How trade can drive inclusive and sustainable vegetable sector development in Africa: options for Dutch policy support

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This report discusses the role of trade in addressing global challenges of food security and sustainable production, first within a general food system framework context, followed by an application of this framework on the opportunities in African countries to increase vegetable production. The report concludes with a reflection of implications of findings for the Dutch food security policies. Potential options for Dutch development assistance to support the horticultural sector in Africa and to stimulate associated trade evolve around further enhancing participation of smallholder farmers in horticultural markets (inclusivity), further developing and adhering to food safety standards also in domestic markets (safe nutrition) and mitigating environmental trade-offs (environmental sustainability).

Keywords: food systems. sustainability, Africa, vegetables, Dutch food security policy

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Preface

In tackling global challenges of producing sufficient healthy food for an increasing population the food system approach is increasingly used as a framework for seeking entry points for transformation towards a more sustainable, inclusive and resilient food system. Food system approaches increasingly consider a more holistic point of view beyond the value chain to include more (global) environmental and socio-economic drivers and food security outcomes.

The 2019 Dutch Government Food security policy note also takes the food system concept as key for addressing food security, and in achieving SDG and the Paris Climate Agreement. The policy note announces that within the framework of the government's Multiannual Country Strategies, food system analyses will be conducted to result in (country-) context-specific refined priorities. This report contributes to this by evaluating how international trade can contribute to more inclusive and sustainable food systems, and, more specifically, how enhanced trade relations with the European Union and the Netherlands can help to increase vegetable production in African countries.

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Prof.dr.ir. J.G.A.J. (Jack) van der Vorst
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Executive Summary

Trade is generally positively associated with food security, increasing availability and diversity of food at affordable prices, but can have important trade-offs socially and economically by crowding local farmers out of the market, by exposing importing countries to risk from external perturbations (e.g. price peaks, COVID-19 outbreak) and by exacerbating environmental challenges associated with food production and climate change. Applying a food system framework in analysing the relationships between different activities in the food system and their drivers helps to shed light on these trade-offs and allows for policy responses that explicitly address these trade-offs.

Malnutrition can be combated with better, healthier food, including more vegetable consumption. In many West and East African countries, vegetable consumption is much lower than reference norms for a healthy diet indicate. Projections of fruit and vegetable production possibilities in these regions indicate it is lagging behind the need, with a growing need for imports as a result. Regional trade and extra efforts on local production growth are strategies for meeting local demand in the future.

Scope exists for sustainably increasing horticultural production, while addressing the potential trade-offs. Dutch development support can be instructive in stimulating these processes. Horticultural production can be made more inclusive by lowering transaction costs to integrate more farmers in modern supply chains. This includes investments in public support and infrastructure, in addition to empowering farmers' position in the supply chain by establishing farmers' organisations. Further experimentation with contract farming for such organisations and less-endowed farmers is desirable. Support should further be given to independent quality and food safety control and certification, public extension and market information services. Finally, programmes aimed at improving productivity, such as *Seed.nl*, combined with investments aimed at reducing crop losses and waste and technologies to cope with climate change, offer opportunities to make horticultural production more environmentally friendly.

Contract farming has proven to be often a more efficient mechanism vis-a-vis trade in spot markets to organise horticultural production and trade, particularly when traders assist in providing required inputs and technical assistance. However, trends suggest that over time contract farming typically concentrates with an ever-smaller number of producing farmers. This suggests horticultural production, through contract farming, provides clear advantages to some, but certainly not for everybody.

And for the least endowed for whom the options outlined above are insufficient to engage them in stimulating horticultural production and trade, complementary development policies should remain to exploit other livelihood opportunities, possibly options outside of the agricultural domain. Such policies include existing policies focusing on improving health and education as well as mitigating short-term penury by using, for instance, cash transfers.

1 Introduction

Trade can be an important instrument in reducing hunger and malnutrition and enhancing a country's food security. Indeed, via imports trade increases access to a wider variety of food than domestic production offers, and imports stabilise domestic markets by overcoming local food supply shortages. Through exports, trade generates incomes and foreign revenues, improving purchasing power and proving means to pay for food imports. However, trade may also expose importing countries to risks from external perturbations, as the food price spikes in 2008 and 2012 have shown (e.g. Morrison and Sarris 2016). The recent COVID-19 outbreak, the spread of the pandemic around the world and its disruptive consequences for food security, like temporary border closures, has illustrated again how vulnerable internationally connected food value chains can be (Swinnen and McDermott 2020). Moreover, trade can exacerbate environmental challenges associated with food production, land use and climate change, by promoting intensive production methods (Balogh and Jámbor 2020).

This report discusses the role of trade in addressing global challenges of food security and sustainable production, first within a general food system framework context, followed by an application of this framework on the analysis of opportunities in African countries to increase vegetable production and enhance trade relations in vegetables with the European Union and the Netherlands in particular. The report concludes with a reflection of implications of findings for the Dutch food security policies (Kaag and Schouten 2019).

Why focus on vegetables?
Vegetables[1] play a key role in reducing malnutrition problems through their contribution to improving the nutritional value of the diet (Willett, Rockström et al. 2019). Data show that current production levels of vegetables in many low- and middle-income countries (LMICs) fall short in meeting local demand and many countries rely on imports. Demand for vegetables as nutritious food is expected to rise in LMICs in future, as result of continuous population and income growth, and demand for more diverse diets (e.g. FAO 2020; de Steenhuijsen Piters, Dijkxhoorn et al. 2021). Increasing demand indicates production opportunities in countries which already have comparative advantages in producing vegetables but may increase import dependency of those countries that lack these advantages.

Because vegetable production in LMIC is often labour-intensive, expanding production in these countries can lead to meaningful job creation and income-generation opportunities. The Netherlands is an important producer, exporter (of products and seeds) and importer of vegetables – the latter also as transit country for exports to other EU member states. In this context, it is interesting to investigate whether, and if so how, vegetable sector performances in LMICs can benefit from more intensive trade relations with the Netherlands. The alleged benefits are elaborated in socio-economic and ecological terms, to establish alignment with the intended SDGs of (1) no poverty, (2) zero hunger, (13) climate action (i.e., combat climate change and its impacts) and (15) life on land (sustainable use of terrestrial ecosystems). For a manageable scope of the report, the analysis of Dutch vegetables trade relations with LMICs will focus on a few African countries.

The report has the following structure, answering the questions in successive chapters:
- Why is a food system framework useful when analysing the role of trade in achieving SDGs on poverty, hunger, climate change and sustainable use of terrestrial ecosystems?
- What's the added value compared with a Value Chain approach?
- How may trade affect food and nutrition security, and how does international trade relate to environmental degradation and climate change impacts?
- Which factors determine current and future vegetable production and use in Africa, and how does international trade (exports and/or imports) contribute to access and availability of vegetables?

[1] Vegetables are the group of edible plants that are defined by the FAO as vegetable items. This definition excludes potatoes, which are in the Roots and tubers product category.

- How has vegetable trade impacted food system outcomes in Africa? What are options to counter trade-offs?
- How can Dutch policy help Africa with the development of their vegetable sector and thus contribute to the objectives of reducing malnutrition and promoting climate-smart agriculture?

The report ends with several concluding remarks and a summary of main findings.

2 Concept of food system thinking

Food systems thinking gained increasing traction following the sharp price rises for agricultural and other commodities in 2008/09, which once again put food security (or rather, food insecurity) high on the policy agenda. In addition to expanding food production, improved access to food became a critical component in the thinking about food security. At the same time, the limitations of natural conditions for a growth in agricultural production became increasingly clear, especially in relation to anticipated climate changes. It was also clear that an increase in food production alone would not improve food security, but that nutritional value is important when it comes to combatting malnutrition (and obesity). The research community and policymakers were encouraged to look more broadly than at agricultural production alone to enhance food security for a growing world population. Since then, many reports and scientific articles have appeared that use the food systems approach as a framework for understanding changes in food systems in relation to food security and climate change. This also makes it a useful approach for designing transformative action at the interface between science and policy (see for example Fresco, Ruben et al. 2017).

2.1 The food system concept explained

Food and nutrition security (i.e., access to and availably of sufficient nutritious food at all times) and the socio-economic and ecological effects of producing and consuming that food are outcomes of an interplay of multiple factors operating at multiple scales. A food system approach is needed to comprehend how food moves from producer to consumer and how policies should be designed to correct for negative environmental and social outcomes of food system activities to gain more efficient outcomes (Ericksen, Stewart et al. 2010; Fresco, Ruben et al. 2017). A food system approach gathers multiple (biophysical, economic, political and social) factors and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outcomes of these activities, including socioeconomic and environmental context and dynamics (HLPE 2014). The food system approach looks at these activities: how they interact, how they result in outcomes and how these results feed back again to system activities and to socioeconomic and environmental drivers of the system.

The food system literature has shown different ways of conceptualising the food system: some have a greater orientation on (impacts on) natural resources (e.g. UNEP 2016), others on (consequences for) diets (e.g. Global Panel on Agriculture and Food Systems for Nutrition 2016). Moreover, there are multiple narratives of what causes food systems failure and how to improve it (see Béné, Oosterveer et al. 2019). Van Berkum et al. (2018) provide a generic framework for food system mapping and analysis that helps to identify how distinct types of policy incentives or business innovations can influence the relationships between multiple stakeholders (input providers, farmers, traders, public officials, processors, retailers) that could lead to adjustments in the interactions of different components (consumption, distribution, value chain, production), with the aim to improve system outcomes. The scheme in Figure 2.1 describes the different elements in a food system and the relationships between them. On the one hand, the framework looks at all the activities relating to the provisioning and utilisation of food, and, on the other hand, at the outcomes of these activities in terms of food security (including nutrition, that is, the extent by which healthy and safe foods are available and accessible), socioeconomics (income, employment) and the environment (biodiversity, minerals, water, climate, soils). A defining feature of system thinking is that it views the behaviour of a system as an interplay of interacting subsystems (i.e. for instance, parts of the food supply activities, markets, and biophysical subsystems like land or water), in which feedback plays a key role, rather than as a simple chain of cause-effect relationships.

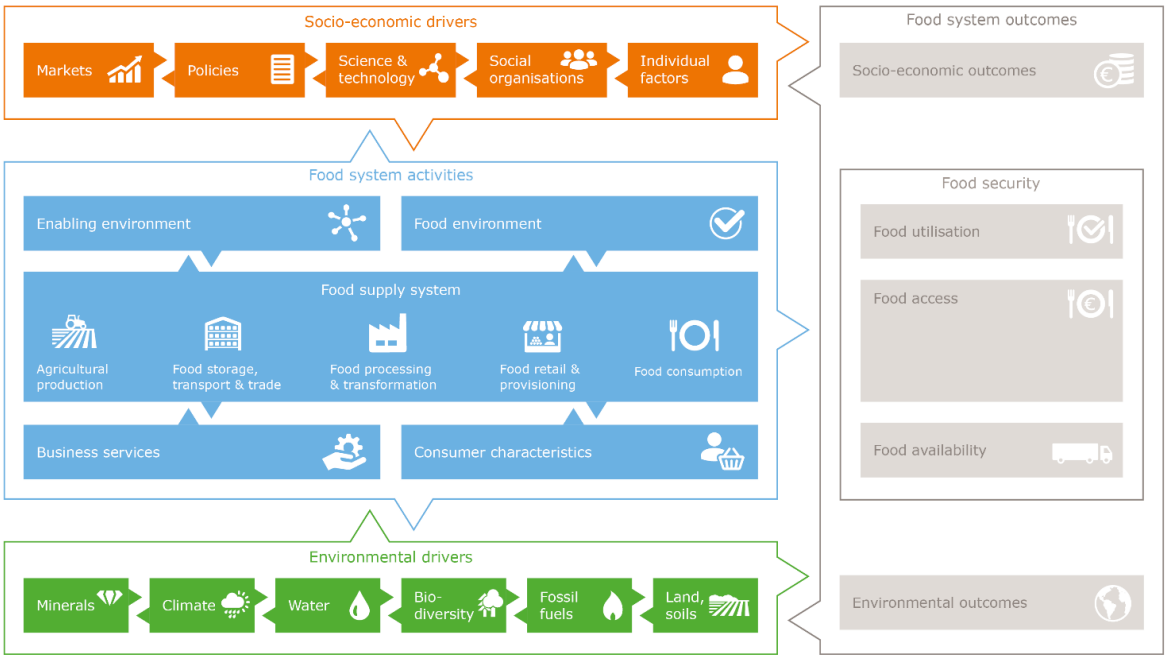

Figure 2.1 *Conceptual framework of mapping the relationships of food system activities to its drivers and outcomes*
Source: Van Berkum et al. (2018).

The value added of applying a food system framework
As shown in this report, the application of a food system framework reveals where the main interactions and feedback between the subsystems occur, and this produces several useful insights:

- It maps out inefficiencies from which opportunities for a more efficient use of natural resources can be identified (beyond one product and/or one value chain).
- It highlights the vital role of the food system's socio-economic drivers.
- It shows the implications of the food system relationships and interventions for health and malnutrition.
- It helps to shed light on the trade-offs between different intervention strategies.
- It sheds light on non-linear processes and feedback loops in the food system.
- It allows for a better understanding of how policies and other factors may encourage or discourage specific actions or behaviour.

This list of insights reflects the advantages of using a food system approach for shaping transformative action to enhance food and nutrition security. System thinking broadens the perspective when seeking solutions for root causes of problems such as poverty, malnutrition and climate change. Food system thinking allows to include feedback from the effects of an intervention that does not directly relate to food production and/or consumption and analyse what this feedback implies for food system activities and the outcomes of the (whole) food system. Again, the added value of the approach is the wider perspective it offers for finding sustainable solutions for a sufficient supply of nutritious food.

2.2 Where systems thinking differs from chain analysis

The wider perspective and 'overall inclusion' of system activities and relations with domains not directly central to food production and consumption is what distinguishes a food system thinking from a value chain analysis. Value chains are a core element of a food system (as presented in Figure 2.1), and surely are a useful framework to unpack the complexities of a food system. However, the focus of value chain innovations is often on increasing economic efficiency (higher productivity, more profit), and disregards environmental objectives and/or social impacts of these innovations. To take a more

holistic view in which measures take the complex social and environmental context into account, value chain structures and development need to be viewed through a food system lens.

Value chain development holds great potential to contribute to improving outcomes of the food system yet should consider the social and environmental context and effects. *In food system development* tensions and trade-offs occur, for instance when combining the objectives of developing economically viable value chains and improving food and nutrition security; the first may not coincide with a better income for all value chain actors or automatically lead to enhanced food access or inclusiveness. Likewise, a solely efficiency focus may compromise environmental objectives as well, while offering cheap food may not satisfy the nutrition requirements of the population (food supply should enable diet diversity). Identifying and addressing these potential trade-offs while searching for opportunities for convergence and multi-stakeholder partnerships are an integral part of the value chain framework that fits in a food system perspective. This also implies that value chain innovations (investments) of technical nature should simultaneously consider their socio-economic and environmental implications, and when trade-offs occur, should be complemented with organisational (governance) interventions that help change behaviour to enhance the sustainability of a food value chain producing healthy and safe food (see for examples e.g. Bijman and Bitzer 2016).

3 Channels of impact of trade on food security and environmental externalities[2]

3.1 How trade effects food security

There is much historical evidence that international trade promotes economic growth, as it allows countries to use its resources more efficiently by specialising in products and services it can produce most competitively (e.g. Brooks and Matthews 2015; OECD, 2020). Economic growth is assumed to directly contribute to poverty reduction, as it creates employment opportunities and reduces prices, among others for food, from which all – also the less affluent – consumers can benefit. Following this argument, there is a positive association between trade and food security, as it contributes to food availability (importing when domestic supply falls short of demand) and improves access to food (through increased economic growth and higher incomes, and lower prices). Next, regarding food utilisation, the third element of food security, with increased economic growth and incomes, trade also contributes to the nutrition of households. Trade makes food cheaper and, hence, allows better access and utilisation to people. Also, trade may contribute to a more diversified diet by providing various food products otherwise not available locally (Kummu, Kinnunen et al. 2020). On stability - the fourth element of food security: by balancing international food surplus and deficit, trade improves the stability of the three preceding elements (also by reducing seasonal effects on food availability) and make local markets less prone to policy or weather shocks.

