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African domestic supply booms in value chains of fruits, vegetables, and animal products fueled by spontaneous clusters of SMEs

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Abstract

There is an international consensus that Africans consume less fruits and vegetables (FV), and animal products (AP) than they need for adequate nutrition, and that production and supply chains of these products are constrained. Yet, in this paper, we show that despite these problems, there is a lot of dynamism in demand and supply of these nutrient-dense products in Africa: (1) macro evidence of "domestic supply booms"—with supply growing as fast as or faster than in Asia and Latin America; (2) only 2–4% of FV, and 10% of AP consumption in Africa is imported, and only about 1–2% of the output of FV and AP is exported: the supply booms have thus been overwhelming domestically sourced,

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not imported; (3) micro evidence of substantial shares of consumption of FV and AP in total food consumption, similar to Asia's; (4) evidence of rapid development of spontaneous clusters of farms and off-farm SMEs (output wholesalers, logistics, processors, and agro-dealers supporting farmers). These clusters are important in fueling the supply booms. Illustrative cases from Ethiopia, Nigeria, Tanzania, and Zambia are presented. We recommend that African governments and international partners: (1) internalize the fact that these spontaneous clusters are forming and already fueling supply booms; (2) note that important drivers of the booms have been government investments in wholesale markets, roads, and other infrastructure like electrification, and agricultural research/extension; (3) leverage and support existing spontaneous clusters and help new ones to form by greatly increasing those three types of public investments.

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In the past decade, the international debate has sounded the alarm on urgent problems in the African[1] food system. An international consensus appears to have formed with a general image of Africa's food supply and consumption in a quagmire of slow growth, malnutrition, and import dependence, with domestic food supply chains often described as broken, failed, and stagnant (African Development Bank, 2020; AGRA, 2023; FAO, ECA, AUC, 2019; The Economist, 2020).

In particular, there has been widespread attention to: (1) the deficit of Africa in consumption of nutrient-dense foods such as fruits and vegetables (FV) and animal products (AP) (e.g., Harris et al., 2022; Miller et al., 2022); (2) the high cost of nutrient-dense foods in Africa (e.g., Heady & Alderman, 2019; Masters et al., 2018), import dependency for nutrient-dense foods, and limited growth in their supply, occurring only in small pockets of transformation (African Development Bank, 2016). The domestic production and domestic supply chains of FV and AP are often described as severely underdeveloped and stagnant (e.g., AGRA, 2023). Solutions in the international debate are often focused on exports (African Development Bank, 2016), leapfrogging via digitalization (AGRA, 2023; United Nations, 2023), and agro-parks and other special economic zones (African Union, 2023).

In this paper, we do not critique the international debate in its attention to these serious problems and challenges. In fact, we applaud the attention to the consumption deficit of nutrient-dense foods. However, we contend that the above attention to the problems and challenges should be complemented by attention to emerging evidence of the growth in consumption and domestic supply of FV and AP. These domestic supply booms are fueled by the exciting rise of spontaneous clusters of farmers and value chain actors of FV and AP in Africa.

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We do not see these two viewpoints as competing: the debate should simultaneously see how much African food systems are still inadequate and also recognize where and how and why some parts of those systems are dynamic. This will point to important policy implications which involve emphasizing doing more and better the investments and policies that have facilitated the dynamism we document.

We show three things. First, from the lens of macro data, we show that there have been domestic supply booms of FV and AP in the past decade in Africa. This growth was as fast or faster than in Asia, often seen as a success case. But the growth was just at or a bit slower than the pace of population growth and thus still needs to accelerate to create adequate levels of nutrition.

Second, from the lens of micro data, we show the demand for FV and AP has grown to be substantial. It now rivals the consumption of starchy staples in terms of the share of food consumption in value terms.

Third, via synthesis of five illustrative cases, we show the rapid rise of spontaneous clusters that fuel the domestic supply booms of FV and AP in various African countries. These clusters have developed in a grass roots dynamic over the past 10–15 years responding to the tremendous growth in domestic demand—both urban and rural.

The cases are based on recent field studies of spontaneous clusters of small- and medium-scale farms, and small- and medium-scale enterprises (SMEs) downstream (processors, wholesalers, and third-party logistics) and upstream (farm input suppliers or agro-dealers and agricultural service providers) (Macchiavello et al., 2022; Naugler et al., 2024 and Rutsaert et al., 2021). The term spontaneous cluster (Hu et al., 2019; Reardon et al., 2021; Reardon & Barrett, 2000; Schoonhoven-Speijer & Vellema, 2020) comes from the marriage of two concepts: (1) a vertical cluster, featuring farmers as well as FVC (food value chain) actors upstream and downstream from farms (Pietrobelli & Rabellotti, 2006) and (2) spontaneous, to emphasize that the firms and farms cluster independently and are self-coordinated or uncoordinated, not managed by a large company or by government or NGOs. These spontaneous clusters arise where there are propitious demand conditions (e.g., accessible growing urban markets for FV and AP) and supply conditions (e.g., wholesale markets and roads combined with availability of water and other needed resources). These spontaneous clusters can be contrasted with "policy-driven clusters" such as agro-parks and special economic zones set up and managed by governments and "anchor companies" (Huang et al., 2012; Ulimwengu, 2019) as well as outgrower schemes supplying a large processor or supermarket or exporter.

We present the African cases of spontaneous clusters as illustrations of how fast FV and AP farms spread, and how they were supported by rapidly proliferating SMEs in output and input supply chains upstream and downstream from the farms. These SMEs include wholesale, processing, logistics, input retail, and agricultural services like well excavating. We show how little direct role the government had and how important their indirect role was in creating the enabling conditions, including roads, wholesale markets, electricity, and in some cases, new or adapted technologies provided by NARS (National Agricultural Research Systems). These cases are focused on clusters supplying domestic markets. We focused on the latter because domestic markets for these products represent 98 and 99% of AP and FV output in Africa (in tons terms) as only 2 and 1% of these two product categories is exported (Awokuse et al., 2019).

The paper proceeds as follows. Section 1 shows the growth of African supply of FV and AP using macro data. Section 2 discusses patterns and growth in and demand for these products reviewing micro data. Section 3 presents five case studies of spontaneous clusters, two of AP and three of FV. Section 4 concludes and presents policy implications.

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MACRO VIEW OF GROWTH OF DOMESTIC SUPPLY OF FV AND AP

Table 1 shows macro supply trends for starchy staples versus FV and AP in Africa, Asia, and Latin America of production and per capita availability growth over 10 years (2020 versus 2010) and import shares and adequacy rates for 2020. The following points are salient.

