**UNIVERSITÀ DEGLI STUDI ROMA TRE**

**Faculty of Economics “Federico Caffè”**



**Master in Human Development and Food Security**



**Dimensions for the future of food systems**

***A collaborative effort by Roma Tre’s Students in Master in Human Development and Food Security 2018/19***

By:

Emanuela Alzari, Vincenzo Angrisani, Jonathan Attura, Ana Rita Azevedo, Violet Chanza Black, Chiara Bordin, Greta Campora, Rubina Cantele, Valentina Carlino, Martina De Felice, Amanda De Filippo, Julia Elsey, Alena Goebel, Mary Kathryn Hart, Anna-Maria Heikkinen, Gabriela Martel, Laura Meritani, Mattia Mogetta, Rachid Mokrane Scipioni, Anatolia Mubisi, Lourdes Orlando, Louise Sarant, Dzingai Shepherd, Cathrine Terro and Arturo Turillazzi

Professor: George-André Simon

**About this document**

*This paper is the result of an assignment developed jointly by the Master in Human Development and Food Security and FAO’s Global Forum on Food Security and Nutrition (FSN Forum). The assignment tasked students with scrutinizing comments received through a series of public FSN Forum online discussion and to analyze them in the context of food systems. The work also includes original inputs from the students.*

Food systems include the governance and economics of food, its sustainability, and the processes associated with the production, distribution, and consumption of it. Their political, social, and environmental dimensions impact our natural resources, human health, and most dimensions of life on Earth. The multiple obligations of a healthy food system include feeding the planet and safeguarding land and water resources, climate change adaptation and mitigation, reducing the harmful impacts of agriculture, ensuring animal health and welfare, promoting sustainable and inclusive development.

With a view towards ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity, the international community has taken a holistic approach to create increasingly sustainable food systems. Food security has been a primary sector of the United Nations’ mandate through multiple organizations including the Food and Agriculture Organization (FAO) and the International Fund for Agricultural Development (IFAD). Giving all people access to sufficient, safe and nutritious food is undeniably among the first strategies to eradicate poverty. Nutrition and hence food systems play an important role in achieving all the Sustainable Development Goals (SDGs) as it both an input and an output of development.

The Global Forum on Food Security and Nutrition of FAO asked contributors how value chains can be shaped in order to improve nutrition. These contributions formed the basis of this paper. Food systems are extremely complex; for the sake of brevity this paper will discuss aspects of the food system we believe to be crucial for future contexts.

Food systems extend far beyond the business perspective, and implementing a sustainable, resilient and fair food system would simultaneously improve people and ecosystems’ general health and well-being. We believe that a transformative vision of food systems is urgently needed. To articulate what we envision as a viable food system of the future, we organized our collaborative paper around a traditional agricultural value-chain, from growing and harvesting to storage and processing, transportation and trade, all the way to the consumption and health dimensions.

The evidence cited in this paper comes from various sources. The Global Food and Nutrition Security Forum by FAO[[1]](#footnote-1) provided a wealth of arguments and case studies, some of which were reused in this paper, and other references are made throughout to other stakeholders, farmers, researchers, scientists and policy-makers. While many experts point out the importance of a complete overhaul of food systems’ perception, a critical assessment of these visions, and whether they could be applied and scaled-up remains missing.

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# 1. Production and Natural Resource Management for Biodiversity

The global population in 2010 was estimated to be 6.9 billion people, and by 2050 is predicted to reach between 8.5 billion and 10 billion people (Samir, 2017). This projection is expected to lead to an increase in food demand and consequently in production, negatively affecting the environment and our health in irreversible ways. Maintaining food security through sustainable agricultureintensification (Tilman et al., 2010) is arguably the greatest global challenge humanity faces today. (Godfray et al., 2010).

To address the challenges in supplying a sustainable source of healthy food, stakeholders are starting to embrace a holistic approach of the food chain covering policies, local, regional, and global economies and businesses, farmers, individuals, diets, and natural resources.

In many parts of the world, the large-scale cultivation of a single crop on concentrated land is widespread. Referred to as “conventional” farming, it relies on the systematic use of fertilizers and pesticides, and on intensive production patterns. Unfortunately, the Green Revolution’s sole focus on increased production has had a lasting and detrimental impact on biodiversity, soil quality, rural social cohesion, traditional indigenous farming and nutrition.

Scenarios on the future of food production, in a context of global climatic change, temperature hikes, altered rain seasons, large-scale top soil erosion, increased salinity, biomass depletion and biodiversity, can appear daunting, if not altogether bleak.

It has now become clear that a rise in production is not the only important levy to ensure food security and nutrition for the decades and centuries to come. In fact, the main challenge is to re-think and re-shape the entire food system, starting from the production stage, towards a more sustainable system. An ideal approach would encompass dimensions of food security, human development and income, causing no harm to the environment and natural resources, and keeping small farmers out of debt and poverty. This approach on agriculture in general, and on how its value-chain is organized, could be a valuable entry point for policy.

## **1.1 Toward a more sustainable system**

The prevailing agricultural technologies and techniques used today adversely affect human health and the environment. Such practices are incompatible with the sustainable development of agriculture, which must produce food while addressing climate change and the degradation of natural resources. Moreover, current food value chain practices and food prices risk endangering smallholder farmers, weakening economies and deepening rural poverty.

In order to preserve the ecosystem while delivering healthy and sustainable food, new approaches are required. These approaches must deliver on key issues, including empowering rural areas, providing ecologically functional production of food while harnessing and regenerating ecosystem services, and strengthening resilience to climate change.

A number of proposals were advanced to encourage the adoption and scaling-up of best practices for sustainable farming systems. Special attention was given to the agro-ecological approach and to organic farming systems, particularly concerning their impact on resilience to and mitigation of climate change. Beyond the socio-politico drivers for sustainable food systems, climate change is systematically addressed as a key component in adopting more sustainable systems.

### **1.1.1 Innovative Production Systems**

Agroecology and organic farming are two methods that encompass a variety of changes, both to practices and legislation that allow farmers to profit from their investment and management of natural resources. Both are holistic approaches that incorporate dimensions of food security, sustainability, and land management in the structure of the practice. These methods for production challenge the status quo, but they might also work cohesively alongside it.

Food systems innovation requires active response to the multiple pressures that are exerted on the production of food, fuel, and fiber. The sector will not be able to be a viable emancipatory or sustainable activity if we depend solely on industrialized, conventional agriculture. Our analysis depended heavily on the production of plants, but this is also the case for livestock, fisheries, and forestry. Neither these industries nor the environment will be able to handle the stressors of an added billion people in a business as usual scenario.

The causes for a destabilized agricultural sector might be the dependence on fuel that renders the system unsustainable, or the destruction of valuable land, or the migration of populations who are unable to support themselves and their families. Whichever the reason, the restructuring of the food system has been cited across the world, and serious scientific attention must be given to these “alternative” systems if we are to find a balance for agriculture in our modern society.

### **1.1.2 The agroecological approach**

According to recent major reports (IAASTD 2009, de Schutter 2010) in order to feed nine billion people in 2050, we need to shift towards agroecology as a way to boost food production and improve the situation of the poorest. In this way, small-scale farmers, which feed 50% of global population, could double their production in 10 years in critical regions through agro-ecological strategies that are already available.

Agro-ecology emerges as one of the most sustainable solutions in order to tackle climate change, energy issues, and the financial crisis (Denevan 1995 Altieri 2004). It is rooted in traditional small-scale agriculture, which may provides us with a tremendous amount of diversity (crop and animals) enhanced by soil, water and biodiversity management regimes (Altieri 2000). As a farming practice, it is a holistic approach that seeks to build long-term fertility, healthy agro-ecosystems and secure livelihoods.

Despite the strides made in agricultural industrialization and mechanization, the majority of farmers in developing countries today operate on a very small-scale, are vulnerable, and rely on traditional and subsistence methods. In fact, the evidence shows that smallholder systems are sustainably productive without using chemicals, biological regenerative and energy-efficient and also tend to be participative and socially just (Altieri, 2000).

The agro-ecological approach offers a valuable alternative to industrial agriculture by relying on traditional farming knowledge and low input, indigenous techniques. These strategies can be strengthened by providing small farmers with adequate coping strategies against climate change, transferring contextually-relevant scientific innovations, and expanding resources for these farming systems. Our aim in this research is to demonstrate a need for investments in science that will provide data on agro-ecological systems, to incorporate these into our existing production systems. It is important to understand how agroecology can be scaled up and improved, with the same level of attention to detail the Green Revolution was given.

The main critic voiced by opponents of alternative farming systems relates to the lower crop yields that sustainable farming supposedly produces. However, yield measurement has too often been taken as a measure of performance, in which a mono-crop intensive system with a large per-unit productivity is difficult to assess against an integrated agro-ecological system. Indeed, agroecology delivers increasing resilience, higher crop diversity, ecosystem and resource health, and other positive externalities that are more difficult to quantify. Moreover, since most of the world’s poor rely on agriculture for their livelihoods, the promise of agroecology’s stable and sustainable employment is critically important.

Given the significance of an agro-ecological impact on the environment and its presence globally, a significant investment should be made into a scientific study of its potential, such that we might find mechanisms to scale up its implementation and support in legislation. The results could be multidimensional, with impacts on the environment and the wellbeing of farmers and society at large.

### **1.1.3 Organic farming**

Organic farming also provides potential to renovate food systems and address environmental degradation and human health issues. Its premise has moved beyond a niche movement that promises pesticide-free products or cruelty-free animal proteins. Today, most organic products provide a market standard for fair, environmentally conscious, healthy foods.

These values are recognized to be pillars in the organic farming approach (Niggli Et al.; 2017). Organic farming may be qualified as an alternative model to agroecology (Rosset and Altieri 1997, Guthman 2000), as it is more focused on the system of farm management and food production. It is also driven by a horizontal implementation, uniting citizens and stakeholders in a push for more sustainable, holistic methods and regulation.