However, positive effects of trade on food security are not always evident. Only 23% of global food production is internationally traded (D'Odorico, Carr et al. 2014), while only 5% of vegetables produced may be traded internationally (Rabobank 2018). Against these figures, the availability of food is determined by local factors mostly, among which poor rural infrastructure is mentioned as a primary constraint (FAO, 2019). Open trade may also eradicate local production potential in food-deficit countries by lowering prices for food products, which puts high pressure on local farmers. One of the most cited arguments against free trade is that trade liberalisation increases food dependency (and import bills) and makes consumers more vulnerable to external shocks in food availability (e.g. Koning and Pinstrup-Andersen 2007; de Schutter 2011). Also, the nutritional balance of increased access to cheaper and more diversified food is not evident as by creating a 'nutritional transition', trade openness can also be responsible for obesity and diseases due to increased access to unhealthy food (Global Panel on Agriculture and Food Systems for Nutrition 2020). And lastly, whether trade openness will indeed induce food market stability is questioned by recent international price spikes (in 2007/2008 and 2011/2012). This leads to conclude that international trade and policies to further encourage trade play an ambiguous role in the current food system. Figure 3.1 illustrates this ambiguity.

Overall, these arguments suggest that trade liberalisation also changes the internal terms of trade, thereby creating a mixture of winners and losers because of how food prices are affected by the trade reform. In this context, understanding price transmission, that is, how a change in an import tariff translates in a change in prices for domestic producers and consumers, is key in considering food security outcomes of trade reforms. McCorriston et al. (2013) point at infrastructure, information flows, taxes and subsidies as major factors to mediate price transmission effects across constituent groups, space and time.

It is also clear that in addition to trade, food security is much affected by macroeconomic factors (Diaz-Bonilla 2015; Brooks and Matthews 2015; OECD 2019), including domestic taxes and subsidies (Kherallah, Delgado et al. 2002). Indeed, macroeconomic factors influence the four components of food security through different channels. Domestic production and imports determine availability (first

[2] This chapter is largely based on Van Berkum, 2021.

component). Economic growth, generating employment opportunities and higher income levels, is strongly linked to food access (second component). In fact, it is evident that the ultimate driving force of global food security is the overall level of economic development, affecting each of its dimensions. Government revenues, sometimes raised from export taxes, might also be used to implement policies and investments in favour of food security such as research and development (affecting availability and stability, the first and fourth component of food security), basic health services and food assistance and social protection programs (affecting use/nutrition, the third component). Nutrient security pertains to the individual the most, but is largely affected by income and access to food determining factors (e.g. Global Panel on Agriculture and Food Systems for Nutrition 2020). From this perspective, actions that affect non-agricultural markets and employment - such as building infrastructure or ensuring equitable access to education - could be just as important for food and nutrition security as policies and investments in the agri-food sector. Overall, this means that the discussion on trade and food security needs to be placed in the context of an overall framework of macroeconomic and exchange rate policies (Diaz-Bonilla 2015; OECD 2019).

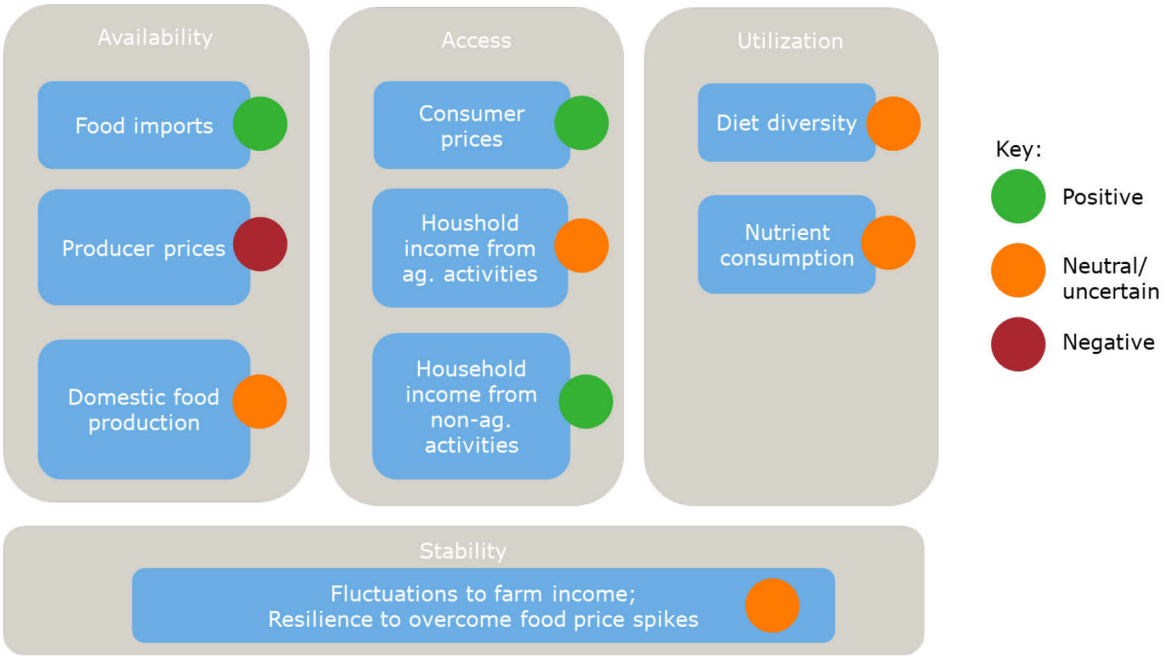

Figure 3.1 *Channels of impact of increased international trade on the four dimensions of food security in food deficit countries a)*
a) The figure can also be drawn from the perspective that a country exports vegetables - as if it were a cash crop. Impacts in producer prices will be positive, yet consumer prices may be negatively affected. Utilisation effects are uncertain – see Achterbosch et al. (2014).

3.2 Environmental effects of trade in agri-food commodities

International trade has the potential to increase environmental externalities such as transboundary pollution, deforestation, transportation, and production relocation avoiding environmental standards, as it promotes specialisation and reliance on more input-intensive production methods. Trade acceleration and trade liberalisation are considered as significant drivers of environmental impacts in the literature (see Balogh and Jámbor 2020).

In recent decades, significant deforestation in the Amazon biome, in some Southeast Asian countries and in some African countries—such as Angola and Zambia—have added to global GHG emissions and biodiversity loss. Deforestation is known to be driven partly by international trade. In Indonesia and Malaysia, forests have been cleared to produce palm oil, which is traded on international markets. In

Brazil, the deforestation of the Amazon has been linked to export-oriented meat and livestock production, with much of the cleared forest used for pasture and soybean production (Dalin and Rodríguez-Iturbe 2016; Pendrill, Persson et al. 2019). In developed countries, the deforestation-related emissions 'embodied' in imports are greater even than those generated by domestic agriculture. For instance, a significant part of the EU environmental footprint is related to food trade, with deforestation emissions constituting an estimated 15% of the total carbon footprint of food consumption (Pendrill, Persson et al. 2019). Intensive livestock (pigs and poultry sector) production in Europe - highly dependent on imports of soybeans from Latin America - contributes significantly to local agricultural environmental impacts, most specifically to soil acidification and air and water pollution (Leip, Billen et al. 2015).

The literature on the environmental effects of agricultural trade suggests three categories of solutions to address trade-related negative environmental externalities (Balogh and Jámbor 2020):

- First, consumers (mainly in developed countries) should be tempted to reduce consumption of livestock products, because demand for these products are a key factor in the trade-environment nexus.
- Second, environmental harm can be reduced or mitigated by adopting sustainable technologies (i.e. precision agriculture, drought-resistant seeds) and improved natural resource management practices (for nutrients, pests, water and soil management)—both of which require investments in knowledge and technologies in the agricultural sector.
- Third, trade-related policies and regulations can contribute to limiting environmental degradation. Such agreements must be harmonised at the international level, not only for environmental reasons but also to reduce compliance costs for exporters. While environmental provisions have increasingly figured in regional trade agreements over recent years (OECD 2020), they lack specific environmental targets. Various sustainable trade initiatives exist today, mainly in tropical products such as cocoa, coffee, palm oil and soybeans, and for fish and timber, in which the private sector, social organisations and governments are working together to set up more sustainable international chains (van Oorschot, Wentink et al. 2016). Yet the impact of these agreements remains limited, because consumer demand and willingness to pay for sustainably produced commodities is still low, and because small-scale farmers are unable to benefit from their investments in good agricultural practices due to lack of market power while traders (exporting and/or importing companies) be able to generate a market premium for sustainably produced products (Ruben 2020). Moreover, the standards imposed through sustainability schemes initiated by importing countries are not always supported by exporting countries and standards cannot be enforced on a global scale (van Oorschot, Wentink et al. 2016).

4 Vegetable supply, affordability and trade relations

4.1 Vegetables are part of healthy diets: availability and affordability

Unhealthy consumption patterns are considered one of the largest risks to human health, globally (Willett, Rockström et al. 2019). Mortality and loss of quality of life caused by poor diets are considerable, and place a greater burden on many nations than poor health resulting from the use of tobacco, drugs and alcohol and unsafe sex combined Willett, Rockström et al. 2019. Many countries now face a triple burden of malnutrition: with some groups facing undernourishment (insufficient intake of energy and protein), while others may lack sufficient intake of (micro)nutrients and again other groups are overweight or obese. These three faces of malnourishment now co-exist in many countries and regions and sometimes even within the same communities.

A healthy diet is viewed as a key solution for all three forms of malnutrition. Current scientific thinking on healthy food patterns, lead to a broad-brush definition of a healthy diet as largely plant-based, with a large share of fruits, vegetables, whole grains and plant-based protein sources (nuts and legumes). Intake of animal protein sources should be limited to dairy products, fish and poultry mostly, while consumption of refined sugars and carbohydrates should be limited altogether (Willett, Rockström et al. 2019; FAO 2020). A shift to more healthy consumption patterns would not only yield considerable reductions in mortality and improvements in quality of life, but it would also lead to considerable savings in health costs. A shift to healthy diets would lead to 12-14 million deaths avoided annually by 2030 (FAO 2020). To the contrary, maintaining current consumption patterns would imply a global health costs bill of around USD 1.3 trillion by 2030, annually (FAO 2020). Equally important, a shift towards a healthy diet is also considered to be more environmentally friendly, to a large part due to an aggregate reduction in global consumption of (Willett, Rockström et al. 2019; Béné, Fanzo et al. 2020).

The multifaceted face of malnutrition implies a needed reduction in consumption of animal products for some groups, while it would entail an increase for others. It does, however, imply an increase in consumption of fruits and vegetables for most citizens globally. Current WHO recommendations on consumption of fruits and vegetables in a healthy diet amount to 200g per capita per day for both fruits and vegetables. The recently developed healthy reference diet[3] (Willett, Rockström et al. 2019), taking into account a range of health indicators and aspects of disease prevention, includes larger reference intake for vegetables (300 g per capita per day). Either way, current average consumption of fruits and vegetables by most of the global population falls short of these reference targets (see Figure 4.1 below).

[3] Often called the EAT Lancet diet after the journal in which this review was published.

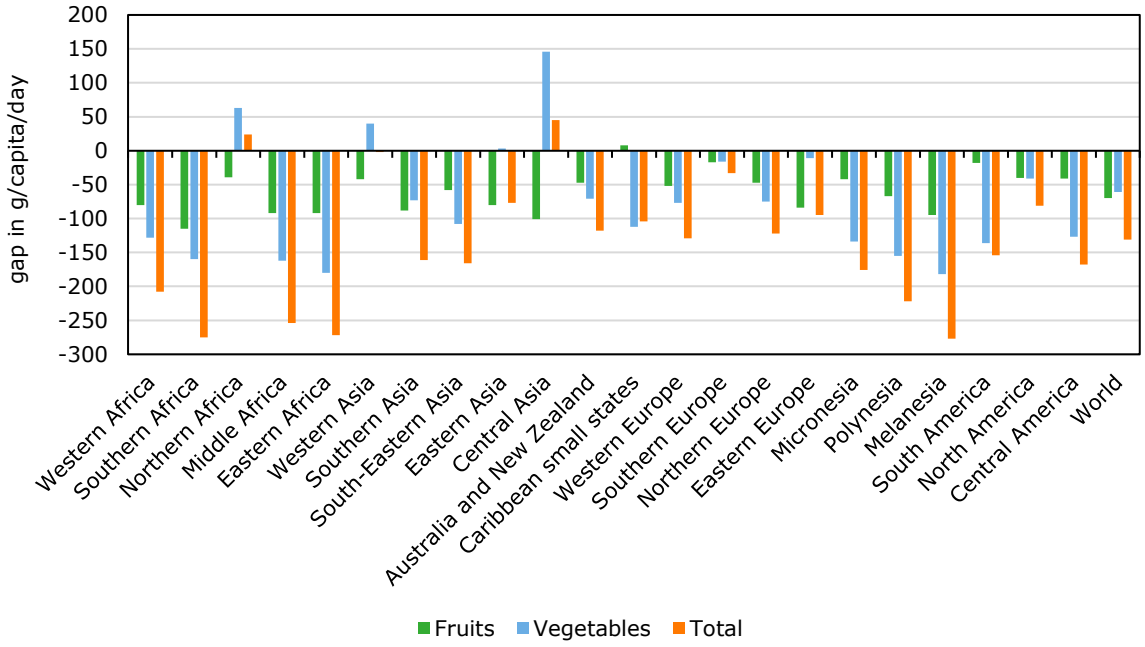

Figure 4.1 *Gap between actual intake of fruits and vegetables (gram/capita/day) and recommended levels per geographical zone*
Source: de Steenhuijsen Piters et al. (2021), based on Food system dashboard 2021.

Only average consumption in countries in Northern Africa, Eastern and Central Asia meets this target, due to high levels of vegetables consumption. The gaps between actual consumption and recommendations are somewhat smaller in Europe and the US, as compared to developing countries, but not by a large token. Overall, the gaps between recommended and actual intake are largest in the pacific island nations. Other studies equally point to a considerable gap between recommended and actual intake of fruits and vegetables in developing countries. Kalmpourtzidou et al. (2020) suggest that globally in 88% of the countries intake levels fall short of recommendations. Both Hall et al. (2009) and Frank et al. (2019 report figures of around 80% of adults in LMIC not meeting recommended intake of fruits and vegetables.

Micro-level analysis of consumption patterns in specific countries confirms the gap between actual intake and recommendations, but reveals further diversity in consumption across incomes, localities and countries. In general, consumption of fruits and vegetables is expected to rise with income (Pingali 2015), but this does not describe consumption patterns in full. Moreover, it is often assumed that consumption of fruits and vegetables is higher in urban areas, due to greater availability, better storage and cultural norms, but actual studies provide inconsistent results (de Steenhuijsen Piters, Dijkxhoorn et al. 2021). For instance, consumption of vegetables by Nigerian urban populations is below recommendations (Raaijmakers, Snoek et al. 2018), while vegetable consumption appears higher in rural areas (Mekonnen, Trijsburg et al. 2021). Conversely, the consumption of fruits appears higher in urban areas. Overall, nutritional status of the rural population in Nigeria appears better than the urban one (Mekonnen, Trijsburg et al. 2021). Yet again, the reverse is observed in Ethiopia (Mekonnen, Talsma et al. 2020). Such differences across countries limit further generalisation.

Differences in fruit and vegetable consumption across regions are to a large degree shaped by differences in income and prices. Low incomes, vis-a-vis relatively high prices of fruits and vegetables, are a key impediment to greater consumption. The cost of a healthy diet is found to be 60% higher than the cheapest diet supplying daily minimum intake of nutrients. It is five times more expensive than the cheapest diet providing minimum daily energy intake (FAO 2020). These insights explain why a healthy diet is currently unaffordable for 3 billion people globally, people found mostly in the poorest cohorts across all regions in the world (FAO). Nonetheless, consumption of fruits and vegetables is found to be price elastic, with a reduction in prices by 10% leading to proportionally greater increase in consumption by 12% (FAO 2020). This is contrary to price inelasticity of basic staples, where consumption changes

little with changing prices. There may therefore be scope for enhancing consumption by pricing policies (as discussed in Section 5), in addition to raising productivity, production and imports.

4.2 Production and consumption of vegetables in developing countries

In many low- and medium-income countries, the production of fruits and vegetables is also lower than WHO guidelines. A focus on production in West Africa, East Africa and South Asia (de Steenhuijsen Piters, Dijkxhoorn et al. 2021, Chapter 8) reveals that per capita supply only exceeds consumption recommendations in a handful of countries (Iran, Malawi and Nepal). Below WHO recommendations, but still fairly high, are production figures for Niger, Mali and Nigeria (150-300 g/capita/day). In all other countries per capita production is below 150 g/capita/day. The estimate in these data excludes food waste, so actual supplies to consumers are lower.