First, imports form a small share of overall consumption of AP (10%), fruits (2%), and vegetables (4%) in Africa, in all cases lower than the import share of staples (15%). The great majority of AP and FV comes from domestic supply. Moreover, the import shares are close to those in Asia. These low import shares are at odds with what we observe to be the widespread view that SSA is strongly import dependent (e.g., African Development Bank, 2016; Rakotoarisoa et al., 2012).

Second, the domestic supply of FV and AP has grown quickly (albeit from a low starting point) over the past decade, with a jump of 36% of the output of vegetables, 43% of fruits, and 29% of AP from 2010 to 2020. This growth is as fast or faster than in Asia and much faster than in Latin America. This growth contributed to forming the important role of FV and AP in African diets shown in Section 2.

To our knowledge, there is little acknowledgement of this rapid domestic supply growth for example in African horticulture in the international literature and debate. By contrast, in our literature review, we found many articles on constraints to horticulture production in Africa,

TABLE 1 Macro trends in supply of starchy staples, fruit/vegetables, and animal products.

	Domestic production growth: (2020–2010)/2010	Per capita availability growth (2020–2010)/2010	Share of imports in consumption (imports/consumption-by-disappearance), 2020	Adequacy: food available/healthy diet level, 2020 (positive are above adequate)
Starchy staples				
Africa	32%	−2.0%	15%	
Asia	14%	0.1%	14%	
Latin America	24%	−1.6%	17%	
Vegetables				
Africa	36%	0.9%	4%	−55%
Asia	25%	14.3%	2%	25%
Latin America	4%	−3.6%	6%	−64%
Fruits				
Africa	43%	5.6%	2%	−40%
Asia	26%	17.6%	7%	−31%
Latin America	−8%	−12.6%	4%	−64%
Animal products				
Africa	29%	−4.2%	10%	−33%
Asia	31%	18.3%	8%	40%
Latin America	14%	3.1%	4%	155%

Source: Authors' calculations using data from FAO Food Balance Sheets; availability and adequacy data are drawn from Dolislager et al. (forthcoming), derived by comparing consumption per capita with the level that would generate a healthy diet per nutrition norms noted in Harris et al. (2022).

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and a number of publications (e.g., African Development Bank, 2016) pointing to emerging success stories in horticultural exports; the attention in the literature to the latter can be contrasted with the fact that only 1% of African fruit and vegetable is exported.

Third, weighing against the above good news of rapid supply growth, population grew as fast or faster. Per capita availability of vegetables just edged up by 0.9% over the decade, fruits only by 5.6%, and animal products fell a little (−4.2%). Asia did better in all three and Latin America did better in animal products. That is, Africa did as well or better in growing output but that was only just barely or not enough to keep up with population growth.

We applied the lens of a longer period and analyzed FAOSTAT food budget sheet data for various AP items, comparing 2000–2020. Keep in mind that the SSA population increased nearly 2-fold over those two decades. We found that in absolute terms output grew rapidly but did not exceed population growth in red meat (whose output increased 2-fold) and fish and seafood (whose output grew 1.7-fold), so output per capita stagnated or declined despite rapid output growth. By contrast, dairy output grew 2.6-fold and poultry and eggs, 3.8-fold, both faster than population growth, so output per capita grew.

Moreover, the cross-country macro data disguise substantial increases in per capita consumption in specific countries. For example, for Ethiopia, Bachewe and Minten (2023) show that consumption of FV per capita grew 1.6-fold in urban and 1.3-fold in rural areas from 2011 to 2016 (albeit from a low base). For AP, such as dairy in Ethiopia, Minten, Habte, and Tamru (2020) show for Addis Ababa that annual kilograms intake per adult equivalent increased by 31% in only 10 years (2005–2016). For fish in Nigeria, Liverpool-Tasie, Sanou, et al. (2021) show that the share of households consuming fish rose from 59% to 72% over just 5 years, 2010–2015. For chicken and eggs, in Ethiopia, Abegaz et al. (2018) show that intake doubled in real terms from 3.8 birr/capita per year to 7.1 in 15 years (1996–2011). In Ghana, Knößlsdorfer and Qaim (2023) show that intake of chicken rose from 40,000 tons in 1999 to 260,000 tons in 2018; in per capita terms that is from 2.1 to 8.4 kg in those two decades.

Fourth, nevertheless, Africa's intake of these nutrient-dense foods is below what is required for a healthy diet, by 55% for vegetables, 40% for fruits, and 33% for AP. While these deficits are similar to Latin America in FV, and Asia in fruits, Asia does much better in vegetables and both Asia and Latin America do much better in AP. These findings are in line with studies noting that quantities of these products are still too low and often costs to consumers are too high (Anderson & Birner, 2020; Vermeulen et al., 2020).

SUBSTANTIAL AND RISING CONSUMPTION OF FV AND AP IN AFRICA: VIEW FROM MICRO DATA

Shares of FV and AP in food consumption: Africa versus Asia

Table 2 shows the shares of FV and AP (compared with starchy staples) in total household food consumption in value terms[2] in Africa, with a comparison of urban and rural, and within rural, by peri-urban rural versus other rural. The table includes figures for Asia; the comparison with Asia is interesting because Asia is often held up in general as an agricultural success story compared with Africa. The following results stand out. First, as expected from Bennett's Law (Popkin & Bisgrove, 1988), the shares of starchy staples are 30% and 42% in urban versus rural areas in Africa. The patterns in Asia, 26% versus 37% for urban versus rural, are very close to those in Africa.

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TABLE 2 Shares of starchy staples, fruits, vegetables, and animal products in household food consumption in value terms in Africa and Asia.

	Africa			Asia	
		Rural			
	Urban	Peri-urban rural	Other rural	Urban	Rural
Starchy staples	30	40	43	26	37
AP + FV	35	27	27	43	38
Fruits and vegetables	15	13	13	14	13
Vegetables	12	11	11	9	10
Fruits	3	2	2	5	4
Animal proteins	20	14	14	30	25

Note: Figures for Africa are from Dolislager et al. (forthcoming) based on data from Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Guinea-Bissau, Malawi, Mali, Niger, Nigeria, Senegal, and Togo. Figures for Asia are the simple average of four countries of figures from Bangladesh, Indonesia, Nepal, and Vietnam in Reardon et al. (2014). Total food consumption value includes the value of food consumed at home from own production, gifts, in-kind transfers, and purchases. Purchases data for purchases for consumption at home because LSMS do not disaggregate by products the data on food-away-from-home; the effect of that latter exclusion is not discoverable from the data.

