% of the surface area of forests have the possibility to be certified

as an organic gathering area of natural products such as berries and mushroom; these areas are fertiliser- and pesticide-free (Luomuinstituutti 2014).

Figure 1a shows the map of Finland; the Lapland region is almost one-third of Finland. As an area with developed infrastructures, it can be a case in point for the future possibilities of food digitalisation. Despite the long distances between communities in Lapland, the major road network and traffic by air as shown in Figure 1b is quite good. The developed infrastructures can be harnessed for better logistical storage, handling and distribution of food products in the region.

The climate change is a great challenge for all sectors of the society, also for agriculture, which is why the climate change adaptation and mitigation must be considered at all stages of our food system. For agricultural production, there are technical solutions to improve the production efficiency, facilitate adaptation to climate change and restrain the creation of greenhouse gas emissions. In all these cases, the best possible use should be made of the knowledge and skills of the farmers (MMM 2014). This will be helped with the planned Arctic cloud service programme that helps companies in the field to be well established in Lapland.

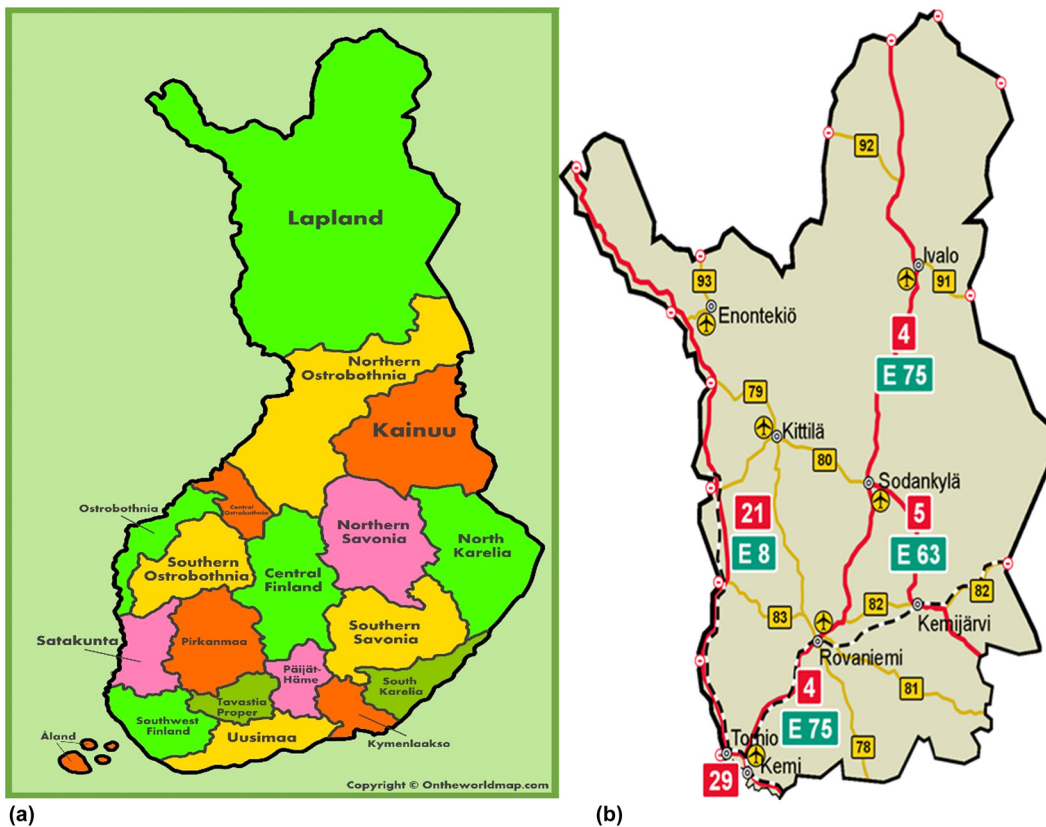


Figure 1: (a) Administrative map of Finland © on the World Map (b). Map of Lapland (major roads and towns) © Wikivoyage Travel guide.