Two studies provide snapshots on future production of fruits and vegetables under different scenarios (Siegel, Ali et al. 2014; Mason-D'Croz, Bogard et al. 2019). Future availability is a function of a multitude of factors including population growth and economic development, as well as specific sectoral interventions on trade development and efforts to reduce food waste. The various scenarios continue to highlight differences by regions and sometimes countries. All scenarios computed by (Mason-D'Croz, Bogard et al. 2019) suggest that by 2050 China, India, most of the Middle East and some European countries will have production exceeding consumption recommendations. But the picture is bleak for Sub-Saharan Africa (SSA). The ratio of availability to recommendations varies from 0.39 to 0.55 for this region, implying insufficient supply of fruits and vegetables for 0.8-1.9 billion inhabitants. A main factor explaining supply is lagging demand, is that population growth outpaces productivity growth.

A key unknown in these scenarios relates to the magnitude of food wasted and the overall food availability to consumers. These scenarios made different assumptions on the scale of food waste. When it remains as high as current estimates (33% of global production lost) only 19 countries globally (3.6 billion people) will have sufficient availability of fruits and vegetables by 2050. That being said, detailed recent studies suggest a downward revision of food waste losses, which for vegetables and fruit may amount to 10-15% in developing regions (Fabi, Cachia et al. 2021).

Another factor that will have a clear impact on availability of fruits and vegetables is climate change. The scenario studies did not take account of the impact of climate change. Likely changes in climate per region (mean temperature change or rainfall patterns) remain highly uncertain. Moreover, climate change could be a factor that further increases pest and disease pressure in vegetable production systems (Ebert Andreas 2017). Climate change is expected to lead to lower crop yields and higher prices, particularly impacting low-income countries (Mason-D'Croz, Bogard et al. 2019), but this should be explored in future scenario studies.

Clearly, sufficient production of fruits and vegetables is by no means guaranteed in the medium to long term, particularly so for many African countries. That being said, there is scope in meeting gaps in local or regional consumption by trade with other regions.

4.3 Vegetable trade positions and trade relations between Europe and Africa

Generally, the organisation of horticultural value chains in developing countries is characterised by three distinct phases: 1) a traditional and locally-oriented phase; 2) a transitional phase in which midstream supply becomes spatially elongated and 3) a modern phase in which supply chains serve urban demands and are de-seasonalised (Joosten, Dijkxhoorn et al. 2015; Barrett, Reardon et al. 2020; Reardon, Heiman et al. 2021). The first phase is the least organised, highly seasonal and sees many smallholder producers supplying horticultural produce to local wet markets. It has only limited integration between

producers and traders. Prices are set daily in spot-markets and may fluctuate considerable due to changing demand and supply. The second transitory phase is characterised by a spatial elongation between production and demand. Horticultural produce is traded over longer distances connecting more remote rural producers with urban demand. Facilitating this trade is an emerging segment of midstream actors, traders and processors, being incentivised by growing urban demand and/or enhanced infrastructure. The use of contracts between farmers and processors starts to emerge (See Section 6.1). This transitory phase is now visible in many developing countries and the emergence of many actors in this midstream is often dubbed the 'hidden middle' (Reardon 2015). The requirements in terms of quality or delivery times imply that often the least-endowed producers are excluded from transitory value chains, a trend that is further re-enforced in the modern phase (see Section 5). In the final 'modern' phase horticultural supply chains are highly organised vertically, with the use of contracts between producers and traders being the norm. Cold-storage facilities allow chains to become de-seasonalised as well as to cover larger spatial distances. Often these value chains are geared towards intercontinental trade, but they may also feed high-end urban domestic demand (e.g. supermarkets).

Globally, about 23% of food is traded internationally (D'Odorico, Carr et al. 2014), while only 5% of vegetables may be traded internationally (Rabobank 2018). Overall, the value of exports from Africa, Asia and Latin America increased 4-5-fold in real value terms in the last twenty years (Barrett, Reardon et al. 2020), while growth has been particularly fast in high-value products for which standards are important. Despite these impressive growth rates, exports often remain small in comparison to full agricultural output. Kenya's horticultural sector is one of the largest in Sub-Saharan Africa generating employment for 2,5 million people, but 90% of the vegetables are marketed locally, with an overall market value of 7 to 8 times the value exported (Lenné and Ward 2010). Nonetheless, vegetable exports can be among the most important export flows. This holds for Ethiopia where in terms of value the export of fresh vegetables was the third largest export flow after coffee and oil seeds (Easterly and Reshef 2016).

Such patterns hold for nearly all African countries, whereby exports are less than 20% of total agricultural value implying domestic markets are more important in value terms. This is also illustrated by the export shares of total domestic supply of vegetables in the African countries presented in Figure 4.2. Only Burkina Faso, Morocco, and South-Africa export more than 10% of their domestic supply. On the import side, Angola, Burkina Faso, Cote d'Ivoire, Guinea, Mozambique and Senegal rely significantly on imports. In general, though, the international market integration of vegetable producers in African countries is limited.

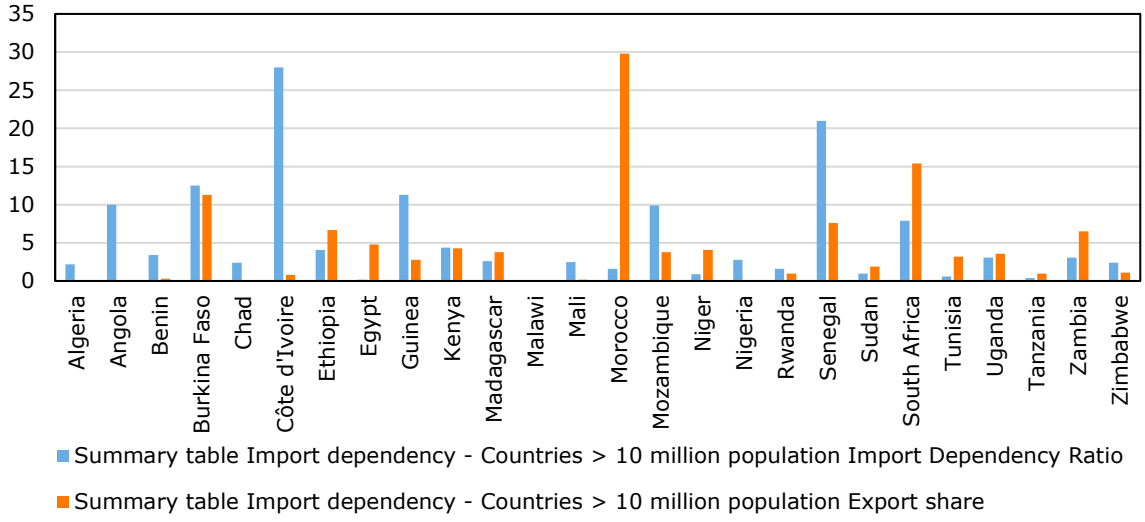

Figure 4.2 *Import and export shares of domestic supply of vegetables in African countries (in %) a) a) import dependency ratio = import x 100/(production + imports - exports). Export share of total domestic supply = exports x 100(production + imports - exports). Countries presented are countries with over 10 million inhabitants.*
Source: FAO 2020.

As a rule of thumb, particularly in the absence of storage conditions, the distance over which fruits and vegetables are traded is a function of its perishability. As most fruits and vegetables are perishable, they are consumed in places close to where they are produced. For instance, (highly perishable) leafy vegetables are typically produced at most at 100 km from key urban markets (Dube, Heijman et al. 2018).

Conversely, a less perishable vegetable like onion is traded over larger distances. For instance, more than 50% of Tanzanian Onion production is exported to Kenya (König, Blatt et al. 2011 Lenné and Ward 2010). Some exceptions (de Steenhuijsen Piters, Dijkxhoorn et al. 2021) to this rule are long-distance trade of tomatoes in Nigeria, whereby low disease pressure makes production more favourable in the arid north, while consumption concentrates mostly in the large urban markets in the south. Another example is mango trade from Burkina Faso to Cote d'Ivoire, aided by refrigerated rail transport.

Lack of proper packaging, cold storage facilities or other missing infrastructures are cited as key impediment to trading fruits and vegetables over longer distances (e.g. Raut, Gardas et al. 2019; Gligor, Tan et al. 2018; Kareem and Rau 2018). Nonetheless, trade in vegetables does exist, also to and from developing countries over longer distances. Table 4.1 lists the value of vegetable import and export flows of the EU with its major trading partners.

Table 4.1 *EU imports and exports of vegetables (HS code 07), Extra-EU trade, 2018 values in million euro a)*

Major origins of imports	Import value	Major destinations	Export value
Morocco	1,031	Norway	318
Egypt	290	Switzerland	418
Senegal	70	Belarus	94
Kenya	179	Russia	50
USA	313	Morocco	39
Canada	228	Algeria	94
Mexico	81	Egypt	177
Guatemala	44	Senegal	84
Costa Rica	35	USA	325
Chili	40	Canada	68
Argentina	133	Brazil	43
Israel	136	Israel	45
India	162	Saudi Arabia	72
China	493	UAE	116
New Zealand	35	Japan	75
Total Extra EU	4,722	Total Extra EU	3,000

a) potatoes are included.

Source: Comext 2021.

Table 4.1 shows that Morocco is, by value, the most important (non-EU) country of origin for EU's vegetable imports. Equally, EU imports from Egypt and Kenya are sizeable, being larger or comparable in magnitude to other key trading countries such as the USA, China, Argentina or Canada. Very limited amounts of vegetables are exported from the EU to developing countries, with only small quantities traded to Morocco and Senegal. Most EU exports are destined for medium and high-income countries, particularly in close vicinity. Appendix 1 provides details for imports and exports to and from the Netherlands, revealing a similar pattern as Table 4.1.

Conversely, the EU is the most important destination for vegetable exports for countries as Morocco, Egypt, Kenya and Senegal as shown by Table 4.2. For all four countries considered in this table the EU-28 is the most important export destination. But while exports to the EU constitute 27.5% of Egypt's vegetable exports, for Kenya, Morocco and Senegal this figure is much higher. For Senegal, in

fact, the EU-28 is virtually the only destination for vegetable exports. It is worth pointing out that the Netherlands is a key EU market for each of these countries, in addition to the UK and France.

Table 4.2 also reveals that vegetable trade from these countries to their direct neighbours is extremely limited. Only trade from Egypt to Saudi Arabia is worth mentioning. However, such regional trade flows may be higher than the official records indicate, as some cross-border trade may be traded informally. Nonetheless, these limited trade flows mirror the key insights from Section 4.2: average incomes in these exporting countries and their neighbours are low, limiting demand for relatively expensive vegetables.

Table 4.2 *Key trading partners of selected African vegetable exporters (2018)*

Egypt			Kenya			Morocco			Senegal		
Destination	Value		Destination	Value		Destination	Value		Destination	Value	
	USD million	% of total		USD million	% of total		USD million	% of total		USD million	% of total
EU-28	263,4	28,9	EU-28	182,9	73,1	EU-28	1.121,9	87,1	EU-28	70,0	97,0
Russian Federation	138,4	15,2	India	14,6	5,8	Russian Federation	98,9	7,7	Mexico	0,7	0,9
Saudi Arabia	135,1	14,8	United Arab Emirates	10,4	4,1	Mauritania	16,1	1,3	Switzerland	0,5	0,7
United Arab Emirates	43,7	4,8	Pakistan	10,2	4,1	Senegal	7,6	0,6	Mali	0,3	0,5
Algeria	34,7	3,8	Somalia	8,9	3,6	Qatar	6,9	0,5	Mauritania	0,2	0,3

Source: Comtrade 2021.

Dutch trade contacts with African countries in the field of vegetables are very modest. In 2018, the Netherlands imported around 190 million euros from Africa, mainly from Morocco, Egypt, Senegal and Kenya. Export value amounted to 260 million euros (mainly onions and potatoes). In addition, there is a growing export of vegetable seeds. The Netherlands' export of these seeds is mainly to Algeria, Egypt and Morocco. This export is growing, but with a value of 100 million euros (in 2018) it is also modest in size, if related to the Netherlands' total exports of seeds (3.5 billion euros). At the same time, the total import value of vegetable seeds in African countries was about 250 million euros in 2018, one third of which comes from the Netherlands.

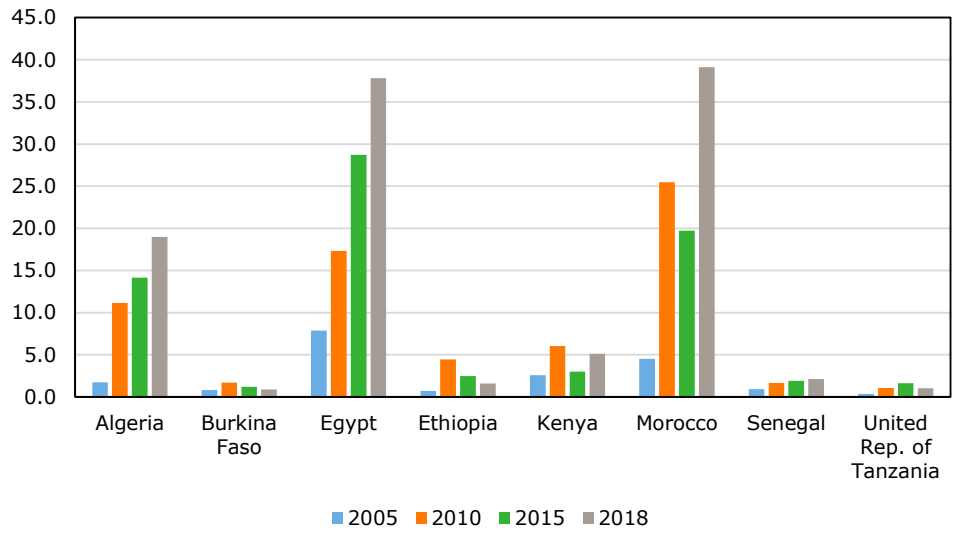

Figure 4.3 *Dutch exports of vegetable seeds to African countries (countries presented where Dutch export values >USD 1m), in USD m*
Source: UN COMTRADE

5 Benefits and trade-offs of developing country horticultural trade

Even though horticultural imports and exports are relatively small, compared with the overall sector output, this does not imply that trade is not important for the countries concerned. In Kenya, for instance, a vibrant market exists with over 200 exporters of fruits and vegetables (de Steenhuijsen Piters, Dijkxhoorn et al. 2021). Various studies (e.g. Maertens and Swinnen 2009; Van den Broeck and Maertens 2016; Van den Broeck, Van Hoyweghen et al. 2018) shed light on the impact of exports to European countries, particularly for African countries for which this trade is well developed (such as Senegal, Kenya, Morocco, Ghana and Madagascar). Much less is known on the impacts of domestic or regional trade in Africa, even though international (or intercontinental) exports constitute only a small fraction of aggregate vegetable production (see Section 4.3). Contrary to intercontinental exports, domestic or regional trade is often organised much more informally, with on-the-spot farmgate harvest purchases by middlemen (e.g. Lenné and Ward 2010; Lenné and Ward 2011). The informality may be a reason why insights into the functioning of this trade, and its impact, are less well established.

Horticultural exports from African countries to Europe typically rely on contract farming arrangements between a major processor/exporter and farmers cultivating a specific crop. The contract on the one hand obliges the farmer to supply the produce to the exporter exclusively, often at a pre-specified price. On the other hand, the processor resolves market failures that the farmers face, such as limited access to credit, inputs and/or knowledge. An emerging body of scientific studies document positive impacts of such schemes (Van den Broeck and Maertens 2016; Bellemare and Bloem 2018; Barrett, Reardon et al. 2020) although literature points at ambiguous food system outcomes too.

Section 5.1 presents an overview of the key impacts of horticultural trade on food and nutrition security, thereby considering the elements as introduced in Figure 3.1. Section 5.2. lists key potential trade-offs in food system outcome, for instance between income generation and environmental impacts of trade. Chapter 6, then, continues by focusing on key interventions, either to strengthen benefits, or to mitigate potential trade-offs.

