



CHAPTER 3

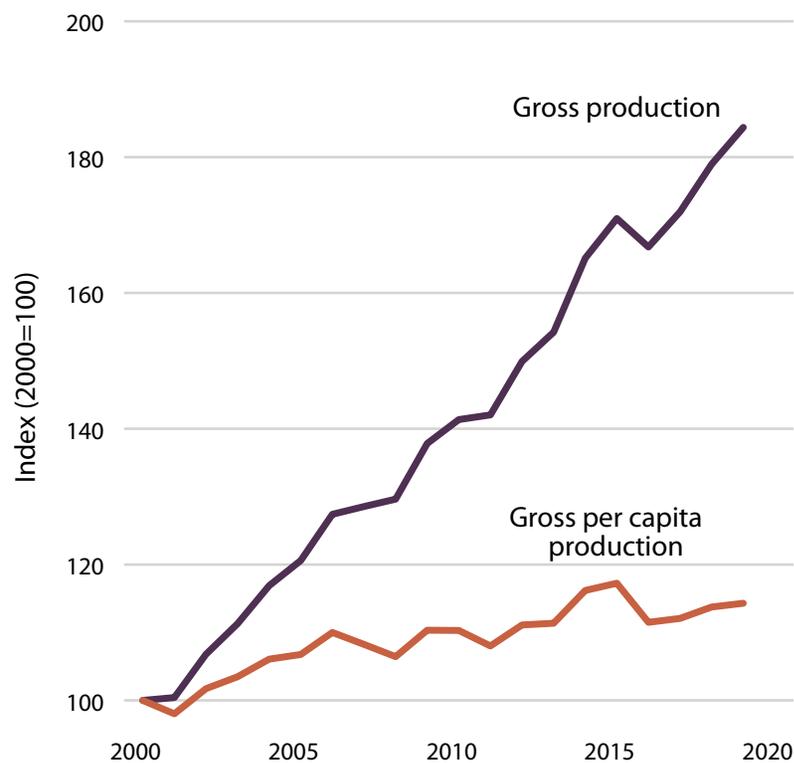
The Dynamics of Africa's Fruit and Vegetable Processing Sectors

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Introduction

The production of fruits and vegetables (F&V) in Africa has increased 3.3 percent annually during the last 20 years, but only 0.7 percent in per capita terms (FAOSTAT 2022; Figure 3.1). Africa has the lowest per capita production and consumption of F&V in the world, although South Africa, Morocco, and Egypt are large producers and exporters.

FIGURE 3.1—INDEX OF GROSS PRIMARY FRUIT AND VEGETABLE PRODUCTION IN AFRICA, 2000–2020



Source: Data from FAOSTAT database (accessed March 20, 2022). <http://www.fao.org/faostat/en/#data>
Note: 2000 = 100.

Key characteristics of the F&V sector in Africa (and elsewhere) are that production is mostly small-scale (Wakholi et al. 2015) and that most produce is traded while fresh rather than processed. F&V often have specific soil and climate requirements in order to grow, and production therefore tends to be concentrated in the most suitable locations, making trade important. Because produce is highly perishable, domestic and intraregional trade is usually more extensive than international trade, except for the trade of tropical fruits such as bananas and pineapples, for which there is a significant export market.

F&V are high in value and can turn a significant profit for farmers. However, the commercial production of F&V is often not a realistic option for smallholder farmers with inadequate means of production and lack of access to a reliable market outlet (Schreinemachers, Simmons, and Wopereis 2018). Infrastructure is a significant challenge for Africa's F&V trade. Large distances between F&V producers, processors, and consumers, as well as poor road conditions and a lack of refrigerated transportation, result in high transportation costs and losses, in addition to high risk for the traders involved. Postharvest losses for F&V in Africa south of the Sahara amount to 56 ± 25 percent for fruit and 44 ± 17 percent for vegetables. These percentages can be reduced in principle to 25 ± 16 percent and 11 ± 14 percent, respectively, using various types of interventions (Affognon et al. 2015).

Africa, however, is also the fastest urbanizing continent, and because consumers and markets concentrate in cities, marketing and logistics become easier. Urbanization is associated with shifting behavior in consumer consumption: modern retail (e.g., supermarkets, grocery stores) and packaged foods grow in importance, and there is higher consumer demand for fresh and safe food. These shifting patterns create opportunities for smallholder farmers in peri-urban areas to supply urban markets and to add value through processing and targeting higher-value market segments.

