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Small and medium enterprises (SMEs) disrupt food systems to deliver healthy diets to urban consumers: Twiga case study, Nairobi, Kenya

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Abbreviations and acronyms

FKE	Federation of Kenya Employers
FMCG	Fast Moving Consumer Goods
GAP	Good Agricultural Practice
ICT	Information Communication technologies
IFC	International Finance Corporation
MSMSEs	Micro, small and medium- sized enterprises
SMEs	Small and Medium Enterprises

Introduction

The global population and urbanization are rapidly increasing. Currently, 56% of the world's population – 4.4 billion inhabitants – lives in cities (World Bank, 2022). This trend is expected to continue, with the urban population more than doubling by 2050, at which point nearly seven out of 10 people will live in cities (World Bank, 2022). It is estimated that more than 90% of future urban population growth will be in low- and middle-income countries (Tefft et al, 2018). Africa has the highest population growth and urbanization rates in the world (UN-Habitat, 2010). More than half of the projected global population growth between 2015 and 2050 will occur in Africa and by 2050, Africa's cities will be home to an additional 950 million people (UN, 2017; OECD, 2020).

Urbanization comes with various challenges including food unavailability, inaccessibility, and unaffordability due to evolving consumption patterns and food production and supply processes (Szabo, 2016). Rapid urban growth and an increasing number of megacities imply that more food needs to be made available to people who live in an environment that has traditionally been perceived as inappropriate for agriculture (Szabo, 2016). In addition, urbanization often contributes to increased poverty in urban areas and manifests itself in mushrooming urban informal settlements (slums) (UN-Habitat, 2014). By the year 2014, it was estimated that 61.7% of urban residents in Africa lived in slums where income poverty is a major concern (UN-Habitat, 2014).

With increased urbanization, the food choices of the urban population including where and how they source their food, will have strong implications for rural, peri-urban, and urban areas and the overall food system (Tefft et al, 2018). To ensure food and nutrition security, food environments need to be shaped to deliver healthy and nutritious foods to urban consumers in a timely and economically accessible manner, especially those in the lower income stratum who tend to be more vulnerable (FAO, 2016). Urban areas are most afflicted by profound inequalities stemming from differences between socioeconomic groups, ethnicity, migratory status, location of residence (slums or informal settlements), city size, and a host of other factors, which affect their access to essential services and needs (CSIS, 2020).

The informal sector plays a major role in the urban food provision in most African cities. The sector's positive attributes include flexibility and rapid responses to price changes; willingness to collect goods from remote producers; and low profit margins, which keep prices down (Romanic, 2016). It also increases choice and affordability for low-income urban consumers by selling so-called inferior products not offered by the formal sector (Romanic, 2016). Informal markets are important to the urban poor in many ways. They are a source of food especially for fresh fruits and vegetables. The majority of urban low-income residents purchase fruits and vegetables from informal markets such as tabletop vendors, and open-air markets (Wanyama et al, 2019b; Chege et al., 2021b). Further, informal retailing of food within low-income neighborhoods provides employment opportunities especially for women and youth.

In Kenya, urbanization is rapidly increasing with approximately 32% of the population residing in urban areas. The rising urban population has put pressure on basic facilities such as water, sanitation, security, housing and transportation (APHRC, 2020). In Nairobi, over half of the urban population resides in slums which have extreme poverty levels and poor access to nutritious food, water and hygiene, and sanitation facilities (Kimani-Murage et al, 2020; County Government of Nairobi, 2017). Chronic undernutrition rates among children under 5 years in the Nairobi slums are also quite high, ranging between 26% and 50% (APHRC, 2020). A study conducted in 2015 in Kibera slum, one of the biggest informal settlements in Africa located in Nairobi, showed that stunting among children under-5

was at 46%, 11% were underweight, 2.5% were wasted, while 9% were overweight (Kimani-Murage et al, 2015). In addition, 7.5% of women of reproductive age (15-49 years) were underweight while 32% were overweight/obese, showing that undernutrition is not the only problem in the urban informal areas, but over nutrition and micronutrient deficiency are also a big challenge, a complexity referred to as triple burden of malnutrition[1]. Even though there are currently no definite numbers about the proportion of adolescents who are undernourished in urban slums, figures from the Kenya Demographic and Health Survey (KDHS 2015) show that nationally, 17% of adolescent girls are malnourished.

In terms of diets, consumption behavior of urban residents varies depending on the economic status of the household. A recent study with a sub-sample of residents in Kibra and Mathare slums show that 31% of the households are undernourished (Wanyama et al., 2019b). When the households are grouped into expenditure terciles (a proxy of the household's economic status), the group in the lowest tercile has the highest undernourishment levels (53%). The study also found that cereals are the most consumed foods contributing 58% of total calorie consumption among the sampled households, while consumption of more nutritious foods such as fruits, vegetables, fish, eggs, and milk is relatively low. The diet situation of the informal settlement residents may have worsened due to the ongoing Covid-19 pandemic. A study conducted in 2020 showed that many households in the slums of Nairobi have reduced their consumption of fruits and vegetables in terms of frequency and quantity during the pandemic period compared to the period before (Chege et al, 2022). This further reinforces the need for sustainable solutions that will make nutritious foods more available, accessible, and affordable to the low-income consumers in urban areas of developing countries.

Informal markets in Nairobi *(structure, functions, and market failures)*

There has been an upsurge of formal outlets such as supermarkets and shopping malls in Kenya over the past decade, but the informal sector such as wet/traditional markets for fresh and dry foods, food retail vendors by the roadsides, micro, small and medium- sized enterprises (MSMEs) etc., remain resilient and are found almost all over Nairobi (Global Site Plans. 2017). Kenya relies heavily on the informal sector, with the MSMEs being the most significant sector contributing to economic development (Kinyanjui, 2010). Activities such as hawking, vending, roadside *kiosks*, shops, and food selling stores, repairs, craftsmanship, and market trade are some of the many forms of economic activities dominating informal markets in cities like Nairobi and they largely contribute to Kenya's economic and social development (Okwudiri, 2022).

The informal sector is instrumental in not only promoting supply of food to the city residents but also in the creation and promotion of income earning opportunities. According to Government of Kenya, (2016), informal markets are the most popular for selling fresh agricultural produce. At times, formal entities such as supermarkets and other formal retail outlets source fresh agricultural produce from the informal markets. The main markets in Nairobi where both formal and informal enterprises co-exist include *Wakulima*, *Mutindwa*, *Gikomba*, *Kangemi*, *Toy*, *Kawangware*, *Burma*, *Kariokor*, *Nyama Kima*, and *City markets* (GoK, 2016) but almost all residential estates in Nairobi have smaller informal markets that become active in the afternoons and/or evenings. Generally, the structure of these

[1] Triple burden of malnutrition refers to the coexistence of undernutrition, overnutrition and micronutrient deficiency (Pinstrup-andersen P, 2007)

informal markets can be considered highly competitive since they are dominated by small enterprises and individuals competing against each other and selling similar or related products and services (Okwudiri, 2022).

Table 1 provide a summary of the distinct features of formal markets like supermarkets, and informal markets like wholesale/retail wet markets and informal food retail vendors located in the urban informal settlements of Nairobi. While formal outlets such as supermarkets have fixed structures, are relatively larger in terms of space occupied by the goods and often have modern cash counters, most of the informal outlets are smaller in size, often have temporary structures and buyers interact directly with the sellers and they have no modern counters. Sellers in the informal outlets sometimes give credit to their buyers especially those that are well known to them. this is not the situation for formal outlets like supermarkets. The range of products and quantities sold in the formal and informal outlets also differ. Table 1 provides additional characterization of these markets such as service features and the product range and quantity.