5.1 Food security effects of horticultural trade in African countries

5.1.1 Food availability

First, considering *food availability* (with major determinants: food imports, producer prices, domestic food production, food exports) the impact of horticultural exports is, a priori, ambiguous. After all, such exports compete for inputs (land, labour, capital) used for food production destined for the domestic market. Theoretically, greater exports may thereby reduce domestic food supply and increase prices at the domestic market. Yet, such an effect is not observed in relevant studies (Van den Broeck and Maertens 2016). To the contrary, in most countries rising exports correlate positively with increasing food availability, even though for most countries it remains below the food security threshold (Van den Broeck and Maertens 2016). How this effect comes about, differs per country. Some countries witness a concurrent increase in domestic food production (Ethiopia, Ghana, Kenya). Moreover, enhanced revenues generated from horticultural exports, with associated higher prices in export markets, allow countries to import more food at the same time. Such a pattern (considering the value of horticultural trade against food imports in tonnes) bears out for many countries, including Ghana, Kenya and Senegal (Van den Broeck and Maertens 2016). Only Ethiopia witnessed a decline in imports, but domestic food production in this country rose substantially at the same time.

It is worth pointing out that this observed correlation between (increases in) horticultural exports and domestic production does not reveal a specific chain of causality. Also, whether horticultural exports equally lead to spin-offs that structurally increase the local supply of horticultural products remains to be explored. Anecdotal evidence suggests that sometimes shipments that do not meet stringent EU standards, or when global prices are too low, end up in local markets (Van den Broeck and Maertens 2016). Either way, in some countries - Kenya is a notable case - local and international vegetable markets have developed more broadly, with many exporters active (de Steenhuijsen Piters, Dijkxhoorn et al. 2021) as well as an evolving domestic market (Chege, Andersson et al. 2015). Moreover, East Africa witnesses considerable regional trade in vegetables (König, Blatt et al. 2011).

5.1.2 Food access

Second, in terms of *food access* (consumer prices, household income) various studies document positive impacts of horticultural trade. In general terms, food access improves when the gains in income are greater than any possible increases in consumer prices. The latter may rise due to horticultural exports when it induces a shift of productive capacity leading to lower inputs in (non-export) food items. This process will put an upward pressure on consumer prices in domestic markets, but such effects have not been observed so far (Van den Broeck and Maertens 2016).

At the same time, many actors involved in horticultural exports witness increases in incomes and/or reductions in poverty (Van den Broeck and Maertens 2016; Ton, Vellema et al. 2018; Barrett, Reardon et al. 2020). This applies to the farmers directly involved in growing the crops, but also to others benefiting from increased demand for labour in processing zones. Demand for labour may increase substantially in post-harvest processing to meet stringent overseas standards. Wage labourers involved in post-harvest processing are often still farmers, albeit less endowed than the contract farmers supplying produce. In the case of Senegal, studies (Maertens and Swinnen 2009; Maertens, Colen et al. 2011) illustrate that the income effect for wage labourers is larger than for the contract farmers. Yet, this effect is not found in all countries and circumstances: while this appears to hold for wage labourers in the horticultural sectors in many African countries, the evidence from Latin America is mixed where studies suggest wage labourers end up in low-paying jobs that offer no clear escape from poverty (Van den Broeck and Maertens 2016). Moreover, a recent study on contract farming in developing countries concludes that no significant change in wage labour income can be detected in communities where contract farming takes place (Meemken and Bellemare 2020). Different explanations exist, including the possibility that labour benefits accrue to a few selected households, or mostly in post-harvest operations outside local communities. It may also be the case that the studies cited above may present a too optimistic picture, due to publication bias.

While a considerable body of studies have documented the income effects of households engaged in horticultural exports, only few studies have investigated income impacts on households active in domestic or regional horticultural value chains. Studies from East Africa suggest that farmers generate considerable revenues from vegetable production for domestic and regional markets (König, Blatt et al. 2011; Weinberger, Pasquini et al. 2011). In the case of indigenous leafy vegetables, it is mostly female farmers who supply to a large and perhaps growing market (Weinberger, Pasquini et al. 2011). Similar to insights from international value chains, farmers operating in Kenyan tomato value chains typically belong to middle-income categories, while employed field workers are typically poorer cohorts (König, Blatt et al. 2011).

Food access is shaped not only by income changes, but also by the level of income elasticity. In general, positive income elasticities are found, but lower than one (see Lenné and Ward 2011, citing Ruel, Minot et al. 2005), suggesting that less than proportional increase in vegetable consumption when incomes rise. Considerable differences though exist across African countries, with elasticity for instance being much lower in Kenya as compared with Malawi.

5.1.3 Food utilisation

Third, any changes in *food utilisation* (diet diversity, nutrient consumption) remain largely undocumented. In Kenya farmers engaged in a contract to supply vegetables to domestic supermarket

chains are found to become more nutrient secure (Chege, Andersson et al. 2015), and similar impacts are likely to arise in the case of international exports. Either way, allocating time to either crops for exports, or to wage labour, implies actors involved become more (but not fully) reliant on markets for food purchases, thereby consuming less of their own produce. Some studies suggest nutrition diversity is greater for market purchases than own produce, particularly for the poorest (Van den Broeck and Maertens 2016; Nandi, Nedumaran et al. 2021). As the income elasticity of fruits and vegetables is positive in many areas, and typically greater than staple grains, increases in income often lead to more nutrient-diverse diets (Pingali 2015; Pingali 2015, FAO 2020). On the other hand, some point out that women are more often involved in wage labour activities and remain responsible for domestic food preparation. And how reductions in time available for household chores affects household diet diversity is unknown.

Whether greater exports also increase local availability remains open for investigation. Findings from (Kummu, Kinnunen et al. 2020) suggest that trade and imports have contributed to increasing diversity of market supply for most of the world's population in the past decades. Yet, the picture is mixed with respect to changes in diversity of fruits and vegetables in developing country markets, with supply diversity increasing strongly in some countries (e.g. Kenya, Ghana), but reducing in others (e.g. Nigeria, Senegal).

5.1.4 Food stability

The fourth and final dimension relates to *food stability* (price and income stability). In some countries, the season for horticultural exports is complementary to the main agricultural season. Indeed, this can allow farmers and labourers to supplement incomes at a time when other production activities are low. Yet, it does not negate the fact that horticultural export opportunities are highly seasonal and incomes from it thereby not necessarily stable. Indeed, in Kenyan domestic and regional horticultural chains, most of the market price risks fall on the shoulders of the farmers, which means that revenues can vary widely (König, Blatt et al. 2011).

Moreover, over time a concentration of contract farmers may occur, an effect often shaped by evolving standards (e.g. Maertens and Swinnen 2009; Tyce 2020) whereby products are sourced from an increasingly smaller number of contract farmers. In some sectors, production eventually shifts to estate farming with little to no supply by smallholder producers (e.g. the case of tomato farming in Senegal (Maertens, Colen et al. 2011). Gains in incomes may not be sustained for all actors eventually.

Finally, food stability depends in part on the stability of food trade relations. Proxies include import dependency as well as the number of trading partners, an indicator that proxies stability of trade relations. On the aggregate, many countries have become more reliant on imports from a smaller number of trading partners (Kummu, Kinnunen et al. 2020), despite increased supply diversity for much of the world population (see above). While this may suggest a reduction in food stability, the picture for fruit and vegetables in developing is more positive. While import dependency increased, for nearly all developing countries the number of trading partners increased as well (Kummu, Kinnunen et al. 2020).

5.1.5 Concluding remarks

To summarise, studies on the impact of vegetable production and its trade document positive impacts on several food security related indicators, at least with respect to food availability and food access for the farmers involved in horticultural production. Some studies suggest positive impacts for wage labourers in some instances, but whether this holds in all circumstances (or where not) remains to be determined. Information on the other dimensions of food security remains scarce of ambiguous: whether horticultural production and trade contributes to enhanced food utilisation and stability is less clear.

One further caveat remains as pointed out by Bellemare (2018). While many of the studies are carried out with great scrutiny, they generate only limited insights in the potential impact of promoting

horticultural exports in other areas than current exports mainly come from. A recent study on the labour market effects in contract farming in developing countries, not only from horticultural production, reaches a similar conclusion. Meemken and Bellemare (2020) conclude that overall, no significant income gains by labourers can be detected in communities in which farmers are involved in contract farming. This finding contrasts with the positive outcomes reported for wage labourers in Section 5.1.2. The authors suggest this is due to publication bias, whereby discussion is based on a select set of publications documenting positive impacts, while many studies in much less successful contract farming schemes have not been published.

This finding does not negate the fact that horticultural trade may lead to positive impact in some areas, but that it is difficult to extrapolate findings from such regions. There are specific agro-ecological, geographical and institutional factors that explain why specific regions were targeted for setting up horticultural export zones. The impact of such underlying factors is not always well captured in impact assessments, providing only limited insights into the potential impact of horticultural production in areas lacking such conditions. Key bottlenecks that make some countries or regions less suitable for horticultural production remain, a discussion to which we come back in Section 5.3.

5.2 Potential trade-offs of developing country horticultural trade

5.2.1 Potential conflicts between economic and environmental food system outcomes

Environmental concerns raise when vegetable export opportunities to Europe (or any other market) encourage farmers to rely increasingly on fertilisers and pesticides in producing vegetables. While health hazards of use of chemicals are typically manageable due to the strict EU standards, local soil and water quality impacts of potential overuse of chemical inputs may be significant. Empirical evidence, though, refutes the concerns related to fertiliser and pesticide use, and soil nutrient overexploitation (see e.g. Van den Broeck and Maertens 2016, referring to a case in Guadeloupe and in Costa Rica, where farmers did not intensify pesticide use when switching to export production). Based on evidence from the Kenyan green beans sector Okello and Okello (2010) show that EU pesticide standards encourage Kenyan farmers to use alternative control practices and pesticide protection products in the production of fresh export vegetables.

The evidence on water overexploitation is more mixed. Ulrich (2014) indicates that Kenyan farmers associate the expansion of horticultural export with increased water scarcity. Delgado (2015) and Schwarz et al. (2015) express concerns about unsustainable water use in the asparagus sector in the arid coastal zone of Peru – and call for stricter regulations on water use for horticultural production. Yet, in a cross-country study on virtual water trade, Schwarz et al. (2015) point out that the growth in horticultural exports is beneficial for developing countries from a water efficiency perspective. These findings for horticultural products are in line with Dalin and Rodriquez-Iturbe (2016), who based on literature review conclude that food trade favors efficient allocation of water resources, as places with higher productivity tend to produce and export to less productive ones, thus reducing overall water consumption.

What about the carbon footprint of shipping fruit and vegetables over large distances? Their current trend in air importation could account for significant greenhouse gas (GHG) emissions which could be mitigated by increasing their local production. Michalsky and Hooda (2015) estimate CO_2 emissions of the production and transport associated with five fruit and vegetables commodities, namely apples, cherries, strawberries, garlic and peas in the UK, Europe and non-European countries. All these commodities are commonly bought by UK consumers and can be produced in the UK; yet part of them is imported from abroad. The authors show that on average (across the five SFVs), commodities produced outside the EU, all in fresh/chilled state, were found to contain embedded (arising from

production, air freighting and distribution within the UK) GHG emissions of 10.16 kg CO_2e/kg[4]. This is 9.66 kg more CO_2e emissions compared to a kilogram of these commodities produced and supplied locally, indicating that substituting local production for imports would imply significant emission savings. The study's results are mainly driven by the significant impact of the transport stage for commodities sourced from outside the EU, if transport mainly takes place by air freight. Note that trade in bulk agriculture (e.g. raw crops like grains) are often shipped with the least emissions resulting intensive transport mode (e.g. ocean freight) which makes transport emissions of these type of products and trade small compared to other modes (e.g. Dalin and Rodriquez-Iturbe (2016).

5.2.2 Potential trade-offs between economic and social objectives

Studies document increasing concentration over time with respect to the number of smallholders engaged in horticultural export (Maertens, Minten et al. 2012; Weinberger and Lumpkin 2007). In a key green bean processing area in Senegal, for instance, the number of smallholders engaged as contract farmer dropped from 23% to 10% between 2000 and 2005, while exports of tomatoes from the Senegal River Valley originate from a single estate farm only (Maertens, Minten et al. 2012). Similarly, in Kenya a concentration in the number of smallholders involved has been reported as well (Weinberger and Lumpkin 2007; Tyce 2020). Hence while the number of smallholders engaged in horticultural contract farming has declined over time, the number of labourers engaged in processing over time has increased.

Horticultural production is assumed to be labour-intensive (Weinberger and Lumpkin 2007), more so than other crops, suggesting that communities in which horticultural production commences, witness rising demand for labour as well as wages. Horticultural production, and export, may thus be an important stimulus for local rural labour markets in which few alternative opportunities exist. In particular, it may offer jobs for the poorest households.

While some studies (as cited in Section 5.1) point to positive employment effects, others cast doubt. Particularly in Latin America, studies suggests that the wages of labourers in horticultural export production are too low to allow for a meaningful escape from poverty (Van den Broeck and Maertens 2016; citing Barron and Rello 2000 and Ortiz and Aparicio 2007). Data suggest that lemon harvesters in Argentina were not able to raise incomes above poverty thresholds even after real wages increased (Ortiz and Aparicio 2007). A similar picture has emerged for tomato harvesters in Mexico. Paradoxically, these groups of labourers have access to only few other income-generating means, if any.

[4] CO_2e = Carbon dioxide equivalents

6 How can trade in vegetables contribute to sustainable and inclusive food system outcomes?

As the previous chapter shows, there is often no conclusive positive empirical evidence of benefits of vegetable exports on food security, inclusiveness and environmental indicators. To use trade to improve food system outcomes, vegetable producers and traders in African countries must ensure that they can offer competitively. This may require investments in increasing productivity and improved efficiencies throughout the chain. Development strategies should also consider public concerns about inclusiveness and environmental impacts; public policy clearly has a role to play here. The following sections discuss several key drivers of trade and sector development followed by suggestions for policy interventions to support inclusive and sustainable vegetable sector development. Drivers mentioned are contract farming addressing market failures (Section 6.1), product standards (Section 6.2), taxes and subsidies (Section 6.3), stimulating regional trade (Section 6.4) and infrastructure development (Section 6.5).

6.1 Contract farming to address market failures

Horticultural value chains often rely on contract farming arrangements between processors/exporters and out-growers or producers. Contract farming is also increasingly applied within domestic value chains (e.g. Barrett, Reardon et al. 2020; Alulu 2020) next to intercontinental vegetable trade. These contracts stipulate farmers to deliver a prespecified quantity of crops, at a prespecified level of quality, to the processor at a given price.

Contract farming is often a more efficient mechanism, vis-a-vis trade in spot markets, to organise horticultural production and trade (Grosh 1994; Otsuka, Nakano et al. 2016). Foremost, it makes easier to agree on and adhere to quality and food safety standards, particularly when traders assist in providing the required inputs and technical assistance. The latter provision of inputs, in the wake of imperfect input and capital markets that characterise many developing countries, is a second key advantage. Third, horticultural production is typically perishable making spot market trading more risky, both to producers and processors. Fourth, contracts often specify the price in advance, shifting some of the price risk from farmers to traders. Fifth, these arrangements allow to share input costs between trader and farmer. These factors are much more prominent in horticultural production, being more knowledge intensive and with quality and food safety standards relatively more important than with staple crop production.

The increases in income that contract farmers and some wage labourers realise in such arrangements are testimony to the fair success by which these contract farming address existing market failures (see Section 5.1). There is considerable evidence that contract farming not only positively affects productivity in the crops targeted, but also other crops (Barrett, Reardon et al. 2020). Minten et al. (2009), for instance, find considerable spill-over effects from vegetable contract farming on rice production. Such technological spill-overs could provide one explanation for the correlation between horticultural exports and domestic food production as discussed in Section 5.1.1.

Moreover, there is some evidence on spill-overs from contracts in international horticultural trade to domestic markets. Contracts specified for international (intercontinental) trade are typically more elaborate than those agreed upon in domestic markets (Otsuka, Nakano et al. 2016). The former are a means to introduce new production and processing technologies to producers, guided by standards set in overseas markets. Domestic contracts focus more on stipulating the marketing arrangement (price, time of delivery) and are less elaborate on quality standards, both free-riding on the efforts of international exporters, as well as due to less stringent standards in domestic markets (Otsuka, Nakano et al. 2016).