Second, the shares of AP and FV combined are 35% for urban versus 27% for rural. This is interesting for two reasons. (1) The shares are close, showing a convergence in diets between rural and urban areas. (2) The share of AP and FV in urban areas exceeds that of starchy staples in urban areas, a point made even more important given that urban areas form a big share of total food consumption in African countries (e.g., 58% in Nigeria and 46% in Tanzania, Liverpool-Tasie, Reardon, & Belton, 2021). But even in rural areas AP plus FV's share is two-thirds that of starchy staples, emphasizing that diet diversification beyond staples is occurring in rural areas too. The peri-urban rural and other rural show the same shares for FV and AP. Finally, the share of FV plus AP in urban Asia is only 1.2 times that in urban Africa, while that ratio is 1.4 for rural areas. This suggests inter-region convergence in urban diet diversification patterns.

Third, the results for FV highlight that urban and rural, and African and Asian shares are interestingly similar, ranging around 13%–15%. That share exceeds the share of individual grains that figure much more prominently in policy debates, such as rice in Tanzania and rice and maize in Nigeria.

Fourth, AP's share is 20% in African urban consumption, which is 1.5-fold that of FV in urban, and 1.4-fold that of AP in African rural areas. In urban areas the African share is two-thirds that of the Asian share; in rural areas, half the Asian share. Thus, the gap with Asia is greater for AP than for FV, and greater in rural than in urban areas. As with FV, we are again struck by the importance of AP's share in African consumption being comparable with that of grains that figure far more centrally in food debates in Africa. An example from Nigeria is fish having a 10% share in food consumption, similar to rice or maize (Liverpool-Tasie, Sanou, et al., 2021).

Table 1's multicountry and cross-section results disguise several points concerning evidence of dynamism in nutrient-dense food consumption over time. On the one hand, there has been growth in shares documented from micro data in several countries. For AP, the few household survey studies we could find show that AP shares in household food consumption tend to

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increase over time. For example, for Ethiopia, Minten, Mohammed, and Tamru (2020) show the share rose from 8% to 13% over 2000–2016.

For FV, Parkhi et al. (2023) for Nigeria show over 2010–2019 that the share of households consuming fruit jumped from 32% to 63% in the poorer North, versus 58% to 83% in the richer South. The share of households consuming vegetables stayed near 100% over the period in both regions. The share of FV in food consumption stayed at around 12%–13% over the decade in the combined urban plus rural North versus growing from 13% to 16% in the richer south. For Senegal, Faye et al. (2023) show with FAOSTAT data that cereal consumption (in tons) grew 2.6-fold and FV consumption grew 4.4-fold over 1990 to 2018. For Ethiopia, Minten, Mohammed, and Tamru (2020) show the share of FV in total food consumption rose from 4.5% to 9% over 2000–2016. For the findings on increases in shares of FV, a qualification can be necessary in certain cases; for example, Bachewe and Minten (2023) note that fruit and vegetable prices grew faster than cereals prices in the past decade, which would have been one component in driving the increase in the FV share.

On the other hand, there has been a transformation of the product composition within FV and AP. For example, the composition of FV consumption in Africa has undergone what can be called Westernization with a shift from a focus on traditional vegetables (such as African eggplant, okra, and indigenous green leafy vegetables) to nonindigenous vegetables especially tomatoes, onions, and chili peppers. These three items are versatile to use in traditional dishes as well as relatively new (over a half century) dishes such as rice jollof in Nigeria. These three nontraditional vegetables are the dominant vegetables in the diet, for example, in Senegal, Faye et al. (2023), and Nigeria, Parkhi et al. (2023).

Table 3 shows the shares of AP and FV in total food consumption by income terciles. The following points stand out. First, the distribution of FV shares over terciles is flat in every spatial category for vegetables especially, although the (low) fruit shares tip up over income terciles. Country studies such as in Senegal (Faye et al., 2023) show that the upper- and lower-income consumer terciles have similar shares of the overall category of FV in food consumption, but the item composition of the FV category differs over terciles: the lower income consumers source cheaper FV items. Moreover, the total expenditure in value terms and the level in kilograms of FV is higher for the upper income terciles.

Second, the distribution of AP shares over terciles is moderately rising (with a ratio of 1.6) between low- and upper income terciles and sharply rising (with a ratio of 2.0) between rural and urban areas. This is consistent with a hypothesis of AP as a luxury over income terciles. This finding is echoed in country studies such as in Ethiopia (Abegaz et al., 2018), as well as in Asian studies (Reardon et al., 2014).

Purchases in urban and rural FV & AP consumption

Purchases form a large share of African consumption of FV and AP in both urban and rural areas. These purchases form an enormous demand pull for the domestic supply booms fueled by spontaneous clusters we discuss below.

The total purchased volume of FV and AP from domestic supply chains from rural producers to urban consumers is huge and has grown over time. Three points combine to show this.

First, the great majority of urban consumption of FV and AP comes from purchases, not from urban agriculture. For example, Faye et al. (2023) in Senegal and Lazaro et al. (2024) in

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TABLE 3 Shares by income terciles for Africa.

	Urban			Rural					
				Peri-urban rural			Other rural		
	Lower income	Middle income	Upper income	Lower income	Mid income	Upper income	Lower income	Mid income	Upper income
Staple foods	38	31	24	47	43	35	49	43	38
AP + FV	29	36	37	23	26	32	22	25	31
Fruits and vegetables	15	16	14	14	13	14	13	13	13
Vegetables	13	13	11	12	11	11	11	11	11
Fruits	2	3	3	2	2	3	2	2	2
Animal proteins	14	20	23	9	13	18	9	12	18

Note: The information sources are as in Table 2. Income terciles are proxied by terciles of total expenditure per adult equivalent. Terciles were constructed by each spatial category (urban, peri-urban rural, and other rural).

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Tanzania show that 99% of FV consumed in urban areas is purchased; 1% comes from urban gardens.

Second, almost all FV and AP consumed in Africa are domestically produced. Above we showed that imports of FV and AP are a tiny share of total consumption of those items (4% for vegetables, 2% for fruit, 10% for AP). Domestic supply chains provide 96% of vegetable consumption, 98% of fruit consumption, and 90% of AP consumption in Africa.

Third, urban markets for FV and AP production in rural areas have grown dramatically. The urban population level and share of regional population has grown fast. In 1990, 28% of the population of SSA was urban; by 2022, it is 42%.[3] Urban population in those three decades increased 3.5-fold from 142 to 513 million.

Fourth, urban markets are important food markets in many African countries. The high urban population share noted above even understates the share of national food consumption by urban consumers. For example, urban consumption constitutes 60% of Nigerian national food consumption while the population share is around 50%. For Tanzania, urban areas have a 46% urban share in food consumption versus 35% of the national population. Note that these urban market shares in food consumption mean they are approximately 30–50 times more important than FV and AP export markets.