The opportunity related to organic farming is not only in terms of sustainability of production. It is well argued (Crowder and Reganold 2015) that organic farming may be more profitable than traditional pesticides-based methods of production. It could also reduce the negative externalities related to agriculture, including pollution of natural resources and the extinction of many species. It is also able to enhance the resilience of agro-ecosystems by contributing to many ecosystem goods and services (Schader, Stolze, and Gattinger, 2012), increase overall biomass abundance and favorite pollination of crops and natural pest regulation (Altieri, and Nicholls 2006).

In this context the evolution and the opportunity related to Organic farming depends mainly on the interactions among all the stakeholders along the value chain. Organic agriculture develops co-innovation between farmers, farm advisors and scientists, and can improve farmer-to-farmer as well as farmer-to-consumer communication and cooperation.

To conclude, if a more holistic approach is matched and Organic farming will be able to qualify itself as a reliable, innovative way of production in order to gain attention and support from a political standpoint, then a strong sustainable and profitable alternative to usual growing and harvesting can be set and scaled up.

## **1.2 Biodiversity and ecosystem functioning**

Biodiversity is the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems. Biodiversity plays a decisive role in ecosystem functioning, being crucial for food security and better nutrition; determining and contributing to human well-being.

The recent IPBES Global Assessment on biodiversity (2019) has demonstrated the devastating loss in biodiversity, demonstrating the shrinking the amount of species diversity in plants and animals driven by a plurality of factors including agriculture. Therefore, what is needed is a drastic change in our production system toward a more sustainable one, that protects biodiversity as part of its design.

Mainstreaming biodiversity requires a coordinated effort of high-level engagement with national governments, traditional leaders and international organizations: taking into consideration that agriculture relies on biodiversity but mostly impacts biodiversity. There is a need for a closer cooperation between actors to optimize the delivery of multiple ecosystem services. Promoting the translation of expert knowledge on soil biodiversity into environmental policy and sustainable land management for the protection and enhancement of ecosystem services requires further integration between academia and research institutes (with extension services) and farmers as end users and feedback providers.

Diverse steps have to be taken: on the one hand, scientists have to become more central in the process and on the other, governmental supported platforms would help to bring different parties together and start these interactions

### **1.2.1 Soil biodiversity**

The most neglected part of biodiversity, often ignored in conventional industrialized agriculture and under-evaluated as an asset, is soil biodiversity. Soil provides significant ecosystem services, including processes related to nutrient cycling. It is a key asset of natural capital, providing goods and services that sustain life not only through the support of food production, but also with the provision and promotion of effects as carbon sequestration and greenhouse gas mitigation.

However, soil health is strongly affected by current land use practices; in fact, methods such as mono-cropping intensive production and tillage or the use of pesticides and fertilizer lead to soil depletion. Several studies in agricultural areas across Europe (de Vries et al. 2013, Tsiafouli et al. 2015) have shown that land use systems, such as intensive wheat rotations including annual tillage or intensive monoculture with chemical fertilization, consistently reduce biomass and diversity of several groups of soil organisms irrespective of soil abiotic properties.

Soil biodiversity might provide the solution for sustainable agriculture, that is to say, to reducing conventional pesticides and fertilizers use through application of biocontrol agents and biofertilizers. In fact, soil flora and fauna play a vital role in sustaining the above ground biodiversity and terrestrial ecosystems forming a complex web of biological activity: a soil rich in species, it is a soil rich in health. Soil organisms contribute a wide range of essential services to the sustainable function of all ecosystems. They act as the primary driving agents of nutrient cycling, regulating the dynamics of soil organic matter, soil carbon sequestration and greenhouse gas emission, modifying soil physical structure and water regimes, enhancing the amount and efficiency of nutrient acquisition by the vegetation and enhancing plant health.

These services are not only essential to the functioning of natural ecosystems but constitute an important resource for the sustainable management of agricultural systems. *As an example*, earthworms improve the structure and fertility of soil by accelerating decomposition processes, enhancing nutrient cycling and facilitating water percolation. The findings published in the scientific journal Global Change Biology show a systematic decline in earthworm populations in soils (by >80% in intensive agriculture) that are ploughed every year.

A concrete example of practices to minimise external inputs for nutrient supply and disease control in agriculture is the use of fungal communities composition and diversity in root systems of coffee grown. This practice may be compromised in conventionally-managed coffee, reinforcing reliance on fungicides to achieve disease control, and may need to be restored in order to successfully shift from conventional to organic management.

### **1.2.2 Integrating livestock and diverse crop for healthy soils**

Diversification of livestock production and their integration in farming systems will contribute to mainstreaming of biodiversity into agriculture and producing nutrient rich food (protein, vitamin, carbohydrates, etc.). Some nutrients are available in limited concentrations in the soil, but the below-ground biodiversity assume active roles in nutrient transformations, mineralization, etc., increasing the food production and the quality of food. Thus, a model of multifunctional small farm which integrate crops, horticulture, livestock and natural vegetation is key to sustainable development in countries dominated by small farms, extending the benefits of farms beyond the economic sphere. By preserving biodiversity, open space and trees, and by reducing land degradation, the farm provides valuable ecosystem services to the larger society. Along with agriculture the farmer is having livestock which yields milk and the dung is converted into valuable vermicompost. He had also turned himself into an entrepreneur by processing and value addition to his farm produce through a tunnel drier.

### **1.2.3 Participatory approach to preserve biodiversity**

A participatory and interactive process is of particular importance, involving and dedicating attention to individual capacities, (like indigenous knowledge, and local farmer skills), as well as to organizational, institutional capacities and systemic capacities. This system-wide approach needs to foster joint-ownership, joint-commitment and mutual accountability to achieve biodiversity improvements the planet so urgently requires. Moreover, to fight the problem of biodiversity erosion, policy makers should promote a shift from industrial agriculture to a diversified and more sustainable farming system.

Stakeholders could raise awareness at national and local scales to empower consumers to be knowledgeable about their environments and the importance of biodiversity. This could in turn stimulate the demand for a diversified and healthy food . In developing countries, a crucial role is played by informal markets as a centre of Agro-biodiversity, where people and small farmers from different areas can exchange different seeds and products from different areas of cultivation. Policies and subsidies could support these informal, agroecological practices, and support realities where Biodiversity is preserved and guarded.

An important political tool available to protect and promote Biodiversity is public and private support in the creation of Gastronomic Movements. These movements can have a sizable impact on the state of food security and nutrition security for populations by increasing the availability of diverse, nutritious foods from a variety of sources.A notable example is the MIGA project in Bolivia, where chefs and local family farmers cooperate together to ensure sustainable and traditional process of food production and consumption. The shared knowledge is important for cultural traditions, but also to sustain the use of lesser known food products and create a viable market space for them.Policy programs should also pay particular attention to consumers, their food literacy and their needs to understand how Biodiversity can affect their health and nutrition.

School feeding programs are also a powerful intervention with immediate and long-term impact , and can improve childhood nutrition and provide them with an education on how their diets can influence their future. In addition to nutrition and dietary awareness, school programs could include Ecological Education in order to enable the young generation to understand the connections between certain agricultural practices and their deleterious environmental impact.

## **1.3 Addressing climate change**

Climate change is a significant and growing threat to food and nutrition security affecting vulnerable populations in many countries. Farmers are particularly vulnerable to this, as variations in climate may cause shorter planting seasons, reduced productivity, different pest problems, and much more environmental stressors.

Resilience to climate disaster is closely linked to a high level of on-farm biodiversity, a typical features of traditional/indigenous farming systems. In fact, there is a wide range of studies which emphasize the importance of enhancing plant diversity to reduce vulnerability to extreme climate change. A new recognition of biodiversity is boosted and is relevant for the maintenance of functioning ecosystems. Highlighting the importance of crop diversification used by traditional/indigenous farmers and and resilience strategies for agroecology (Lin et. al 2008). In fact, many small-farmers cope with and even prepare for climate change through agro-ecological practices, increasing the use of drought tolerant local varieties, water harvesting, mixed cropping, agroforestry, soil conservation practices and a series of other traditional techniques (Altrieri and Koohafkan 2008). Resilience derives from the use of inventive self-reliance, expert knowledge, indigenous legacies and locally available resources (Altieri 2002).

An example of these practices, are the “Raised fieldbed ”, which have been used since time immemorial by farmers across the world. The *Chinampas* in Mexico provide us a clear example of farming wetlands, in fact they are sort of “island” of raised platforms ideated by the Aztecs, useful for maintaining the soil dry. The opposite practices are used in semi-arid and arid lands where farmers have generated since centuries management option that can increase the soil’s ability to “store” water for plants use, reduce vulnerability facing drought and mostly stopping soil erosion and degradation (Barrow 1999).

In Nigeria, for example, ridges are included at regular intervals across furrows between crops which are planted on “raised beds”; those structures help to hold rainfall and boost water infiltration. To sum-up, diversified complex agro-systems, like agroforestry, silvopastoral and polycultural, provided examples of how agroecology is able to adapt and resist to climate change; more diverse plant communities are more resistant to shocks (Lin et al. 2008).Surely, that evidence that traditional farmers are aware of the importance of the agroecosystems relies on biodiversity and that many farmers relies on policuture and agroforestry system show us the need to re-evaluate indigenous methods as a main source of knowledge on adaptive capacity.

Furthermore, little has been said about the social resilience of small-scale farmers/indigenous communities in managing such agroecological systems; key factors are the social networks and collective actions developed by peasants to face external stresses (Tompkins and Adger 2004).

As a consequence, farmers adopting the agro-ecological path, which enhances high diversity landscapes, they will contribute to GHG emissions reduction and therefore may contribute to mitigate global warming (Tscharntke et al. 2005).