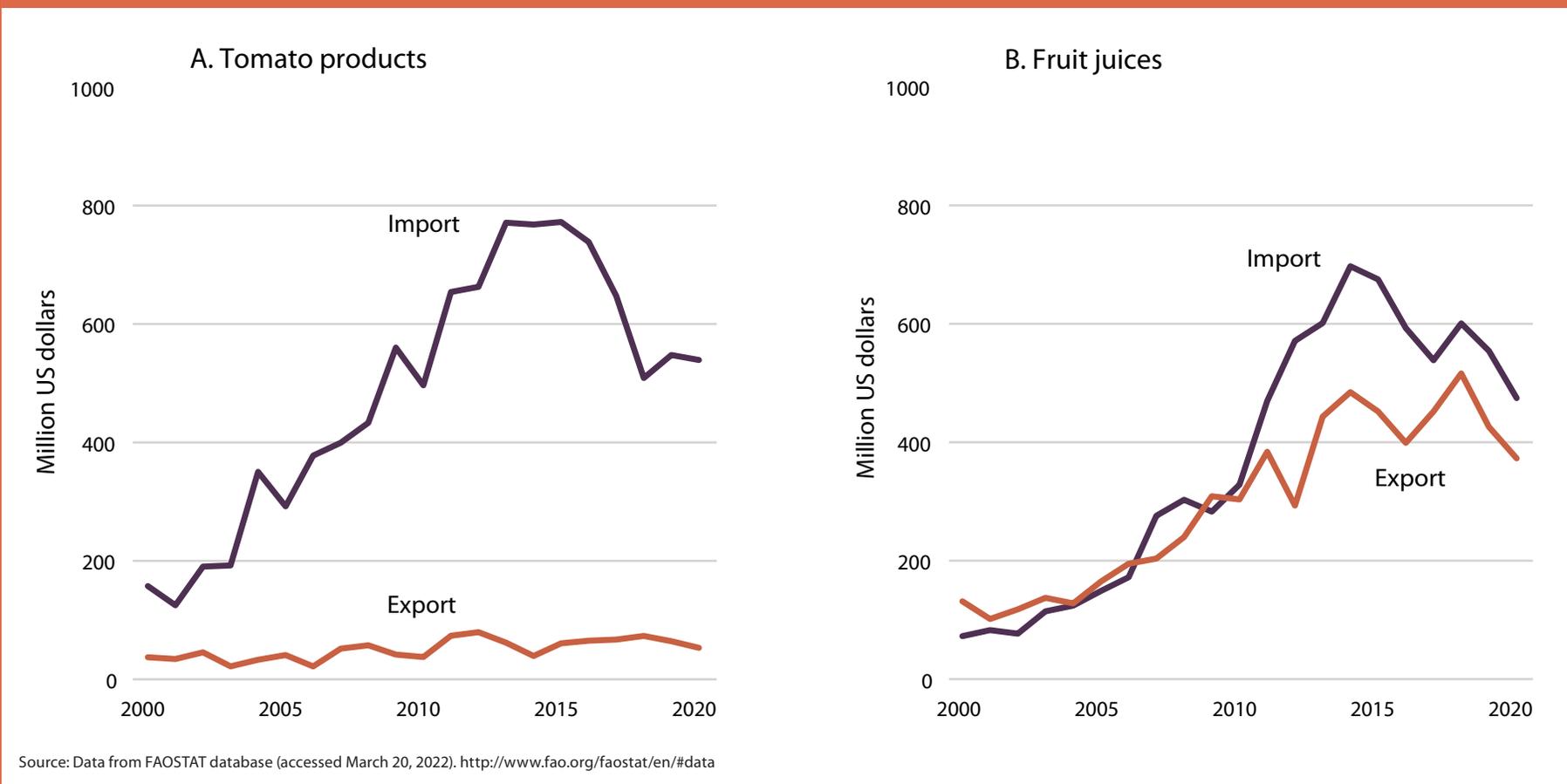
While most F&V are consumed fresh, processing is nevertheless important, and the market for processed products is likely to expand. Processing methods range from artisanal practices such as simple open-air solar drying and fruit juice extraction to the industrial-scale production of fruit juices, jams, and tomato sauces. Many countries in Africa do have a tradition of F&V processing, but most of it is artisanal. Increased industrial processing is likely, as consumers increasingly demand convenience food and food products that meet food safety standards (Reardon et al. 2021).