Rural areas are also a huge market for AP and FV. There is emerging evidence that this market is partly or mostly supplied by supply chains that come from other rural zones. Several points support this. Various studies have shown the substantial shares of purchases in AP and FV consumption and that these have been increasing over time. Dzanku et al. (2024) analyzed multiple waves of LSMS data over the past 10 years for Ethiopia, Ghana, Malawi, Niger, Nigeria, Tanzania, and Uganda. They show that 74% of the rural consumption of FV came from purchases (with the rest from own production); that share was 72% for AP. Similar shares were found for FV with nationally representative rural surveys in Senegal and Mali (Faye et al., 2023 and Smale et al., 2020, respectively). Faye et al. (2023) found that purchases were not confined to rural areas near towns but extended over rural zones (75% in rural peri-urban, 78% in intermediate zones, and 75% in hinterland areas).

The geography of these supply chains to rural areas requires more research. But emerging evidence shows that for a number of key products, such as triad of vegetables noted above (tomatoes, onions, chilis), medium-long supply chains run from key clusters of production of those vegetables to reach all over rural areas; short supply chains (within a given zone) tend to be confined to green leafy vegetables. We discuss further below an example of this. Tomatoes from a few main irrigated tomato clusters are supplied to rural and urban consumers all over Tanzania (Ijumba et al., 2024). This is similar to the Nigerian case, where tomatoes from a few areas in Northern Nigeria supply most of the large tomato market in urban and rural areas of Southern Nigeria (Liverpool-Tasie, Yau, et al., 2023).

SPONTANEOUS CLUSTERS IN AP AND FV FUELING DOMESTIC SUPPLY BOOMS

General characteristics of the spontaneous clusters studied

Hall et al. (2017) identify three categories of commercial farming in Africa: (1) plantations; (2) outgrowers for contractors such as cacao processing facilities; and (3) commercial farmers which they define as only medium farmers. We class the farms in the spontaneous clusters in

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(3) but note that small commercial farmers are also in that cluster so redefine the commercial category as small and medium farmers.

The spontaneous clusters studied developed in response to rising domestic demand for FV and AP. Their development was facilitated on the supply side by various factors: (a) government investment in infrastructure, in particular roads and wholesale markets giving them access to demand, and sometimes electricity grids and improved seeds and extension in new practices by NARS (national agricultural research and extension services); (b) good natural conditions such as sufficient water.

These clusters consist of: (1) farmers; (2) off-farm enterprises which provide services upstream and downstream from the farmers. Those services are in output value chains (such as wholesalers, processors, and logistics firms) and input value chains (such as agri-dealers in variable inputs, equipment, and agricultural services). In all the clusters examined in this section, the enterprises in the off-farm segments of value chains are MSMEs (micro, small, and medium enterprises). They are based in nearby towns/secondary cities or in the rural areas. Most of the wholesalers' and processors' sales are to domestic markets. In only a few cases does a small portion of the product go to cross-border trade (some Zambian vegetables and some Nigeria fish).

Moreover, in our cases, the enterprises are not financed by foreign direct investment (FDI). However, their startup paths and finance were diverse: (a) local small-scale crop farmers or fishers that diversified into the cluster product; (b) medium-scale local commercial grain farmers who began producing the cluster crops (such as in the Zambian vegetable clusters); (c) urban-based investors who bought or rented land to start medium-sized vegetable or fish farms; this was common in our cases (such as in Ethiopia and Zambia) and in the African literature (see e.g., Brønd et al., 2016; Hall et al., 2017; Jayne et al., 2016; Neven et al., 2009).

FDI is however present in some African cases of spontaneous clusters such as via larger domestic-registered firms established by foreign nationals or multinational firms (such as fish farming in cages in the great lakes in Zambia (Genschick et al., 2017)). Also, while we do not class these as spontaneous clusters of independent small/medium farmers, there are clusters "anchored" in FDI, such as in horticulture primarily for export in Kenya and Senegal (e.g., Maertens & Swinnen, 2009) and for domestic or regional markets of dairy with Indian FDI in dairy in Uganda (Van Campenhout et al., 2021). Moreover, FDI has been present upstream from clusters, for example in fish feed mills.

In the clusters studied, relations among the actors are not coordinated by formal contracts. However, there are various forms of informal coordination among actors within the clusters, such as illustrated in Nigeria fish clusters (Liverpool-Tasie et al., 2024) but found in various forms in the other clusters: (a) traders in wholesale markets often have associations with informal coordination/rules; (b) MSME processors sometimes have de facto collective investments such as where they have privately constructed fish smoking kilns in wholesale markets that are "open access" to other fish processors when not in use by the owners; (c) fish farmers such as in Nigeria sometimes collectively hire security, labor, and managerial staff to look after their colocated farms; (d) there are various "relational contracts" (Macchiavello et al., 2022) between wholesalers, processors, or feed suppliers and farmers, such as in the provision of credit. There are also occasionally inter-scale relations among farms in some situations, such as in Nigeria where sometimes medium-scale farms provide support services to small farmers such as training and sourcing inputs collectively (Liverpool-Tasie, Nuhu, et al., 2023).

We provide five illustrations below. Each case discusses the proliferation and behavioral changes over time in farms and off-farm value chain actors and indicates the key enablers including natural conditions and the role of governments.

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Ethiopian dairy spontaneous cluster near Addis Ababa

In only one decade (2005–2016), dairy consumption per capita in Addis Ababa (a city of 4.5 million) grew 31% (Minten, Habte, & Tamru, 2020). The city was expanding, and household incomes were rising quickly. It created a huge market demand. Supplying it rose a spontaneous cluster of dairy farming and processing near to and in Addis.

Dairy farming has developed quickly both inside and around Addis Ababa. Minten, Habte, and Tamru (2020) found that 31% of the city's supply came from 29,000 dairy cows inside the city: 26% from suburban areas, and 37% from nearby rural areas. Notably, 89% of the milk supplied to Addis came from small-scale farms. Medium-scale farms supplied 11% of the milk but that segment was growing much more quickly than small-scale farmers: they increased 8-fold from 2007 to 17 (mainly in the suburban areas). Moreover, medium-scale farms had nearly 5-fold the yields per cow and 15-fold per worker than small-scale farms. Milk yields among medium-scale farms grew substantially over the decade while those of small-scale farms stagnated. The medium-scale farms tend to be urban or peri-urban. This phenomenon has also been noted in India (Burkitbayeva et al., 2023).

Medium-scale farms have been driving the dairy boom in and near Addis. This is similar to what was found by Neven et al. (2009) for the development of vegetable supplies into Nairobi in the 2000s. Minten, Habte, and Tamru (2020) show that the medium-scale farms are much more likely than small Ethiopian dairy farms to undertake capital-led intensification, using (1) cross-bred cows rather than traditional breeds; (2) artificial insemination; (3) commercial feed; (4) animal health and dairy-related extension services. These in turn were supplied by growing input and services supply chains, and the proliferation of commercial feed mills.