In order to preserve these traditions small farmers should be empowered and economically encourages to follow this path, by governments and stakeholders at national and international level. Officials and leaders can provide science-based and results-oriented toolkits for climate adaptation, supplemented by indigenous knowledge and practices. Facilitating access to climate information and meteorological conditions to farmers would have a considerable impact on the adaptation of farmers to climate change, and could serve as a part of the digital revolution for smallholder agriculture, which leads us to innovative technologies for agriculture.

## **1.4 Chapter 1 Conclusion**

Our aim in this chapter is to demonstrate the input dimension of the food system to properly demonstrate the importance of food production. A holistic analysis of food systems must properly understand all sectors of the process of production, distribution, and consumption. However, the production part of the system has a significant impact on the distribution and consumption of food, with a large impact on the environment and the shaping of social and spatial relationships between the farm, farmers, and consumers.

The first part of this chapter sought to establish the importance of alternative farming systems to the current conventional model, and what impact they had on the social, political, and ecological dimensions of farming. Indeed, as the issue with food systems is not unidimensional, the response to ensure productive and healthy food systems will not be uniform. Introducing a larger variety of farming systems can provide proven benefits, while tackling the issues of climate change, human health, and political-economic stability.

The second part of this chapter included a study of one of the main resources impacted by agriculture, which is the soil. This practical example was used to demonstrate the importance of biodiversity in natural ecosystems and the general ecosystem services that are being severely harmed by conventional agricultural systems. Our study could expand to touch other sectors of the agribusiness sector, including fisheries, forests, mountains, which would bolster the conclusion of the significant services rendered by healthy natural resources.

It is only in combination that we can properly assess the “initial” part of the agro-food system, that is to say the part that produces the foodstuff that humans need. The legislation that shapes agriculture must become an enabling environment that carefully considers the pressures on agriculture that will exacerbate food insecurity, such as climate change in vulnerable regions. The subsequent sectors of the food system work in synergy with these issues, as we will see.

## **1.5 Chapter 1 Bibliography**

-Altieri, Miguel. 2004. Linking ecologists and traditional farmers in the search for sustainable agriculture. Frontiers in Ecology and the Environment.

-Altieri, Miguel, Koohafkan, Parvis. 2008. Enduring farms: climate change, smallholders and traditional farming communities. Malaysia.

- Barrow, Christian J. 1999. Alternative irrigation: the promise of runoff agriculture. London.

- De Schutter, Olivier. 2010. Report submitted by the Special Rapporteur on the right to food. UN General Assembly.

- IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for Development). 2009. Agriculture at a Crossroads. In: International Assessment of Agricultural Knowledge, Science and Technology for Development Global Report. Washington, D.C.

- Altieri, Miguel, Koohafkan, Parvis. 2010. Globally important agricultural heritage systems: a legacy for the future.Rome.

-Tompkins EL, Adger WN. 2004. Does Adaptive Management of Natural Resources Enhance Resilience to Climate Change?

- Tompkins, Emma, Adger, Neil. 2004. Climate Change? Ecology and Society. (online). <http://www.ecologyandsociety.org/vol9/iss2/art10>

- Tscharntke T, Klein AM, Kruess A, Steffan-Dewenter I, Thies C. 2005. Landscape perspectives on agricultural intensification and biodiversity: ecosystem service management.

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# 2. The Future of Storage, Processing and Packaging

In conversations on agriculture, particularly when it comes to discussing food security and how to achieve it, the immediate post-harvest stages of storage, processing and packaging are of critical importance. It is where a lot of the food that’s produced is lost, particularly in lower and middle-income economies. Policy-makers and food experts have made clear that the food we currently produce exceeds our consumption needs. However, a large chunk of it is either lost or wasted. Some have estimated that without processing, as much as 50 to 60% of fresh food would be lost between harvest and consumption, spoiled by pest and micro-organisms (Fellows. 2005). If done well, the storage, processing and packaging of a raw agricultural product into a processed food item will ensure it is safe to eat, has a longer shelf-life, and gives it more market value.

While incredible strides have been made worldwide to improve how food is kept, transformed, and to preserve it in adequate packaging, the level of investment and infrastructure needed can be challenging for poorer economies. Back in 2008, global private investment geared towards research and development in agriculture and food processing made up over 20% of the total R&D expenditures that year-but almost all of it took place in high-income countries. It is seemingly picking up fast in India and China, but investments remain largely negligible everywhere else (FAO. 2017, p. 51).

While upfront costs and the physical capital needed to store, process and package food can vary widely depending if it is conducted at industrial scale or at the cottage industry level, certain pre-conditions need to be met. Storage, especially cold storage, needs constant electricity flows. On-farm storage and warehouses, which add value to a seasonal and perishable product by holding the harvest until after peak season for higher returns, also rely on electrification. So do machines that blend fresh tomatoes into paste. In many poorer economies, electricity cuts can occur often, especially outside of the main urban centers, making these types of investments risky. Once the product has been transformed and packaged, it needs to be rolled out onto the domestic market or taken to ports for export. Unfortunately, good roads and reliable communication networks don’t always exist (World Bank. 2017, p. 11).

For certain commodities such as smoked fish, or dried fruit, food processing can be undertaken at a low-cost. However, reaching higher levels of processing while maintaining the safety of the food can be a challenge for many poorer economies. The demographic transition that is ongoing in many middle and lower-income countries is driving both agricultural production on-farm, as well as the appetite for food that can be stored and moved around without compromising its safety.

## ***2.1 Example of the Egyptian tomato***

*The Egyptian tomato highlights many of the challenges faced by middle-income economies at the post-harvest, processing and packaging stages of the food value-chain. Egypt has three tomato harvesting season, and the summer one is by far the most productive, as almost 50% of the country’s arable land is covered in tomato crops. While the domestic production is large, the Egyptian tomato is doused in so much pesticides and fertilizers that it reduces its potential for export. Only 1% of the total crop is auto consumed, and postharvest losses cut down 20 to 25% of the total production. Less than 1% (75,600 tons) of the total tomato production in Egypt will be dried, canned, or made into paste. Valued at over 900 million Egyptian pounds, the processed 1% increases the value of a ton of tomatoes at farm level from LE1750 to LE7000 once processed. The lack of reliable infrastructure, proper storage facilities, refrigerated trucks and machinery means that farmers might decide to leave their harvest to rot on-farm if prices hit rock bottom, or when the market is located far away. Adequate postharvest practices and higher levels of processing would add tremendous value to the tomato crop and create new opportunities for the youth and for women (Sarant. 2013).*

Food safety isn’t guaranteed everywhere and at all times, and continues to be a threat to many people, especially in poorer countries. Many food-borne diseases, which are still a critical cause of mortality worldwide, can be traced back to improper processing and storage. In 2015, the WHO listed 9 factors that contribute to outbreaks of food-borne diseases: unsafe water used in food cleaning and processing; poor production processes and handling; including improper use of agricultural chemicals; the lack of storage infrastructure; and inadequate or poorly enforced regulatory standards (FAO. 2017, p. 87).

In parallel, rural youth all over the world are turning their backs on farming, which is no longer seen as a means to provide dignified livelihoods. Instead, they seek employment at a higher level up the value chain, a trend that the processing industry is likely to increasingly tap into in the future. In many countries, the critical food added-value, sustainability and other off-farm food systems-related activities account for a large share of manufacturing and services sector. Growing urbanization also impacts how people eat, and the range of food products they purchase. City-dwellers are associated with a growing demand for processed food, meat and dairy products (ibid., p. 106) as well as fresh fruits and vegetables-which can only be provided if a sufficient infrastructural base and efficient food value chain exist.

## ***2.2 Women’s role in food processing***

*Most of the employment in Sub-Saharan Africa remains in agriculture. Although women represent 43 percent of the farming labor force, trends show an unequal share of women and men involved in paid activities. Inequality also manifests itself in the types of work where women dominate, as compared to men, the latter being far more involved in higher paying jobs. In overall terms, FAO argues that women are still lacking equal access to resources and opportunities and this could be one of the reasons why the agriculture sector is underperforming in many developing countries (FAO. 2011; Kapinga and Montero. 2017; Dube et al. 2018).*

*Beside unpaid household chores, women also face difficulties accessing loans. This is mostly related to their limited access to ownership of resources such as land, even though some governments such as Tanzania have passed laws that promote equality in property ownership. Lack of networks and societal acceptance could be one of the setbacks of women’s participation in the labor force (Ali and Ali. 2013). One case study from Iringa, Tanzania of a group of women processing food products displayed poor processing tools and lack of appropriate information and financial resources to be the reason why women entrepreneurs in the district were only processing on a small scale (Kapinga and Montero. 2017).*

*Nutrition and food security at the household level also depends largely on women as they are more involved in the decisions regarding food processing and preparation at the household level. As most food is perishable, women play a crucial role in finding means of storing it in a good condition for their families (World Bank. 2009; FAO. 2011). For example, women in Sub-Saharan Africa collect and dry vegetables and store them for dry season. Processing these foods prevents food losses and ensures food availability for their families. Achieving utilization however requires knowledge on how to process food items hygienically (UNDP. 2011). Food processing in rural areas does not just concern items that can be stored for long periods. Food that’s just been harvested needs to be processed very fast, since basic infrastructure such as electricity is often lacking.*

*Consumption patterns differ according to age groups and areas. In India, a study revealed that the older generation favors fresh foods over processed foods. The younger generation, however, is showing a clear shift towards ready to eat foods. Since India’s youth make up about one billion people, the need and market size for food processing is enormous (Mukherjee et al. 2013). The authors argue that processing plays a measure role to ensure the food security of a fast-growing population. According to him, all stakeholders (including the government) should support the efforts put in place in the food processing sector with investments and policies to ensure the equal participation of both men and women.*

A bar graph produced by HLPE (FAO. 2017, p. 114) describing the distribution of food losses and waste along the supply chain demonstrates that the combined post-harvest, processing and packaging stages in developing countries contribute to the largest chunk of food loss. In richer economies, such as Japan, Korea, the United States and Europe, food is wasted at the consumption stage. Postharvest is the stage of crop production that immediately follows harvest, including cooling, cleaning, sorting and packing.

