

Report on Digital Platforms in Kenya Case Study Report: Twiga Foods

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Abbreviations and Acronyms

DC	Distribution Centre
FGDs	Focused Group Discussions
KGS	Kilogrammes
KII	Key Informant Interviews
LDRI	Local Development Research Institute
SME	Small and Medium Enterprises
Std. Dev	Standard Deviation

1.0 INTRODUCTION

1.1 Background

According to a review of digital agriculture platforms in smallholder production systems in low- and middle-income countries, the growth in these platforms has been particularly fast in Africa. Kenya and Nigeria have emerged as hotspots in this regard (Shakhovskoy et al., 2021). Different types of platforms can be found in Africa. A well-known example is DigiFarm operated by Safaricom, a Kenyan mobile network operator, which offers different types of services to farmers in collaboration with existing digital agricultural service providers. Another example in Kenya, Twiga Foods takes a more active role in the value chain by contracting farmers and supplying their produce to small stall owners.

Digital agricultural services in Africa are increasingly being offered as part of integrated digital platforms that combine different types of services, such as markets for inputs and outputs, financial services or information about production methods. It is possible to distinguish between open, mediated and contract models, depending on the level of vertical integration (Mercy Corps, 2018). Open platforms offer only a space for social networking, but do not directly engage in transactions. Mediated models get actively involved in the aggregation of supply and demand, but without contractual obligations. The third type of platform involves entering into contracts with suppliers and off takers. Platforms can combine these different approaches on both the supply and demand sides (Figure 1). The platform can be legally obliged to fulfil purchases made through its platform based on terms and conditions, but this is distinct from creating a legal purchase order.

1 Model → 2 Crops → 3 Buyers → 4 Transport & Logistics → 5 Farmer engagement → 6 Financial services & payments
eCommerce platforms take open, mediated, or contract models on seller and buyer sides. Engaging farmers requires a mediated or contract model (2/2)

Model variation	Description	Example platform
	Platform supports aggregation/ facilitation without legal/ offtaking arrangements with farmers, and lets buyers purchase independently from platform	 ...aggregates produce from any SHF and sells to any buyer
	Platform supports aggregation/ facilitation without legal/ offtaking arrangements with farmers, and actively identifies potential buyers of produce	 ...aggregated potatoes from SHFs and located buyers including hotels/ restaurants
	Platform supports aggregation/ facilitation without legal/ offtaking arrangements with farmers, but has legal offtaking arrangements with buyers	 ...aggregates produce from any SHF and sells to contracted buyers
	Platform contracts to offtake produce with farmers, but buyers buy independently from platform	 ...collects produce from contracted SHFs and sell to any buyer
	Platform contracts to offtake produce with farmers, and has legal offtaking arrangements with buyers	 ...collects produce from contracted SHFs and sell some to contracted export market

Source: Dalberg analysis. Note: *The platform can be legally obliged to fulfil purchases made through its platform based on terms and conditions, but this is distinct from creating a legal purchase orders.



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Figure 1: Types of Digital Agricultural Platforms

1.2 Twiga Foods Digital Platform

Twiga Foods is a tech-enabled food distribution company based in Nairobi that connects smallholder farmers to Small and Medium Enterprises (SME) retailers in Kenya's urban centres. Founded in November 2014 by Peter Nonjob and Grant Brooke, the company is on a mission to consolidate the highly

informal and fragmented retail food distribution sector in Africa. Twiga Foods distribution system aims to help farmers earn higher returns for their produce while offering consumers higher quality produce at a more affordable price.



Distribution Centre and Banana Ripening Facility

Twiga uses the customer location data to build algorithms that help them optimize the supply chain from procurement to delivery and an increasingly lower cost per unit. Today, Twiga delivers 600,000 kg of food a day to 10,000 customers, and with the commissioning of the firm's new state of the art 200,000 square foot Distribution Center (DC) at Tatu City, which is expected to increase the installed capacity to 5.0 million kg per day. The new DC will also host Africa's largest banana ripening facility, and allow Twiga to reach any kiosk within Kenya in 24 hours with everything they need and more.

In just five years, Twiga has built a solid distribution network comprising of 13 collection centres, cold storage facilities, 12 depots, trucks and vans for collecting and distributing food, over 400 permanent staff and the same number of casual staff, and represents more than 17,000 farmers across 20 counties in Kenya, supplying over 8000 vendors in Nairobi and its environs with 200 tonnes of produce daily.

1.3 Rationale

The impact of digital agricultural platforms on agricultural production patterns and incomes in Africa remains poorly understood. Early evidence points to positive impacts “with regard to yield and income rise of farmers, financial security through insurances; pension schemes and job creation through the prolongation of value chains in the areas in which platform companies operate” (von Bismarck-Osten, 2021, p. 44). The most in-depth study available to date focused on DigiFarm in Kenya (Busara and Mercy Corps, 2021). The study shows that financial services are most highly valued by platform users. Better access to information about farming and higher farm production and income were most frequently cited as the main benefits perceived by platform users.