Table 1: Features of food outlets in the informal settlements of Nairobi, Kenya

	Formality	General features	Service features	Product range	Product quantity
Supermarkets	Formal	• Fixed structures • 300–500 m2 • 1-2 modern cash counters	• Self service • No possibility of credit sales	• Large variety of Food & non-food products • Large selection of type and brands of processed & ultra-processed foods • Frozen canned and cooked foods	• Small to very large packing size (e.g. • 0.5–10 kg of rice)
Kiosks	Informal	• 1-10m2 • Small, temporary, or mobile stands • No modern cash counter • Individually- or family-owned	• Over the-counter service • Direct contact to the Operator • Offer purchase on credit to known customers	• Food and non-food products • No frozen food	• Small quantities and limited varieties of products • Repackage food and non-food products into smaller quantities for resale
Mom & Pop Shop	Informal	• Fixed structures • Smaller than supermarkets but larger than kiosks • Individually- or family-owned	• Over the-counter service • Direct contact to the Operator • Offer purchase on credit to known customers	• Offer a moderate variety of non-food items, processed and ultra-processed foods, especially cereals.	• Small quantities and limited varieties of products but larger quantity and variety than Kiosks
Tabletop /roadside vendors/ *mama mboga*	Informal	• 1-5m2 • Small mobile and temporary roadside stands • No modern cash counter	• Direct contact with the vendor • Individually owned, mainly by women and youth • Can offer credit, especially to well-known customers	• Mostly a large variety of fruits and vegetables, • Shred vegetables upon request • Sells sliced fruits, e.g., watermelon	• Large variety of fruits and vegetables but in small quantities • A few varieties of other staples and in small quantities
Open air or wet markets	Informal	• 1–10 m2 per stand	• Open on specific market days, weekly.	• Stock fresh fruit and vegetables, cereals,	• Wholesalers have larger

	• Semi-permanent structures operated by various retailers • No modern cash counter	• Stalls are individually owned • Service is by operator • Generally, no credit offered unless to well-known customers	legumes, roots and tubers and spices • Some have a section with non-food items	volumes than retailers • Food items are not packaged. Cereals, roots, tubers, etc are sold by wholesalers in 90 kilogram sacks • Non-food items are packaged

Source: Adapted from Chege et al. (2021c) and Berger & van Helvoirt (2018)

Within the open air/traditional markets, wholesalers and retailers have different characteristics that define how the markets operate. Some of the wet markets operate as both wholesale and retail markets with different individuals playing the role of wholesaling and retailing at different times of the day. In addition, there are vendors who source from these markets, mostly at wholesale prices and resell the commodities outside the markets or near residential areas. The structure, operations and governance of the wholesale markets, retail markets and vendors selling outside these markets is explained below.

The performance of the traditional wholesale markets greatly affects the costs, prices, and distribution of benefits throughout the production and marketing system. The bulk of the costs in the vegetable trade occur in the wholesale and distribution segment of the value chain. Wholesale marketplaces are also where significant inefficiencies in the food system are concentrated.

The wholesale wet / traditional markets

In Nairobi, *Gikomba, Kangemi, Toi, Kawangware, Githurai, Ngara, City Park, Wakulima, Korogocho,, Mutindwa, Savannah and Kenyatta markets* can all be categorized as county council markets. Most of these markets have both a wholesale and a retail component but the most popular wholesale markets are *Wakulima, Gikomba, Kangemi* and *Githurai*. *Wakulima* market has a majority share of wholesale transactions and supplies fresh fruit and vegetables to many of Nairobi's residents, either directly or indirectly (Owuor et al, 2017). In 2008 for instance, Wakulima handled an estimated 56% of the value and 67% of the volume of vegetables flowing into the city's wholesale markets (van der Lans et al 2012). *Gikomba* market handled an estimated 23% of the value and 16% of the volume of vegetable flowing into the city.

Within the Nairobi markets, the wholesalers as a group are divided into collecting wholesalers and distributing wholesalers. *Collecting wholesalers* specialize in collecting produce from farmers across the country. They travel long distances to purchase commodities from the producing areas. To facilitate their operation, collecting wholesalers frequently employ purchasing agents who work in the production areas on their behalf. Purchasing agents reduce costs by identifying produce for sale, carrying out the negotiations, accumulating, assembling and carrying the produce to a nearby earth road for ease of collection. Hence, they streamline the procurement process (Dijkstra, 1997). Once enough products are obtained, collecting wholesalers then transport the commodities to the main cities/towns generally using lorries with a minimum of seven tons. These professional collecting wholesalers sell primarily in urban wholesale markets to distributing wholesalers. Collecting wholesalers operate in such a way as to allow distributing wholesalers to focus entirely on their urban clientele. For *distributing wholesalers,* being absent from the market results in lost revenue and poor customer relations (Dijkstra, 1997). The urban

clientele that these distributing wholesalers serve are highly diverse. They include traders in traditional open-air retail markets, green grocers serving middle-class clientele in roadside kiosks, high-end green grocers mostly in established retail centers, supermarkets, hotels and schools. In some cases, some wholesalers act as both collecting and distributing wholesalers whereas at other times, these roles are played by different people.

The distributing wholesale begin operations at the market from very early in the morning, at around 03.00hrs or earlier to around 07.00hrs (Irungu et al., (2007). The wholesale component is dominated by men who receive agricultural produce from transporters/traders arriving from production regions, and many times they sell through brokers based at the markets. Market access and infrastructure problems are common in these markets and lead to substantial waiting time for wholesalers and transporters. Most wholesale markets operate throughout the week while others like *Kangemi* market have specific market days (two days per week). On the market days, producers and mobile traders come to sell their goods while on normal days the usual regular retailers are found within built-up shelters. Wholesaling areas in these markets constitute an open space where produce is unloaded and moved to retail traders (Owuor et al, 2017). The wholesale markets are managed by county council administrators whose roles include management of market infrastructure such as stalls and sanitation facilities, conflict resolution, security maintenance and trade section allocation, amongst others. Wholesalers incur county levies at source and end markets. The County Government has different levies for different markets, and different products/commodities as outlined in the Nairobi County Finance Bill 2021.

Despite their size and importance in the Nairobi food system, most actors remain informal. As such, they face various challenges.: According to Federation of Kenya Employers (FKE) (2021), lack of markets, difficulties in getting licenses, poor infrastructure and stiff local competition are some of the major constraints faced by informal enterprises. In addition, those selling at the traditional markets or outside of those markets do not always have access to sanitation facilities or they are not up to good standard whenever available (Global Site Plans. 2017). There is the influence of cartels in the markets, poorly constructed stalls, and limited space for expansion (RSA, 2015). Markets may allocate space for dumping garbage with the county government clearing this periodically, but this varies by market. Food handling and safety are key concerns given the difficulty/lack of enforcement of food safety standards and regulations in the informal trading system. The prevalence of produce of substandard hygiene and quality is also due to poor consumer awareness (RSA, 2015).

Information asymmetry among market players distorts market prices, reduces actor margins, skews trade benefits toward middlemen, and blocks entry of new market players while increasing the wide gap between the farm gate and market price for many agricultural commodities (RSA, 2015). Additionally, most vendors in these markets do not have formal offices, and low levels of membership in associations which implies low level of organization, cooperation, and coordination (RSA, 2015).