Minten, Habte, & Tamru, 2020) note that SME milk processing firms tripled (from 8 to 25) in only 10 years; this rapid growth is similar to what Minten et al. (2016) documented for teff processors, transporters, and wholesalers in and to the Addis market in the same decade. Dairy processing reached 200,000 liters of milk per day.

Concentration in processing (with a quick increase in the share of medium-scale firms and decrease in share of small-scale processors) has proceeded faster and further than in the farming sector: the four leading processors produced three-quarters of the pasteurized milk. The concentration is far less among processors producing unpasteurized milk as expected. Cooperatives only have a 5% share in processing.

Several interventions by the government facilitated this growth. First, the government provided artificial insemination (AI). More than 60% of farmers had access by the end of the decade recalled to AI agents. The number of AI agents available in each district tripled over the decade before the survey. However almost 40% of farmers reported not yet having access to AI. While levels of adoption are still low overall, the number of calves born using artificial insemination was 10 times higher in 2016 than 10 years earlier (Minten, Habte, & Tamru, 2020).

Second, there have also been large increases in access to livestock extension, veterinarians, pharmacies, and medicines, contributing to better animal health care and lower animal death rates. Increased investments were made in these by the public as well as the private sector. ILRI (International Livestock Research Institute) and the Ethiopian NARS provided extension on care/improvement of dairy cattle. The NARS had their own farms in the region where they did research and trained extension agents.

Third, the government made large investments in roads. By mid-2010s, the total length of all-weather surfaced roads had tripled compared with 15 years earlier.

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However, the development of this spontaneous cluster has been held back by energy constraints. A reliable electric grid has been a consistent problem for Ethiopian dairy to assure a consistent cold chain, especially for coolers in rural areas, partly explaining their much lower presence in Ethiopia than for example in Uganda, and also explaining the much bigger spatial gradient in dairy prices found in Ethiopia (Ignowski et al., 2022).

Spontaneous clusters of fish farming in Nigeria focused on domestic markets

Research is emerging on fish-capture and aquaculture clusters and rapid development in domestic supply in SSA, such as in Kenya (Naziri et al., 2023). In Nigeria, domestic fish output in tons (per FAOSTAT data) grew 4.1-fold (twice the pan-Africa rate). Imports into Nigeria rose only 2-fold. These data point to a boom in domestic fish supply. By 2020 this supply was 75% by (equal parts) marine capture and inland capture and 25% by aquaculture (which was nearly 0% in 2000) (Liverpool-Tasie et al., 2024).

There are several important aquaculture and capture fishery clusters developing in Nigeria. We focus here on three, in the Southwest in Oyo State (near Ibadan and Lagos), in the Southeast in Ebonyi, and in the North in Kebbi State. We draw on a rapid reconnaissance study of hundreds of supply chain actors (Liverpool-Tasie et al., 2024) and a 10-year recall of numbers by size strata of supply chain actors in the set of four main fishing/fish farming clusters in Kebbi State (Gona et al., 2018).

These clusters in each of the three states have characteristics in common. They are based in areas with good water resources for fish production. They are well-connected by government-built highways to major cities near and far and well served by government-developed wholesale markets. They all display dynamic transformation in the structure and the conduct of the value chains whose actors are present in the clusters. They are all dominated by SMEs which responded to increasing demand and favorable conditions. They all mainly supply domestic markets in general and urban markets in particular. Large companies do not figure in these cases as buyers or as aquaculture producers.

To illustrate the size and growth of primary producers in these clusters, we focus on findings from the Kebbi State clusters (one big cluster in Yauri and a few smaller ones) which by 2018 included around 21,000 fishers and fish farmers (about two-thirds small-scale and a third medium-scale). Over the prior 10 years there had been a 182% increase in fishers and a 200% increase in fish farmers (Gona et al., 2018). This growth rate was even greater than a boom qualified as a Quiet Revolution in aquaculture in Bangladesh (Hernández et al., 2018).

There has been intensification of aquaculture in the clusters of all three states (Liverpool-Tasie et al., 2024). Examples include: (1) diffusion of mobile fiber and tarpaulin tanks to adapt to small landholdings and high pond construction costs and (2) diffusion of antibiotics and commercial fish feed use on both small- and medium-scale farms.

Fueling that farm technology intensification has been rapid growth in fish farm input value chains (Liverpool-Tasie et al., 2024): (1) emergence of long-distance (cross-state) trade in fish seed from clusters of hatcheries in areas with good environmental conditions and transport (similar to Bangladesh; Hernández et al., 2018); (2) emergence of markets for broodstock for hatcheries; (3) emergence of specialized long-distance fingerling traders; (4) spillovers from poultry feed sector (processing and marketing) development to supplying fish farms, again, similar to what has happened in Asia; (5) emergence of rural-hub one-stop-shops such as Chi

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Farms in Oyo that sell and distribute juveniles, live catfish, frozen catfish, fillet, and fish feed to fish farmers and provides training to farmers.

There were nearly 9000 output supply chain midstream actors (wholesalers, processors, and transport logistics) in the Kebbi clusters by 2018. Growth in these segments was dynamic. For example, the number of rural and urban wholesalers in the clusters grew 1.3-fold over the decade (as fish producers increased 1.9-fold, this implies an increase in trader scale over the decade). Urban fish retailers in the state jumped 2.5-fold. These midstream intermediaries were in urban and rural retail markets, rural and urban wholesale markets, farmgate markets, and trader collection points totaling around 255 over the period (Gona et al., 2018).

The technologies and supply chain organization of midstream actors transformed in the Kebbi as well as the Oyo and Ebonyi clusters (Liverpool-Tasie et al., 2024). Examples include: (1) indigenous innovation in processing, such as locally manufactured kilns and adoption of gas burners for fish frying (reducing wood use); (2) lengthening of value chains of smoked fish to markets around Nigeria and to neighboring countries; (3) improvements in cold storage infrastructure by private and public investments; (4) rapid development of third-party logistics in private and public transport (again, similar to what occurred in Asia, for Myanmar see Belton et al., 2018).

The fish farming-centered spontaneous clusters in Nigeria were not directly developed by the government. But the government had several important roles. First, the government invested in road and water infrastructure. This is illustrated by the Yauri cluster in Kebbi State (Gona et al., 2018; Gona & Sunday, 2023). The government built the A1 Highway that runs diagonally through the area in Southeast Kebbi State watered by the River Niger (the largest in West Africa, and the longest in Africa after the Nile and the Congo) and Kainji Lake (a large reservoir on the River Niger built in 1964–68 by the government and a dam which now supplies electricity to much of Nigeria). This confluence of highway, river, and reservoir is the water and transport hub of the large Yauri cluster.