Finnish Lapland is well-positioned to become a model region in the bioeconomy, which refers to economy that uses biological natural resources to produce food, products, energy and services (Liitto Lapin 2013). It is one of the northernmost parts of the world with a forest cover. The region seeks to reduce dependency on fossil energy, prevent the impoverishment of ecosystems and promote the sustainable economic development by identifying emerging bioeconomy-based branches in Lapland and making important strategic choices for the region. The strategy ensures that Lapland is linked with the implementation of the national bioeconomy strategy and action programme, taking its viewpoints into consideration. The available support measures aim at promoting business that is solely based on the bioeconomy, improving expertise and enhancing product development.

There are on-going initiatives with regard to business operations in Lapland. The objective is to establish growth environments for digital business, attract international know-how and investments and establish new business in the region. Finnish Lapland invests in the utilisation of digitalisation and the development of robotics in the Arctic environment and conditions, particularly in testing operations. The test subjects include vehicles, equipment, materials, services and systems. The Aurora intelligent transport testing area in Fell Lapland is one example of such recent investments. The goal of the project is to create an international transport automation testing environment and competence centre in the area, thus achieving global front runner status in the testing of automated driving in Arctic conditions (Ohtonen et al. 2016).

The Climate Programme for Finnish Agriculture recognises the climate-related objectives set by the European Union and in other international contexts and promotes these, but the approach is different. The Climate Programme stresses a new way of thinking, i.e., comprehensive sustainability of food production and consumption (MMM 2014).

The facilities and leisure services offered by the tourism centres make Lapland an attractive remote work location. The resort offers authentic tourism services as sustainable as possible, and each resort creates its own dynamic symbiosis. Once the data communication connections have been sorted out, remote workers can settle for work in the northern region from the southern part of the country and elsewhere around the world (Holopainen and Jokikaarre 2016). Ultimately, it is hoped that the Finnish Lapland will attract people to work for at least part of the year from Lapland.

3.1 Case studies of villages in Lapland

Lapland was chosen as a model area for clusters development by the European Commission (European Commission 2018). The European Commission's Cohesion Policy aims to reduce differences and ensure a balanced development between regions, and to ensure growth across Europe through smart specialisation.

The Smart Specialisation Platform assists Member States and regions to develop, implement and review their Research and Innovation strategy for Smart Specialisation Strategy (EU 2018). These include a focus on identifying niche areas of competitive strength, solving major societal challenges, bringing in a demand-driven dimension, fostering innovation partnerships, emphasizing greater co-ordination between different societal stakeholders and aligning resources and strategies between private and public actors of different governance levels.

The villages chosen as examples of green economy process model of the bioeconomy here are Saija and Nellim. These two villages were examined in that framework by Timonen et al. (2018a). Both villages are in Finnish Lapland near the Russian border with a large reservoir of unutilised natural resources that hold great potential for local utilisation. Saija is located in the eastern Lapland, about 40 km north of Salla, near the Russian border while Nellim village is near the south-eastern corner of Lake Inari in Lapland.

In the villages, there were projects linked to the government's top priorities of promoting the bioeconomy, clean coal-free and renewable domestic energy, the circular economy, nutrient recycling, the bioeconomy experiments, short-chain food supply and added value nationally and internationally (Timonen et al. 2018a). The pilot areas add to the nutrition and energy self-sufficiency of agriculture as well as the multi-active use of forests and wood supply.

Saija village in Salla, eastern Lapland, plans to start producing energy from the agricultural side streams and forestry (Timonen et al. 2018a). The plant is designed to be fed from the side streams of nearby restaurants and public kitchens (fodder crops and side-streams of food production). The side stream from the slaughter of reindeer contains a lot of fat that is useful in the production of biogas and is a good addition to the feed of the plant. Salla municipal waste is currently exported ca. 300 km to Oulu, where the local energy company processes it and converts it into energy. The authorities of the Salla municipality are considering the Saija power plant's ability to absorb some of the municipal's bio-

waste and thus reduce greenhouse gas emissions by reducing the transport mileage (Timonen et al. 2018a).