Packaging, even if it appears somewhat less critical a step than storage and raw agricultural material processing, can ensure a longer product-shelf life, determine a food product’s level of desirability, and is a determinant factor for export. The packaging industry is the world’s third largest industry sector (behind the food and petrochemical industries) and experiences an annual growth rate of 3 to 5% in almost all countries (Manalili. 2014, p. 23).

In poorer economies, the large volume of agricultural production coupled with demographic pressure could strengthen the packaging sector on the domestic market. Oftentimes, however, the technology and investment are not up to par with the size of the production, and the packaging quality is too low to allow for export. The packaging industry is made of three subsectors; machinery, service and manufacturing, of which the latter appears to have the greatest potential in developing economies. That’s mostly because processing is a step that almost inevitably takes place near the source of raw material production, and because of the availability of paper and cardboard (ibid., p. 38). In addition, newer, less polluting material than plastic -but as efficient in guaranteeing the safety of the food products- will need to be developed, if we have any ambition of ridding the planet from microplastics.

## **2.3 The true cost of food**

The price paid we pay for food at the supermarket does not reflect the true cost of the product. The true cost of food also includes externalities that are not included in its commercial price. This gap between the price and true cost as well as the lack of transparency in the value chain gets in the way of creating a food system that is more just, sustainable and nutritious than the current system.

### **2.3.1 Unaccounted externalities**

Food production creates externalities that producers are not charged for. These include greenhouse gas emissions, soil degradation, pollution of rivers, the rise in antibiotic resistance and the increase in obesity and other diseases. These externalities are higher for industrial farming than for organic farming. As industrial farming, commonly referred to as “conventional” farming, can lead to a short-term and unsustainably higher output, the price of industrially produced food is lower than organically produced food despite considerably higher externalities. This inequality in prices renders a level playing field between the two farming systems impossible as organic farmers cannot offer their products for the same price as industrial farmers and consumers that are not aware of the true cost of food tend to choose the cheaper and industrially produced option. Consequently, a race to the bottom takes place. Industrial farmers compete with one another to lower prices at the cost of people and the environment while organic farmers are unable and unwilling to participate in this pricing spiral. The long-term true costs are shifted onto consumers, governments, future generations and the planet through health care costs, taxes, pollution clean-up and deferred costs such as climate change implications caused by emissions.

### **2.3.2 True Cost Accounting**

True Cost Accounting aims to monetize and quantify the impact of food production on people and the planet. FAO (2014) estimates hidden costs of USD 2.1 trillion in environmental damage plus another USD 2.7 trillion in social costs – this is a total of USD 4.8 trillion of hidden costs in the food system. With the aim to create a “better understanding and managing the impacts and externalities of agriculture and food value chains (TEEB. 2018, p. iv), the Economics of Ecosystems and Biodiversity report (TEEB) concludes that investments in sustainable food systems have to go far beyond increasing productivity only; they have to take the eco-agri-food system as a whole into account (ibid. p. 86). This entails that the commodification of food has to end and that externalities need to be rendered transparent and be internalized by producers. This then links profit to sustainability. Food production becomes more fair and, contrary to the mainstream belief, having the big picture in mind, it becomes more affordable and negative externalities decrease due to sustainable farming practices.

### **2.3.3 Policy implications**

Today, the paradigm of diminishing food prices prevails. In most countries, institutions maintain this as the top most priority through complex manipulations of price mechanisms, trade rules and taxes. The economy of current food and farming profusely rewards producing more crops the cheapest way possible in order to remain competitive on the global market (ibid., p. 8). Consumers need to be educated about their food choices from farm to fork so that they can make informed decisions. Moreover, policy makers need to use a system approach in order to better understand and predict outcomes and impacts of their decisions on different sectors, actors and over time. It is implicit that public funding for agriculture can only be given to farmers that have internalized negative externalities. Today, this is still not the case as most agricultural subsidies go to industrial farms and high levels of resistance from agribusinesses to account for their damage persist and hinders the progress towards a more just, sustainable and nutritious food system.

## ***2.4 Food technology of the future***

*Thanks to the technological improvements that humanity has been through during history, farming has developed new methods and innovations. Mainly in the last years, the overall farming industry has been subjected to changes in order to deal with technology. Indeed, 3D printing, lab-grown meat, the blockchain and the system eLocust3 are just some of the technology-based innovations that could be implemented in order to reduce animals’ exploitation and food waste.*

*Some institutes such as TNO, an independent research organization, are developing 3D printing for food. It will build the end product with the possibility to choose among the food’s taste, shape and composition. 3D printing of food will revolutionize not only the farming industry, but indirectly the food service industry. In the future, 3D printing will allow people to choose what to eat and have it done without having to cook or to go to a restaurant. On the other hand, 3D printing will also increase the number of possible recipes and save time and money not only to the consumers but also to retailers and producers.*

*The blockchain applications on food are various and can be used to solve issues such as food fraud, foodborne diseases and safety recalls. Particularly, blockchain has its positive effect on food traceability. Indeed, food industry is extremely vulnerable to food contamination that leads to human lives’ threats and diseases. As a matter of fact, blockchain technology can easily find the main source of food contamination saving time and money. Its structure will create an accountable and traceable system of all the shared data gathered from the components of the food value chain; consequently, the overall process of food production will be monitored step-by-step.*

*Another innovation that could permanently change the farming and food production industry is lab-grown meat. This future sustainable engineering is a process for which “meat grows from stem cells harvested by biopsy and cultured in laboratories for a few weeks” (McFadden. 2018). This innovative meat production process can reduce animals’ exploitation and human interference with nature, lowering the actual implication of the farming industry in producing food.*

*Finally, eLocust3 is an innovative system developed by FAO and partners to monitor crop pest. The desert locust is regarded as the most dangerous food pest that threatens food security. ELocust3 is a data recording and transmission system that allows producers to monitor food even in remote locations by inserting details regarding habitat, vegetation, soil rainfall and locusts. Then, this information is transferred in real-time via satellite at that country’s National Locust control center and then to the FAO of Rome (Cressman. 2016). This innovative tool allows farming industry to prevent the likelihood of food related diseases and contamination.*

## **2.5. Chapter 2 Conclusion**

Higher levels of consumption and demand for processed food items go hand in hand with the accelerated rates of urbanization worldwide. People want to purchase clean food products with a longer shelf-life, that are adapted to the fast-moving pace of city life. To keep up with the demand of processed food products in terms of quantity, quality and diversity, emerging economies have to step up their game at the post-harvest stages of storage, processing and packaging. These industries have the potential to absorb a large proportion of women and disenchanted rural youth seeking higher paid jobs, by creating a dynamic off-farm sector in the economy. The upfront capital that is needed, the existence of often inefficient communication and road networks, the low and plateauing investment in agricultural R&D and domestic legislation are all hurdles that will need to be overcome for a functioning and efficient postharvest system to be established.

##  **2.6 Chapter 2 Bibliography**

* Cressman, Keith et al. 2016. FAO. An Innovative Tool for Crop Pest Control (online). <http://www.fao.org/3/a-i6058e.pdf>
* The Economics of Ecosystems and Biodiversity. 2018. Measuring What Matters In Agriculture And Food Systems (online). <http://teebweb.org/agrifood/wpcontent/uploads/2018/10/Layout_synthesis_sept.pdf>
* FAO. 2014. Food wastage footprint: full cost accounting (online). Rome. <http://www.fao.org/3/a-i3991e.pdf>
* FAO. 2017. The Future of Food and Agriculture: Trends and challenges.
* Fellows, Peter. 2005. FAO. Processed foods for improved livelihoods.
* Foodtank. 2019. 12 Ogs Highlighting the True Cost of Food (online). <https://foodtank.com/news/2019/04/10-orgs-highlighting-the-true-cost-of-food/>
* Manalili, Nerlita. 2014. FAO. Appropriate Food packaging solutions for developing countries.
* McFadden, Christopher. 2018. 11 Innovations That Could Build the Food of the Future (online).: <https://interestingengineering.com/11-innovations-that-could-build-the-food-of-the-future>
* Sarant, Louise. 2013. Learning Alliance: Value chain of buffalo milk, tomatoes and dates in Egypt.
* World Bank. 2017. Future of Food-Shaping the Food system to deliver jobs.

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# 3. Transportation and Trade

Transportation systems have dramatically expanded food production and distribution worldwide, playing an important role in overall food systems. However, there are still many challenges to be overcome, such as unequal access to healthy food, unequal access to transportation for agricultural workers, increasing geospatial and economic concentration among the major food producers, and emerging competition for farmland between food and fuel (Pothukuchi and Wallace, 2009). Because the health of individuals is inextricably tied to the health of communities, regions, and ecological systems, public, private and civil society stakeholders need to act to both mitigate current disparities and enhance the future viability and sustainability of these systems.

Following transportation, trade is also an integral part of all food systems. Nonetheless, the relationship between food systems and trade remains complex: despite its integral role, it is unclear if global trade is compatible with local, sustainable food systems that benefit small-scale farmers and human development. Trade can significantly contribute to productivity and the availability of food and household income, and can therefore have a beneficial effect on food security. Trade barriers imposed by net exporting countries on the other hand could lead to food shortages and hence negatively affect all four dimensions (availability, access, utilization, stability) of food security.

This chapter draws from the online discussion, “Examining the linkages between trade and food security: What is your experience?”, of the FSN Forum. The relationship between trade and food systems, along with the current debate on policies and agreements and the necessity for cohesion between food security measures and trade regulations, will be systematically presented.