Second, the government-built wholesale markets and some fish collection points in the fish farming areas and along the rivers. They have recently built some cold storage rooms in these wholesale markets.

Third, the government invested in fish seed multiplication centers. For example, in Oyo State, the government through the Federal Department of Fisheries' Fish Seed Multiplication Centers and the Nigerian Institute for Oceanography and Marine Research (NIOMR) made the initial investment in fish seed multiplication. This led to private sector seed multiplication. The Kebbi State government provided various breeds of fingerlings to farmers and also stocking the rivers.

Ethiopian vegetable spontaneous cluster in the Rift Valley focused on the domestic market

Important to the vegetable boom in the Rift Valley has been the large and growing demand from urban areas, and overall income growth. The urban population of Ethiopia nearly tripled in 20 years from 10 to 26 million. Average per capita income in Ethiopia nearly doubled in two decades: Ethiopian GDP/capita more than tripled from 262 (constant USD) in 2000 to 852 in 2021.

As expected from Bennett's Law, with such a rapid increase in income/capita, the FV share in consumption doubled over 10 years, from 4.5% in 2006 to 9% in 2016. FV consumption per capita increased 1.3-fold in urban areas and 1.4-fold in rural areas between 2011 and 2016. In

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Addis Ababa, 19% of the food basket was vegetables in 2020, significantly higher than national levels. In 2020, per Minten, Mohammed, and Tamru (2020), almost three-quarters of the four main vegetables in Addis Ababa were procured from the Rift Valley vegetable cluster.

The natural and constructed context was favorable to the rise of the cluster. The Central Rift Valley is near lakes and crossed by rivers and endowed with shallow water tables, all good for irrigation. The area is on a good road and a three-hour drive to Addis Ababa. It is close to three major secondary cities. The area's climate zone (subtropical semiarid) is good for vegetable farming when irrigation water is available.

Minten, Mohammed, and Tamru (2020) present survey findings regarding the vegetable farming boom in the Rift Valley. They showed rapid entry of SME farmers and growth of output and commercialization. A spontaneous cluster developed of vegetable farms, wholesalers, input retailers, and outsource agricultural services. This cluster mainly supplies the huge Addis Ababa market with none of the product is exported. The main findings are as follows.

There was a rapid increase in vegetable production in the 2010s in the Rift Valley. The boom was driven on the supply side by private (farmer) investment in pump irrigation. The great majority of pumps are powered by fuel-based generators rather than an electricity grid. The irrigated area in the cluster more than doubled over a 10-year period.

Moreover, while 40% of the area is operated by small-scale farms, almost 60% of the vegetable area is cultivated by medium-scale tenant (land renting) farmers who produce 70% of the vegetable output of the cluster. The area operated by the medium-scale farmers tripled over the decade, pointing to concentration in farming.

Minten, Mohammed, and Tamru (2020) found that the small-scale farms in this cluster, as shown for Zambia below, specialize in easy entry (low investment) green leafy vegetables such as Ethiopian kale. The medium-scale farms specialize in vegetables that require more investment, such as (high-return) tomatoes. Tomatoes require more labor and spraying than do other vegetables like onions. But tomatoes and onions are both higher value and have higher production costs than leafy greens, so medium-scale farmers grow tomatoes and onions.

Third, the farms in the cluster have undertaken rapid intensification, with large investments in pump irrigation, purchase of seedlings, fertilizers, and pesticides. Farming costs for the medium-scale farmers were twice those for small-scale farmers of vegetables. But these costs are about 10 times more than the costs for producing staple grains and thus there are significant entry costs. The great majority of seeds, including hybrid seeds as well as pesticides, are from private agri-dealers (with the government supported cooperatives playing a small-scale role). Fertilizer is bought mainly from cooperatives.

Pump ownership a decade before was about half by the farmers themselves; a decade later three-quarters were owned by the farmers themselves. The pumps are mainly imported from China. Minten, Mohammed, and Tamru (2020) and Hossain (2009) who noted that the availability of cheap pumps (imported) was crucial to the intensification and yield increase of rice in Bangladesh. Minten et al. note the similarity with the drivers of the vegetable boom in Ethiopia.

First, driven by the medium-scale farmers requiring heavy inputs of labor and inputs, combined with their assets constraints (equipment and skills), SME outsource services have rapidly developed and sell the farmers the following: (1) equipment and labor teams (managing migrant labor) for digging wells and ponds; (2) mechanized plowing; (3) planting seedlings; (4) applying chemicals; (5) harvesting; (6) loading of trucks; (7) marketing. This is similar to one-stop-shop outsource services in mango areas in Asia (e.g., for Indonesia, Qanti et al., 2017).

Second, the commercialized SME farmers in the cluster sell their vegetables to urban areas, especially to Addis Ababa. The great majority of vegetables are sold through wholesale markets

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by wholesalers. The wholesale markets are crucial public goods in the rapidly expanding and already huge volume of marketed vegetables.

Third, a major role was played by private input suppliers such as sellers of pumps and imported seeds and chemicals, and seedling producers. The outsource services noted above were major facilitators of the boom.

Fourth, land and labor markets have played major roles. There has been an influx of intra-Ethiopian migrant labor into the vegetable cluster. About 4300 workers are employed in the cluster. Land markets especially for rental land have been crucial as many medium-scale farmers entered by renting land (Minten, Mohammed, & Tamru, 2020).

First, there was no management of this cluster by government or any entity. There were no government subsidies of any kind for the vegetable boom, not for pumps, nor inputs, nor land.

Second, government investment in infrastructure has been crucial, in particular in rural electrification (important for pumps), ICT infrastructure, wholesale markets, and roads (Dorosh & Minten, 2020). The length of asphalted and gravel roads in the country tripled from 2007 to 2016 while the share of the population with access to electricity more than doubled, from 22% in 2008 to 45% in 2017.

Third, the government National Agricultural Research System (NARS) played little role in the vegetable boom. Hybrid tomatoes were the main varietal innovation and those were adopted from foreign seed sources. There was also little role of public extension services as the latter are focused on foodgrains in Ethiopia.

Fourth, there was very little role played either by NGOs or donor schemes, nor by microcredit institutions or banks. It was a grass roots, SME-driven spontaneous undertaking.

Vegetable spontaneous clusters in Tanzania focused on the domestic market

Aggregate supply of domestic FV grew rapidly over the past several decades. Tanzanian FV output in tons (per FAOSTAT data) increased 4.1-fold from 1990 to 2020. Vegetable output grew 2.3 times and fruit output, 7-fold. This rapid growth kept up with population growth (2.4-fold) for vegetables and well exceeded it for fruit. Fruit supply responded to growth in fruit demand which is income-elastic while for vegetables is inelastic (Lazaro et al., 2024). Tanzanian income per capita increased 6-fold in constant dollars over the three decades (per World Bank data).