The area's potential to be self-sufficient in food production and further processing will be developed after the capital outflow from the purchase of fossil-based energy has been reduced, and the investment costs for the new energy production plant have been covered. The opportunities for the food production of livestock, reindeer processing (reindeer chips), cattle (beef), mushroom cultivation (Matsutake mushrooms) and greenhouse cultivation (fruit and vegetables) in the village will be economically viable (Timonen et al. 2018a). The general level of assessment in Saija village reflected the assumptions in the study by Kuha (2015), where the author concluded that almost 50% of food imported to Lapland can be produced locally. In addition, the share of total price for food products as described under "food capital outflow" in Lapland is 30% (Kuha 2015).

Nellim village is close to the Russian border, evacuees from Petsamo (Skolts) inhabited the village after the World War II, and it has a large reservoir of unutilised natural resources that holds a great potential for value addition to its raw materials and energy production. For the village to be more self-sufficient, sustainable and to implement the green economy targets, the share of the local food production in the area must grow in relation to the imported food consumption (Timonen et al. 2018b).

Due to the cost of air travel, more attention is being paid to the carbon footprint of tourism. This will be a key challenge for a technological change. In the report of Timonen et al. (2018a), nearly 90% of the respondents from a workshop that assessed the bio-energy initiative believed that the plant would be able to produce the planned amount of renewable energy for the Nellim village's needs. The respondents also believed that the plans would promote the interests of all villagers, i.e., all the inhabitants of the village can benefit from the planned facility. Furthermore, 75% of respondents believed that everyone are able to take part in the planning of works in the village and the decision on the power plant was equal and unanimous.

Tourism platforms on the international market offer the opportunity to build a fully digital operation and supply chain. The creation of platforms has made it possible to simplify the business model for the Nellim village, as transactions can occur directly between systems of different companies (Timonen et al. 2018a).

Sodankylä, a municipality in Lapland, is an example of an area that recognises its focus areas and potentials and has substantially increased the utilisation of local

foods, and the potential of berries, vegetables, feed and meat production in the area (Kitti et al. 2014). There were village meetings on green economy vision for 2020, and the villagers' view on the current state of the village was explored alongside the related challenges and means of achieving the future vision. It was seen important to develop renewable energy production in Sodankylä village and reduce the amount of capital flowing out of the village due to the purchase of fossil fuels (Timonen et al. 2018b).

The communities in these case studies support the green economy. However, the realisation of related activities will depend largely on the local people, their experiences, networks and cooperation (Figure 2).

3.2 Distributed and localised manufacturing

As mentioned previously in this section, the possibility of Finnish Lapland becoming a model region in the bioeconomy will depend on the action programs that are implemented. As we face global challenges of population growth, environmental concerns and safety, food manufacturers need to adapt to efficient and smart production systems to enhance long-term sustainability. The current large-scale centralised food production practices are faced with challenges by the need to keep food local and strengthen food sovereignty. Food consumption and preference often vary with time, and suppliers need to respond to the demand and market trends. Such a trend is in favour of keeping modular processing closer to the people by processing the local raw foods within the community, which is a benefit to the distributed and local manufacturing. Distributed and local manufacturing is decentralised and closer to consumer protection network that provides flexibility and a faster response to the needs of the market (Rauch et al. 2017). Distributed and localised manufacturing, which is gradually happening in the Lapland region, can serve as a good purpose that can tie very well into a circular economy. Distributed manufacturing has the potential to increase sustainability in food production as it offers greater product customisation.

The substantial investment required in implementing large-scale automation is a prohibiting factor for SMEs to adopt automated processes within their production line (Golombek 2019). More sustainable food manufacturing will require a more holistic approach that identifies several factors to be considered by all actors in local, regional and global food enterprises as shown in Figure 2.