A rapid market study conducted in five wholesale markets in Nairobi (Kawangware, Kangemi, Githurai, Mutindwa, and Toi) showed that majority of the wholesalers are women, they fall within the age of 36 – 55-years, and youth (18 – 35 years) make less than 30% of the wholesalers (Chege et al., 2023b). Operating a wholesale business may require some capital investments which youths may Flack, hence they are less involved as wholesalers.

The retail wet / traditional markets

Most wholesale markets also double up as retail markets in Nairobi. The county council markets such as *Kawangware, Toi, Ngara, City Park, Korogocho, Mutindwa, Savanna, Dagoretti, and Kariobangi* however operate largely as retail markets. These markets are dominated by retailers (mostly women) who purchase agricultural produce from wholesalers, break the bulk, and sell in smaller quantities largely to individual consumers but also to institutions such as hotels, hospitals and schools. Agricultural products traded here are primarily fresh (vegetables and fruits) but can also include cereals, legumes, roots, tubers and plantain, spices, and animal-source foods (GAIN, 2023). The retail markets operate daily from around 07.00hrs to 22.00hrs or later but this schedule may differ based on the level of security, street lighting, available stock, and customer flows into the market (Owuor et al, 2017). The peak retail business hours in the retail markets begin at roughly 16.00hrs to 20.00hrs and coincide with arrival of residents in residential estates from work. Fresh fruits and vegetables traded in these markets are most fresh in the morning, but quality deteriorates as hours pass with the majority of traders lacking quality maintenance mechanisms such as refrigerators. Because of the cash constraints and the lack of storage, vendors try to sell all fresh agricultural stocks by the end of each day. The commodities sold at the end of the day may be of lower quality but they are also sold at a lower price, what the retailers call "*the evening price*", which is meant to clear the stock to avoid commodity losses. Many low-income consumers target these "evening prices" as the commodities are sold at a lower price hence more affordable to them. Product quality is not a major concern to these consumers targeting evening prices.

Like the wholesale markets, these markets are managed by county council administrators in conjunction with local trader associations. Because of the nature of these markets, traders are usually clustered within the designated market area; operate daily but the number of retailers might increase on specific days of the week (market days); and most of them have fixed space allocations and stalls. The markets have operational sanitation and waste disposal facilities although they are not services always.

A rapid market study conducted in five traditional markets in Nairobi (Kawangware, Kangemi, Githurai, Mutindwa, and Toi) showed that most retailers in these markets fall within the age of 36 – 55-years while the youth constitute around 39% of the retailers (Chege et al., 2023b). The study further showed that about a third of the retailers were women.

There are other vendors who are located outside the wet markets, near the residential areas, or near shopping centers. They source their commodities from wholesalers in the available wholesale markets such as *Marigiti, Githurai, Kangemi and Kawangware* market, early in the morning between 5 am and 9 am when fresh commodities arrive from production areas. They wake up very early and travel to the wholesale markets, risking their own security, with many traveling with cash or mobile money. After purchase, the vendors transport the commodities using public vehicles to their business locations. Most of the commodities are put in sacks and tied above the passengers' vehicles affecting the quality of the produce. The whole supply chain from sourcing, purchase, transportation to vendor retailing is unorganized, inefficient and has high transaction costs and post-harvest losses.

A study conducted with different categories of randomly selected vendors (Kiosks, table tops/*mama mboga*, mom and pop shops, mini supermarkets, and grocery stores) in Kibera and Mathare informal settlements of Nairobi showed that majority of the vendors are female (61%) aged between 36 and 55 years and the highest level of education they have attained is secondary education (52%) (Table 4). The majority of the vendors sell fresh vegetables (38%) and fresh fruits (24%) and only 13% sell roots and

tubers such as potatoes, sweet potatoes, and arrowroots. Three quarters of the interviewed retailers give credit to their customers. These local vendors (who most times are the owners of the businesses) have created relationships with the buyers who are mostly from within their locality. They know the buyers and therefore they sell the commodities to them on credit based on trust.

Table 2: Characteristics of vendors in the informal settlements of Nairobi, Kenya

Characteristic	Male	Female	Overall
Gender	38.58	61.42	100
Age			
25 -35 years	42.46	37.19	39.22
36 -55 years	42.74	51.40	48.06
> 55 years	4.75	6.32	5.71
Education	0.56	0.53	0.54
None	24.30	34.21	30.39
Primary	55.03	49.82	51.83
Secondary	20.11	15.44	17.24
Tertiary	0.56	0.53	0.54
Allows credit	72.63	77.37	75.54
Sell roots and tubers	9.22	15.09	12.82
Sell fresh vegetable	19.27	48.77	37.39
Sell fresh fruits	16.20	28.77	23.92
Sell *Omena* (Silver fish)	1.40	8.60	5.82
Number of observations	**358**	**570**	**928**

Source: Chege et al., (2023b).

The most significant constraints faced by retailers included: lack of storage / cold storage in marketplaces, poor market infrastructure, and seasonality of supply, perishability, and wholesale price fluctuation / volatility.

Despite their shortcomings, the wholesale and retail markets and informal vendors are important for urban food systems, food and nutrition security and livelihoods. Some of the markets are located near informal settlements in Nairobi and play a critical role in food and nutrition security of the slum dwellers. Informal food retailers remain the main source of food provisions for slum dwellers (Chege et al., 2021; Wanyama et al., 2019a) who constitute about 60 percent of the urban population (Njoroge and Munene, 2017; Wanyama *et al*, 2019b).

Contribution of MSMEs in improving diets of urban consumers: case of Twiga Foods

Micro Small and Medium-Enterprises (MSMEs) in many developing countries play an important role in the agri-food systems. They provide employment opportunities as well as source of foods for urban consumers. In Kenya, the MSMEs provide an interesting disruption in the rapidly growing traditional markets. Efficient sourcing of foodstuffs is one of the challenges faced by MSME food vendors in Nairobi. Traditionally small-scale food vendors travel by informal buses to wholesale wet markets several times a week to source limited volumes of fresh fruit and vegetables. These early morning trips generate additional costs including bus fare, relatively high unit costs for small volumes of purchases, insecurity, and opportunity costs for mostly female vendors.

Twiga Foods, a Kenya agritech and logistics private company formed in 2014, seeks to resolve some of these issue through the efficient sorting and distribution of fresh produce in urban Kenya to reduce fragmentation in the produce market (Cook & O'Neill, 2020). It employs a cashless mobile-based business-to-business (B2B) food supply (fruits and vegetables) platform that connects farmers to small and medium-sized vendors, outlets and kiosks, and the main aim is to address the problem of food flow from farmers to markets in urban areas across Kenya (Cook & O'Neill, 2020; von Bismarck-Osten, 2021).