Our analysis of FAOSTAT data shows that this domestic supply growth went to domestic consumption: as <1% of Tanzanian horticultural output is exported. The composition of vegetable output changed, with tomatoes shifting from 9% to 17%, and onions from 3% to 7%, mirroring a consumption shift toward tomatoes and onions in Tanzania as in other African countries (as discussed above). Tomato output leapt 4.4-fold in those three decades.

There was a rapid diffusion of FV farming (National Bureau of Statistics, 2021). In 2008, 9.5% of Tanzania farms grew FV; just 12 years later (2020) the share doubled to 21%. The fastest shift was among small-scale farmers, from 8% of farms to 20%. For medium-scale farms, the shift was from 24% to 38%, and large farms, from 16% to 26%. Overall, area under FV jumped 130%—adding 240,000 hectares in that decade. Half of that increase in area was a jump in area under tomatoes. By contrast, cereal area expanded only 27%.

While green leafy vegetables are grown throughout Tanzania in small-scale plots in rural areas or near cities, most of the other main vegetables and fruits are grown on farms clustered in specific zones with favorable climates and soils and water. Examples are citrus and bananas

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in the hot areas of the coast and tomatoes in well-watered areas near highways. The combination of similar FV consumption patterns all over Tanzania (Lazaro et al., 2024) with FV-growing farms (apart from green leafy vegetables) producing in spontaneous commercial SME horticulture farm clusters in specific areas has led to the formation of long supply chains criss-crossing the country.

An example is the clusters of irrigated tomato farms, such as in the center of the country (Morogoro-Dodoma), in the Southern Highlands (such as Iringa), and in the eastern region of Dar es Salaam, sending out tomatoes to cities and rural areas all over the country (Ijumba et al., 2024). These findings are similar to what we show for Zambia and Ethiopia, and what was found in Nigeria for the case of tomato (Liverpool-Tasie, Yau, et al., 2023).

These long horticultural supply chains criss-crossing Tanzania feed an urban population that grew 4.5-fold and went from 19% to 35% of the population from 1990 to 2021. The urban share of national consumption of FV reached 60% by 2017. The supply chains also go to rural areas: 60% of rural consumption of FV is from purchases and much of those (e.g., for tomatoes and onions) come from outside the rural household's zone (Lazaro et al., 2024).

The FV supply chains function via urban and peri-urban FV wholesale markets peppered around the country. These markets have spread quickly in a short time, keeping pace with rapid urbanization and income increases. The first multiple city survey of these markets was undertaken in 2023 (Ijumba et al., 2024). They found 55 FV wholesale markets in eight cities in Tanzania, of which 31 wholesale tomatoes. Nearly all started in the past three decades and two-thirds of them in only the past 20 years: about 10 of those markets were started in each of the past three decades. Eighty-four percentage of the markets were started by municipal/district governments and represent important public investments in the enabling environment over time. Moreover, the number of wholesalers in these 31 markets nearly doubled in just the past 10 years.

As in the other cases presented here, the government played no direct role in establishing FV farms or marketing FV or even distributing inputs. All these functions have been served by private sector MSMEs and small-scale and medium-scale farms. Farm clusters developed where climate, soil, and water were available and importantly a highway traversed the zone to serve urban markets. Examples include clusters near Morogoro in the Center and Iringa in the Southern Highlands.

In a typical city an official wholesale produce market was set up in the 1970s to 1990s. In each of the eight cities traders quickly spread to other points around the city and started informal markets. The latter were then recognized by the municipal governments and supported by infrastructure and security services (Ijumba et al., 2024).

Zambian vegetable spontaneous clusters near Lusaka focused on domestic markets

Kabwe et al. (2023) outline nongovernmental drivers of the vegetable clusters that have formed about a half day drive around Lusaka, the capital city. These are not the traditional peri-urban gardens of an earlier era but irrigated clusters of small- and medium-scale farms located along highways within reach of the urban market. The urban population grew from 3.5 to 9 million in 20 years, with a near doubling of GDP per capita from 2000 to 2021.

First, there has been a rapid ingress of SME farmers into commercial horticulture per se. Kabwe et al. (2023) shows that the share of SME farms growing FV jumped from 38% in

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2007 to 79% in 2018; the share of SME commercial farms in the total of SME farms (growing all crops) jumped from 18% to 30% over those 10 years.

The latter implies a 1.6-fold increase in a decade of the number of commercialized farms. In absolute numbers, horticulture was started by 664,000, of which 188,000 entered commercial horticulture. The result was that by 2018, 1.3 million farmers produced FV, and 486,000 sold them. This boom in SME commercial horticulture can be compared with there having been an only 1.1-fold increase in maize farmers, and 1.4-fold increase in maize sellers, to 1.4 million maize farmers and 489,000 maize sellers. Moreover, the commercial horticulture farmers are 3.8 times more numerous than cotton sellers (although cotton commercial farming dominates the debate on cash cropping).

Second, the farming boom has involved in some cases shifting from grain farming into vegetables for some plots while staying in the traditional communal farming areas. In other cases, vegetable farms have been started outside communal areas, in peri-urban areas, along rivers, and near roads to access water and transport to urban markets. Many have sunk boreholes for irrigation both in communal and non-communal lands. An important set of these clusters is in the ring of highways to and around Lusaka that traverse well-watered areas.

Third, vegetable commercial farmers early in the decade were mainly small-scale. Over the decade many scaled up into medium-scale and even some large commercial farms. While there are many small-scale farms participating, the bulk of the vegetable marketed volume is formed by medium-scale farms, as in the Ethiopia cluster.

Fourth, vegetable farm output composition diversified and climbed the value ladder over the decade, from around 50% tomatoes, 25% leafy greens (low entry costs basic greens, cabbage, and rape), and 10% other (higher value) vegetables, to 40%, 25% greens, and 25%, other (higher value) vegetables. The other 10% is fruit.

Fifth, vegetable farming has intensified. Compared with traditional off-season vegetable farming in communal villages, which relies little on inputs other than labor, the vegetable boom clusters grow vegetables with irrigation (from rivers or from the ground via boreholes and pumps) and with external inputs (seeds, including hybrid tomato seeds, fertilizer, fungicides, and insecticides to control the heavy disease pressure during the growing season).

These new vegetable areas ranged around Lusaka include complementary services based in urban areas or colocated with the farms. The output supply chain actors include wholesalers and truckers who move the mass of vegetables to Zambian urban markets. The bulk is sold to Lusaka, the capital with a metro area of 3 million, and Kitwe, a city of nearly a million north of Lusaka, as well as a dozen other large and medium-scale cities. A small share is sold in cross-border trade to a border town in the Democratic Republic of Congo.