The market for processed foods is growing rapidly in Africa, but most of it is for ultra-processed snack foods and beverages, while F&V play a minor role (Reardon et al. 2021). The consumption of ultra-processed snack foods and beverages alongside other dietary behaviors and lifestyle factors has contributed to an increase in overweight and obesity, which have increased in Africa from 28 percent of the adult population in 2000 to 42 percent in 2016 (WHO 2018), adding another dimension to Africa’s long-standing challenges with hunger and micronutrient deficiencies. To address Africa’s nutritional challenges, it will be

important to provide consumers with a wider range of healthy food options that combine convenience and hygiene with good nutrition.

In light of these recent trends, the objective of this chapter is to describe the development of Africa’s F&V processing sectors. This chapter uses a case study approach, because data are very limited. For instance, FAOSTAT (the statistical database of the Food and Agriculture Organization of the United Nations) has data on primary tomato production, but not on processing, except in the trade domain, which has data on the import and export of tomato products (paste,

FIGURE 3.2—IMPORT AND EXPORT VALUES OF TOMATO PRODUCTS (A) AND FRUIT JUICES (B) FOR COUNTRIES IN AFRICA FROM 2000 TO 2020, IN CURRENT US DOLLARS



peeled, juice) and fruit juices (concentrated, single-strength) (FAOSTAT 2022; Figure 3.2) but does not show how much is processed and consumed domestically. These trade data do confirm that Africa imports substantial amounts of tomato products and fruit juice concentrates, although these imports appear to drop after 2015.

We selected four case studies that are relatively well-documented in the literature. These include three formal, relatively structured supply chains—tomato processing in Nigeria and Ghana, fruit juice production across Africa, and pineapple processing in West Africa—and one less formal supply chain—the drying of African leafy vegetables in Kenya and Tanzania. These supply chains are certainly not limited to the countries and regions indicated; for instance, there is also a tomato processing industry in North Africa, and leafy vegetables are commonly processed across Africa, but the focus on specific countries and regions allows for more concrete descriptions of the challenges and opportunities

faced. For each case study, we executed rapid literature reviews, focusing on the challenges, opportunities, and policy environment of each supply chain.

Case Studies

Tomato Processing in Ghana and Nigeria

Background: Tomatoes are the fourth most economically valuable food crop produced in low- and middle-income countries, after rice, sugarcane, and wheat (Schreinemachers, Simmons, and Wopereis 2018). Every country in Africa produces and consumes tomatoes. In West Africa, tomatoes (along with onions) are a key ingredient for many local dishes that are consumed daily (Awan et al. 2012). However, mean tomato yields are low in Cameroon, Ghana, and Nigeria, West Africa’s largest tomato producers (Table 3.1). Tomato production in Nigeria fell sharply from 2016 to 2017 because of drought and a large-scale infestation

TABLE 3.1—TOMATO PRODUCTION AND TRADE IN TOMATOES AND TOMATO PRODUCTS FOR AFRICA’S 10 LARGEST TOMATO PRODUCERS, MEANS, FROM 2018 TO 2021

Country	Tomato yield (tons/ha)	Tomato production at farmgate value (million US\$/year)	Export value (million US\$/year)		Import value (million US\$/year)	
			Fresh tomatoes	Tomato products	Fresh tomatoes	Tomato products
Nigeria	4.3	1,342.2	0.0	0.4	0.3	71.2
Mozambique	26.3	740.1	0.0	0.0	1.6	1.6
Algeria	60.0	696.5	0.2	0.1	0.0	34.7
Egypt	39.1	664.9	43.7	11.8	0.1	10.3
Cameroon	12.4	640.5	0.1	1.3	0.0	9.5
Kenya	24.1	468.9	0.1	0.1	1.4	2.9
Ghana	7.8	340.3	0.0	8.3	1.2	46.8
Morocco	91.2	314.3	740.0	11.0	0.1	11.9
Malawi	21.7	312.3	—	—	0.1	0.1
Niger	26.3	310.7	0.0	3.1	0.1	7.7
Africa	13.7	6,883.4	854.1	57.4	36.3	516.0

Source: Data from FAOSTAT database (accessed March 20, 2022). <http://www.fao.org/faostat/en/#data>

Note: — = data not available.

of the invasive South American tomato pinworm (*Phthorimaea absoluta*, also known as *Tuta absoluta*). Tomato production is also highly seasonal, and market gluts are common even in countries that produce too little to satisfy local demand. Processed tomato products are, therefore, economically important, and concentrated tomato paste, as well as canned tomato (peeled, diced, or puree), is an important globally traded commodity. The world's five largest tomato processors are China, Italy, Spain, Turkey, and the United States (California), with China and Italy dominating the international trade in tomato products.