Yet questions on the potential and scope for using contract farming arrangements remain. First, whether contract farming allows integration of large groups of farmers in value chains, with associated welfare effects, remains open to debate (Barrett, Reardon et al. 2020). As highlighted in Section 5.2.2, a tendency exists for the number of farmers engaged in contract farming arrangements to decrease over time. High transaction costs of working with large groups of smallholder farmers are seen as one key explanation for such an effect to occur (Barrett, Reardon et al. 2020), in addition to more strict standards in export markets (e.g. Tyce 2020). Sourcing more products from a smaller group of farmers is likely to reduce the costs involved (for instance in relation to extension, monitoring etc.) by export companies. Economies of scale, reducing production costs on greater acreages, may further reinforce this process. But reductions in the number of contract farmers involved may not be inevitable. For instance, when the rural sector is fairly homogenous with many equally-sized smallholder farm operations, or when economies of scale are minor (as possibly the case in vegetables (Barrett, Reardon et al. 2020)), a concentration over time is much less likely (Vandemoortele, Rozelle et al. 2012). Either way, also considering ambiguous impacts on labour markets (Section 5.2.2), long-term welfare effects of horticultural value chains may in some instances be less inclusive than anticipated.

Second, questions remain on the potential to enforce contracts in institutionally weaker environments, next to questions on the optimal level of competition. Both questions are closely related. In general, the frequency by which farmers default on contracts can be perceived as an indicator to the level of competition in the market. When multiple traders compete, some may incentivise to default on existing contracts with competitors by offering better prices. Defaults are, however, also proof of the fact that contracts may be too strict and do not allow farmers to profit from rising prices.

Whether defaults are frequent in horticultural production is not well documented. Insights from a study investigating defaults on contracts in food aid procurement (Upton and Lentz 2017) suggest considerable rates of default exist: for instance, 28% of farmers in the food aid procurement in East Africa were observed to default (Upton and Lentz 2017). This may suggest either a much more concentrated sector, at least for some countries, or greater means to enforcing contracts.

Limited competition, and by consequence less frequent defaults, provides a greater incentive for an exporter to keep provisioning farmers with inputs. On the other hand, market concentration is unfavourable in the long run with traders potentially squeezing farmers, paying them less than would have been the case with more competition. A study on the Rwandan coffee sector (Macchiavello and Morjaria 2020) is illustrative. It found that greater competition in processing mills increased defaulting as new entrants offered farmers more favourable sales opportunities. In the long-run, however, the quantity of coffee supplied reduced and made both farmers and mills worse off.

Note that the above examples relate to staple crops or classic export crops. For such crops, the added advantage of contracts may only be small when well developed and transparent spot markets exist. The specificities of the horticultural sector (perishable, knowledge intensive goods) may still make contract farming the arrangement of choice in many instances, except for crops that are less perishable or for which quality standards are less demanding (onions or potatoes).

Studies (Sexton and Xia 2018) suggest there is considerable market concentration in many parts of the agriculture and food sector. The degree to which market concentration also leads to stronger market power, or stifles innovation and productivity growth, remains open for debate (Sexton and Xia 2018; Barrett, Reardon et al. 2020). Challenges thus remain in finding effective means in stimulating better contract enforcement in often weak institutional requirements and a broader quest to design effective anti-trust policies that may provide the right incentives for exporters in the short run, while stimulating an open competitive market in the long run (Barrett, Reardon et al. 2020).

Agreed contracts ideally allow farmers to benefit better from price hikes, while a more stable institutional environment aimed at improving contracts enforcement is desirable. These considerations should inspire additional experimentation with, and research on, contract farming in vegetable value chains. As this discussion highlights, focus should be on heterogenous effects in more diverse settings, including from failed contract farming arrangements, which types of farmers and labourers (do not)

benefit and how can they be made (or kept) inclusive? For instance, it may be worth considering variation in contract stipulations, based on the differences in barriers to engage in horticultural production of distinct groups. An experiment on contracts in rice farming in Benin (Arouna, Michler et al. 2021) suggests a contract that simply guarantees a prespecified price to farmers delivers the same effect as more complex and expensive contracts with input delivery and technological extension. Consequently, tailoring the contract to the needs of specific groups of farmers may improve efficiency.

In addition, there could be scope to stimulate the formation of farmer cooperatives and design contract arrangements around cooperatives (Otsuka, Nakano et al. 2016). This would allow the inclusion of less-endowed farmers into horticultural production while reducing the transaction costs to processors (Otsuka, Nakano et al. 2016). Nonetheless, even producer cooperatives may have limited scope for including the least-endowed farmers (Bernard, Collion et al. 2008; Bijman and Wijers 2019). Assistance to latter group lies primarily with general development policies and scope for their inclusion in horticultural production, except for possible labour market opportunities in processing, remains limited.

Finally, stimulating local and regional markets and raising local demand is another key avenue to engage more farmers in horticultural (contract) production. This is explored in more detail in the next sections.

6.2 Product Standards in international trade

In recent decades public and private standards on quality, food safety, environmental and ethical aspects have become increasingly important in regulating food production and trade. Their rapid spread through trade and foreign direct investment has triggered debates on their impact on international trade and development, with many arguing that standards are non-tariff barriers to trade and that standards are marginalising the poor. Summarising theoretical and empirical literature, Swinnen (2016) arrives at nuanced conclusions. Standards can promote trade but who gains (domestic/foreign consumer/producer) depends on the nature and implementation aspects of the standard. The empirical literature shows many examples of strong export growth from developing countries in Africa and Asia in sectors where standards have spread rapidly, for example in 'high value' food products such as fruits, vegetables, seafood, fish, meat and dairy products (Swinnen and Kuijper 2020). In all these examples, positive effects of technology transfers, productivity growth and value chain transformation (or 'modernisation') are highlighted. Empirical literature also indicates that value chain governance through contracting and (hybrid forms of) vertical integration that involve technology and input transfers to local suppliers with limited access to capital and technology can be successful in integrating smallholders with high value high standard sectors (Reardon, Barrett et al. 2009; Ton, Vellema et al. 2018; Swinnen and Kuijper 2020).

Whether smallholder farmers participate in (and benefit from) high-standard export production and trade, depends on how attractive or necessary farmers' involvement appears to traders or processors. Smallholders are more likely to participate in value chains when the farm sector is more homogeneous and when the region contains mostly small-scale farms (Vandemoortele, Rozelle et al. 2012). In contrast, when local production structures are more mixed, sourcing from smallholders only occurs when it is not more expensive than sourcing from large farms. Moreover, farmers' bargaining position in supply chains is generally weak and need to be empowered to benefit from market integration. Government policies can support the establishment of producer organisations with proper legislation, with information and knowledge transfers enabling them to operate such organisations, sometimes using financial support measures (such as tax exemptions). Also helpful for integrating smallholders into value chains are policies that invest in institutions for independent quality and food safety control, certification, public extension and market information services (Reardon, Barrett et al. 2009; Swinnen and Kuijper 2020).

To emphasise the importance of investing in food safety standard compliance, consumer perceptions of food safety affect their food choices and may reduce consumption of fruits and vegetables (e.g. (Ngo et al., 2020). Concerns of foods in low- and middle-income countries are mainly related to the

consumption of fresh, perishable foods such as fresh fruits and vegetables and animal sourced foods from informal and domestic (wet) markets. Food safety practices in these markets tend to be weak compounded by risks in food preparation and consumption practices for example by using contaminated water to wash fresh produce or absence of refrigeration in storage of fresh produce (see, among others (Jaffee, Henson et al. 2018; Hoffmann, Moser et al. 2019). Moreover, various studies (e.g. Schreinemachers, Grovermann et al. 2020) show widespread misuse of chemicals, and use of obsolete, unduly hazardous and banned chemicals in vegetable production in developing countries.

Concerns by EU consumers about the safety and quality imply that EU's imports of food and agricultural products are highly determined by international agreements such as the Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) agreements under the WTO, and by private standards applied by businesses. Such standards and regulations can be an obstacle to access the EU. For example, Kareem and Rau (2018) estimate the impact of SPS measures of the EU on African exports of fruits and vegetables. Their results suggest that the SPS regulations act as a barrier to entry by limiting new entrants to markets, while having limited effects on established trade flows.

These conclusions are in line with literature that finds that despite EU's tariff protection has become very low for imports originating from developing countries (for instance, under EU's Everything But Arms initiative, the 50 poorest countries can access the EU market without duties and quotas), these countries are constraint in their exports to the EU by their inability to comply with product and process regulations such as social, environmental and food safety (hygiene) standards (e.g. Bureau and Swinnen 2018; Kornher and von Braun 2020). In its series of surveys in 23 developing countries, the International Trade Centre documents impacts of non-tariff measures on trade opportunities, where it was found that for agricultural products, developed countries are perceived as comparatively more NTM-restrictive than other markets (International Trade Center (ITC) 2015). The ITC survey analyses highlights that export companies in the agro-food sector are impacted by SPS regulations, especially for certification or quality control. Overall, the results indicate the need for more effective domestic institutions among African exporters and producers to meet compliance with the SPS measures and other product and process standards of the EU and other developed countries. There is clearly a case to be made for increased technical assistance and capacity building in this area, as part of the broader Aid for Trade agenda.

6.3 Taxes and subsidies and the role of pricing policies

National pricing policies are the set of policies that influence domestic or farmgate prices. These include border tariffs and export taxes, crop-specific subsidies, decoupled farmer assistance and monetary (exchange-rate) policies (e.g., Anderson 2009). Together these policies determine whether domestic prices differ from world market prices and whether consumers or producers are subsidised or taxed. As argued in this section, the scope for reforming pricing policies for enhancing horticultural production in LMICs is limited, though options may exist to use pricing policies to encourage consumption of more healthy foods.

As a rule of thumb, there is a tendency for governments to subsidise the production and/or consumption of staples, sugar, dairy, and meat products, while key export commodities (like soybeans, palm oil and cocoa) and protein-rich plant products (legumes and nuts) are more often taxed (Kherallah, Delgado et al. 2002; Anderson 2009. Such pricing policies benefitting the major staple crops in particular, may have played a role in disincentivising production of horticultural products (Pingali 2015), which is, from the perspective of healthy diets, the opposite of what is desired. Moreover, significant differences in pricing policies exist between countries with levels of farm support highest in high-income countries (HICs), while low in LMICs (Anderson 2009).

There are several explanations for these patterns, including subsidies in OECD countries as well as an 'urban bias', the latter being more prevalent in developing countries. Urban bias refers to the tendency for policies and policy instruments to favour urban populations over rural ones (Lipton 1977; Bezemer and Headey 2008). Governments have a political incentive to keep food prices low, particularly in

urban areas, and do so by subsidising staple crops. On the other hand, key export commodities are more often taxed. While this is an easy means for governments to raise public finances, it is a tax on agricultural production, providing a disincentive to farmers for raising production (e.g. Malan and Berkhout 2016; MAFAP study).

While the level of taxation has come down over time it remains persistent, notably in low- and middle-income countries. It is estimated that in 2016 farmgate prices in low-income countries were 41.2% below the estimated counterfactual farmgate price level (in the absence of discriminatory pricing policies) (FAO 2020). But, by zooming in on patterns of price support for Fruits and Vegetables for African countries (see Figure 6.1), a slightly more positive picture emerges, as the nominal rate of protection (NRP)[5] for fruits and vegetables shows a clear upward trend over the last two decades in many African countries, reaching levels close to or above zero in most recent years.

Considering specific pricing policies underlying these NRP estimates, (Matsumoto-Izadifar 2009) finds that the devaluation of the CFA in the 1990s most likely contributed to the development of horticultural exports in Senegal by encouraging exports. At the same time, other studies (Coulibaly 2014; Owoundi 2016) claim that exchange rate policies of African countries – and in particular those in the CFA currency zone where the CFA currency is pegged to the euro) - have had no significant impact on the competitiveness of their agricultural sector. (Beckman, Estrades et al. 2018) show that African countries did not apply export taxes on fruits and vegetables (only some countries did, such as Argentina and Pakistan) and hence did not affect the NRP trends on fruits and vegetables for African countries. Moreover, as pointed out by Tyce (2020), the Kenyan government played an active role in supporting its fruit and vegetables sector, but not via pricing policies (see Section 6.4).

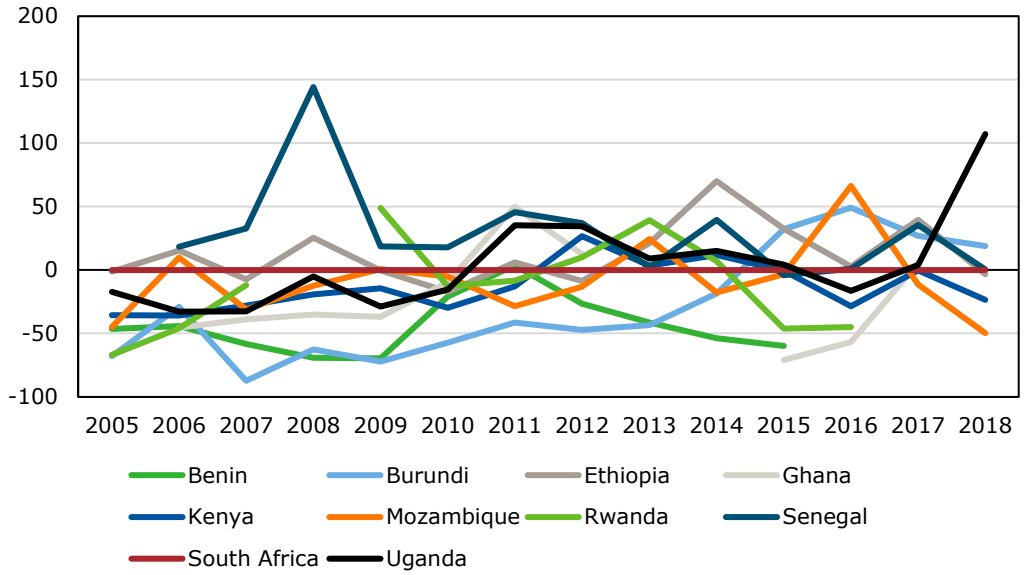

Figure 6.1 *Nominal Rate of Protection (NRP, in %) of Fruits and Vegetables in selected African Countries*
Source: Ag incentives 2021.

Another aspect of pricing policy relates to those policies set in high-income countries (HIC). Concern exists on the impact of agricultural price support to producers in HIC on producer incentives for the horticultural sector in LMICs. The case has been raised with respect to trade agreements between the EU and ACP countries, stipulating tariff and quota free reciprocal access to each other's' markets. It is argued that producers of subsidised agricultural products in, and subsequent exports from HICs,

[5] The Nominal Rate of Protection (NRP) measured the difference between the farmgate price and a reference world market price, undistorted by domestic policies (tariffs, export taxes, crop subsidies etc. A more comprehensive measure of farmer price support or taxation would be by computing the nominal rate of assistance (NRA), extending the NRP to cover broader sector support or decoupled income support. Unfortunately, limited availability of data and policies prevents the computation of NRAs for fruits and vegetables (Anderson, K. (2009). *Distortions to Agricultural Incentives.* Washington, DC, World Bank.)

depress world market prices, lowering incentives for smallholders in LMICs (Blanco 2018). For instance, exports of processed tomatoes from Europe to Ghana is mentioned to have contributed to the decline of Ghana's domestic tomato processing industry (Berthow and Schultheis 2007). Reforms of the EU Common Agricultural Policy (CAP) have lowered the incentives for raising agricultural production over the last decade (Bureau and Swinnen 2018). However, studies suggest this has had only limited impacts on EU exports of fruits and vegetables to African countries (Kornher and von Braun 2020). Nonetheless, reduced exports from EU countries to Africa may simply be replaced by exports from other countries, given the low productivity of Africa's agricultural sector.