The great bulk of vegetables are sold by wholesalers through public wholesale markets. The great majority goes to the domestic market (Tschirley & Hichaambwa, 2010). Kabwe et al. (2023) uses survey data spanning a decade to show that total vegetable sales volumes jumped 4-fold in just 10 years, a massive influx handled mainly by urban wholesale markets.

The input supply chain actors include large numbers of agro-dealer SMEs selling seeds, chemicals, pumps, and sprayers. There are also SMEs producing vegetable seedlings.

Kabwe et al. (2023) note that the government did not play a direct role in establishing farms, digging wells or providing irrigation, supplying inputs, or collecting outputs. NGOs and large companies also did not play substantial roles in the rise of these clusters. Neither did the government subsidize the pumps, variable inputs, or land.

Second, however, government investment in infrastructure was crucial, in particular in rural electrification (important for pumps), wholesale markets, and roads. The government

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upgraded the infrastructure of several large markets such as the Soweto Wholesale Market in Lusaka in the past decade.

Third, the government National Agricultural Research System (NARS) has so far played little role in the vegetable boom. Hybrid tomatoes were the main varietal innovation and those were adopted from foreign seed sources. There was also little role of public extension services as the latter are focused on foodgrains.

CONCLUSIONS, POLICY IMPLICATIONS, AND RESEARCH AGENDA

An international consensus has been reached that Africans consume less than a nutritionally adequate amounts of FV and AP. Also, all agree that farming and supply chains of these products face important challenges.

Nevertheless, in this paper, we show three signs of dynamism in the demand and supply of these nutrient-dense products in Africa. First, we provide macro evidence showing there are domestic supply booms in FV and AP. Supply is growing as fast as or faster than in Asia and Latin America. However, in FV, supply is growing only just fast enough to keep up with population growth. But in some key AP, such as dairy and poultry, supply is already growing much faster than population. Second, we provide micro evidence showing substantial shares of consumption of FV and AP in total food consumption. The shares are similar to those found in South and Southeast Asia in the past decade. There is also some emerging micro evidence of per capita consumption growth. Third, an important part of our story is the rapid development of spontaneous clusters as they are major sources fueling the overall supply growth in these products. Understanding those clusters opens the door to understanding the surprising dynamism in overall supply of FV and AP.

These spontaneous clusters are the opposite of the managed agro-parks (again) in vogue among governments and donors (Ulimwengu, 2019). Rather, these spontaneous clusters emerged as "grass roots" without the managing or funding hand of government, NGOs, big food companies, or even private equity firms. They are composed mainly or entirely of MSMEs (micro, small, and medium-scale) farmers and supply chain actors (wholesalers and processors midstream, agro-dealers of inputs upstream, and lateral services such as logistics) (Reardon, 2015). These small/medium farms and firms have been very responsive to domestic demand growth. They have invested vigorously for a decade or two and built important clusters, such as a vegetable cluster in the Rift Valley supplying more than half of Addis Abeba's vegetables.

The clusters have in common that they form where: (1) the farms and MSMEs have access to effective demand, in particular where governments have built highways to and wholesale markets in towns and cities wherein there is dynamic demand for FV and AP; (2) the farms and MSMEs have access to a good resource base, in terms of access to natural resources (e.g., enough water), to energy (e.g., access to fuel for generators or electricity grids); and in some instances access to new knowledge and innovative inputs (e.g., where governments have provided initial agricultural research, seed and fingerling multiplication, and extension); (3) and there are government policies allowing imports of production inputs not manufactured locally (fertilizer, feed ingredients, vehicles, and machinery).

Our positive message is meant to say to governments and researchers that huge spontaneous growth has occurred where investments, policies, and natural conditions were supportive. In recognizing that growth one recognizes the important role of those fundamental investments

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and policies. That recognition does not wave away concerns about real problems and constraints but rather emphasizes that addressing those problems is best done by governments' continuing and intensifying those investments and those policies. We believe that governments should focus on these fundamental drivers. We contend that this will facilitate the further growth in the many existing spontaneous clusters and lead to the diffusion of secondary and tertiary clusters. The combined effect of this further growth and diffusion could lead over a decade or two to adequate nutritional levels of consumption of FV, and as key AP products are already growing faster than population, lead to that adequacy perhaps as soon as in a decade. We cannot of course be precise in these extrapolations as much depends on governments fixing a lot of poor infrastructure and building and maintaining much more, and starting or staying the course on business policies that enable domestic MSMEs who are the main players in this growth boom.

There is much further research to do on this theme. We suggest five areas.

1. Drivers and constraints: There is a need to understand further what have been the investments that got the clusters to this point, what are the constraints to further expansion, and what is the needed further investment and multipliers to move supply to the point of nutritional adequacy. It is important to understand the roles of government actions versus organizational forms within the clusters (Otsuka & Ali, 2020). An example is the analysis of the potato spontaneous cluster in Gansu, China, that was facilitated by government investments and internally supported by trader associations (Zhang & Hu, 2014).
2. Agglomeration effects: There is a need to understand further the cluster agglomeration economies and how they affect the growth and innovation of firms and farms (e.g., as in Bangladesh, see Hu et al., 2019). A subset of this is the need to understand governance and informal coordination and institutions in the clusters and how this affects transaction costs (e.g., as in Peru, see Escobal & Cavero, 2012).

An extension of this work could be more general on the "empirical industrial organization" of these clusters. This could include understanding their effects on the efficiency of value chains bringing food to consumers, on consumer pricing, on sector restructuring, and on the development of relational contracts between MSMEs in these clusters and small-scale farms (Liverpool-Tasie et al., 2020; Macchiavello et al., 2022) as well as their resilience to climate shocks and violent conflict (Reardon & Zilberman, 2018; Vargas et al., 2024).

3. Nutrition impacts: There is a need to quantify the impacts of these clusters on nutrition (in quantity and in quality as in nutrients/micronutrients) as well as on affordability of FV and AP. An extension of this is to examine the spatial and socioeconomic distributional impact of these supply booms nutrition and affordability; an example of this is Muhonda et al. (2024) in Malawi looking at the supply boom in affordable fish from Lake Malawi.
4. Inclusiveness: There is a need to examine the micro dynamics of entry and growth of actors into the cluster as well as multipliers on youth and women employment.
5. Food safety and environmental impacts: There is a need to understand the impacts as well as the existing and potential institutional arrangements that could improve these impacts.

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ENDNOTES

[1] Africa is our shorthand in this paper for Sub-Saharan Africa.

[2] Our analysis is limited to showing value shares as we focus on the role of the products in the food economy of the household. We do not analyze shares in nutrition categories like calories or protein or vitamins; a given product will usually have different shares in those than it does in total consumption in value terms.

[3] www.data.worldbank.org/indicator/sp.urb.totl.in.zs?locations=ZG

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