Processed tomato products are not ideal from a nutritional point of view, because they can be high in sugar and salt, and low in micronutrients. However, tomato paste is often used as the basis for preparing a wide range of vegetable and meat dishes in West Africa and elsewhere. Therefore, the availability of tomato (and onion) is important to make other vegetables palatable, and its contribution to a healthy diet should not be underestimated, even though fresh tomatoes have a higher nutritional value than processed.

From 2018 to 2020, Africa produced about US\$6.9 billion worth of fresh tomatoes per year (measured at farmgate value), imported \$0.6 billion of mostly tomato products, and exported \$0.9 billion of mostly fresh tomatoes (nearly all from Egypt, Morocco, and Tunisia) (FAOSTAT 2022). Nigeria and Ghana, along with Libya, are Africa's largest importers of tomato products by value. Both Ghana and Nigeria have large-scale processing plants built with foreign aid in an attempt to replace imported tomato products with locally produced and processed tomatoes.

Challenges: In Ghana and Nigeria, an inadequate and unstable supply of low-cost tomatoes caused by low yields, the seasonal nature of production, and tomato varieties unsuitable for processing due to low Brix values (a measure of total soluble solid content) limit local processing of tomatoes. Tomato production is generally rainfed and small-scale, and tomato farmers prefer to sell to the highest bidder rather than supply a processing plant with tomatoes on contract. Processing plants are therefore unable to acquire enough produce when market prices are high and cannot process tomatoes year-round.

Large processing plants remain idle because they are unable to source the raw material they need; they also face additional challenges, such as access to loans, the high cost of packaging, high operating costs, and unstable power sources (Boamah and Sumberg 2019). In Ghana, the Wenchi and Pwalugu tomato processing and canning factories were built with foreign aid in the 1960s

but closed in the 1980s (Robinson and Kolavalli 2010). In Nigeria, the Dangote tomato processing facility is no longer functional because the raw materials that can feed the plant's capacity of 1,200 metric tons per day are not available (*Bloomberg News* 2021). Foreign companies have invested in processing plants that use imported tomato concentrate from Italy and China, to which water, starch, and seasoning are added to produce tomato sauces popular on the local market. Processed tomato products, however, either imported or locally produced, are often of poor nutritional value.

Opportunities: Small-scale processors are often better able to acquire fresh tomatoes from the market than are larger plants, and they are also more flexible in producing a range of processed products in addition to tomato products. In northern Nigeria, women largely control a cottage industry for tomato processing: they take advantage of aggregation and innovation, such as using social media marketing and establishing a network of consumer clients to whom they supply their products, as a unique way of organizing supply and processing. The introduction of improved production practices (improved varieties, irrigation, and protected cultivation) could raise yields substantially and expand tomato production into the off-season, thereby stabilizing supplies. These improved practices would also facilitate the adoption of dual-purpose tomato varieties (i.e., tomatoes with sufficiently high Brix values that are suitable for fresh consumption as well as for processing). For instance, the Tomato Jos company in the state of Kaduna in northern Nigeria produces tomato paste locally and has contracted around 3,000 farmers, for the potential to cultivate 300 hectares of irrigated land (Caleb Ibukun Olanipekun, personal communication with the company).

Policy environment: The value of Nigeria's imports of processed tomato products peaked at \$220 million in 2013 (FAOSTAT 2022). In 2017, the government raised import tariffs on tomato concentrate from 5 percent to 50 percent and introduced a levy of \$1,500 per ton of tomato concentrate (*Daily Trust* 2021). These measures led to a rapid decline of imports, from \$180 million in 2017 to \$95 million in 2018 and \$48 million in 2020 (FAOSTAT 2022). At the same time, mean tomato yields have not increased over the past 20 years and were just above 4 tons per hectare from 2016 to 2020 (FAOSTAT 2022) because production was heavily affected by an infestation of the South American tomato pinworm. While a tariff may be necessary to prevent foreign companies from dumping excess supplies of tomato concentrate in West Africa, it is also important to promote

the productivity of local farmers and, ideally, the consumption of fresh tomato as well. The issue of imports should be addressed at the level of regional economic communities, as there is extensive regional trade in tomatoes and tomato products.