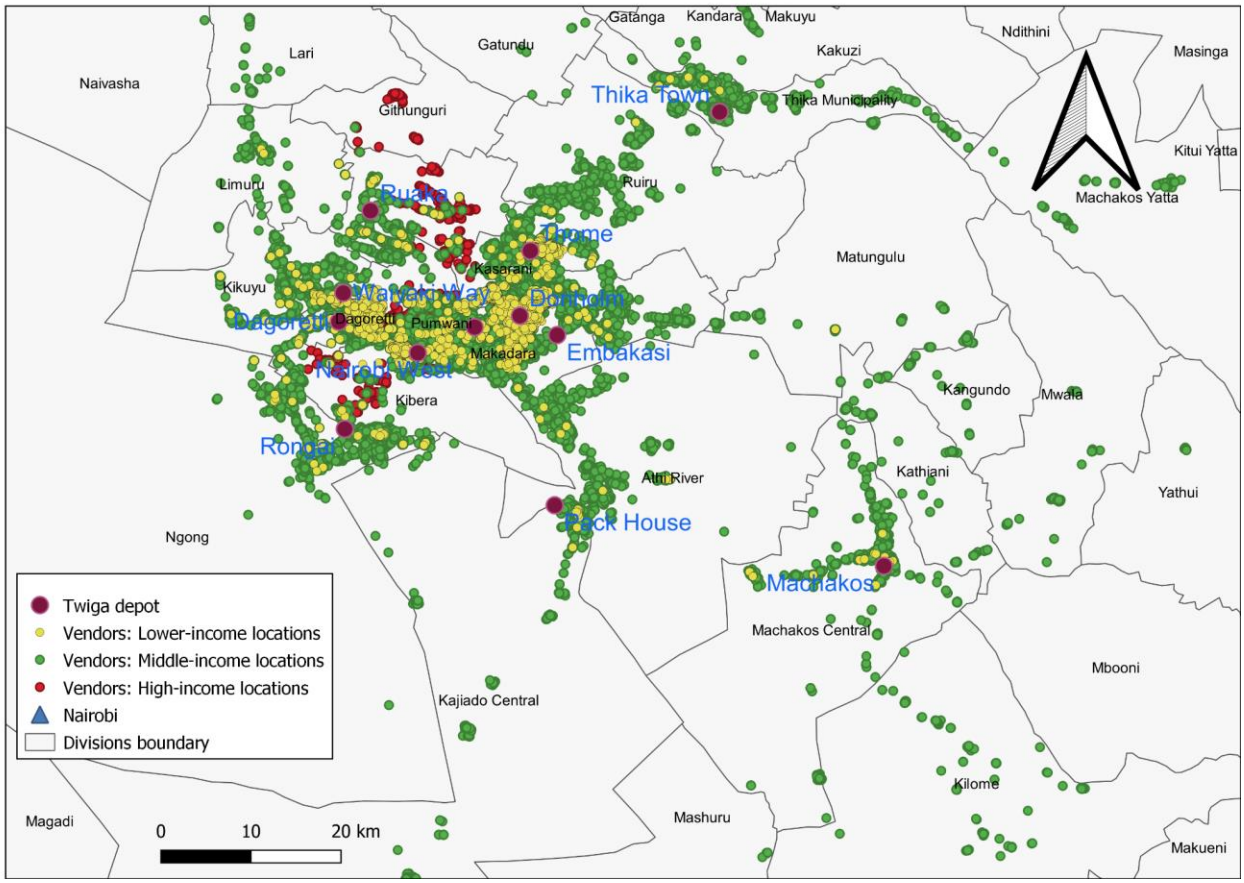
On the production end of the food system, Twiga sources quality fresh produce and processed food commodities from over 4,000 farmers and food manufacturers. They source fresh produce directly from farmers to provide a guaranteed market and fair pricing thereby eliminating the logistical challenge of taking their produce to buyers and reducing their chances of suffering post-harvest losses. To join Twiga as a supplier, the farmer signs up online and provides the necessary details of their farm and commodities produced. Twiga then issues a purchase order, booking the produce with specific details about harvest. After harvesting, the commodities are delivered to Twiga's collection point, they weigh the produce, issue a receipt and the farmer receives payment within 24hours of commodity collection via the M-Pesa mobile money platform. Additionally, Twiga Foods links farmers to other agencies and service providers in the agri-food system with a mission of helping them to access timely supply of better quality and quantity of the produce (von Bismarck-Osten, 2021). For example, they work with their own agronomists who support their producers on agronomic issues and other needed technical assistance, they link them with service providers working on irrigation and water installation and management, and provision of quality planting materials. All fresh produce is bulked at the Collection Centers or delivered to a central processing center. The fresh produce is processed and graded at Twiga's packhouse and dispatched to more than 100 sales routes.

Twiga uses Information Communication technologies (ICT) through mobile phone to estimate demand from vendors and match this with the supply. At any given time, the model allows Twiga to know what and how much the market demands and they can pull this from suppliers since the model collects and maintains data with farmer details, scouting reports and harvest details. The data-based system enables Twiga to plan and execute logistical strategies to ensure efficient collection of produce from farmers, efficient transportation to Twiga warehouse and prompt payment to producers.

Twiga delivers pre-ordered commodities from their warehouse and depots to thousands of vendors at their point of sale. Figure 1 shows the distribution of vendors within and around the Nairobi metropolis. The company serves consumers from all income strata. The majority of the Twiga's vendors are in the middle-income areas of Nairobi (green dots in Figure 1), followed by those in the low-income areas

(yellow dots) and there are a few in the high-income areas (red dots). Its depots are strategically located across the low-, middle- and high-income locations to reduce the travel time and costs for the vendors. As at the time of this analysis, Twiga's depots were located in Syokimau and Machakos Town in Machakos county, Rongai in Kajiado, Ruaka, Thika road and Thika town in Kiambu, Embakasi, Donholm, Thika Road, and Nairobi West, Dagoretti, Waiyaki Way, Kaloleni in Nairobi County.