## **3.1 Transportation**

According to FAO’s most recent projections, the world population is expected to increase and reach 9.7 billion people by 2050 (FAO, 2017). In a scenario of modest economic growth, global food production would increase by 50% compared to 2013 production levels (FAO, 2017). Sustainability is one of the challenges facing food production and distribution, and the demographic shifts, emergence of facilitating technologies, infrastructure and individual consumption will have a profound effect on global food systems.

Food production and distribution represent two important stages of the food supply chain, which describes how food ends up on our tables. The process is composed of five stages: production, processing, storage, distribution, consumption and disposal. Food supply chains have become increasingly globalized, in part due to the rapid growth in the transport sector. The globalization of food trade and transportation has created a range of opportunities as well as vulnerabilities and risks. Increasingly, some challenges include high levels of food loss and waste, difficulties in tracking the origins of food, and controlling the safety and quality of food products. This has impacts on consumers, as well as the environment and biodiversity.

It is also important to consider that food represents just one industry involving global trade. Products traded over long distances tend to be of high value and are not easily perishable. Understanding the significance of food supply chains requires a comprehensive approach since it includes much more than simply transport and infrastructure.

Improving the sustainability of transportation in food systems may require innovative solutions. Some areas in need of such strategies include disparities in neighbourhood access to healthy foods, promoting safe and affordable transit for agricultural workers, sustainable agriculture, prioritizing farmland for food, and sustainable biofuels.

Transportation plays an important role in food systems by ensuring a safe, efficient, accessible and convenient means of food provision to meet the population’s nutritional requirements, satisfy consumer interests, and enhances people’s quality of life. Consumer access to healthful foods and producer access to markets should thus be of high interest to policymakers. Yet, there appears to be a lack of transportation-related policies and programs to address these issues, especially in developing countries. Transportation was not mentioned by commenters in the FSN Forum consultation on trade, perhaps pointing to a lack of awareness of its importance in a discussion of food systems. Employing a systems thinking approach to issues such as transportation and sustainability is critical in identifying the root causes of system failures, such as factors that make food systems vulnerable to climate risks and inefficiencies that contribute to excessive greenhouse gas emissions.

## **3.2 Trade**

The increasing complexity of trade has serious implications for the world’s poor, who are often disproportionately disconnected from global, regional or even local markets. While not discussing trade liberalization, it has been suggested by the contributors of this conversation that smaller countries who are interested in engaging in trade have a place at the table, so to speak. One of the major concerns repeated throughout the comments is the way food has been changed from “food to feed the masses” to “food as a commodity”, a narrative in favour of larger food producers, while continuing to hold down smallholder farmers who cannot compete. The views expressed by the commenters encourage opening up policy decision making to the governments of smaller countries, while the larger, richer countries currently make the vast majority of international trade decisions.

Comments on the impacts of trade on food security heavily suggest that the FAO definition of food security be modified to include applications such as trade policy and agreements. This is to encourage collaboration between high-, middle-, and low-income countries. The following subsections include examples of the above-stated reservations about current trade policy, including criticism of the World Trade Organization (WTO) and some suggestions to make global trade rules more compatible with food security.

Whereas current trade policy and practices cater heavily to larger food producers, the commenters offer an alternative idea of trade that would incorporate smallholder farmers, by increasing market access, traceability measures, a review of externalities, and training on farming productivity, negotiation skills, and identifying the most accessible markets.

The real challenge is creating a system in which trade rules and agricultural policy are mutually supportive. As it stands, is it believed that international trade does not contribute to food security, though policy recommendations have been proposed. A major concern relates to high food prices that result from policies favouring industrial food production.

### **3.2.1 Example of the less-documented impacts of the North American Free Trade Agreement (NAFTA) on Mexican corn**

The North American Free Trade Agreement (NAFTA), signed in 1994, has greatly benefitted the economies of the United States and Canada, and Mexico to a much lesser extent. NAFTA, sanctioned by the WTO, was created to encourage other Free Trade Agreements (FTAs) between larger and smaller economies. The example of Mexican corn remains one of the more controversial results of NAFTA. Primarily, the agreement had a negative impact on poor corn farmers in Mexico, further impoverishing them. Audley *et al.* (2004) argue that the loss of hundreds of thousands of agriculture jobs in Mexico can be attributed to the US agricultural subsidies allowed by NAFTA. Reports on NAFTA have easily ignored the impact of trade liberalization on domestic producers through prices. NAFTA should have questioned whether the removal of restrictions on maize imports would drive down the price of Mexican corn toward the lower US export price.

Many commenters expressed that NAFTA disproportionately benefited the larger corn producers that could afford to drop their prices to meet the US export price, while smallholder farms were left behind to fail. It can be argued that it was not only the implementation of NAFTA, but also Mexico’s protectionist policy for maize producers, which was more protectionist than policies of the US or EU. Furthermore, if differences in crop varieties produced in the US and Mexico meant that they were not substitutes, then trade liberalization should not have reduced Mexican producers’ prices to the same extent as the effect that reduced import tariffs had on US import prices. If subsidy programs did offset any price fall, or if the corn varieties were in fact not competing, the declines in Mexican maize employment or production could not be attributed to NAFTA. Policymakers should then address Mexico’s rural poverty and agricultural development that are unrelated to NAFTA.

Analyzing corn production and employment in Mexico between 1990 to the present, NAFTA negatively impacted agriculture in Mexico and contributed to poverty, which in turn increased food insecurity among many Mexicans and continues to do so today. Only time will tell if the United States Mexico Canada Agreement (USMCA) will improve the livelihoods of farmers and farm workers in Mexico. As it is written now, “NAFTA 2.0” does not propose any changes from NAFTA on this issue, but hopefully the government of Mexico will be able to negotiate a more farmer-friendly policy.

### **3.2.2 The relationship between trade and smallholders**

As it was stated before, the relationship between the positive and negative externalities of trade agreements, food systems, and food security is extremely complex. International trade has been said to contribute to poverty reduction and food security. But does this statement hold true for smallholder farmers in developing countries?

It has been repeatedly mentioned in the FSN Forum that the problem with much of the well-intentioned trade agreements and policies is the unintended consequences on local food production, storage, and markets. The commodity-based global food system tends to ignore that, for much of the world, there are isolated local food systems that have little connection with globalized markets. Small local farms are often dismissed as “inefficient” by policymakers when considering productivity. Yet, they play a crucial role in providing low-cost foods to the local poor, feeding a substantial proportion of the world’s population, and contributing to food sovereignty.

A better approach to global food security may be to focus attention on the local food security value chain (FSVC) and then to determine how national and regional trade agreements and rules can support the local FSVC. Agricultural policies should consider smallholders needs, since they suffer the most from food insecurity. The majority of the 570 million farms worldwide are small. Smallholders supply 80% of food produced in Asia, sub-Saharan Africa and Latin America by farmers, artisan fisher folk, pastoralists, landless and indigenous people. In addition, 70% of the 1.4 billion extreme poor live in rural areas, and 75% of these rural poor are also smallholders (CFS, 2016). Trade policy interventions are key to supporting family farmers, because the market does not recognize the needs of these producers.

An important source for interesting cases of smallholder inclusion and interventions in trade is the 2017 report, “The Human Face of Trade and Food Security”, by the Centre of Strategic and International Studies. It presents lessons on the enabling trade environment in Kenya and India, providing more diverse opportunities and challenges for food security and smallholders in exchanging goods and services (Kuhlmann, 2017).

In Kenya, market conditions have made maize a challenging crop for many farmers. Stakeholders noted that other crops besides maize, such as sorghum in East Kenya, could be better suited for market and production. Common crops, such as beans, that have not been fully commercialized do not seem to have a significant payoff in the market, with better implications for farmers in terms of income and access to higher performing inputs. Yet, these crops are familiar to farmers and have a high return in terms of ensuring local food security. Although beans are among the most traded commodities in East and Southern Africa, more than 90% of this trade is informal, and only 60% of traders have access to information on bean prices (Eliud *et al.*, 2017). As observed in this specific case, one of the biggest challenges for farmers and policymakers is how to make agriculture remunerative in the market.

Regional trade could be the solution to commercializing beans and neglected crops. For example, the International Center for Tropical Agriculture (CIAT) and the Pan African Bean Research Alliance promote Bean Corridors, consisting of bean production, distribution (distribution and aggregation centres, warehousing and storage, commodity exchanges), and consumption hubs (market and retail outlets, dealers, processing units).

There are currently nine Bean Corridors being formed, following the geography of the market across 17 countries, of which Kenya is a central one. These Corridors will address production and distribution bottlenecks and market failures (including cross-border trade barriers) to ensure that improved bean seed and market opportunities reach smallholders, many of whom are women, and that better quality bean varieties reach consumers. A regional approach would help to include more smallholders, by providing them with more commercial opportunities, better market links, and a platform for sustained engagement with policymakers.

The corridor approach attempts to link all stakeholders in the value chain, while stimulating financial opportunities and improving access to market information (e.g., through mobile phones). Farmers can make better informed decisions about when and where to sell, also by comparing the prices on offer. It is an avenue for turning bean production in small quantities into large quantities that can influence economic development in Africa and make trade more inclusive of smallholders.

### **3.2.3 Criticism towards WTO and possible solutions**

Trade can pose threats to food security if considerations about its impact on this dimension are not taken adequately into account. In this regard, the WTO Agreement on Agriculture (AoA), which outlines rules governing agricultural trade, has been highly contested. In fact, despite the reference to food security in the Preamble of the Agreement among the Non-Trade Concerns, it does not include any specific provision aiming at improving food security. The Special Agreement on Agriculture (WTO) has been criticized for being entirely market- and export-oriented, which has led to the exclusion of small farmers from the system. In general, it has highlighted the incompatibility between food security and the current rules of trade liberalization. The system laid out by WTO, which allows the flow of cheap agricultural products from developed countries into local markets in developing countries, has displaced local farmers’ production. This phenomenon has severe repercussions on local small farmers, who are not able to compete with imported products. It has been also argued that although developing countries could benefit from exporting, the benefits are disproportionately held by outsiders, the local rich, and the government, and not local farmers and communities.