Fruit Juices Across Africa

Background: Fruit nectars or juices are commonly consumed across Africa (Ogiehor and Nwafor 2004; Ngadze, Verkerk, and Nganga 2017). In West Africa, people prefer to drink traditional juices such as tamarind (*Tamarindus indica*), monkey bread or baobab (*Adansonia* sp.), roselle (*Hibiscus sabdariffa*), and monkey orange (*Strychnos spinosa*) juice. In southern Africa, traditional juices include sand apple (*Parinari curatellifolia*) and marula (*Sclerocarya caffra*) juice. Data on fruit juice consumption in Africa are very limited, in part because a lot of the production is artisanal. However, the consumption of industrially processed and packaged juices is growing in line with global trends. Worldwide, orange juice is the most consumed juice, accounting for 42 percent of total juice consumption by volume (Tetra Pak 2016).

Artisanal juice production is common in various parts of Africa. For example, in Morocco, an estimated 200 million liters of juice are consumed annually, with 77 percent made by artisanal producers (Sylla 2020). In some rural areas of Zimbabwe, reports show that up to 40 percent of households produce juice as a source of additional income (Ngadze, Verkerk, and Nganga 2017). In Senegal, 70 percent of roselle juice (locally called “bissap”) is made by artisanal producers (Cissé 2010), who usually plant roselle to demarcate the borders of their fields. Some larger companies in Senegal, such as Kirène and Laiterie du Berger, produce traditional juices using industrial methods (Cissé 2010). South Africa is Africa’s biggest producer of fruit juices, with about 25 percent of all fruit juices imported by African countries originating from South Africa (FAOSTAT 2022). In 2021, the country processed 100 million tons of fruit into juice (South African Fruit Juice Association 2021).

From 2010 to 2020, African countries imported more fruit juices than they exported, although the difference is not large (Figure 3.2B). Only Côte d’Ivoire, Egypt, Kenya, South Africa, Tunisia, and Uganda are net exporters of fruit juice. Pineapple juice concentrate and orange juice (single-strength and concentrate) are the most important exports. South Africa and Kenya together account for 85 percent of the continent’s export of pineapple juice concentrate, while South

Africa accounts for 70 percent of the continent’s export of orange juice concentrate and 52 percent of the export of single-strength juice (followed by Egypt, with 19 percent) (FAOSTAT 2022). In terms of imports, apple and grape juice concentrates represent 25 percent and 20 percent of Africa’s import value of fruit juices, respectively. South Africa is the main importer, and some of its imported grape and apple juice is shipped from there to other countries in Africa. However, while Brazil processes 70 percent of its orange production, South Africa and Egypt process just 17 and 10 percent of their production, respectively (Neves, Trombin, and Marques 2020).

Challenges: The global trade in fruit juice concentrates is highly competitive. In Africa, farmgate selling prices for fresh fruits are often too high to make industrial juice production profitable. For instance, according to the Citrus Growers Association of South Africa, the price offered by exporters of fresh oranges was 20 times the price offered by local processors in the 2019/2020 season (CGA 2020). In Morocco, reports show that imported fruit juice is 50 percent cheaper than locally produced fruit juice (Sylla 2020).

Hygiene is very important in juice production, and there can be serious health risks to consumers if processing methods are not hygienic. The use of pasteurization and cold storage is essential to ensure food safety but is often not guaranteed in artisanal fruit juice production. The lack of stable power sources in rural areas is a major challenge for the development of the juice processing industry.

While fruit juice can be an important source of micronutrients, it can also contain high amounts of sugar, and factory-packaged juices may contain only a small fraction of actual fruit juice. High fruit juice consumption can therefore be a contributing factor to overweight and obesity (O’Neil, Nicklas, and Kleinman 2010; Ruxton and Myers 2021).

Opportunities: The African juice market has expanded by more than 65 percent over the past decade. African consumers are also becoming more aware of the importance of food quality and food safety. For small-scale producers able to meet food safety requirements, this growing awareness offers the opportunity to develop specific products for the local market, such as premium juice, freshly squeezed juices, and traditional juices. Small- and medium-sized companies can achieve quality only through training in good hygiene practices and the use of appropriate equipment.

African countries export mostly fresh fruits (as well as fresh tomatoes in Morocco and Egypt), but processing presents an opportunity to increase the value of fresh fruit. It appears essential to introduce specialized varieties suitable for processing in order to develop a fruit juice industry. The organization of farmers into producer groups (clusters or cooperatives) is also important for reducing costs: processors would no longer have to deal with thousands of small-scale producers.

Policy environment: Because most fruit juice processing remains small-scale and artisanal, African countries have not created dedicated policies in an attempt to expand the sector. Morocco is an exception: the Moroccan government has stimulated local processing of citrus fruits through improved access to financing and promotion. Currently, there are a dozen Moroccan producers of fruit juice, of which four use local produce, while the others import fruit juice concentrates (Sylla 2020).