In addition to price policies to support production, one may equally consider pricing policies that aim to stimulate consumption of vegetables as a promising avenue. For instance, fiscal policies could lower the price of fruits and vegetables, for instance by lowering the rate of Value Added Tax (VAT) vis-a-vis other food items, thereby stimulating demand and substitution. To date, such subsidies are applied only in four countries (Canada, Fiji, USA and UK), and only in specific settings (Mason-D'Croz, Bogard et al. 2019). And while modelling studies project positive impacts of such subsidies on vegetable consumption levels (Thow, Jan et al. 2010) that may help to achieve policy goals on nutrition and the environment (Latka, Kuiper et al. 2021), actual policy experiments are scarce. Moreover, the question is how effective fiscal policies are in countries where a sizeable proportion of produce is traded in informal markets. To gain a better insight into the motivations of the population to eat vegetables (and fruit), the rise of smartphones and technical developments offer opportunities to collect and disseminate information. The study ENRICH Bot[6] is an example where ICT is being used to improve the fruit and vegetable intake and food choice motives (FCM) in real time and in situ of urban consumers in low and middle income countries, with an application for urban consumers living in Nairobi (Kenya) as experiment

6.4 Stimulating regional and continent-wide free trade arrangements

The data in Chapter 4 reveals limited horticultural trade between neighbouring African countries. This could both be an artefact from the selection of countries in the table, being geared more towards EU markets and less towards neighbours. But also, a considerable portion of regional trade is informal and may not appear in official trade statistics. Nonetheless, as highlighted, in some instances considerable intra-regional trade in horticultural products exists as equally highlighted in Section 4.3. Clearly, scope exists for better matching supply and demand of vegetables across countries, or to make better use of comparative advantages in vegetable production.

To stimulate intra-African trade, various free trade agreements have been negotiated across Sub-Saharan Africa (such as ECOWAS, SADC, COMESA and ECA). From 1 January 2021 the Africa-wide African Continental Free Trade Agreement (ACFTA) entered into force aiming to liberalise trade across the continent. Information on the precise impact that these arrangement have had (and will have) on regional horticultural trade remains scarce.

Simulations on the potential impact of the ACFTA suggest that trade in agricultural products and manufacturing will benefit the most from ACFTA (Abrego, de Zamaroczy et al. 2020). Some additional stylised facts on the impact of existing free trade arrangements in SSA have emerged. Overall evidence on their impact on stimulating trade exists, but the impacts on economic growth have been uneven. Free trade arrangements tend to benefit economies that are more developed to begin with and already had deeper trade relations with neighbouring countries (Gammadigbe 2021). As Abrego et al. (2020) point out, intraregional tariffs between African countries are already low. This likely holds for the horticultural sectors as well as we discuss in Section 6.3. In fact, the key impediments to trade are related to poor infrastructure and weak connectivity as well as inefficient and corrupt customs processes (Abrego, de Zamaroczy et al. 2020). In other words free trade arrangements should not be considered as a panacea, but require matching investments in e.g. infrastructure (as we come back to in Section 6.4) and policies

[6] See link: The ENRICH Bot, a smartphone application measuring fruit and vegetable intake and food choice motives: Development and validation for the case of urban Kenyan consumers

to provide targeted assistance to the weakest countries that stand to gain the least, or may even loose out from free trade (Abrego, de Zamaroczy et al. 2020; Gammadigbe 2021).

6.5 Infrastructure development

Infrastructure is a public good, bar some exceptional cases, and its provision therefore a prime task of governments. At the same time, infrastructure is a dominant factor in explaining differences in development outcomes. Indeed the returns from infrastructure investments may be greater than reform of macro-economic or trade policies (Barrett 2008). Many studies document how more and better rural infrastructure leads to greater agricultural productivity and or income (e.g. Zhang and Fan 2004; Stifel and Minten 2008). The reasoning is that better infrastructure leads to greater access to in- and output markets, and reduces market transaction costs (Renkow, Hallstrom et al. 2004). Better infrastructure thus allows smallholders in LIMCs to source inputs at lower, and market output at higher prices, but also allows them to profit from greater non-farm opportunities. The resulting income effects translate into reduced poverty (e.g. Calderón and Servén 2010) and increases nutritional status (Stifel and Minten 2017), for instance increased diet diversity (Nandi, Nedumaran et al. 2021). Moreover, costs of healthy and nutritious diets decrease with greater levels of rural infrastructure (Bai, Alemu et al. 2021).

The importance of infrastructure extends to horticultural production and particularly to export thereof. Infrastructure and/or geographical attributes such as proximity to airports, available road infrastructure, stable electricity supply as well as digital infrastructure, next to favourable agroclimatic conditions, are crucial in explaining the site selection for horticultural production zones in horticultural exporting countries (Barrett, Reardon et al. 2020). Amongst other things, such infrastructure improvements allow producers to set-up cold storage facilities, widening the range over which perishable products can be traded, as the case with mango trade between Burkina Faso and Cote d'Ivoire (de Steenhuijsen Piters, Dijkxhoorn et al. 2021). Such underlying factors are so important, cannot extrapolate potential impact of new horticultural exports to zones where infrastructure is lacking (Bellemare and Bloem 2018).

The supporting role of governments often extends beyond the task of physical infrastructure to the provisioning of 'soft infrastructure' as well as the coordination of associated market failures. In the case of Kenya the horticultural export sector benefited from active government involvement in stimulating competition (and reducing corruption) amongst air freight companies, streamlining export procedures at airports, next to the deployment of a market information system with data on key export markets (Tyce 2020). Less prominent in the case of Kenya has been an active government role in providing a regulatory environment, informing and enforcing production to comply with stringent overseas standards (see also section 5.3.2). Similarly, in Senegal government and donor support have been instrumental in facilitating the development of the horticultural sector (Matsumoto-Izadifar 2009).

A particular government intervention in Kenya, that has been considered important in stimulating horticultural trade has been the provision of market information (Tyce 2020). The provision of information on market prices (including trends and fluctuations over time) is hypothesised to improve their market power and may further enhance their agricultural investments. The fact that many smallholder farmers in developing countries now own, or have access to a mobile phone, has inspired experimentation with provisioning prices information to farmers directly. Some of these studies (e.g. Jensen 2007; Muto and Yamano 2009; Aker and Fafchamps 2014; Aker and Ksoll 2016) suggest that such information allows farmers to market their produce at better conditions. So far, little is known on the role of improved price information in horticultural markets (including domestic ones) and whether this can stimulate farmer producer responses. This remains for further experimentation.

Finally, it is worth pointing out only in a few countries a considerable export vegetable sector (and sometimes associated domestic sector) has developed. In many countries, production of horticultural products has been much less responsive. A lack of investment in infrastructure conducive for the horticultural sector has been cited as a key reason (Pingali 2015). Yet as Pingali (2015) points out this lack of investment is a symptom of a deeper cause, namely a long-term prioritisation by policymakers, donors and philanthropical organisations of major staple crops at the expense of the horticultural sector.

7 Making Dutch food security policies contribute to inclusive and sustainable vegetable sector development

7.1 Dutch food security policy objectives and options to support horticultural development in Africa.

In the 2019 Dutch Food security policy letter to the Dutch parliament (Kaag and Schouten 2019), prepared in conjunction with the ministry of Foreign Affairs and Development cooperation, the ministry of LNV substantiates its focus on SDG 2 Zero Hunger. This is also echoed in three more specific policy goals to help reduce hunger that are formulated as follows:

1. Eradicate current hunger and malnutrition (SDG 2.1 and 2.2), with the aim of a Dutch contribution to a sustainably better nutritional situation for 32 million young children over the period 2016-2030.
2. Promote inclusive and sustainable growth in the agricultural sector (SDG 2.3), with the aim of a Dutch contribution to a sustainable increase in productivity and income for 8 million smallholder farmers over the period 2016-2030.
3. Realise ecologically sustainable food production systems (SDG 2.4 and 2.5), with the aim to contribute to an ecologically sustainable use of 8 million hectares of agricultural land over the period 2016-2030.

While the IOB Policy Review Food Security 2012-2016 (IOB 2017) concludes that Dutch efforts lead to a substantial increase in agricultural production and income, to an improvement of the business climate and to a better nutrition for vulnerable groups, the food security policy is currently challenged to achieve more on nutrition, inclusivity, environment and climate in the scope of food security policy. A focus in Dutch policy on the development of the horticultural sector in developing countries certainly can help improving access to healthy food in those countries, generating more production of nutritious produce and raising income generating opportunities. However, the analyses in the previous chapter show that promoting the horticultural sector development – either via export or domestic sales - does not automatically lead to better food security and can also be accompanied by negative environmental and social effects. Any food security policy therefore must consider these potential trade-offs and build-in incentives to avoid or at least limit trade-offs. For example, by pairing sector-oriented support with a focus on increasing productivity with social (inclusion) and environmental criteria.

As outlined in Chapter 4, scenarios indicate that the demand for vegetables in Africa will greatly exceed the local supply in the foreseeable future. Importing vegetables, also through more regional trade, is an option to balance the market. Sector development that generates employment and income locally is another, where exports can function as a revenue model for products that meet the requirements of the international market. A flourishing horticultural export sector already exists in several African countries, but it is still relatively small and spillovers into production destined for local markets are small. Given the surplus of demand and ample availability of labour in many African countries, there should be great opportunities for further development of the generally labour-intensive vegetable sector in these countries.

Potential options for Dutch development assistance to support the horticultural sector in Africa and to stimulate associated trade evolve around further stimulating the engagement of smallholder farmers in horticultural production and markets (inclusivity), means to further develop and adhere to food safety standards also in domestic markets (safe nutrition) and avenues mitigate environmental trade-offs (environmental sustainability).

7.2 How can the African vegetable sector develop sustainably? Some implications for supporting public policy

As discussed in Chapter 6, the active involvement of governments has been instrumental in developing the export-oriented horticultural sectors in Kenya and Senegal. In fact, prolonged public support has been instrumental in agricultural sector development in many countries including the Netherlands (Chang 2009). Hence, there is scope for Netherlands' support to African governments in this process with the development of adequate supportive policies and institutions (Table 7.1).

First, options exist to support more inclusive horticultural production
Policies to enhance smallholders' integration into supply chains should focus on reducing transaction costs for smaller and less resourceful producers for entering more modern value chains. Such policies include, for example, investing in rural infrastructure (roads, storage facilities, energy, ICT networks) to connect small-scale farmers in remote areas to markets. Moreover, farmers need to be empowered to obtain a better bargaining position in the supply chain. Government policies may support the establishment of producer organisations with proper legislation, with information and knowledge transfers enabling them to operate such organisations, sometimes using financial support measures (such as tax exemptions). At this point, options for Dutch support are to help empower farmers to obtain a better bargaining position in the supply chain, for instance by assisting local governments in drafting proper legislation to enable producer organisation establishment, with information and knowledge transfers, also directly to farmers enabling them to operate such organisations. Dutch expertise to unite growers in cultivation associations and marketing cooperatives is widely available and praised worldwide. A further role lies with redesign contract farming arrangements that provide greater incentives for less endowed farmers cohorts, as well as traders, to engage in horticultural production.

Second, support to produce safe and nutritious food needs to be advanced
To realise opportunities on the international, and increasingly regional and domestic markets, compliance with quality and food safety requirements is necessary. Here policies that invest in institutions for independent quality and food safety control, certification, public extension and market information services (Swinnen and Kuijpers, 2020; Ton et al., 2017; Reardon et al., 2009) are essential. Horticultural chains make extensive use of contracts, whereby the processor or trader provides farmers with working capital, good quality seeds and modern cultivation information. Contract farming mechanisms used in horticultural trade often include product quality and food safety requirements, because such standards – either public or private - are increasingly regulating international trade implying that non-compliance practically means no export opportunities. Accordingly, low-income countries must invest in efforts to raise domestic production and consumption standards, and in sector-supporting programmes to reinforce compliance (see above). Dutch knowledge and expertise can make valuable contributions in supporting low-income countries in the design, implementation and compliance of food (safety and quality) standards and help strengthen capacity with the local private business sector to meet food safety and WTO SPS requirements. Enhanced food safety may lead to increased prices, the negative side-effects of which may be compensated for by domestic pricing policies, for which temporary budget support by donors may be considered. Moreover, enhanced donor support in research on vegetable crop improvement is required, while correcting the so-called crop bias, the latter meaning the historic over-investment in research on staple crops (Pingali 2015). Research points out (e.g. Schreinemachers, Sequeros et al. 2017) that the public returns in vegetable improvement are on par with investments in staple crops, and may be higher when accounting for impact of enhanced nutrition. Such investments may further contribute to enhancing resilience and make horticultural production more sustainable.

Third, horticultural production can be made more environmentally sustainable and resilient
Investments in productivity growth, reduction of crop losses and waste and techniques to cope with climate change (with drought-resistant seeds, for example) are necessary interventions to bring local supply more into balance with local needs, while considering the boundaries of the natural environment that will become increasingly restrictive due to climate change. One sector (in addition to

fisheries) the Dutch government pays specific attention to is the starting material sector. Availability of good and diverse plant and animal starting material (seeds, varieties), for both cultivation and further breeding, is indeed crucial for each country's longer-term food production capacity. Maintaining agro-biodiversity and sustainable use of genetic resources are an absolute precondition for global food security, especially in the longer term and with a changing climate. With these arguments, the Dutch food security policy supports several countries (e.g. Nigeria and Ethiopia) strengthening their seed sector, so that farmers have access to high-quality starting material on site. The projects are a collaboration of Dutch and local knowledge organisations, local authorities and farmers. Although the emphasis is on extension and training of farmers' cultivation practices, attention is also given to marketing opportunities of the produce.[7] The seed programme (SeedNL) offers farmers and related businesses opportunities to tap into new markets, which can also be exports, but the policy letter does not place any extra emphasis on using this market channel in boosting sector development.

Finally, regarding environmental concerns of intensified horticultural production, these can be reduced or mitigated by adopting sustainable technologies (i.e. precision agriculture, drought-resistant seeds) and improved natural resource management practices (for nutrients, pests, water and soil management)—both of which require investments in knowledge and technologies in the agricultural sector. Projects supported by the Dutch food security policy should consider the potential trade-offs between interventions that aim at increasing yields and environmental impacts.

[7] See for instance S4C, at https://www.dutchvegseedsnigeria.com/

Table 7.1 *Policy options for Netherlands' support for developing horticultural sector in developing countries*

Broader aim		Specific development policy options for the horticultural sector	Relation to key Dutch policy objectives		
			SDG 2.1& 2.2 Eradicate hunger in all its forms	SDG 2.3 Promoting inclusive and sustainable growth in the agricultural sector	SDG 2.4 & 2.5 Realise ecologically sustainable food production systems
Support to produce safe and nutritious foods	a.1	Policies and programmes that invest in institutions for independent quality and food safety control: - Certification, public extension and market information services.			
	a.2	Design for and experiment with contract farming arrangements for meeting improved domestic food standards (see also b.3).			
	a.3	Support fundamental research, both in the public and private domain, on vegetable crop improvement for developing countries (see also c.1).			
	a.4	Enable farmer support for experimentation with improved planting material and inputs (see also b.2 and c.3)			
	a.5	Domestic pricing policies to raise demand and/or compensate for increased prices due to higher food safety standards.			
	a.6	Enhance domestic vegetable demand through awareness raising on nutritional quality of diets			
Support more inclusive horticultural production	b.1	Investment in rural infrastructure: - Roads, storage facilities, energy infrastructure, ICT, rural extension services			
	b.2	Empowering farmers for a better bargaining position in the value chain:(see also a.4 and c.3) - Support (creation of) farmers' cooperatives or marketing associations - Supportive legislation and (temporary) financial support			
	b.3	Design contract farming arrangements that are more inclusive, i.e. more accommodating towards less endowed producers in horticultural value chain.			
Make horticultural production more environmentally sustainable and resilient	c.1	Support fundamental research, both in the public and private domain, on vegetable crop productivity improvement (see also a4): - Investments in productivity growth (genetic and crop system) - Reduction of crop losses and waste - Techniques to cope with climate change (i.e. drought-resistant seeds).			
	c.2	Strengthening developing countries' seed sectors.			
	c.3	Enable farmer support for experimentation with (see also a.4 and b.2): - sustainable production methods to minimise environmental impact of horticultural production (i.e. precision agriculture, drought-resistant seeds) - improved natural resource management practices (for nutrients, pests, water and soil management)			

8 Conclusions

The key value of using a Food System lens
Trade is generally positively associated with food security increasing availability and diversity of food at affordable prices, but can have important trade-offs socially and economically by competing local farmers from the market, by exposing importing countries to risk from external perturbations (e.g. 2008 and 2012 price peaks, COVID-19 outbreak) and by exacerbating environmental challenges associated with food production and climate change. Applying a food system framework in analysing the relationships between different activities in the food system and their drivers helps to shed light on these trade-offs and allows for making policy choices that are based on awareness of these trade-offs.

Vegetable production does not meet domestic demand in Africa
Malnutrition can be combated to a significant extent with better, healthier food, including more vegetable consumption. In many West and East African countries, the consumption of vegetables is much lower than the norms for a healthy diet indicate. Projections of possible fruit and vegetable production possibilities in these regions indicate that this is lagging behind the need, with a growing import need as a result. Regional trade and extra efforts on local production growth are strategies for meeting local demand in the future.