Figure 1: Distribution of Twiga vendors within and around Nairobi

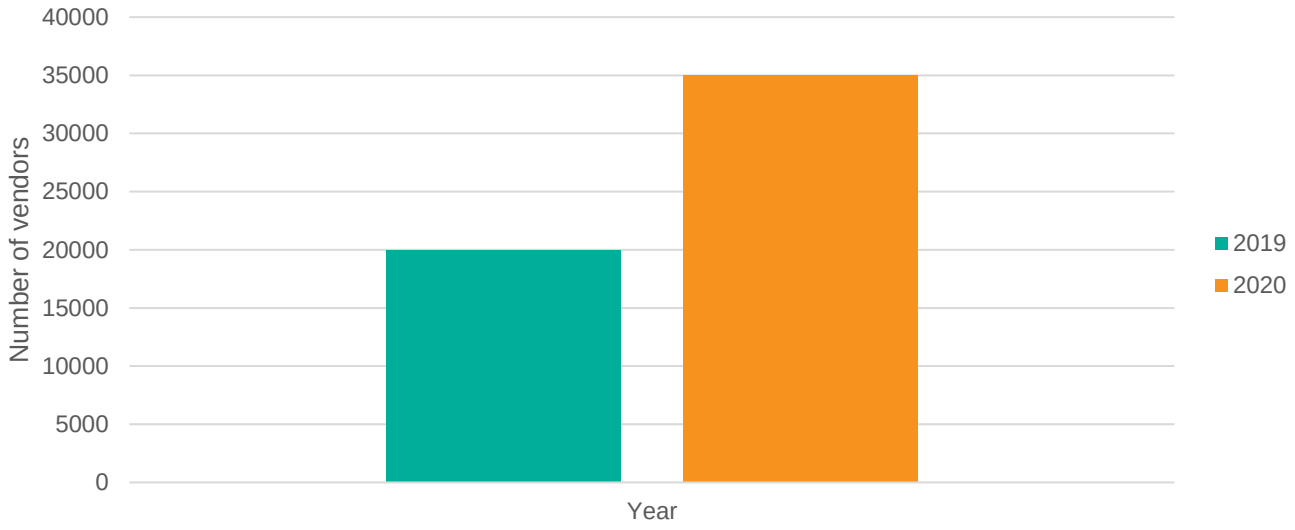


Source: Generated using 2019/2020 Twiga Foods data

A vendor interested in joining the Twiga vendor network signs up online and a Twiga sales representative visits the vendor to register them in the system. The registered vendor then places their orders with a sales representative or directly on Twiga's ICT enabled application. Upon receipt of the orders, Twiga dispatches the commodities via its distribution vehicles free of charge and the orders are delivered to the vendors within 24 hours of placing the order. Twiga also runs a toll-free number where vendors can call and place their orders. This helps especially where a vendor does not have access to a smart phone or in circumstances where the Application fails. Additionally, Twiga has several depots located closer to the vendors to enhance access to high quality FFVs within the locality. The depots are strategically located to reduce the travel time and costs for the vendors. The depots are in Syokimau and Machakos Town, in Machakos County, Rongai in Kajiado, Ruaka, Thika road and Thika town in Kiambu, Embakasi, Donholm, Thika Road, and Nairobi West, Dagoretti, Waiyaki Way, Kalolen in Nairobi.

The company has grown tremendously over the years, and it continues to supply different types of foods to consumers. Between 2019 and 2020, and Covid-19 notwithstanding, the number of vendors in Nairobi supplied by the company grew by 67%, from 20,000 to 35,000 vendors (Figure 2). These numbers may have increased over the past year considering the remarkable growth of the company over the past years. During 2021/2022, the company expanded its coverage within Nairobi and across other towns and cities in Kenya, such as Kisumu, Uasin Gishu, Embu, Meru, Kirinyaga, Machakos, Nakuru and Kiambu.

Figure 2: Growth of Twiga vendors between 2019 and 2020



Source: Authors analysis using Twiga Foods data

An analysis of a random sub-sample of the Twiga vendors in Nairobi reveal that their vendors are mostly female (64%) with ages ranging between 25 and 55 years (Table 5). The study showed that 71% of the vendors have either primary or secondary level of education and 96% of them are sole proprietors.

Table 3: Characteristics of sampled Twiga vendors in urban Nairobi, Kenya

Characteristic	Category	Female	Male	Overall
Gender		63.6	36.4	100
Age	*Below 25*	8.3	4.2	6.8
	25 to 34	40.5	56.3	46.2
	35 to 55	50	39.6	46.2
	Above 55	1.2	0	0.8
Level of education	*Primary*	15.5	16.7	15.9
	Secondary	56	54.2	55.3
	Tertiary	28.6	29.2	28.8

Business type	*Sole proprietorship*	95.2	97.9	96.2
	Partnership	4.8	2.1	3.8
Number of observations		**204**	**117**	**321**

Source: Hungry Cities Trader Survey 2021 (Chege et al., 2021)

On the consumer end, to ensure that consumers get the commodities they demand, Twiga seeks to ensure all orders from the vendors are processed and delivered in a timely manner. Consumers can also register through a mobile phone application and make orders for their preferred commodities which are then delivered to their doorstep. Since 2020, Twiga entered a cooperation agreement with Jumia Kenya, a Business-to-Customer (B2C) e-commerce platform for food operating across the country, to deliver high quality food commodities directly to consumers through their online platform (von Bismarck-Osten, 2021). Although this platform is mostly accessed by the middle- and high-income consumers, it has the potential to serve low-income consumers as well.

Through this ICT based innovation, Twiga foods has a direct influence not only on the food environment but also on consumer behavior, especially in urban environments where ICT infrastructure is well developed. Efficient bulking, transport, handling, sorting, and distribution logistics allow Twiga to reduced postharvest losses substantially thus contributing to more efficient value chains, consistent food availability to consumers and lower overall costs when compared to traditional wholesale markets and informal distribution systems.

Twiga Foods has collaborated with research organizations such as the International Center for Tropical Agriculture (CIAT) to understand consumer behavior and needs, and how to best deliver what vendors and consumers need[2]. As a company serving other businesses as well as consumers, there is need to understand consumer needs to package their products in a way that is profitable but also meets consumer demand. Some preliminary analysis on vendors and consumers needs show that vendors would prefer slightly differently packaged commodities compared to the uniform offerings from Twiga. For example, they would prefer to be supplied a mix of small and large onions instead of only small or only large onions. Further, vendors would prefer to be supplied a mix of either small and medium or medium and large tomatoes compared to only large tomatoes, and the preferred level of ripeness is moderate (what vendors call “blue band”) compared to either unripe or completely ripe. The vendor preferences are driven by their own business considerations, they know which client can purchase different sizes and ripeness levels, as well as consumer preferences. Less uniform produce allows vendors to better serve their diverse clients.

The value proposition of Twiga Foods in response to market failures

Use of ICTs to improve information flow and efficiency

Many vendors in Kenya and around Africa have to contend with receiving commodity supply from multiple wholesalers and middlemen, making it expensive to stock products, and in the case of fresh

[2] Hungry cities project was designed and implemented by CIAT and Twiga Foods as partners: https://bigdata.cgiar.org/inspire/inspire-challenge-2019/hungry-cities-inclusive-food-markets-in-africa/.

produce, impacting quality. Twiga leverages the robust ICT sector in Kenya in several important ways. It deploys Apps to on-board and service vendor and producers. In 2020, Twiga launched the Soko Yetu Agent model, that allows anyone to register and start recruiting vendors in their neighborhood to join the Twiga supply chain. Once vendors place their orders, Twiga delivers all the products within 24 hours and provides financial support to the customers so that they can stock up. Twiga also collates demand information to develop production profiles and orient farm level decision-making and makes efficient use of mobile money platform (M-Pesa) to facilitate transactions across its network. Data analysis and the provision of strategic insights to improve decision-making differentiates Twiga from traditional mid-market actors in the food system.

Coordinated value chain actors, shorter supply chains and commodity traceability

Twiga Foods leverages mobile phone technology to link demand and supply chain actors for the target value chains. The whole supply and distribution system is connected through ICT, as shown in Figure 3. Vendors make their daily orders through a mobile phone application. Twiga Foods aggregates orders from small vendors and large distributors through the producer mobile App. This information is relayed to producers indicating what produce is required and in what quantities. Once the producers prepare their produce, this is delivered to Twiga's aggregation centers where the commodities are received, documented and each crate labeled. The labelling ensures that each commodity can be traced back to the supplier even when it is at the Twiga warehouses in Nairobi.

At the aggregation center, the commodities (part or whole) can be rejected if they do not meet Twiga's specification in terms of quality, level of ripeness, physical appearance, etc. If a commodity is rejected at this level, the farmer takes it back. Approved commodities are collected by Twiga's trucks and delivered to the receiving warehouses in Nairobi or the central packhouse which has a cold storage and a banana ripening room. The commodity is then either transferred to another warehouse depending on the location where the commodities are needed or it is packed according to the vendor orders and delivered to the vendors. Deliveries to vendors usually happen within 24 hours of order placement. At all levels of commodity transportation and processing, product quality is assessed, and processing report is produced.

Improved linkages along the value chain through mobile phone applications helps to shorten the supply chain, ensures near real-time information flow, creates greater efficiency, and reduces transaction costs contributing to a more profitable value chain for the participating actors.

Twiga Foods delivers vendor orders to their point of sale reducing travel time and the associated costs for the vendors. The fresh fruits and vegetables are stored overnight in refrigerated stores in Twiga's warehouses. This preserves the quality of the produce such that the commodities are fresh and in good quality at the time they are delivered to the vendors.