Furthermore, the space for national policy to implement measures promoting food security has been progressively limited and undermined by the increasing trade liberalization. The challenge is to make liberalized trade agreements compatible with food security. It has been proposed to evaluate trade agreements ex ante in order to assess their ability to ensure food security and contribute to poverty reduction. Moreover, farmers should be involved in trade negotiations and have the chance to sit at the negotiation table. One approach that could improve coherence is the rights-based approach, which should be incorporated into agreements concerning food systems. This approach ensures that trade does not just serve the interests of larger producers, but recognizes the human right to food. Overall, there is a demand for more transparency in the decision-making processes at WTO and clearer integration of human rights in terms of food security.

## **3.3 Chapter 3 Conclusion**

Throughout the discussion regarding the impacts of international trade on food security, the main takeaway shows that the current worldview of food security, international trade, and food systems needs to evolve before any major changes or positive impacts can be seen on an international level. While changes can be evident at the community and sometimes country level, a larger global shift will be required if we wish to achieve the sustainable development goals (SDGs) in the timeframe suggested. Trade may be a promising vehicle for these required changes.

## **3.4 Chapter 3 Bibliography**

CFS (Committee on World Food Security). 2016. *Connecting smallholders to markets*. Rome.
<http://www.fao.org/cfs/home/activities/smallholders/en/>

Eliud, B., Robin, B., Collins, O., Sylvia, K., & Rubyogo, J. 2017. *Bean corridors: A novel approach to scale up national
and regional trade in Africa.* A brief by the Pan-Africa Bean Research Alliance. Nairobi.
<https://cgspace.cgiar.org/bitstream/handle/10568/80540/PABRA20_Bean_Corridors_BRIEF.pdf?sequence=5&isAllowed=y>

Kuhlmann, K. 2017. *The human face of trade and food security: Lessons on the enabling environment from Kenya and India.* A report by the CSIS Global Food Security Project. Washington, D.C. <https://csis-prod.s3.amazonaws.com/s3fs-public/publication/171206_Kuhlmann_HumanFaceFoodSecurity_Web.pdf?UIIn_uS4Z6IoUMSi727Q8QrUyHfGnehl>

Pothukuchi, K., & Wallace, R. 2009. Sustainable food systems: Perspectives on transportation policy. *Healthy, Equitable Transportation Policy: Recommendations and Research*, 113-129. <http://digitalcommons.wayne.edu/urbstud_frp/5>

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# 4. Consumption, Nutrition and Food Disposal

The existence of value chains, the investments around them, and the recognition of their importance to human development and the alleviation of hunger presents nutrition-sensitive value chains (NSVCs) as a better-framed approach to our problem. A nutrition-sensitive approach considers how the development of food value chains could contribute to improving nutrition. As highlighted by IFAD, "to achieve good nutritional outcomes, one must consider not only the way food is produced, but also how it is processed, distributed, marketed and consumed. This has led to a growing interest in leveraging the potential of value chains for nutrition" (de la Peña, 2018). Improving nutrition means also facilitating food security by ensuring that nutritious and diverse foods are available and affordable for all, at all times. Hence, it is crucial to understand the role of food production as a vital input into the economic and social development for communities in extreme poverty, as this knowledge plays an important role in achieving the Sustainable Development Goals (SDGs).

*“A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socioeconomic and environmental outcomes.”* (HLPE, 2014, 29)

This chapter focuses on the last yet important stage in the cyclical NSVC we have presented in this paper. It discusses those parts of the NSVCs that bear the overall significance of investing in agriculture and food systems – i.e. consumption and nutrition – together with the impacts these have on the environment due to waste management. We will illustrate a clear analysis of the food consumption patterns, the nutritional aspects in the NSVC and the disposal impacts in the food system.

## **4.1 Consumption**

### **4.1.1 The eradication of extreme poverty through markets**

The paragraph will analyze consumption patterns and virtuous models to follow, the role of agriculture in consumer behaviour, the eradication of extreme poverty though markets, and external literature. More sustainable and ethical food consumption can be stimulated through increasing awareness on how food is produced and the externalities (social, health, environmental) involved, and by changing social norms. Promoting healthy diets and lifestyles to reduce the global burden of non-communicable diseases requires a multisectoral approach.

Strategies must not merely be directed at ensuring food security for all, but must also promote consumption of adequate quantities of safe and nutritious foods. Any recommendation to that effect will have implications for all components in the food chain. It is therefore useful at this juncture to examine trends in consumption patterns worldwide and deliberate on the potential of the food and agriculture sector to meet the demands and challenges posed by this report.

At the heart of the SDGs is a commitment *“To eradicate poverty everywhere, in all its forms and dimensions by 2030”.* With the 2030 Agenda for Sustainable Development, world leaders moved past poverty reduction and set out to achieve sustainable development that leaves no one behind. The eradication of extreme poverty through markets is possible through innovative ideas like:

1. A registered brand or name for agricultural products by communities or NGOs, so as to facilitate market penetration through local identity, the organization of festivals and activities to attract visitors, and the improvement of community facilities.

2. The facilitation of educational modules on agricultural production, the processing of local products, marketing, and nutrition in schools and communities.

3. The establishment of links with people who have migrated or left their communities in order to expand the market.

Historically, large-scale farmers avail better opportunities with the lowest risk, while smallholders face greater risks and vulnerabilities. An appropriate mechanization for the fragmented landholdings and market linkages with adequate input and logical prices may help enhance the gap between input and output in agriculture, which in turn may improve income for smallholders.

One institutional form that deals with many of the constraints of agriculture in an integrated manner is 'contract farming'. It constitutes a potential way of overcoming market imperfections, minimizing transaction costs, and gaining market access by smallholder farmers. In many developing economies, contract farming has been recognized by both policy makers and analysts as a new development model or paradigm for linking smallholders to markets. It has become an attractive policy instrument to assist small farmers to gain access to markets, information, credit, and necessary services to manage their risk.

If farmers in extreme poverty do not manage to obtain other essential basic products because they are the most cheated in business dealings, and the final actors in the value chain, i.e. the consumers, earn more than these farmers, they cannot escape from extreme poverty. A well-supported agricultural and economic policy will be needed to eradicate it.

Households that have reduced access to resources must find alternatives otherwise they run the risk of becoming chained to poverty rather than escaping it. These households could rather situate themselves between the farmers and the market and act as intermediaries for the sector. They could participate in value chain by working in marketing or processing and packaging of products for final sale.

Another point of view is the dimension of a country’s economic policy. These policies must intervene to regulate the price of products in the external market or provide subsidies to producers. As long as prices are determined by the market, extreme poverty cannot be eradicated. It will instead be necessary to: encourage producers to be more dynamic and independent; facilitate farmers’ access to markets; protect the internal market by facilitating the organization of cooperatives.

“Productive work for the poor typically means either wage-paying occupations, contractual agreements that employ in value chains, or raising yields on smallholder farms” (Chandy *et al.* 2015). Those who are unable to find such work may remain underemployed, working in informal occupations in markets that are insufficiently integrated, or they are self-employed. Where residents have little purchasing power and minimal connection to neighbouring markets, producers often rely on natural resources for their livelihoods, farming without fertilizers or irrigation, foraging in forests, or fishing in rivers and coastal waters.

As a result of population growth and the degradation of the environment, natural resources are increasingly under stress and less capable of supporting decent livelihoods. Among the constraints of productive work is the absence of developmental progress in most of the world’s poor economies, especially those in sub-Saharan Africa, despite the fact that many have recorded impressive rates of growth over the past decade. Structural transformation is a catalyst both for raising labour productivity and for enabling poor workers to switch occupations. Another constraint is the chronic underinvestment in the networks that connect people to markets. Poverty itself is an important driver of vulnerability and the absence of resilience, and poor people live in places that lack effective institutions to provide such resilience. In addition to this, they have no access to formal coping mechanisms, such as credit and insurance markets (Chandy *et al.*, 2015).

Several models of factors affecting the behaviour of food consumers have been proposed in the literature. One of the earliest and most influential models was proposed by Pilgrim (1957). In his model, food acceptance is dependent on perception. Food perception is a function of three factors:

1) physiological effects of the food,

2) perception of sensory attributes,

3) influences from the environment.

Pilgrim hypothesized that these determinants interact in influencing food choice, but he did not explore these interrelations. His model also incorporates the time factor, with external influences being either recent or long established, and with some physiological influences being relatively stable for an individual, while other influences would vary over short periods with the ingestion of foods (e.g. hunger). Pilgrim's model served as a point of departure for many subsequent models of factors affecting food acceptance and behavior. Although some differences can be observed between these models, they generally distinguish between three types of factors: 1) properties of the food, 2) factors related to the person engaged in food consumption, and 3) environmental factors. This categorization scheme is also used in our model of the food consumer. It is acknowledged that the boundaries between the three groups of influencing factors are fuzzy, and that mutual influences occur. Thus, any comprehensive analysis of consumer behavior with respect to foods must consider all three types of factors.