Options to improve food systems outcomes exist ...
First, contract farming arrangements with service provisioning (training, inputs, pre-finance, storage etc) have proven to be a mechanism for providing the right incentive for many farmers in producing and marketing of horticultural produce. Yet, farmers are also observed to default on contracts in some instances, both signalling contracts are too restrictive to farmers, and in various countries means to enforce contracts remain too limited. It calls for adapting (or experimenting with) the contract for specific circumstances to provide adequate incentives to both farmers and other actors in the value chain.

A key role remains for public support for standard compliance investments (e.g. in providing the right institutional environment as well as training of producer (organisations). The active role some governments (e.g. Kenya and Senegal) played in this field has been instrumental in stimulating horticultural exports and could possibly have had positive domestic spin-offs.

Next, scope remains for governments to offer market incentives for the production and consumption of vegetables. While the sector appears little affected by export taxes or tariffs, both regionally and globally, a key option for governments remain to enhance the incentives to consumers through subsidies or tax reductions or exemptions.

Finally, infrastructure development is instrumental for reducing costs of trade, locally, regionally and globally. Long within-country times, lack of cold storage, limited connectivity (also regionally) and, amongst others, inefficient customs operations are major impediments affecting trade in vegetables in many countries.

... but exports of vegetables have mixed food security effects ...
Using a Food Systems lens, this study highlighted a number of trade-offs, or areas where the above options may only have limited impact.

Some African countries (Morocco, Egypt, Kenya and Senegal) export significant amounts of vegetables to the EU, typically relying on contract farming arrangements. Literature points at positive impacts of such schemes (increasing incomes) but mainly applying to farmers directly involved in growing the crops, with little evidence for spin-offs that structurally lead to increased domestic supply, or regional supply and improved access to vegetables. Overall, little research has been done into the effect of vegetable production and trade on food and nutrition security in African contexts.

Trade-offs between social and economic objectives emerge. Trends suggest that over time horticultural production typically concentrates with an ever-smaller number of producing farmers. This suggests horticultural production, through contract farming, provides clear advantages to some, but certainly not for everybody. In some instances, farmers dropping out may still benefit from enhanced employment opportunities in processing, but not always does such employment provide a secure and stable income.

The scope by which less endowed farmers can be integrated in horticultural value chains remains up for further investigation, and experimentation. Further stimulating demand, particularly so in domestic or regional markets, may allow for a greater group of farmers to be included in horticultural production. Or simpler forms of contracts, such as the provision of simple price guarantees (futures) (and possibly better market price information), may prove beneficial in hedging some of the price risks involved for less endowed farmers. Such models require further experimentation.

In the end, such options may still prove limited in engaging the least endowed and may lead to the conclusion that stimulating horticultural production and trade is clearly not a panacea for engaging all smallholder farmers. For such groups, complementary development policies should remain to assist the least endowed with creating a stable base and possibly options outside of the agricultural domain. Such policies include existing policies focusing on improving health and education as well as mitigating short-term penury by using, for instance, cash transfers.

... and potentially negative environmental effects

Environmental impacts of vegetable production for export to the EU are mixed, with literature indicating producers do not overuse chemical inputs and growth of exports may be beneficial from a water efficiency perspective, while studies also indicate that substituting local production for imports in key export markets would imply significant CO_2 emission savings (reducing transport by air freight).

Addressing these environmental externalities is specific for each effect. Addressing carbon emissions rest with pricing these externalities, or by mandating efficiency standards. In the case of chemical inputs allowable levels of use (or permissible levels of traces on produce) are set in key export markets (EU) but produce destined for local or regional markets may not automatically meet these strict criteria, particularly if stricter standards come at a higher price. For domestic markets, a delicate trade-off between production at higher quantities with lower standards and lower prices, versus lower quantities with higher standards at higher prices may emerge. While enforcing strict food safety standards is conditional on the effective local institutions enforcing these, also for local markets, mitigating this trade-off could in part be addressed through consumer price policies such as tax reductions. Further means to stimulate local demand can be envisioned through marketing strategies aimed at equating local production with higher quality and high food safety standards. Experiments from Senegal for marketing local rice in a similar way have yielded positive results in raising domestic awareness and consumption (e.g. Demont, Rutsaert et al. 2013).

Scope exists for Dutch food security policies to contribute to inclusive and sustainable vegetable production

Scope exists for sustainably increasing horticultural production, while addressing the potential trade-offs. Horticultural production can be made more inclusive by lowering transaction costs to integrate more farmers in modern supply chains. This includes investments in public support and infrastructure, in addition to empowering farmers position in the supply chain by establishing farmers' organisations. Further experimentation with contract farming for such organisations and less-endowed farmers is desirable. Support should further be given to independent quality and food safety control and certification, public extension and market information services. Finally, programmes aimed at improving productivity, such as *Seed.nl*, combined with investments aimed at reducing crop losses and waste and technologies to cope with climate change offer opportunities to make horticultural production more environmentally friendly.

References and websites

Abrego, L., M. de Zamaroczy, T. Gursoy, G. P. Nicholls, H. Perez-Saiz and J. Rosas (2020). The African Continental Free Trade Area: Potential Economic Impact and Challenges. IMF Working Papers. International Monetary Fund (IMF). Washington, D.C., International Monetary Fund (IMF).

Achterbosch, T. A., S. Van Berkum and G. Meijrink (2014). Cash crops and food security. Contributions to income, livelihoods and agricultural innovation. LEI-report 2014-2015. Wageningen, LEI Wageningen UR (University and Research Centre).

Ag incentives. (2021). 'Ag incentives database.' Retrieved March 22nd, 2021, from http://www.ag-incentives.org/.

Aker, J. C. and M. Fafchamps (2014). 'Mobile Phone Coverage and Producer Markets: Evidence from West Africa.' The World Bank Economic Review **29**(2): 262-292.

Aker, J. C. and C. Ksoll (2016). 'Can mobile phones improve agricultural outcomes? Evidence from a randomized experiment in Niger.' Food Policy **60**: 44-51.

Alulu, J. (2020). Participation in contract farming and its effects on technical efficiency and income of vegetable farmers in Westerns Kenya. Thesis, University of Nairobi.

Anderson, K. (2009). Distortions to Agricultural Incentives. Washington, DC, World Bank.

Arouna, A., J. D. Michler and J. C. Lokossou (2021). 'Contract farming and rural transformation: Evidence from a field experiment in Benin.' Journal of Development Economics **151**: 102626.

Bai, Y., R. Alemu, S. A. Block, D. Headey and W. A. Masters (2021). 'Cost and affordability of nutritious diets at retail prices: Evidence from 177 countries.' Food Policy **99**: 101983.

Balogh, J. M. and A. Jámbor (2020). 'The Environmental Impacts of Agricultural Trade: A Systematic Literature Review.' Sustainability **12**(3): 1152.

Barrett, C., T. Reardon, J. Swinnen and D. Zilberman (2020). 'Structural transformation and economic development: insights from the agri-food value chain revolution.' Journal of Economic Literature **forthcoming**.

Barrett, C. B. (2008). 'Smallholder market participation: Concepts and evidence from eastern and southern Africa.' Food Policy **33**(4): 299-317.

Barron, M. a. A. and F. Rello (2000). 'The impact of the tomato agroindustry on the rural poor in Mexico.' Agricultural Economics **23**(3): 289-297.

Beckman, J., C. Estrades, M. Flores and A. Aguiar (2018). 'The Impacts of Export Taxes on Agricultural Trade.' National Bureau of Economic Research Working Paper Series **No. 24894**.

Bellemare, M. F. and J. R. Bloem (2018). 'Does contract farming improve welfare? A review.' World Development **112**: 259-271.

Béné, C., J. Fanzo, S. D. Prager, H. A. Achicanoy, B. R. Mapes, P. Alvarez Toro and C. Bonilla Cedrez (2020). 'Global drivers of food system (un)sustainability: A multi-country correlation analysis.' PLOS ONE **15**(4): e0231071.

Béné, C., P. Oosterveer, L. Lamotte, I. D. Brouwer, S. de Haan, S. D. Prager, E. F. Talsma and C. K. Khoury (2019). 'When food systems meet sustainability – Current narratives and implications for actions.' World Development **113**: 116-130.

Bernard, T., M.-H. Collion, A. de Janvry, P. Rondot and E. Sadoulet (2008). 'Do Village Organizations Make a Difference in African Rural Development? A Study for Senegal and Burkina Faso.' World Development **36**(11): 2188-2204.

Berthow, K. and A. Schultheis (2007). Impact of EU's agricultural trade policy on smallholders in Africa. Bonn, Germany, Germanwatch.

Bezemer, D. and D. Headey (2008). 'Agriculture, Development, and Urban Bias.' World Development **36**(8): 1342-1364.

Bijman, J. and V. Bitzer (2016). Quality and innovation in food chains, Lessons and insights from Africa. Wageningen, The Netherlands, Wageningen Academic.

Bijman, J. and G. Wijers (2019). 'Exploring the inclusiveness of producer cooperatives.' Current Opinion in Environmental Sustainability **41**: 74-79.

Blanco, M. (2018). The impact of the Common Agricultural Policy on developing countries. E. P. Directorate-General for external policies. Brussels, Belgium, European Parliament.

Brooks, J. and A. Matthews (2015). 'Trade Dimensions of Food Security.'
Bureau, J.-C. and J. Swinnen (2018). 'EU policies and global food security.' Global Food Security **16**: 106-115.
Calderón, C. and L. Servén (2010). 'Infrastructure and Economic Development in Sub-Saharan Africa †.' Journal of African Economies **19**(suppl_1): i13-i87.
Chang, H.-J. (2009). 'Rethinking public policy in agriculture: lessons from history, distant and recent.' The Journal of Peasant Studies **36**(3): 477-515.
Chege, C. G. K., C. I. M. Andersson and M. Qaim (2015). 'Impacts of Supermarkets on Farm Household Nutrition in Kenya.' World Development **72**: 394-407.
Comext (2021). ComExt Intra- and Extra-EU trade data. Eurostat. Luxemburg.
Comtrade (2021). UN Comtrade Database. U. Nations.
Coulibaly, I. (2014). 'Competitiveness and growth within the CFA franc zone: Does the switch to the Euro matter?' International Economics **139**: 1-18.
D'Odorico, P., J. A. Carr, F. Laio, L. Ridolfi and S. Vandoni (2014). 'Feeding humanity through global food trade.' Earth's Future **2**(9): 458-469.
Dalin, C. and I. Rodríguez-Iturbe (2016). 'Environmental impacts of food trade via resource use and greenhouse gas emissions.' Environmental Research Letters **11**(3): 035012.
de Schutter, O. (2011). The World Trade Organisation and the post-global food crisis agenda. November. Activity Report., United Nations Special Rapporteur of the Right on Food.
de Steenhuijsen Piters, B., Y. Dijkxhoorn, H. Hengsdijk, X. Guo, I. Brouwer, L. Eunice, T. Tichar, C. Carrico and W. de Boef (2021). Fruits and vegetables scoping study Phase 1 Wageningen, The Netherlands, Wageningen Economic Research.
Delgado, J. V. (2015). 'The socio-cultural, institutional and gender aspects of the water transfer-agribusiness model for food and water security. Lessons learned from Peru.' Food Security **7**(6): 1187-1197.
Demont, M., P. Rutsaert, M. Ndour and W. Verbeke (2013). 'Reversing Urban Bias in African Rice Markets: Evidence from Senegal.' World Development **45**: 63-74.
Diaz-Bonilla, E. (2015). Macroeconomics, agriculture and food security: a guide to policy analysis in developing countries. Washington, D.C., International Food Policy Research Institute (IFPRI).
Dube, P., W. J. M. Heijman, R. Ihle and J. Ochieng (2018). The Potential of Traditional Leafy Vegetables for Improving Food Security in Africa. Establishing Food Security and Alternatives to International Trade in Emerging Economies. E. Vasily. Hershey, PA, USA, IGI Global**:** 220-243.
Easterly, W. and A. Reshef (2016). Chapter 8: African Export Successes: Surprises, Stylized Facts, and Explanations. African Successes, Volume III: Modernization and Development. S. Edwards, S. Johnson and D. N. Weil, University of Chicago Press.
Ebert Andreas, W. (2017). Vegetable Production, Diseases, and Climate Change. World Agricultural Resources and Food Security, Emerald Publishing Limited. **17:** 103-124.
Ericksen, P., B. Stewart, J. Dixon, D. Barling, P. Loring, M. Anderson and J. Ingram (2010). The value of a food system approach. Food security and global environmental change. I. J., P. Ericksen and D. Liverman, Routledge
Fabi, C., F. Cachia, P. Conforti, A. English and J. Rosero Moncayo (2021). 'Improving data on food losses and waste: From theory to practice.' Food Policy **98**: 101934.
FAO. (2020). 'FAOSTAT.' Retrieved December 11, 2020, from http://www.fao.org/faostat/en/#home.
FAO (2020). The state of the food security and nutrition in the world. Rome, Italy.
Food system dashboard. (2021). 'Food systems data for improving diets and nutrition. ' Retrieved April, 2021, from https://foodsystemsdashboard.org/.
Frank, S. M., J. Webster, B. McKenzie, P. Geldsetzer, J. Manne-Goehler, G. Andall-Brereton, C. Houehanou, D. Houinato, M. S. Gurung, B. W. Bicaba, R. W. McClure, A. Supiyev, Z. Zhumadilov, A. Stokes, D. Labadarios, A. M. Sibai, B. Norov, K. K. Aryal, K. B. Karki, G. B. Kagaruki, M. T. Mayige, J. S. Martins, R. Atun, T. Bärnighausen, S. Vollmer and L. M. Jaacks (2019). 'Consumption of Fruits and Vegetables Among Individuals 15 Years and Older in 28 Low- and Middle-Income Countries.' The Journal of Nutrition **149**(7): 1252-1259.
Fresco, L. O., R. Ruben and M. Herens (2017). 'Challenges and perspectives for supporting sustainable and inclusive food systems ' Great Insights **13**.
Gammadigbe, V. (2021). Is Regional Trade Integration a Growth and Convergence Engine in Africa? IMF Working Paper Washington, D.C., International Monetary Fund (IMF).

Gligor, D., A. Tan and T. N. T. Nguyen (2018). 'The obstacles to cold chain implementation in developing countries: insights from Vietnam.' The International Journal of Logistics Management **29**(3): 942-958.

Global Panel on Agriculture and Food Systems for Nutrition (2016). Food systems and diets: Facing the challenges of the 21st century. London, UK.

Global Panel on Agriculture and Food Systems for Nutrition (2020). Rethinking trade policies to support healthier diets. London, UK, Global Panel on Agriculture and Food Systems for Nutrition.

Grosh, B. (1994). 'Contract Farming in Africa: an Application of the New Institutional Economics.' Journal of African Economies **3**(2): 231-261.

Hall, J. N., S. Moore, S. B. Harper and J. W. Lynch (2009). 'Global Variability in Fruit and Vegetable Consumption.' American Journal of Preventive Medicine **36**(5): 402-409.e405.

HLPE (2014). Food losses and waste in the context of sustainable food systems. A report by the High Level of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome, Italy.

International Trade Center (ITC) (2015). The Invisible Barriers to Trade – How Businesses Experience Non-Tariff Measures. ITC technical paper; Doc. No. MAR-15-326.E. Geneve, Switzerland, International Trade Center (ITC).

IOB (2017). Food for though. Review of Dutch food security policy 2012-2016. IOB evaluation 419. IOB. The Hague, The Netherlands IOB.

Jensen, R. (2007). 'The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector*.' The Quarterly Journal of Economics **122**(3): 879-924.

Joosten, F., Y. Dijkxhoorn, Y. Sertse and R. Ruben (2015). How does the Fruit and Vegetable Sector contribute to Food and Nutrition Security? Wageningen, LEI Wageningen UR.

Kaag, S. A. M. and C. J. Schouten (2019). Kamerbrief Op weg naar een wereld zonder honger in 2030. De Nederlandse inzet. M. v. L. Minister van Buitenlandse Handel en Ontwikkelingssamenwerking, Natuur en Voedselkwaliteit. The Hague, The Netherlands.

Kalmpourtzidou, A., A. Eilander and E. F. Talsma (2020). 'Global Vegetable Intake and Supply Compared to Recommendations: A Systematic Review.' Nutrients **12**(6): 1558.