In-depth and independent empirical studies on the distributional effects of digital agricultural platforms are still lacking. The DigiFarm study only differentiates between male and female users, but does not provide further details on the types of farmers using the service or those not able to do so due to various constraints. To address this gap, this study seeks to understand who in fact benefits from the emergence of digital agricultural platforms and how to scale such platforms in an equitable manner.

1.4 Objectives

- o The main objective of this study is to identify and carry out an in-depth study of one of the main digital platforms in Kenya. The specific objectives include:
- o Identify the drivers of different types of digital platforms
- o Document the distributional effects of digital agriculture platforms

Understand how the growth of the platforms impacts on markets

1.5 Report Outline

The report is organized into several sections and sub-sections. Chapter 2 discusses the methodology followed in conducting the study while Chapter 3 presents the results and discussion. Chapter 3 is organized into several subsections including, results of the survey covering farmers, farmer agents and agents, results of the focused group discussions (FGDs), results of survey of Twiga Food vendors, benefits and challenges with the different levels of engagement and impacts of engagements. Finally, Chapter 4 presents the conclusions and recommendations.

2.0 Methodology

The research was carried out in Kenya and Nigeria as the leading countries in the provision of digital agricultural platforms in Africa, using a combination of qualitative and quantitative research methods. In Kenya steps followed were:

- i. Mapping of the digital agricultural platform landscape based on a review of the literature, platform websites and Key Informant Interviews (KII) (using a common Excel template).
- ii. In-depth case study of one platform, Twiga Foods Platform in the case of Kenya. Four levels of study were adopted in Kenya:
 - a. Mapping of platform provider, users and enabling actors
 - b. Key informant interviews (KII) and focus group discussions (FGDs) with platform provider, users and enabling actors
 - c. Survey of producers engaged in the platform (plus control group)
 - d. Analysis of platform usage data

Based on the results of the analysis of platform usage data, Twiga Foods was identified for the case

study in Kenya. Twiga Foods was willing participate in the KIIs and FGDs and sharing of data, e.g. number and types of transactions, information accessed, log-in times and duration etc. They also supported the survey of producers engaged in the platform (plus control group) and analysis of platform usage data.

The case study was on TWIGA Foods digital agricultural platform provider. The study involved In-depth analysis of TWIGA platform collection of information at three levels, literature review, KII and FGDs. Descriptive statistics was used to describe the data and to determine the magnitude and levels of the different variables. On the basis of qualitative responses, the data was organized, coded so as to determine patterns of the responses and then make deductions.

3.0 Results and Discussions

3.1 Survey of Twiga Foods Farmers, Farmer/Agents and Agents

3.1.1 Characteristics of Farmers, Farmer/Agents and Agents

All the farmers interviewed in Embu, Meru and Kirinyaga counties were aware of Twiga Foods digital platform, their household sold fresh products to Twiga Foods, either directly or through someone else and they were willing to participate in the survey. Respectively, the numbers of farmers, farmer-agents and agents interviewed were 45, 23 and 26 in Embu, 61, 41 and 48 in Meru and 52, 8 and 24 in Kirinyaga, summing up to a total of 158, 72 and 98 respondents.

3.1.1.1 Gender

The gender gap was highest in Meru County for all respondent categories but widest for Agent-Farmer category with 78% male to 22% female and lowest for Farmer category with 61% male to 39% female as indicated in Figure 2. In Embu, the gender parity for farmers was more favorable towards women especially for the Agent-Farmer category with 35% male to 65% female, while at par in the farmer category. In Kirinyaga County, the gender parity was at par for the agent-farmer category but unfavorable for females for the rest of the categories (Figure 2). Considering the group of Agents and Farmer-Agents only, most Agents and Farmer-Agent respondents were male with an overall percentage of 61.5% while the rest were females, which was depicted in Meru and Kirinyaga counties as well. However, Embu County presented a different gender participation as there were more female Agents and Farmer-Agents (52.1%) than males (47.9%).