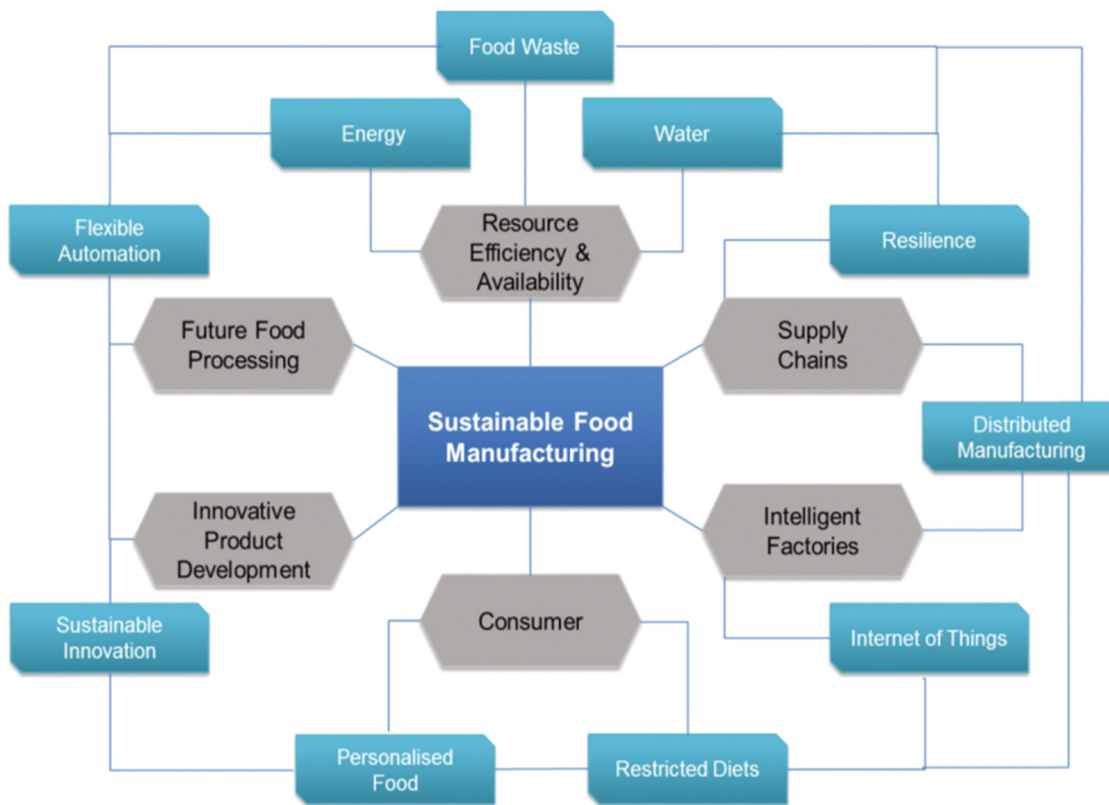


Figure 2: Future research challenges in sustainable food manufacturing (source: Rahimifard et al. 2017).

In order to reduce the waste of natural resources and maintain sustainability, efficient steps are necessary. In the future, innovation and development initiatives that are targeted at food products, their processing and supply are important (Rahimifard et al. 2017).

For example, sustainable food manufacturing that employs distributed manufacturing in Lapland can focus on how to improve the low quality of cultivated berries and mushrooms by employing sensors to monitor soil parameters, ripeness and yield. Intelligent and smart packaging with digital tools that are sustainable can help to reduce food waste and ensure safety. Digital solutions to knowledge gaps such as the authenticity of food ingredients and their geographical origin can be verified with the blockchain technology. The costs associated with storage, transport and distribution will be reduced with a better online visibility for the food business operators using e-commerce.

The yield of crops and other natural products that grow in the Finnish Lapland region are affected by uncertainties in climate. With almost 9 million forest hectares of land, Lapland's forests have the potential to be the world's largest contiguous area that can be confirmed as organic for wild/forest food collection

(Sipola 2016). The output of yield from the area can improve with digital solutions that utilise modellings from abiotic factors such as temperature, solar radiation, pH and CO₂ that affect the soil. For example, the use of hyperspectral frame sensor opens new application areas for lightweight unmanned aerial vehicles imaging. The camera is set to the range of 500–900 nm. In agriculture, this wavelength range is advantageous for crop indices such as yield estimates, detection of crop diseases and flux indices. The system is very suitable for precision agriculture: land use, vegetation and forestry surveys. The device and the software are being continuously developed (Mäkeläinen et al. 2013). In addition, SMEs in a local economy can benefit from a combination of digital and intelligent price tags with a product shelf life information and real-time monitoring of the freshness of products using the sensor technology that will help to minimise spoilage in the retail sector.