Kareem, O. I. and M.-L. Rau (2018). Market Access for Africa's Fruits and Vegetables Exports in the European Union: Evidence from Sanitary and Phytosanitary Measures. Non-Tariff Measures: Economic Assessment and Policy Options for Development. A. Nicita and J. De Melo, UNCTAD**:** 327.

Kherallah, M., C. L. Delgado, E. Z. Gabre-Madhin, N. Minot and M. Johnson (2002). Reforming agricultural markets in Africa: Achievements and challenges, International Food Policy Research Institute.

König, T., J. Blatt, K. Brakel, K. Kloss, T. Nilges and F. Woellert (2011). Chapter 10: Value chains and regional trade in East Africa: the case of vegetables in Kenya and Tanzania. Vegetable Production and Marketing in Africa: Socio-economic Research. Wallingford, UK, CABI. **149**.

Koning, N. and P. Pinstrup-Andersen (2007). Chapter 1: Introduction Agricultural trade liberalisation and the least developed countries. N. Koning and P. Pinstrup-Andersen, Springer Science & Business Media. **19**.

Kornher, L. and J. von Braun (2020). 'EU Common Agricultural Policy-Impacts on Trade with Africa and African Agricultural Development.' Available at SSRN 3613628.

Kummu, M., P. Kinnunen, E. Lehikoinen, M. Porkka, C. Queiroz, E. Röös, M. Troell and C. Weil (2020). 'Interplay of trade and food system resilience: Gains on supply diversity over time at the cost of trade independency.' Global Food Security **24**: 100360.

Latka, C., M. Kuiper, S. Frank, T. Heckelei, P. Havlík, H.-P. Witzke, A. Leip, H. D. Cui, A. Kuijsten, J. M. Geleijnse and M. van Dijk (2021). 'Paying the price for environmentally sustainable and healthy EU diets.' Global Food Security **28**: 100437.

Leip, A., G. Billen, J. Garnier, B. Grizzetti, L. Lassaletta, S. Reis, D. Simpson, M. A. Sutton, W. De Vries and F. Weiss (2015). 'Impacts of European livestock production: nitrogen, sulphur, phosphorus and greenhouse gas emissions, land-use, water eutrophication and biodiversity.' Environmental Research Letters **10**(11): 115004.

Lenné, J. M. and A. F. Ward (2010). 'Improving the Efficiency of Domestic Vegetable Marketing Systems in East Africa:Constraints and Opportunities.' Outlook on Agriculture **39**(1): 31-40.

Lenné, J. M. and A. F. Ward (2011). Chapter 13: An Approach to Strengthening Vegetable Value Chains in East Africa: Potential for Spillovers. Vegetable Production and Marketing in Africa: Socio-economic Research. D. Mithöfer and H. Waibe. Wallingford, UK, CABI Publishing**:** 195.

Lipton, M. (1977). Why poor people stay poor: a study of urban bias in world development, Temple Smith; Australian National University Press.

Macchiavello, R. and A. Morjaria (2020). 'Competition and Relational Contracts in the Rwanda Coffee Chain*.' The Quarterly Journal of Economics.

Maertens, M., L. Colen and J. F. M. Swinnen (2011). 'Globalisation and poverty in Senegal: a worst case scenario?' European Review of Agricultural Economics **38**(1): 31-54.

Maertens, M., B. Minten and J. Swinnen (2012). 'Modern Food Supply Chains and Development: Evidence from Horticulture Export Sectors in Sub-Saharan Africa.' Development Policy Review **30**(4): 473-497.

Maertens, M. and J. F. M. Swinnen (2009). 'Trade, Standards, and Poverty: Evidence from Senegal.' World Development **37**(1): 161-178.

Malan, M. and E. D. Berkhout (2016). The impact of taxes and subsidies on crop yields. Agricultural price distortions in Africa.

Mason-D'Croz, D., J. R. Bogard, T. B. Sulser, N. Cenacchi, S. Dunston, M. Herrero and K. Wiebe (2019). 'Gaps between fruit and vegetable production, demand, and recommended consumption at global and national levels: an integrated modelling study.' The Lancet Planetary Health **3**(7): e318-e329.

Matsumoto-Izadifar, Y. (2009). 'Senegal: Making Better Use of Agribusiness Potential.'

McCorriston, S., D. Hemming, J. D. Lamontagne-Godwin, J. Osborn, M. J. Parr and P. D. Roberts (2013). What is the evidence of the impact of agricultural trade liberalisation on food security in developing countries?, EPPI-Centre, Social Service Research Unit, Institute of Education ….

Meemken, E.-M. and M. F. Bellemare (2020). 'Smallholder farmers and contract farming in developing countries.' Proceedings of the National Academy of Sciences **117**(1): 259-264.

Mekonnen, D. A., E. F. Talsma, L. Trijsburg, V. Linderhof, T. Achterbosch, A. Nijhuis, R. Ruben and I. D. Brouwer (2020). 'Can household dietary diversity inform about nutrient adequacy? Lessons from a food systems analysis in Ethiopia.' Food Security **12**(6): 1367-1383.

Mekonnen, D. A., L. Trijsburg, T. Achterbosch, I. D. Brouwer, G. Kennedy, V. Linderhof, R. Ruben and E. F. Talsma (2021). 'Food consumption patterns, nutrient adequacy, and the food systems in Nigeria.' Agricultural and Food Economics **9**(1): 16.

Michalský, M. and P. S. Hooda (2015). 'Greenhouse gas emissions of imported and locally produced fruit and vegetable commodities: A quantitative assessment.' Environmental Science & Policy **48**: 32-43.

Minten, B., L. Randrianarison and J. F. M. Swinnen (2009). 'Global Retail Chains and Poor Farmers: Evidence from Madagascar.' World Development **37**(11): 1728-1741.

Morrison, J. and A. Sarris (2016). Food Staple Market Volatility and Food Security in Eastern and Southern Africa: what role for intra-regional trade and market policy? Africa's Progress in Regional and Global Economic Integration-Towards Transformative Regional Integration. Rome, Italy, Food and Agricultural Organization (FAO). **18:** 159.

Muto, M. and T. Yamano (2009). 'The Impact of Mobile Phone Coverage Expansion on Market Participation: Panel Data Evidence from Uganda.' World Development **37**(12): 1887-1896.

Nandi, R., S. Nedumaran and P. Ravula (2021). 'The interplay between food market access and farm household dietary diversity in low and middle income countries: A systematic review of literature.' Global Food Security **28**: 100484.

OECD (2019). EU Common Agricultural Policy - Impacts on Trade with Africa and African Agricultural Development Draft paper December 2019 for discussion in the Working Party on Agricultural Policies and Markets, TAD/CA/APM/WP(2019). Paris, France, OECD.

OECD (2020). Greening Regional Trade Agreements on Non-Tariff Measures through Technical Barriers to Trade and Regulatory Co-operation. OECD Trade and Environment working papers 2020/04. Paris, France, OECD.

Okello, J. J. and R. M. Okello (2010). 'Do EU pesticide standards promote environmentally-friendly production of fresh export vegetables in developing countries? The evidence from Kenyan green bean industry.' Environment, Development and Sustainability **12**(3): 341-355.

Ortiz, S. and S. Aparicio (2007). 'How Labourers Fare in Fresh Fruit Export Industries: Lemon Production in Northern Argentina.' Journal of Agrarian Change **7**(3): 382-404.

Otsuka, K., Y. Nakano and K. Takahashi (2016). 'Contract Farming in Developed and Developing Countries.' Annual Review of Resource Economics **8**(1): 353-376.
Owoundi, F. (2016). 'Do exchange rate misalignments really affect economic growth? The case of Sub-Saharan African countries.' International Economics **145**: 92-110.
Pendrill, F., U. M. Persson, J. Godar, T. Kastner, D. Moran, S. Schmidt and R. Wood (2019). 'Agricultural and forestry trade drives large share of tropical deforestation emissions.' Global Environmental Change **56**: 1-10.
Pingali, P. (2015). 'Agricultural policy and nutrition outcomes – getting beyond the preoccupation with staple grains.' Food Security **7**(3): 583-591.
Raaijmakers, I., H. Snoek, B. Maziya-Dixon and T. Achterbosch (2018). 'Drivers of Vegetable Consumption in Urban Nigeria: Food Choice Motives, Knowledge, and Self-Efficacy.' Sustainability **10**(12): 4771.
Rabobank (2018). World Vegetable Map. Utrecht, The Netherlands, Rabobank.
Raut, R. D., B. B. Gardas, V. S. Narwane and B. E. Narkhede (2019). 'Improvement in the food losses in fruits and vegetable supply chain - a perspective of cold third-party logistics approach.' Operations Research Perspectives **6**: 100117.
Reardon, T. (2015). 'The hidden middle: the quiet revolution in the midstream of agrifood value chains in developing countries.' Oxford Review of Economic Policy **31**(1): 45-63.
Reardon, T., C. B. Barrett, J. A. Berdegué and J. F. M. Swinnen (2009). 'Agrifood Industry Transformation and Small Farmers in Developing Countries.' World Development **37**(11): 1717-1727.
Reardon, T., A. Heiman, L. Lu, C. S. R. Nuthalapati, R. Vos and D. Zilberman (2021). ''Pivoting' by food industry firms to cope with COVID-19 in developing regions: E-commerce and 'copivoting' delivery intermediaries.' Agricultural Economics **52**(3): 459-475.
Renkow, M., D. G. Hallstrom and D. D. Karanja (2004). 'Rural infrastructure, transactions costs and market participation in Kenya.' Journal of Development Economics **73**(1): 349-367.
Ruben, R. (2020). Searching effective incentives for global food system transformation. Farewell Adress. W. U. a. Research.
Ruel, M. T., N. Minot and L. Smith (2005). Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicountry comparison. Background paper for the joint FAO/WHO workshop on fruits and vegetables for health W. H. O. (WHO). 1-3 september 2004, Kobe, Japan World Health Organisation (WHO).
Schreinemachers, P., T. Sequeros and P. J. Lukumay (2017). 'International research on vegetable improvement in East and Southern Africa: adoption, impact, and returns.' Agricultural Economics **48**(6): 707-717.
Schwarz, J., E. Mathijs and M. Maertens (2015). 'Changing Patterns of Global Agri-Food Trade and the Economic Efficiency of Virtual Water Flows.' Sustainability **7**(5): 5542-5563.
Sexton, R. J. and T. Xia (2018). 'Increasing Concentration in the Agricultural Supply Chain: Implications for Market Power and Sector Performance.' Annual Review of Resource Economics **10**(1): 229-251.
Siegel, K. R., M. K. Ali, A. Srinivasiah, R. A. Nugent and K. M. V. Narayan (2014). 'Do We Produce Enough Fruits and Vegetables to Meet Global Health Need?' PLOS ONE **9**(8): e104059.
Stifel, D. and B. Minten (2008). 'Isolation and agricultural productivity.' Agricultural Economics **39**(1): 1-15.
Stifel, D. and B. Minten (2017). 'Market Access, Well-being, and Nutrition: Evidence from Ethiopia.' World Development **90**: 229-241.
Swinnen, J. (2016). 'Economics and politics of food standards, trade, and development#.' Agricultural Economics **47**(S1): 7-19.
Swinnen, J. and R. Kuijper (2020). Inclusive value chains to accelerate poverty reduction in Africa. Jobs Working paper no.37. Washington DC, World Bank.
Swinnen, J. and J. McDermott (2020). COVID-19 and global food security. Washington, D.C., International Food Policy Research Institute (IFPRI).
Thow, A. M., S. Jan, S. Leeder and B. Swinburn (2010). 'The effect of fiscal policy on diet, obesity and chronic disease: a systematic review.' Bulletin of the World Health Organization **88**: 609-614.
Ton, G., W. Vellema, S. Desiere, S. Weituschat and M. D'Haese (2018). 'Contract farming for improving smallholder incomes: What can we learn from effectiveness studies?' World Development **104**: 46-64.

Tyce, M. (2020). 'A 'Private-sector Success Story'? Uncovering the Role of Politics and the State in Kenya's Horticultural Export Sector.' The Journal of Development Studies **56**(10): 1877-1893.
Ulrich, A. (2014). 'Export-Oriented Horticultural Production in Laikipia, Kenya: Assessing the Implications for Rural Livelihoods.' Sustainability **6**(1): 336-347.
UNEP (2016). Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. H. Westhoek, I. J., S. Van Berkum, L. Özay and H. M.
Upton, J. and E. Lentz (2017). 'Finding default? Understanding the drivers of default on contracts with farmers' organizations under the World Food Programme Purchase for progress pilot.' Agricultural Economics **48**(S1): 43-57.
Van Berkum, S., J. Dengerink and R. Ruben (2018). The food systems approach: sustainable solutions for a sufficient supply of healthy food, Wageningen Economic Research.
Van den Broeck, G. and M. Maertens (2016). 'Horticultural exports and food security in developing countries.' Global Food Security **10**: 11-20.
Van den Broeck, G., K. Van Hoyweghen and M. Maertens (2018). 'Horticultural exports and food security in Senegal.' Global Food Security **17**: 162-171.
van Oorschot, M., C. Wentink, M. Kok, P. van Beukering, O. Kuik, M. van Drunen, J. van de Berg, V. Ingram, L. Judge, E. Arets and F. Veneklaas (2016). How could sustainable trade contribute to the conservation of natural capital? The effects of certifying tropical resource production on ecosystem services. The Hague, The Netherlands, PBL Netherlands Environmental Assessment Agency.
Vandemoortele, T., S. Rozelle, J. Swinnen and T. Xiang (2012). 'Quality and Inclusion of Producers in Value Chains: A Theoretical Note.' Review of Development Economics **16**(1): 122-136.
Weinberger, K. and T. A. Lumpkin (2007). 'Diversification into Horticulture and Poverty Reduction: A Research Agenda.' World Development **35**(8): 1464-1480.
Weinberger, K., M. Pasquini, P. Kasambula and M. Abukutsa-Onyango (2011). Chapter 11: Supply chains for indigenous vegetables in urban and peri-urban areas of Uganda and Kenya: a gendered perspective. Vegetable production and marketing in Africa: Socio-economic research. Wallingford, UK, CABI**:** 169-181.
Willett, W., J. Rockström, B. Loken, M. Springmann, T. Lang, S. Vermeulen, T. Garnett, D. Tilman, F. DeClerck, A. Wood, M. Jonell, M. Clark, L. J. Gordon, J. Fanzo, C. Hawkes, R. Zurayk, J. A. Rivera, W. De Vries, L. Majele Sibanda, A. Afshin, A. Chaudhary, M. Herrero, R. Agustina, F. Branca, A. Lartey, S. Fan, B. Crona, E. Fox, V. Bignet, M. Troell, T. Lindahl, S. Singh, S. E. Cornell, K. Srinath Reddy, S. Narain, S. Nishtar and C. J. L. Murray (2019). 'Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems.' The Lancet **393**(10170): 447-492.
Zhang, X. and S. Fan (2004). 'How Productive Is Infrastructure? A New Approach and Evidence from Rural India.' American Journal of Agricultural Economics **86**(2): 492-501.

Appendix 1 Key trade data of the EU and the Netherlands on vegetables and vegetable seeds

Table A1.1 *Netherlands imports and exports of vegetables (HS code 07), Extra-EU trade, 2018 values in million euro*

Major origins of imports	Import value 2018	Major destinations	Export value
Turkey	20	Norway	138
Morocco	80	Switzerland	62
Egypt	47	Russia	30
Senegal	24	Algeria	55
Kenya	38	Senegal	71
USA	68	Ivory Coast	32
Peru	43	USA	124
Israel	38	Saudi-Arabia	34
China	68	UAE	62
New Zealand	13	Japan	33
Total Extra EU	587	Total Extra EU	1,165

Source: EU COMEXT.

Table A1.2 *Netherlands imports and exports of vegetable seeds (HS code 120901), Extra-EU trade, 2018 values in million euro*

Major origins of imports	Import value 2018	Major destinations	Export value
South-Africa	12	Turkey	66
USA	73	Russia	45
Peru	31	Morocco	33
Chili	40	Egypt	30
Israel	10	USA	129
India	24	Canada	36
Thailand	24	Mexico	116
China	34	Iran	33
Australia	10	China	41
New Zealand	24	Australia	35
Total Extra EU	329	Total Extra EU	892

Source: EU COMEXT.

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The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 6,800 employees (6,000 fte) and 12,900 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.