Pineapple Processing in West Africa

Background: Pineapple accounts for about 20 percent of the world's tropical fruit production and is the second most cultivated tropical fruit after banana. Globally, the fresh pineapple industry has grown about 6 percent per year since 2000 (ITC 2019). In 2019, West Africa earned about \$66.9 million from fresh pineapple exports to the European Union. Nigeria is the region's largest producer, followed by Ghana, Benin, Côte d'Ivoire, and Togo. Global pineapple markets shifted to the variety MD2 in the late 1990s and early 2000s: this variety is preferred for export because of its long shelf life. Exports from West Africa almost collapsed because growers there produced sweeter but much more perishable varieties (e.g., Smooth Cayenne, Baronne de Rothschild). The MD2 variety accounted for roughly 90 percent of all pineapples grown in the Economic Community of West African States (ECOWAS) in 2014 (ITC 2021), but traditional varieties have regained some popularity in local and regional markets. For instance, Benin produces mostly the *Pain de Sucre* (Sugarloaf) variety, which is popular in West Africa. Processed pineapple products include juice, canned pulp, fruit jellies, marmalades, fruit purees and pastes, and dried pineapple. For these products, juice extraction appears to be the main type of processing.

Challenges: Pineapple, like most other fruit, is highly perishable, and processing is one way to extend its shelf life. Processing is carried out at the artisanal, semi-industrial, and industrial scales. Artisanal processors represent the

largest group, but their processing capacity is low. Artisanal and semi-industrial processors are often family-run businesses or village-level cooperatives that buy fresh pineapple directly from farmers or market vendors and target local markets and occasionally regional markets. Industrial-scale processors often produce below their capacity (60 percent below capacity) due to a lack of raw material (European Commission 2020). They target domestic, regional, and international markets.

Regardless of the scale of processing, a key challenge is the lack of fresh product supply throughout the year. Other challenges include the lack of availability of varieties suitable for processing, high production costs and low productivity, a lack of well-organized cooperatives and access to loans, limited market information, and a lack of processing and packaging equipment as well as of refrigerated storage and transportation. Artisanal and semi-industrial processors are usually not certified, which limits their access to regional and international markets (LEADD 2016).

Opportunities: There is increasing demand for fresh pineapple and pineapple products in regional and international markets. There is also a growing market for certified processed foods (von Braun and Pandya-Lorch 2020). Development partners are involved with the pineapple sector in Benin, and processors can tap into this network to upgrade their processing units, develop business networks that include all value-chain actors, get trained and certified, and as a result, seize market opportunities.

Policy environment: There are some current efforts toward product certification in West Africa, but there is still a lot to do in terms of policy and quality standards. Most countries have no dedicated food safety agency that provides oversight to the pineapple processing industry. In Benin, for instance, only a few processing companies have Hazard Analysis and Critical Control Points (HACCP) or International Organization for Standardization (ISO) certifications (Desclee, Sohinto, and Padonou 2021). *Pain de Sucre* pineapple from the Allada Plateau in Benin became the first protected geographical indication at the African Intellectual Property Organization in 2021. This designation is a step in the right direction, but more policy involvement and support along the value chain is required.

Traditional African Vegetables in Kenya and Tanzania

Background: Spider plant (*Chlorophytum comosum*), amaranth (*Amaranthus* spp.), African nightshade (*Solanum nigrum*), African eggplant (*Solanum aethiopicum*), jute mallow (*Corchorus olitorius*), cowpea leaves (*Vigna unguiculata*), slenderleaf (*Crotalaria brevidens*), sweet potato leaves (*Ipomoea batatas*), and pumpkin (*Cucurbita moschata*) are traditional African vegetables (TAVs) commonly grown and consumed in Kenya and Tanzania (Ayenan et al. 2021). In Tanzania, amaranth and sweet potato leaves are the most popular, while in Kenya, the most popular are cowpea and African nightshade leaves. These vegetables are both resilient and nutritious, and have received much interest among health-conscious urban consumers. TAVs also have the potential to improve environmental sustainability by contributing to agrobiodiversity and strengthening climate resilience among farmers (Mwadingeni et al. 2021). They are generally better adapted to local growing conditions and require fewer external inputs than exotic fruits and vegetables like pineapples and tomatoes, which are usually produced in monocrop systems. However, the production of TAVs can be highly seasonal, and market prices fluctuate greatly.