3.3 Value addition to local foods in Lapland

In order to innovate and bring benefit to local foods of high quality before they end up in the market will

demand a consistent supply of these foods. This will be best guaranteed with support to growers, processors and other stakeholders in the region. The value addition to local foods and natural products in Finnish Lapland is still minimal and can be improved for commercial activities while still preserving the culture.

Tourism in Lapland has strongly grown during the past few years. There were 3 million registered overnight stays in 2018, and the proportion of international overnights was 52% (Statistics Finland 2019). As the region is expected to continue to attract tourists, there will be a growing demand for the local delicacies for consumption and as gift items. The use of digital solutions, such as business to business, e-marketing, etc., throughout the supply chain will be useful (Raheem et al. 2019).

For instance, reindeer husbandry is a form of livelihood that dates back centuries in Lapland, and the animal is an essential part of Lappish cuisine. Reindeer is the most important production animal in Finnish Lapland, and it is widely used in tourism marketing. Local foods in Lapland include sautéed reindeer served with mashed potatoes and fresh lingonberries or lingonberry jam which is a classic dish, but other parts of reindeer are also used without waste, e.g., the meat are served as fillets, cold cuts, jerky, mince and sausages. There are opportunities to develop other novel food products that are reindeer meat-based.

Other local foods in the region include soft bread cheese “leipäjuusto,” which is slightly grilled, giving it the distinctive brown marks. Soft bread cheese is traditionally paired up with cloudbberries and served as a dessert but may also be enjoyed with coffee.

The natural berries that grow in the wild in Lapland are underutilised. According to Turtiainen et al. (2011), only 10% of cowberry and 6% of bilberries in the region are utilised, which offer a great potential for value addition in the future. Digital and technological solutions that incorporate green technology at different processing stages in converting raw and natural resources into final products will ensure sustainability. Lapland forests and bogs grow bilberries, cloudbberries and lingonberries that can be freely picked as long as the environment is not damaged. There are a range of jams and juices made from berries. Mushrooms can also be freely picked in the wild. For example, pine mushroom (Japanese matsutake) can be picked from the forests of Lapland. The mushroom is a delicacy especially in Japan, where the price for kilo can climb up to hundreds of euros.

Barley has been one of the few grains that can survive in the Arctic climate of Lapland. It is traditionally used for baking and brewing. Flatbread ‘rieska’ is baked from barley as a main ingredient; Lapin Kulta Arctic Malt non-alcoholic beer is also made from malted barley to generate a fruity flavour. Flavour can be digitalised by



Figure 3: Sample of some local food products from Lapland at the City market, Rovaniemi. Photo: Dele Raheem.

using multisensory technology to reach a wider audience before being tasted. Pioneering work is being developed on a digital platform ‘iSense’ that is dedicated to flavours and taste ingredients, with disruptive tools and functionalities (iSense 2020).

The almond potato ‘Lapin Puikula’ has the PDO (Protected Designation of Origin) label in the European Union, which means that only this specific type of potato cultivated in Lapland can carry the name.

Figure 3 shows a section of the city market that features local products from Lapland are displayed in the supermarket. The application of digitalisation in food is expected to enhance information on the products for the consumers. Because of this, end customers are increasingly able to tell their manufacturers directly – via the internet – exactly what products they want and when they want it.

Another important feature in the region is the “Lapland Food House concept” where processing, storage, logistics and sales of these products can interact under one umbrella with the use of digital technology as a tool to improve e-business and take advantage of the social media. The concept aims to improve the competitiveness of food business operators and create new networks through digital tools.