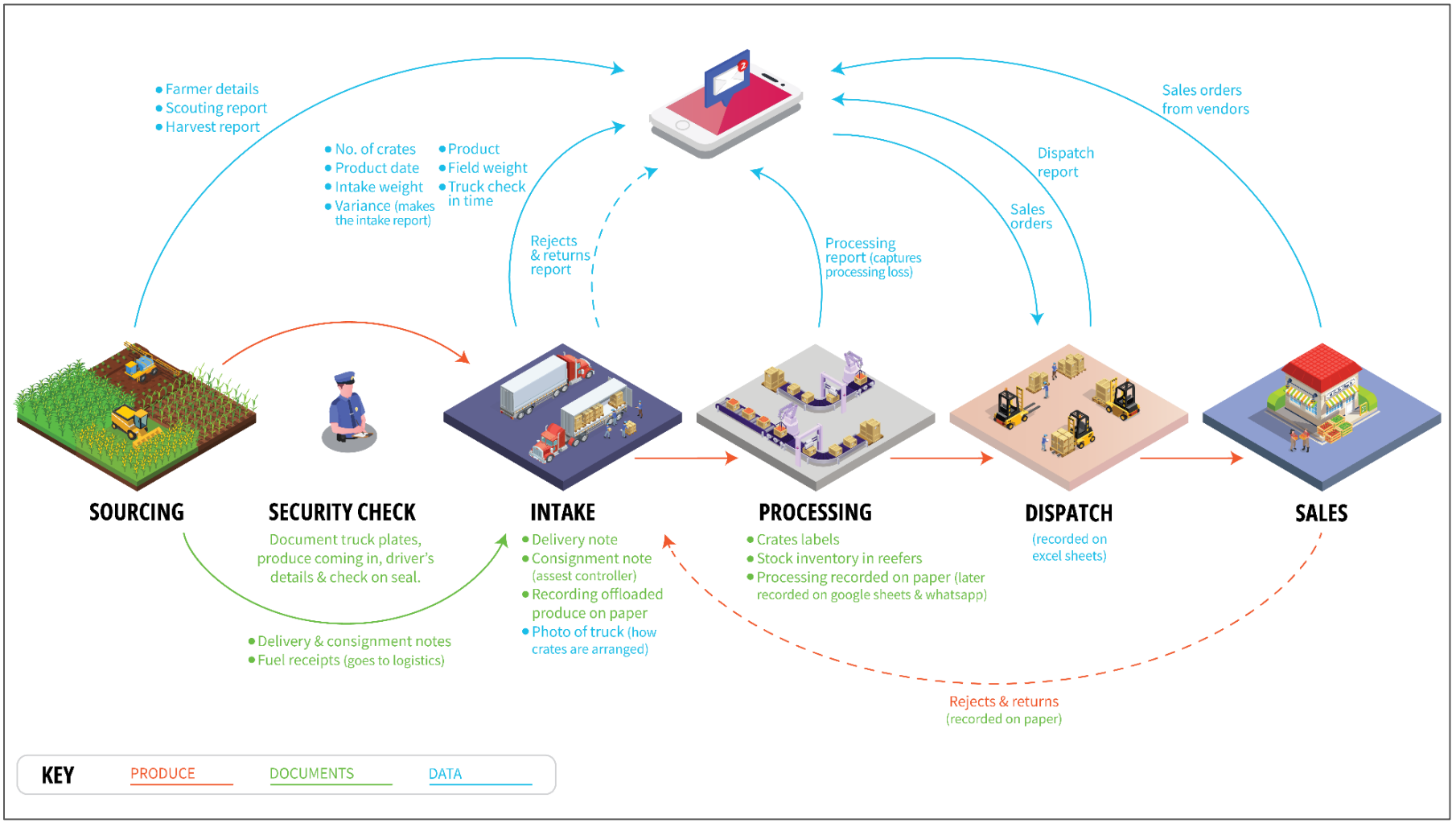
Inclusion of small vendors in the informal settlements

Twiga Foods has built its model around small informal vendors in urban areas of Nairobi and other cities. The informal retail vendors form the largest proportion of food retail vendors in Nairobi (Global Site Plans. 2017). Inclusion of small informal vendor's into Twiga's business model is one of their core value propositions as many of the existing MSMEs mainly target large traders, distributors, and supermarkets. Working with the small informal vendors create employment opportunities especially for

youth and women in the informal segment. The majority of Twiga's vendors are women and youth (Table 5).

As mentioned earlier, these small informal vendors are also important for food and nutrition security of the population in the low-income neighborhoods in Nairobi. They are the main food suppliers and majority of the low-income neighborhood residents prefer to purchase most of their daily food requirements from them.

Figure 3: Information Communication Technology (ICT) enabled Twiga Foods supply chain



Source: Adapted from Twiga Foods ltd.

Food Safety awareness

Food handling and safety has been a key concern in the fresh produce value chains given the difficulty/lack of enforcement of food safety standards and regulations in the largely informal trading system. Basic food handling processes such as washing, handling with clean hands, and storage in clean environments are not guaranteed in the wholesale market system or in the informal retail outlets.

Twiga Food aims to provide affordable, quality, and safe food to Kenya's urban consumers and reliable markets for farmers[3]. They are aware of the importance of food safety in the food value chains they work in. At the production level, they have agronomists who support farmers with production information and advice and visits Twiga's farmers to ensure appropriate use of agricultural chemicals and pesticides. In 2019, Twiga food signed an agreement with the International Finance Corporation (IFC), World Bank's private sector lending arm, in an initiative that sought to boost food safety in Kenya. The goal of the partnership was to enhance food safety practices in line with locally adapted global standards (i.e. Kenya GAP) but focused on the local value chains and ensure traceability of produce from the farm to consumers. Through this partnership, the staff were trained on internationally accepted food safety practices. IFC advised the company on food safety and quality management systems in its produce handling facilities while at the same time training Twiga Foods' staff on internationally accepted practices.

Photo Credit: Kevin Onyango/CIAT

Reduced post-harvest loss

Post-harvest loss is one of the biggest challenges of the traditional marketing models (Owuor et al., 2017). According to FoodFlow (2020), in Kenya, fruits and vegetables have high loss rates of between 40-50% with an estimated 37% of the loss attributable to aggregation and transportation by various actors including vendors.

Twiga's efficient bulking, transport, handling, sorting and distribution logistics, has enabled Twiga to reduce postharvest losses substantially thus making the value chains more efficient, and making foods more available to consumers while reducing costs. Twiga's improved supply chain, cold chain and material handling have reduced high food wastage in the market substantially. According to the company, they have reduced typical post-harvest losses in Kenya from 30% to 4% for produce brought

[3] https://twiga.com/about/

to market on the Twiga network (Bright, 2019), and cut the market average food waste by 70 percent (Nieuwoudt, 2020). According to recent data from Twiga Foods, commodity rejections at the warehouse due to mechanical damage, over-ripeness, and insect and disease damages have been kept below 27% (Table 6). The highest rejection was recorded in Tomatoes at 26.3% and these were mainly due to inappropriate tomatoes size (larger or smaller than required by the company) and level of ripeness. The rejected products were still sold through the conventional markets.