Processing can reduce such price fluctuations while increasing overall supplies and adding value for smallholder farmers and traders. There is a tradition of processing TAVs in East Africa, but the share that is processed is currently small. Weinberger and Pichop (2009) estimated that 2.1 percent of Kenyan farmers and 14.5 percent of intermediaries process TAVs. Basic processing carried out by farmers and traders includes washing, plucking the leaves from the stalks (destalking), chopping, grading and sorting, and blanching—typically achieved by wrapping the vegetables in a cloth and dipping them in hot water for two to five minutes before rapidly cooling them. According to Okello and colleagues (2015), more than 88 percent of consumers in Kenya are willing to pay more for cleaned, sorted, and graded fresh cowpea leaves, while 35 percent and 25 percent of consumers, respectively, prefer destalked and chopped vegetables over unprocessed vegetables. The use of open-air sun drying is also common across Africa south of the Sahara (Kazosi et al. 2021), as is drying in the shade using passive or active air circulation (Mekhilef, Saidur, and Safari 2011). More recently, solar dryers have been introduced to dry vegetables more efficiently and consistently than shade drying (Wakholi et al. 2015).

More advanced methods of processing can include cooling, fermentation, freezing, and processing into powdered vegetables. Cooling and refrigeration are currently applied only in supermarket value chains. Fermentation using lactic acid is practiced to a small extent, but there are health concerns if not executed properly (Wafula et al. 2016). Freezing involves blanching and vacuum packing the vegetables into polythene bags. There is also a tradition in Kenya and Tanzania of using powdered vegetables to prepare soups or stews (e.g., as a bouillon), or to fortify maize or millet flour. Onyango and Imungi (2007) documented the use of powdered vegetables with sesame (simsim) to make healthy snacks in Kenya, including *simshade* (a mixture of nightshade and sesame), *simco* (cowpea and sesame), and *simama* (amaranth and sesame) snacks. Such processed snacks are still being tested and are not yet widely available, despite evidence that wealthier urban consumers are willing to pay for such products (Tepe, Benali, and Lemken 2021). Ingredients that have minor effects on taste and appearance are regarded more positively than those that alter food products more notably (Wanyama et al. 2019).

Challenges: African leafy vegetables are often considered a poor man's food; people generally prefer starchy staples, meat, and imported vegetables, resulting in low consumer awareness of the nutrition and health benefits associated with local leafy vegetables. This perception has changed among wealthier urban consumers, but consumption of African leafy vegetables nevertheless remains low. Although there is much potential for processing these vegetables, currently most processing remains small-scale and artisanal. The link between producers and consumers is not organized, prices are volatile, and compliance with food safety standards is low. Some processing options have low consumer acceptance; for instance, a study in Kenya showed that 44 percent of consumers were not willing to pay for frozen cowpea leaves, and 70 percent were not interested in frozen vegetables in general (Okello et al. 2015), indicating the need to create awareness of the nutritional value of frozen vegetables.

Opportunities: There is increasing interest in TAVs, particularly among wealthier consumers in cities. Kenya and Tanzania are uniquely placed to take advantage of the domestic and regional markets expanding through their ports and centralized locations. There is great potential to increase the production and processing of TAVs in Kenya and Tanzania, which could improve the use of vegetable processing units. More than 90 percent of agricultural produce in the two countries is sold unprocessed. Value added in TAVs remains largely untapped,

though it is key to remember that from a nutritional point of view, TAVs are best eaten fresh with minimal processing.

Policy environment: Government policy objectives in Kenya and Tanzania are geared toward ensuring that all citizens have an adequate, diverse, and healthy diet through improved storage and processing of food commodities, including vegetables. However, research efforts, extension services, policies, and subsidies largely ignore TAVs, and mainly target staples and F&V meant for export.

Discussion

In Africa, only a small portion of F&V is processed, and fresh produce is clearly the most important part of the market. This is positive from a nutritional point of view since fresh produce is healthier. However, the F&V supply is characterized by seasonality, low productivity, and high postharvest losses, which undermine the potential of F&V to contribute to improved economic and nutrition outcomes. Processing can help to stabilize market supplies, add value, and reduce postharvest losses while creating employment. Processing can also make F&V more acceptable to consumers interested in convenience, though it may compromise the nutritional value of F&V. However, the F&V processing industry in Africa is still largely artisanal, with a few exceptions.