It is of utmost importance that SMEs such as in the food sector boldly experiment with novel operations models, develop their technological know-how, and participate in building infrastructures aiming at digital transformation (Latvala et al. 2017).

3.4 Digital transformation

There are initiatives at national levels to transform the food production processes digitally and efficiently. In limiting greenhouse gas emissions, the use of fossil fuel is on the decline and digital solutions are being supported to ensure sustainability.

With the help of industrial Internet, we are moving towards more efficient processes and from mass production towards a more consumer-centric and personalised production of food and its information content. This transition will be a great opportunity for creating new businesses, but it is also a threat to those actors who remain attached to old ways, operating models, and structures, and fail to react to the new competitive environment in time. This applies to a local economy such as the Finnish Lapland. The transition towards more competitive and sustainable food production

requires an open-minded change in the modes of thinking and methods of acting. As a key enabler of individualised food production, the digital transformation offers both producers and consumers tools for gathering and monitoring information on the consumption habits of individuals, the nutrient contents of foodstuffs, and the lifecycle environmental impacts (Kempas 2016).

In considering the future possibilities for food processors, the yield over land for local foods as inputs that need to be processed will need to increase in an ecological and sustainable manner with digital solutions. There are several startup companies exploring the opportunities of digital solutions in the food and agriculture sector. One such digital approach is from Biocode Finland, which provides service for food companies, farmers and consumers to make ecological food choices related to carbon footprint (Biocode 2020). The code gives information about how the products are made and how efficiently they are produced, a knowledge of the carbon footprint combined with other information will provide good tools to restrain climate change.

In another development, the use of peer-to-peer network that is currently applied in Lapland is the REKO system; it employs a new model of a sustainable marketing channel based on social networking services interactions (Szymoniuk and Valtari 2018). The system unites small food producers and consumers with digital modern information and communications technology (ICT) in the creation of sustainable distributed food systems, as it offers consumers a way of ordering products directly from the producer, without the need for intermediaries (Szymoniuk and Valtari 2018; Raheem et al. 2019).

The use of mobile application to prevent farm damages by reindeer; the mobile phone app alerts farmers and herders and provides a better cooperation for their livelihoods (Majuri 2019). The dramatic increase in perennial forage yields in Rovaniemi because of climate change can be better monitored by remote sensing to closely follow the grassland growth (Niemi-läinen et al. 2019).

There are possibilities to use food scanners that were developed by start-ups to provide digital solutions in Finland. The Finnish Spectra engine received awards for a mobile solution that precisely, quickly and efficiently analyses the food composition and nutrition facts (Spectra 2020). The Apple-awarded ‘Wolt app’ is another digital solution that enables one to choose from over 5,000 restaurants in more than 40 cities around Europe (Wolt 2020). It also operates in Rovaniemi, making local

meals around the city to be readily available to customers. VALO Order Service is a business customer service that helps you place orders faster and more secure by integration with Microsoft Teams (Valo Intranet 2020). As a nationwide business customer service, orders can be placed faster and more secure in any part of Finland, which makes it useful in remote and sparsely populated villages. An open service (Biomass Atlas) relevant to Lapland collects location data about biomass under a single user interface. The service enables users to calculate the amount of biomass in a given geographical area as well as examining the opportunities to utilise the biomass and restrictions on its use (Biomassa 2020).

Smartcart is a Finnish technology company with the intent to provide easy-to-use intelligent shopping carts for retail with an integrated tablet and interface specifically tailored for each location (Intellectsoft 2020). Smartcart helps customers with floorplans, locating products and searches, store info and offer suggestions based on customer's location within the store.

Consumers experience stems from their interaction with the final products that most often compete for shelf space in the groceries and supermarkets. A study was conducted to find the impact of a Smartcart device on the consumer shopping process in a Finnish supermarket. Participants' positive evaluations of the device indicate that the in-store technologies have the potential to impact the shopping process positively and thus shape new types of interactions (Eriksson et al. 2016). It is likely that in the future, Smartcart shopping and e-commerce will be common platforms to purchase foods and help customers shape their opinions on a particular food product. One of the Smartcart's pivotal goals is to bring the benefits of self-checkout to the shopping cart itself.