### **4.1.2 The nutrition transition’s impact on consumption**

Changes in agricultural practice over the past 50 years have increased the world’s capacity to provide food for its people through increases in productivity, greater diversity of foods and less seasonal dependence. Food availability has also increased as a consequence of rising income levels and falling food prices. Globally, major changes in dietary patterns are occurring, even in the consumption of basic staples towards more diversified diets. Health consequences come together with these changes in food consumption at global level. For instance, populations in those countries undergoing rapid transition are experiencing a nutritional transition. Differences in socio-demographic factors and other consumer characteristics play an important role in the diverse nature of this transition. Furthermore, following greater urbanization and food industry marketing, the policies of trade liberalization over the past two decades have had implications for our health and facilitated the ‘nutrition transition’ that is associated with rising rates of obesity and chronic diseases, such as cardiovascular diseases and cancer (FAO, 2014; HLPE, 2017). Future food policies must consider both agricultural and health sectors, thereby enabling the development of coherent and sustainable policies that will ultimately benefit agriculture, human health and the environment.

### **4.1.3 Resource management in rural contexts**

Understanding the interplay between agriculture, food systems, and the sustainable management of natural resources is crucial to fight extreme poverty, particularly in rural areas. In 2015, almost 10% of the world population was living in a situation of extreme poverty (World Bank, 2018). Situating people in a vicious cycle, extreme poverty brings social exclusion, gender inequality, malnutrition, exclusion from the labour force, and a lack of access to basic needs.

The most vulnerable individuals are disproportionately composed of rural residents, with 80% of the extremely poor living in rural areas (Casteneda *et al.*, 2016). This population is particularly vulnerable to climate shocks and agricultural shocks, such as low yields or droughts. Hence the importance of best practices in food sustainability, which encompass many activities, from water conservation to maintaining soil health to the promotion of biodiversity and better incomes for smallholder farmers.

Against this background, the exercise proposed by the Global Forum on Food Security and Nutrition (FSN Forum) contributes to identifying a broader set of challenges and opportunities related to rural development and identifying good practices and lessons learned from the forum contributors.

## **4.2 Nutrition**

*“Agriculture biodiversity is the first link in the food chain, developed and safeguarded by indigenous people throughout the world, and it makes an essential contribution to feeding the world” (Nakhauka, 2009).*

Nutrition plays an important role in achieving the SDGs, because good nutrition is not just a desirable outcome of development, but also a vital input into economic and social development (IFAD, 2008). The agricultural and food sectors figure prominently in this enterprise and must be given due importance when considering the promotion of healthy diets. One of the challenges that governments, NGOs, the private sector and civil society have to deal with is the provision of food that is safe, adequate for the entire population, and nutritious. With the increase of the population and market demand, it seems like a real challenge to sustain all three of the requirements.

Agriculture factors into these issues, because it is a main driver of every sector related to the food system. In fact, leveraging agriculture to improve nutrition will positively impact on productivity and poverty. Agriculture is a key point from which to shift a new global agricultural system to ensure better nutrition for all strata of society. In fact, the current global food system produces enough food for the entire population, but access to and the quality of food has become a challenge. In developing countries, most of the energy is derived from three main staple grains: maize, wheat and rice, resulting in diets that often lack micronutrients and other necessary dietary components (Bioversity International, 2013).

### **4.2.1 Malnutrition**

Malnutrition, which includes undernutrition and overnutrition, is associated with micronutrient deficiency, wasting, stunting, reduced productivity and work capacity, as well as overweight and obesity and non-communicable diseases. In addition to this, it negatively affects cognitive development and school performance among children, and it increases health care costs (World Bank, 2006). The vicious cycle of poverty, malnutrition and disease can be broken with appropriate socioeconomic and political changes that aim to promote health and nutrition (WHO, 2019).

Our diets are becoming less and less diversified based on a few crops such as maize, rice, wheat and sugar. Access to nutritious, safe, affordable and diverse food produced in a sustainable manner should be assured by building enabling policy environments. For example, our diets could be improved by moving towards nutrition-sensitive agriculture and value chains but it will require a shift in our way of thinking. Nutrition-sensitive agriculture is an approach that considers nutrition in all stages of the food chain, from production to consumption (FAO, 2017).

Public procurement programs such as school-feeding and hospital kitchens can also be used to improve dietary diversity and to increase demand and supply for more diverse local crop varieties. For example, 12 districts of central and southern India introduced millet in school lunches instead of white rice. In a three-month period, this resulted in 37% higher haemoglobin levels in children compared to the control group (Bergamini *et al*., 2013).

Food systems should not only be transformed to be more sustainable but they should be transformed by empowering the local communities. Poor households have the potential to increase productivity if they have the means to do it. According to Boone *et al.* (2013), having access to cash transfer programs not only contributes to poor household’s food security but also to having more assets and increased agricultural productivity. Cash transfers have also been shown to reduce child malnutrition rates and to provide households with increased resources for food and healthcare (De Groot *et al.*, 2015). More diverse food production and higher incomes do not always translate into better diets and nutrition. Therefore, it is essential to increase awareness and knowledge on nutrition, especially for mothers and vulnerable groups. Strengthening sustainable agri-food systems should be thus be supplemented with other investments such as cash transfers, women’s education, and nutrition and health programs.

Efficient mechanisms are needed to ensure that vulnerable groups – such as children who rely on essential nutrients to grow and develop – are able to benefit from nutrient-rich food. These mechanisms may include diversifying local agriculture, improving market chains to increase safety and nutritional value of staple foods, and promoting micronutrient-dense food production and consumption. In addition to this, more focus should be put on women’s empowerment since they contribute to all stages of the food system and play a critical role in the nutrition of their families. In order to improve agricultural productivity as well as maternal and child nutrition, it is necessary to recognize the constraints that women have in terms of time and resources. In fact, promoting women’s access to resources, such as land, employment and markets, and strengthening women’s participation in decision making can lead to considerable improvements in food security (FAO, 2017b).

### **4.2.2 Obesity: Are there any successful policies and programs to fight it?**

Obesity is considered part of malnutrition. It is a growing public health concern worldwide and is believed to be associated with the nutrition transition that occurs along with economic development and urbanization, sedentary lifestyles, high consumption of energy-dense processed foods, larger portion sizes, and lack of access to fresh, healthy foods. Policy interventions focused at addressing overweight and obesity at different points in the food system and in various countries have been reported by participants in the FSN. The initiatives presented in the forum include public health policies, school-based food education and feeding programs, and work-based lifestyle interventions.

Public health initiatives such as dietary guidelines, nutritional labelling, and nutritional counselling seek to educate the public on healthy eating, portion sizes, and nutritional content of foods, as highlighted. However, for example, despite the rising rates of obesity resulting from Nigeria’s dietary transition, the impact of obesity reduction policies has not been evaluated as the government is focusing on the more dire and pressing concern of undernutrition. Participants also shared interventions aimed at reducing the consumption of energy-dense, highly processed foods through restrictions on advertising to children and taxation policies.

If we look at other countries, the Children’s Food and Beverage Advertising Initiative is a self-regulated program in the USA aimed at increasing the transparency of advertising food to children, as well as improving the nutrition and formulations of participating food products. A second intervention type includes taxing the purchase of sugar-sweetened beverages (SSBs), which has successfully decreased consumption of SSBs in Mexico, for instance. Results are measured by sales and household expenditures of such beverages.

There are initiatives, such as that of the Healthy Weight Commitment Foundation (HWCF) in the United States of America, where partnerships are established between industries, NGOs and educators, which aim to reduce obesity. HWCF members voluntarily pledged to collectively remove one trillion calories from their products. Over a five-year period, 82% of sales growth was seen in lower-calorie products.

The majority of overweight or obese kids live in developing countries, where the rate of increase has been more than 30% higher than that of developed countries. If current trends continue, the number of overweight or obese infants and young children will globally increase to 70 million by 2025 (WHO). One effective solution to this severe problem is food education. Many schools are exploring new ways of encouraging children to engage not just with what nutritional quality means, but also to grasp the intricacies food systems. The main idea of food education is to educate pupils about where their food comes from and the process of production. School garden programs teach students about growing their own food and seasonality. Positive results have been recorded, such as increased intake of fruits and vegetables and reduction of process food, with improved school performance and health.

For example, the “*Healthy Kids Program*”, adopted in various schools in Argentina, consists of workshops on nutrition education and healthy habits for children. The final results include reduced intake of sugars, butter and margarine. School-based feeding programs provide healthy food to children in school and benefit disadvantaged children as measured by indicators of physical growth and cognitive abilities. A study in Southern Ethiopia to assess the impact of such programs on improving children’s diets revealed positive effects in improving dietary diversity, nutritional status and class attendance of school children (Zenebe *et. al*, 2018). All in all, this indicates the importance of focusing on school feeding in private and public schools in order to improve the nutritional status, cognitive skills, education, and attendance of school children.

Finally, working individuals spend most of their weekdays at work, making the worksite a great target environment for implementing nutrition and weight loss interventions. With the rising prevalence and cost of obesity, employer-sponsored wellness programs have become more widespread and effective. Hence, individual-based worksite programs to change employees’ nutrition and exercise behaviors have been shown to produce modest weight loss (Thorndike, 2011).

### **4.2.3 Biodiversity and dietary diversity to improve nutrition**

*“Diversification approaches aim to increase availability and affordability of diverse foods. Principles of sustainable diversification can be applied at different scales, from the national and regional level to the farming system to the backyard garden”* (FAO, 2017a).

Biodiversity plays a key role in improving nutrition. This part aims to examine which programs, national and international, lead to develop, study and promote the NUS (Neglected and Underutilized Species) that improve our diets and can benefit our planet and our biodiversity loss. Biodiversity can promote more sustainable food value chains, enhance human (and livestock) nutrition, and has the potential to fight the poverty trap due to poor nutrition and cognitive consequences.

Kevin Gallagher, from “Future of Agriculture” in Mongolia, shows an effective case study. In Mongolia, the ruralization of the city brings traditional culture to urban sedentary life, where processed foods contribute to micronutrient deficiencies, diabetes and other non-communicable diseases. To fight this path, agriculture can help provide affordable diverse diets through the implementation of biodiverse practices. But it is clear that public health and media campaigns are essential to promote cultural change in line with the emerging lifestyles.