Table 4: Average product deliveries and rejects at Twiga Food warehouse between July-December 2019

	Average Quantity delivered (KG)	Rejected Quantity (KG)	Percent rejected (%)
Product	2019	2019	2019
Bananas	477.8	119.3	25.0
Onions	1,045.7	137.2	13.1
Potatoes	7,726.1	856.9	11.1
Tomatoes	6,358.2	1,673.4	26.3
Watermelon	1,349.6	244.0	18.1

Source: Twiga foods 2020 data

Stable market demand and pricing for producers

In the conventional system, farmers produce fresh fruits and vegetable and straggle to find markets for their produce. During harvest time, markets are flooded with farm produce leading to extremely low prices. Due to fear of losses, farmers sell to brokers who offer much lower and exploitative prices for the produce. The peak supply season is then followed by a lean season where demand is higher than supply.

Under the Twiga supply model, Twiga offers clear demand projections using aggregated vendor demand information gathered through the App. Farmers are assured of market and price stability and can access market information that is critical when making farm agribusiness decisions such as prices, quantity demanded, quality demanded, and collection pints. Twiga also works with medium and large-scale producers who are able to stagger their production to ensure supply is maintained throughout the year.

Access to capital investments for production

Twiga invests in on-farm production technologies to improve productivity and quality. These include boreholes, drip irrigation, greenhouses, improved planting materials and technical assistance for crop production. This capital is not provided to all producers but to those that are more commercial (i.e. medium and large scale producers). In 2020 for instance, Twiga food secured KES3.2 billion (US$29.4 million) in debt funding from the International Finance Corporation (IFC) to support more than 300 irrigated medium-scale contract farmers to complement Twiga's seasonal smallholder farmer supply base. The money was to help stabilize year-round fresh fruit and vegetable volumes in line with the

company's mission of supplying readily available safe, affordable, and high-quality food to Kenya's urban markets.

Twiga's success in capital investment overtime

According to Crunchbase (2023), Twiga Foods has raised a total of $157.1 million in funding from 24 investors over 19 funding rounds since its inauguration. The company, founded in 2014, received its first funding, a $1.75 million seed round in 2016 which was used to develop an internal tech platform for tracking of orders, increase retailer reach in Nairobi, and add fresh product offerings. The company then received a $10.3 million funding in 2017 led by Wamda Capital, and Omidyar Networks, DOB Equity, Uqalo, 1776, Blue Harven Initiative, Alpha Mundi, and AHL. Twiga then secured $10 million in 2018 during the second round co-led by the International Finance Corporation (IFC) and TLCom, a Pan-African venture capital firm. The other key funding the company has received over the years include a $5million funding from Creadev secured in 2019; the $30 million funding raised later in 2019 led by Goldman Sachs, IFC, TLCom Capital, and Creadev for setting up a distribution center in Nairobi, extend its ability to offer supply chain services for both agricultural and FMCG products and invest in expanding into more cities in Kenya, including Mombasa; and the $5 million loan received in 2020 from the United States International Development Finance Corporation (DFC). Among other uses, the later funding was meant to empower smallholder farmers and urban produce vendors (especially women) to have access to markets and improve the agricultural supply chain with cold storage, by enabling Twiga Foods to buy additional transportation and cold storage equipment. The company's latest funding of $50 million was raised in November 2021, led by Cardev. This latest funding was used to expand beyond Kenya and to launch digital products including capital credit and airtime, and electricity token vending, introduction of Fast-Moving Consumer Goods (FMCG) private label products and managing re-engineered fresh own farms.

What seems to work in the Twiga Model and areas of challenge

The Twiga Foods business model constitutes an important innovation in terms of food sourcing, sorting and distribution in an LMIC context. Their work on perishable products such as fruits and vegetables is of particular interest given the nutritional status of households living in poverty in urban Kenya. The Twiga model seeks to disrupt and out-compete the informal middle of the food system by applying modern communications, logistics, storage, food safety and payment models.

What seems to work in the Twiga business model:

- **Use of ICTs across the value chain** to improve information flows, align supply and demand, ensure rapid and easy transactions, and provide improved traceability. These innovations build on the robust mobile money infrastructure developed in Kenya (M-Pesa), high penetration of mobile phones and the emergence of innovative app designers.
- **Sourcing networks operating across Kenya** to ensure consistent and sufficient supply of fresh fruit and vegetables. The Twiga Foods sourcing model currently includes over 20 of the 47 counties in Kenya. Twiga also provides inputs to fresh fruit and vegetables farmers, recovered from their sales, on an annual basis. Likewise, this sourcing model works on demand projections and consistent pricing that reduces the commercial risk for farmers. For larger

farmers (see discussion below), Twiga Foods provides capital investments in boreholes, greenhouses, planting materials and technical assistance for more efficient and profitable production.

- **Disintermediation of the middle of the food system**. Twiga seems capable of outcompeting the constellation of traditional actors and networks that manage the perishable fruit and vegetable markets in Kenya through a combination of information, storage, and efficient logistics. This is seen in their comparatively low levels of food loss, application of food safety practices and competitive pricing models vis a vi traditional wholesale wet markets.
- **Inclusion of informal vendors embedded in low-income communities**. Unlike traditional innovations focused on modernizing food chains through supermarkets, Twiga focuses on upgrading the middle of the food system while maintaining and supporting traditional vendors in low-income communities. This delivers efficiency gains while, at the same time, ensuring social inclusion and positive livelihood outcomes for many female vendors.
- **Provision of more nutrient-dense products** specifically fruits and vegetables, in a cost-effective manner to low-income communities. Efficiency gains achieved with the Twiga model in the mid-stream of the food system can provide access to affordable and safe foods with an improved nutritional profile. This contributes to greater access and affordability of these products in these communities.

Areas of challenge in the Twiga business model:

The strengths of the business model face an evolving set of challenges. Some are due to the emerging nature of Twiga Foods and its rapid growth, others are inherent to fresh produce distribution, and some are unique to the market position and client segments targeted by Twiga. Challenges include:

- **Consistent logistics**. Despite investment in production calendars, bulking and distribution centers, cold storage, near real-time ordering and a product delivery network, Twiga Foods occasionally faces difficulties in guaranteeing on-time delivery of products to vendors. Some of these challenges are inherent in a fresh produce model while others are due to aggressive growth strategies which outpace fulfillment capacities.
- **Product standardization**. In the case of fresh fruit and vegetables, Twiga Foods invested in input provision, modern distribution, ripening and cold storage facilities to ensure the provision of consistent product sizes and volumes to vendors. However, economic experiments conducted with vendors indicated that those located in low-income estates prefer non-standard products (i.e. products with diverse sizes and levels of maturity) as it provides additional flexibility to service diverse consumer needs (Chege et al forthcoming). Standardization and modern product quality standards may have limited economic value for low-income vendors.
- **Product mix**. Twiga Foods started with a focus on fresh fruit and vegetable sourcing and distribution. This model proved successful at delivering value to farmers and vendors and led to the establishment of an effective logistics and distribution platform. Over time, Twiga Foods has successfully marketed this platform to other fast-moving consumer goods and processed food companies. These categories are shelf-stable thus removing some of the logistics challenges but represent a lower margin than the fresh categories. In addition, the spillover effects of fast-moving consumer goods and processed foods are limited or even negative in terms of famer inclusion and consumer nutrition. The establishment of an ideal product mix that is profitable but also retains some of the positive spillover benefits remains an on-going challenge for Twiga.