The technology will help to stimulate interests on new recipes and ideas on how best to utilise some of the products in a local supermarket. SMEs can tap into this available technology to promote their products, their nutritional quality, well-being for local inhabitants and tourists.

4 Enhancement of consumers' experience through digitalisation

There are concerns amongst many indigenous peoples that their source of livelihood, culture and food security

are affected without the opportunity to gain access to local foods that are culturally acceptable. The choice of food on a personal basis is partly dictated by culture and environmental influences. Therefore, it will be important to gain a better understanding of the differential responses to individualised food-derived nutrients in foods as it relates to the genetic make-up of individuals. Digital solutions to help gather important health biomarkers will be essential for a data-driven future that links personal nutritional intake and health.

The current research efforts in agriculture, food, diet and health have not harnessed the full potential of the Internet and related computing technologies in the quest to improve health outcomes with dietary interventions. Therefore, a multi-ontology framework is an immediate preliminary course for utilising the existing database, vocabulary and ontology resources. As we look into the future, there is a need to increase the semantic and logical connectivity so that the fields that relate to agriculture and health speak the same language (Lange et al. 2007).

The key trends in food, nutrition and health are often shaped by the quality attributes and safety of food ingredients. Natural food ingredients are associated with health as they do not contain chemical additives or artificial ingredients. Consumers like to explore and are interested in new experiences that are convenient and match health expectations. They also need to be aware of foods that can cause digestive problems. For instance, some people are sensitive to fermentable oligosaccharides, disaccharides, monosaccharides and polyols, the short-chain carbohydrates and sugar alcohols that are poorly absorbed by the body, resulting in abdominal pain and bloating. Similarly, many people who are intolerant to milk have a specific intolerance to A1 resulting in bloating, abdominal pain or diarrhea (Mellentin 2018). A2 milk that has no A1 protein (which is one of the main types of beta casein protein fractions) can be an option.

In view of the challenges that we will face in the future regarding the link between food, diet, genes and health, there is a need to take advantage of the knowledge from the internet of things and apply it to the food sector. Once food/diet/health ontologies have been sufficiently created and integrated with each other and with other standardised biomedical terminologies, it is realistic to expect that new strategies will evolve to discover diets and food products that deliver health to individuals (Lange et al. 2007).

Consumers can be allergic to different food ingredients based on their genes. A knowledge on the

nutritional quality of foods in a local food can be better promoted through digitalisation. In this regard, the commercial exploitation of milk from the Finnish Lapland Northern Finncattle with low A1 beta casein protein can be further investigated to reach a wider audience. The milk can be flavoured with natural herbs or supplemented as a dairy ingredient.

It was suggested that more courage is required from the Lappish actors to discard their safe, familiar operating models and adopt a proactive, anticipatory stance in utilising digitalisation (Holopainen and Jokikäärre 2016). The authors further suggested that the development of digitalisation should be monitored more closely on the international level, as the actors in Lapland must keep up with the global development. The Lapland food sector would have a plenty of opportunities to make use of digitalisation, but it will need more extensive investments and cooperation with other goal-oriented parties.

5 Concluding remarks

There is a need to encourage a sustainable food system with considerations to our natural resources. In this paper, the need for a local food system to adopt digital solutions to ensure food security and safety is highlighted. With accurate data to inform, the value chain of local products will lead to opportunities to improve on processes at different stages. It will also be easier to share best practices and monitor food safety. The collation of processing data parameters on what goes on at each stage can provide useful information to help artisan food producers at local levels. With the latest technology that incorporates big data, there will be a drive to map and integrate data from across the whole food supply chain, from weather and remote sensing in agriculture, to tracing where raw ingredients were sourced from, the nutritional content of foods, tracking how food has been produced and handled. These innovative breakthroughs are making their ways to the future food system with smart labels on food that can be scanned to reveal a whole host of information about a product, which allow consumers to differentiate between products on health and sustainability grounds.

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