Current policies appear geared toward two main objectives: (1) substituting imports of tomato paste and fruit juice concentrates, and (2) increasing the export of fresh and processed F&V. We found very little evidence of policies geared toward exploiting the potential of processing to improve farmers' incomes and consumers' health. TAVs are particularly low on policymakers' priority lists, despite their nutrition and health benefits, which often exceed those of exotic vegetables; however, processing of TAVs (washing, destalking, chopping, sorting, and blanching) is so limited that it can hardly be considered processing. Data on F&V processing for domestic and regional markets are scarce; therefore, a good overview of how much is currently processed and how this sector is developing is lacking. Better data collection to inform policy decisions in this area is therefore essential.

African consumers are increasingly purchasing processed food (Reardon et al. 2021), and F&V are not an exception. The case study on tomato processing

shows that the local processing industry has difficulty taking advantage of this opportunity due to fierce foreign competition and the relatively high cost of local production. Local processing plants use imported tomato concentrate from China and Italy rather than buy fresh tomatoes from local farmers, who are seeing their markets dwindle as a result.¹

More local tomato processing could have tremendous benefits, including reduced carbon emissions from a shorter value chain, the creation of local jobs, and more income opportunities for farmers. Strong policy support will be necessary to take advantage of these opportunities. The key challenge will be improving the competitiveness of the local processing industry. Nigeria is an interesting example: the Nigerian government has taken some bold steps to improve competitiveness. The effect of the country's restrictions on imported tomato paste on the local processing industry, farmers, and consumers remains to be analyzed. However, such import tariffs must be accompanied by farm-level interventions that help farmers adopt better technologies to increase the stability of the tomato supply and the quantity of tomatoes suitable for processing as well as for fresh consumption.

The case study on TAVs shows that processing of these vegetables is relatively rare and mostly artisanal. From a nutritional point of view, TAVs are best eaten fresh. However, there is increased interest in using TAVs in processed products in East Africa. Given the multiple nutritional and environmental benefits of TAVs, it is important to seize this momentum. Tepe, Benali, and Lemken (2021) showed that while fresh TAVs were consumed mostly among elderly, poorer, and rural populations, processed TAVs enjoyed greater acceptance among younger, wealthier, and urban consumers. They argued that there is a need for carefully designed marketing strategies to ensure that marketing messages also reach the poorest population groups and those most affected by malnutrition. Interestingly, Tepe, Benali, and Lemken (2021) found that graphic information on nutrition and/or shelf life was not helpful in creating additional demand. Women and rural consumers were more reluctant to buy processed products than younger, male, and urban consumers. Promoting a greater diversity of locally processed F&V may enable niche markets to flourish and may provide access to a wider range of nutrients. Ready-to-cook, cut F&V, specifically leafy vegetables, and vegetable

¹ Two documentary films on this subject are worth watching: *The Empire of Red Gold* (2017) by Jean-Baptiste Malet and Xavier Deleu, based on a book of the same title by Jean-Baptiste Malet and produced by Java Films; and *Displaced—Tomatoes and Greed—The Exodus of Ghana's Farmers* (2019) by Elke Sasse, produced by Deutsche Welle. Both films are publicly accessible on the Internet.

powders may have a lot of potential in urban markets. However, promoting these products requires an integrated approach focused both on stimulating supply and demand and on guaranteeing traceability and food safety, which is supported by adequate policies and actions.

The reduction of postharvest losses through processing will have direct environmental benefits, but processing may also lead to increased use of plastics for packaging and increased energy use for storage and processing. Renewable packaging materials and energy sources are available but still not always competitively priced.

It is also important to ensure that processing preserves the nutrition and health benefits of F&V. This goal requires adaptive research to evaluate the retention of nutrition and health benefits in various targeted processed products. Tepe, Benali, and Lemken (2021) pointed out that government support of F&V processing should be directed toward preserving nutrients in the final products.

Conclusion

Africa's F&V processing industry is in its infancy, but urbanization and income growth are creating opportunities to add value to F&V through processing. Current policies appear geared toward stimulating exports and substituting imports but should focus on making processing locally produced F&V more competitive in order to target domestic and regional markets for the benefit of local farmers and consumers. For tomatoes in West Africa, the focus has historically been on large-scale, public-sector processing plants, which have not been successful. Smaller-scale processing plants with more flexible production lines may be more suitable for partnering with groups of local farmers to create stable input supplies of tomatoes suitable for processing. In East Africa, current policies are largely silent on TAVs, and all processing is small-scale and artisanal. Given the clear environmental, nutrition, and health benefits of TAVs, it is important to prioritize processing with a focus on the growing urban markets for these products.

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