- **Sourcing model**. Initially Twiga Foods focused on sourcing fresh fruit and vegetables from small-scale farmers managing an average of 1 hectare per farm. This model presents challenges to scale given the atomized nature of landholdings and the limited number of producer organizations to promote effective collective action. This, in turn, lead to difficulties in guaranteeing sufficient production to meet vendor needs. As a result, Twiga Foods has been implementing arrangements with mid-sized farmers (between 10 and 20 hectares) who are able to deliver consistent production through investments in modern production technology (often supported by Twiga), achieve greater economies of scale and more professional farm management. Impacts of this new model on upstream farm-level employment and incomes remains unclear but are potentially significant.
- **Food safety**. Twiga Foods is one of the few fresh fruit and vegetable distributors serving low-income vendors and estates to invest in food safety. The application of Kenya GAP (Good Agricultural Practice) as mentioned above is feasible with a production base of mid-sized famer who have sufficient volume to offset the costs. What is less clear is the value that formal food safety standards provide to low-income vendors and their clients and their willingness to pay for safety. In addition, the effective management of an 'end-to-end' product traceability system remains challenging in Kenya and globally.
- **Competition**. The success of Twiga Foods served as a proof of concept of a disintermediation model for fresh food and fast-moving consumer goods distribution in Kenya. Not surprisingly, this led to the emergence of competition. Twiga succeeded in parlaying its first mover advantage into an effective sourcing, distribution, and logistics model. Nonetheless, the company faces increasing competition from newer market entrants both in terms of clients as well as in terms of staff retention.

Potential of the disintermediation approach to provide inclusive sustainable healthy diets to all

What can the Twiga Foods case teach us about the potential of a disintermediation model in the LMIC food system to provide multiple benefits in terms of food and nutrition security, incomes, employment, and potential spill-over effects?

Food and nutrition security

How has the entry and consolidation of Twiga Foods impacted fresh fruit and vegetable affordability, accessibility and availability for vendors and consumers in low-income areas of Nairobi? The business model pursued by Twiga Foods focused on outcompeting the traditional wholesale markets to improve the quality, availability, price and accessibility of fresh fruit and vegetable products to low-income vendors and consumers. The overall diversity of products on offer did not change markedly as Twiga Foods focused on high volume products already in demand but positive changes in terms of accessibility and availability were achieved. Specifically, accessibility of fresh fruit and vegetables improved for participating vendors and by extension their customers through the implementation of improved logistics that sought to ensure timely delivery of the correct volume and quality of products to the vendor's point of sale. This reduced frequent trips to traditional wholesale markets to purchase small volumes of produce, saving time and reducing safety concerns by the mostly female vendors. In

terms of availability, the Twiga Foods model seeks to connect consistent supply with existing demand. Despite the difficulties described above, the model has succeeded in ensuring consistent access to a range of fresh fruit and vegetables in line with vendor demands. The evidence around product affordability is less clear. The Twiga Foods pricing model claims to save vendors an average of 30% compared to wholesale market prices but it is unclear whether any of these savings are passed on to consumers. More study is needed to assess the potential affordability impacts.

Income and employment

Twiga Foods improves incomes of farmers and vendors at both upstream and downstream ends of the food system. The reduction in food loss and waste along the supply chain and at the vendor level helps the food system actors to make more money through sale of the commodity. By supplying commodities directly to vendors, it saves vendors time and money as they do not have to pick up the products themselves.

The original Twiga Foods business model did not include direct retail. This changed somewhat during Covid-19 with the introduction of on-line ordering for mid to high-income consumers. In the case of low-income estates, Twiga Foods works with a large network of informal vendors, over 70% of whom are women-owned SMEs to sell its products. This contrasts with the 'modern market' approach of promoting diverse formats of supermarkets or mini markets to displace existing vendors. The Twiga Foods business model has positive employment effects for the vendors in the retail network. Less clear are the income effects of Twiga Foods on these SMEs and consumers. A meaningful assessment of income effects would require additional research.

Potential spillover effects for further research

Beyond food and nutrition security and employment and income effects, the Twiga Foods model presents some potentially interesting spillover effects. All of these require further research and analysis but are worth mentioning. First, in addition to the positive food and nutrition security effects, the implementation of Kenya GAP food safety standards marks a novel application of these standards for low-income, domestic markets. Food safety remains an area of concern in low-income communities due to limited access to water, cold storage, and generally unhygienic conditions around the points of sale. While Kenya GAP would not fully resolve all these issues, it could generate a positive benefit in terms of health outcomes. Second, the use of the Twiga Foods vendor network to disseminate nutrition, dietary and food safety information. Vendors report working with a relatively stable number of clients over time with many repeat interactions. These social connections and trust indicate the potential to introduce additional information around product characteristics or dietary guidance into these interactions.

Two additional spillover effects relate to the net benefits in shifting from a small-holder sourcing model (i.e., 20,000 one hectare farms) to mid-sized farms (i.e. 1,000 ten hectare farms) in terms of productivity, food safety, employment and environmental effects. First, as described earlier, mid-sized farms of between 10 and 20 hectares permit larger capital investment in production technologies including boreholes, greenhouses, improved planting material and professional farm management. According to Twiga Foods, these mid-sized farms are more productive, reporting similar volumes of produce on smaller areas due to technology adoption and generate sufficient cash flow to offset the costs inherent in food safety standards such as Kenya GAP. This means less use of land, water and inputs for similar volumes of food safe fresh fruit and vegetables which, in theory, would allow land

sparing in rural communities. Second, what does a shift from 20 one-hectare farms to one 20-hectare farm mean in terms of employment, income and livelihoods for rural communities? Twiga Foods maintains that mid-sized farms can offer stable, formal employment contracts including social security benefits to households who previously managed one-hectare farms. In addition, these farms generate additional off-farm employment opportunities in packing houses for other members of these households. The sum of these arguments is that a transition to mid-sized farms will allow more efficient production of food safe fruits and vegetables with lower environmental impacts and improved employment quantity and quality for rural households than the current one-hectare model. All of these changes in farm size in the sourcing model require additional research to corroborate that the spillovers are achieved and quantify the distributional impacts among food system actors.

Finally, what has the Twiga Foods case taught us about conducting research with innovative business actors around their potential to contribute to healthy and sustainable diets at scale? Some reflections include:

- Firms like Twiga Foods provide unique opportunities to understand what is happening in food markets serving low-income vendors and consumers in near real-time. This allows researchers the opportunity to understand market dynamics, generate insights and, in collaboration with these firms, test and refine hypothesis on how to improve diverse aspects of these systems. In this specific case, the use of ICT enabled platforms permits rapid and widespread data collection where we can deploy more dynamic analysis that complements targeted experimental approaches.
- From a research perspective, the challenge of working with firms like Twiga Foods is their dynamic nature. They are unlikely to stand still while research is on-going and may shift their model based on changes in market conditions or take up and use findings prior to the conclusion of studies. Successful engagement with this kind of actor requires the use of diverse methods, approaches and skills that may differ from those we commonly deploy in other contexts. Likewise, these kinds of partnership require flexibility and adaptive management from researchers and the firm itself which is not always easy to achieve.
- Active engagement around common questions with firms like Twiga Foods can be mutually beneficial for research insights and scaling of positive practices. However, it is critical to remember that these are for-profit businesses that may decide to pursue commercial strategies that come at the cost of sustainable healthy diets. In the case of Twiga Foods, this is clear in the debate about the adequate product mix between fresh fruit and vegetables, fast-moving consumer goods and processed foods. The overlap of the goal of optimizing for sustainable healthy diets versus optimizing for commercial success may shift over time and not always coincide.

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