Moreover, the government has to preserve our health, making healthy foods more accessible and setting standards in public institutions. Using economic tools to address food affordability and incentives, restricting food advertising and other forms of commercial promotion, improving nutritional quality of the food supply, setting incentives and rules to create a healthy retail and food service environment will ensure coherence between food supply chain and health.

Obesity and overweight are related to trade rules in goods, services, and intellectual property. In a world of trade liberalization and growing interdependence this interaction must be continuously reviewed. Productivity increases along the global food chain, with global branding and partly government-sponsored market promotion also increasing trade of expensive but not necessarily healthier foods. Unfettered free trade can thus increase inequalities of income and access to healthy diets, leading to increases in obesity and overweight.

To conclude, a diverse food system is needed to be applied in order to get benefits in terms of availability, affordability, stability and consumption. In addition to this, biodiversity has the potential to promote nutritious and sustainable diets and the climate resilience of crops. In other terms, it is a great tool for coping strategies where agriculture vary within annual cropping cycles (FAO, 2018). Policies and institutions are essential in supporting a more biodiverse and nutrient-rich food system that is reflected in food-based dietary guidelines.

## **4.3. Food disposal**

Disposing of food in line with ecological practices opens huge opportunities for environmental and societal benefits in developing contexts. Composting reduces CO2 outputs because less trash is burnt, produces less carbon dioxide than traditional landfills or garbage dumps, and does not require infrastructure for transporting waste to central, large dumps. Composting and sanitary landfills do not require elaborate technology in order to function. From the perspective of biodiversity, using compost for agricultural inputs is better for the environmental and human health. Moreover, this is more sustainable than having to purchase fertilizers from chemical companies. In contexts where the rural/urban nexus is not strong, the practice of composting will not be negatively affected because it is a local process. Whether in urban or rural contexts, fertilizers from compost provide nutrients, reduce cultivation costs, reduce irrigation needs, progressively lower crop diseases, and provide a chargeable service to the urban economy.

A common limitation in developing contexts is that of poor physical infrastructure: roads are very poor, limited, or even non-existent for many communities. Fully local solutions are thus key for food disposal, and the opportunities inherent in these modalities of food disposal must become common knowledge for citizens and policy makers. Composting and relying on sanitary landfills at this stage of the food system would help create “closed loop” economies, where all food scraps that are not fed to animals can be utilized to either create fertilizers or minimize useless waste.

Having composting as the main solution for food disposal requires food packaging to be as biodegradable (and thus compostable) as possible in order to minimize non-organic waste. If all aspects of food products are biodegradable, then we will not need elaborate physical infrastructure projects to make food disposal in the Global South sustainable. We need solutions that can be enacted without proper roads or specific machinery or, indeed, any machinery at all. Household- and neighborhood-/village-level composting does not require machinery; it is a so-called manual system and is ideal for developing contexts.

Although biodegradable packaging would be ideal, be it through local production or trade, non-biodegradable food packaging can be dealt with in sanitary landfills. Successful composting programs would require educating communities in composting so that it is carried out safely and effectively for gaining agricultural inputs. The Ghana Organic Agriculture Network finds that a key requirement of successful composting policies and regimes is governmental support to such programs. People and governments need to understand the value of composting before they will participate in it on a large scale. Any educational or outreach programs must incorporate values, skills and logistics that are relevant for creating the most efficient systems of food disposal to minimize waste. For the waste of the food system that cannot be composted, sanitary landfills can be created by elaborating upon examples already present in developing contexts.

Dr. Hisashi Ogawa of the WHO Western Pacific Region presents strategies for improving practices of food disposal and echoes the importance of educating local residents and policymakers. He also emphasizes holistic planning with clarified roles of NGOs and agencies, creating operations that pay for themselves, and having policy coherence at the national level.

The development of human resources so that local people can effectively manage disposal schemes will be a necessary investment in many contexts. For the youth, educational programs can be put in place that educate them about ecological food disposal practices, and perhaps also gives them age-appropriate training in project management.

## **4.4 Chapter 4 Conclusion**

As food reaches the table and arrives at the end of the food value chain, we are faced with challenges related to nutrition and food disposal. Malnutrition requires a comprehensive policy approach that addresses both undernutrition and malnutrition and the difference in contexts, groups of people affected, and health consequences. Nonetheless, both issues can share a framework of analysis so that SDG 1 and 2 are less and less distant. Information and communication are key so that we raise informed global citizens that can make autonomous and conscientious decisions about what they should bring to their tables. Also, at a higher level, information is key to provide authorities with the scientific basis to build their internal policies in a way that they can raise healthy citizens.

While NGOs and development agencies continue their work in supporting all countries in their fight against undernutrition, we can provide our help by researching best practices and lessons learned to be shared, together with becoming the drivers of change in our communities. There is no one single approach to tackle the issues revolving around hunger but there surely is a holistic approach we can all play a role in.

## **4.5 Chapter 4 Bibliography**

Bergamini, N., Padulosi, S., Ravi, S. B., Yenagi, N. 2013. *Minor millets in India: neglected crops go mainstream*. In: Diversifying Food and Diets [online] [http://www.b4fn.org/fileadmin/templates/b4fn.org/upload/documents/Diversity\_for\_Food\_and\_Diets/CS8\_Bergaminietal.pdf](http://www.b4fn.org/fileadmin/templates/b4fn.org/upload/documents/Diversity_for_Food_and_Diets/CS8_Bergaminietal.pdf%20)

Bioversity. Eds. Fanzo, J., Hunter, D., Borelli T. & Mattei, F. 2013. *Diversifying Food and Diets. Using agricultural biodiversity to improve nutrition and health*. Routledge. London & New York. [online]<https://www.bioversityinternational.org/fileadmin/user_upload/online_library/publications/pdfs/Diversifying_food_and_diets_1688_01.pdf>

Boone, R., Covarrubias, K., Davis, B., Winters, P. 2013. *Cash transfer programs and agricultural production: the case of Malawi.* [online]<https://onlinelibrary.wiley.com/doi/full/10.1111/agec.12017>

Castaneda, A., Doan, D., Newhouse, D., Nguyen, M. C., Uematsu, H., Azevedo, J. P. 2016. *Who Are the Poor in the Developing World?*. Policy Research Working Paper. No. 7844. World Bank, Washington, DC. [online]<https://openknowledge.worldbank.org/handle/10986/25161>

Chandy, L., Kato, H. & Kharas, H. 2015. *From a billion to zero: three key ingredients to end extreme poverty*. Washington, D.C., Brookings Institution Press.

de Groot, R., Palermo, T., Handa,S., Ragno, L. P. & Peterman, A. 2015. *Cash transfers and child nutrition: What we know and what we need to know*. In: Innocenti Working Paper No. 2015-07. UNICEF Office of Research, Florence. [online] [https://www.unicef-irc.org/publications/pdf/Social%20protection%20and%20nutrition\_layout.pdf](https://www.unicef-irc.org/publications/pdf/Social%20protection%20and%20nutrition_layout.pdf%20)

FAO. 2014. Ed. Ghattas, H. 2014. *Food security and nutrition in the context of the global nutrition transition*. [online]<http://www.fao.org/3/a-i3862e.pdf>

FAO. 2017a. *Nutrition-sensitive agriculture and food systems in practice: options for intervention*. [online] <http://www.fao.org/3/a-i7848e.pdf>

FAO. 2017b. *Empowering women to end hunger and poverty.* [online] <http://www.fao.org/zhc/detail-events/en/c/471293/>

FAO. 2018. *Biodiversity for Sustainable Agriculture. FAO’s work on biodiversity for food and agriculture*. [online]<http://www.fao.org/3/a-i3022e.pdf>

HLPE. 2017. *Nutrition and food systems*. A report by the High Level Panel of Experts on Food Security and Nutrition ofthe Committee on World Food Security. Rome. [online]<http://www.fao.org/3/a-i7846e.pdf>

IFAD. 2008. *IFAD and the SDGs*. [online]<https://www.ifad.org/en/ifad-and-the-sdgs>

Nakhauka, E. B. 2009. *Agricultural biodiversity for food and nutrient security: The Kenyan perspective*. International Journal of Biodiversity and Conservation Vol. 1(7) pp. 208-214 [online]<http://www.academicjournals.org/app/webroot/article/article1379947922_Nakhauka.pdf>

Pilgrim, Francis J. 1957. *The Components of Food Acceptance and Their Measurement*. In: The American Journal of Clinical Nutrition. [online] <http://vorga.org/5-2-171.full.pdf>

Thorndike A. 2011. *Workplace interventions to reduce obesity and cardiometabolic risk*. Current Cardiovascular Risk Reports. 5(1), 79–85. [online]<https://www.ncbi.nlm.nih.gov/pubmed/22708000>

WHO. Commission on Ending Childhood Obesity. 2017. Facts and figures on childhood obesity. [online]<https://www.who.int/end-childhood-obesity/facts/en/>

WHO. 2019. *Global Database on Child Growth and Malnutrition*. [online]<https://www.who.int/nutgrowthdb/about/introduction/en/>

World Bank. 2006. Why invest in nutrition? In: *Repositioning Nutrition as Central to Development. A Strategy for Large-Scale Action* [online]. <http://siteresources.worldbank.org/NUTRITION/Resources/281846-1131636806329/NutritionStrategyCh1.pdf>

World Bank. 2018. *Understanding poverty: overview*. [online] <https://www.worldbank.org/en/topic/poverty/overview>

Zenebe, M., Gebremedhin, S., Henry, C. & Regassa, N. 2018. *School feeding program has resulted in improved dietary diversity, nutritional status and class attendance of school children*. Italian Journal of Pediatrics, 44(1), 16. [online]<https://ijponline.biomedcentral.com/articles/10.1186/s13052-018-0449-1>

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