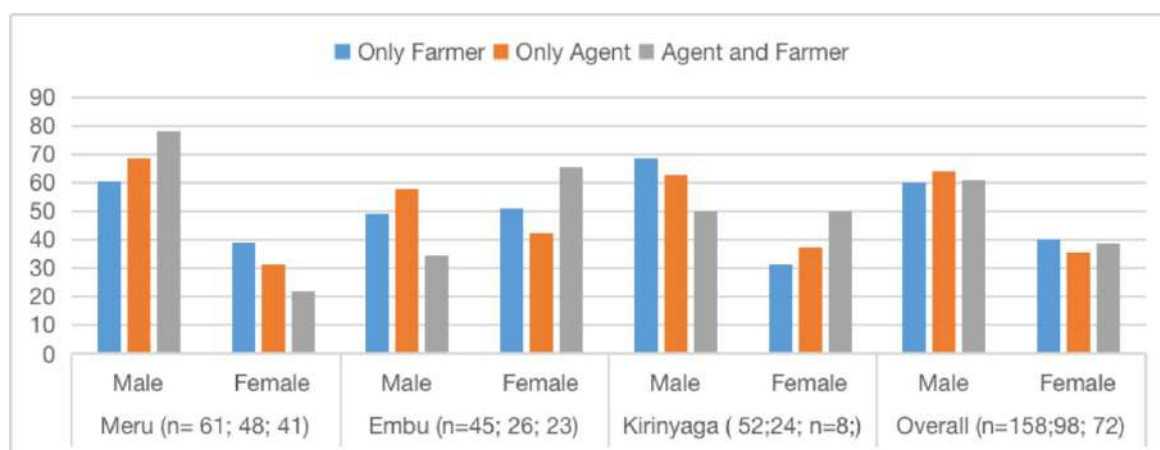


Figure 2: Gender of the Respondents

All the farmers from Embu, 96.3% from Kirinyaga and 93.3 % from Meru owned one or more phones, resulting to overall phone ownership of 97.85%, while 1.5% had access to a phone belonging to someone else. The study considered the potential for mobile phone technology usage to revolutionize agriculture in Africa through its positive impact on agricultural production in terms of accessibility to information on market prices, weather updates, and agricultural techniques. The use of mobile phones has facilitated transactions and reduced transportation costs for farmers, making it easier for them to sell their products, an advantage that comes with adoption of technology at the agricultural production level, and the study showed that the farmers, farmer-agents and agents of Twiga foods were not an exception. However, the challenges that accompany phone usage which include limited access to electricity, poor network coverage in rural areas, low literacy levels, and the high cost of mobile phones and internet data were faced by the farmers, farmer-agents as well as the agents of Twiga foods as per the study findings. According to Corrigan (2020) on Africa's ICT infrastructure, the private sector had, despite some restrictions to its contributions, fared well in constructing ICT infrastructure, and this should be promoted and incentivized. At the same time a study by Baumüller (2015) states that farmers' willingness to pay for the price information largely depends on the cost of service. Figure 3 shows the type of phone(s) owned or accessed by the respondents.

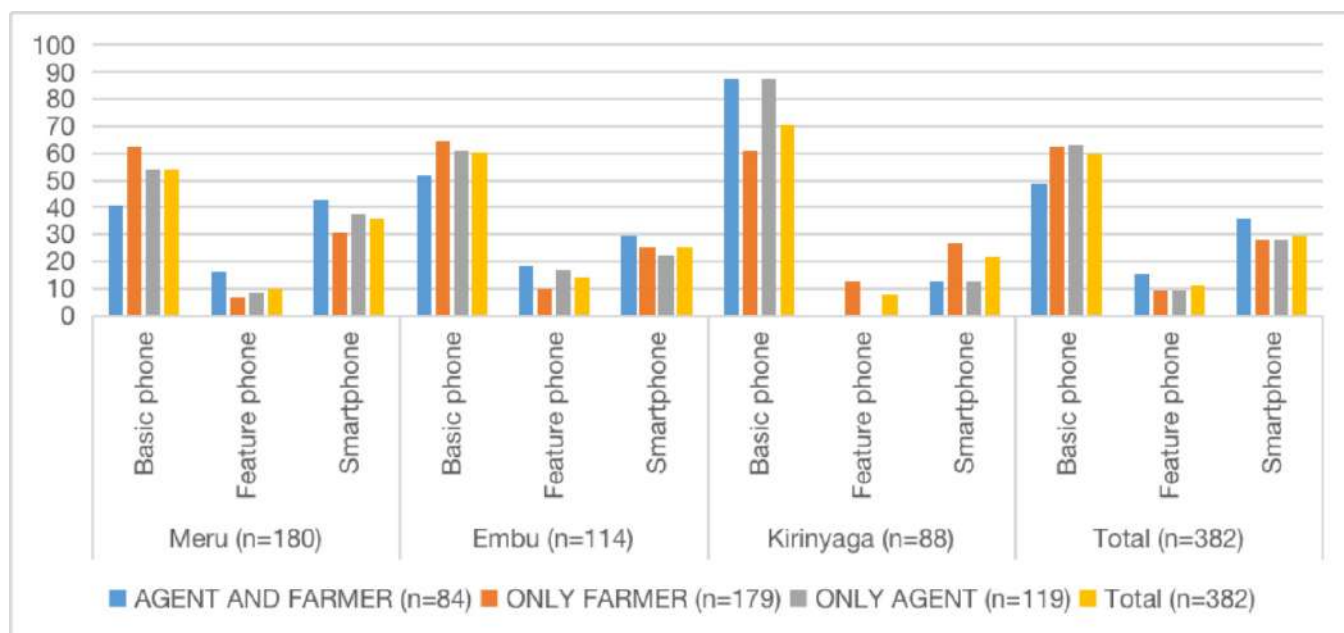


Figure 3: Types of Phones Owned or Accessible by the Farmers, Farmer Agents and Agents

3.1.1.2 Level of education

The highest level of education for a majority of agents and farmer agents from Meru, Embu and Kirinyaga counties was secondary school (45.0%) followed by primary school (36.4%). A few had gone up to the university, college and vocational training level (4.6%, 5.5% and 0.9%, respectively). In addition, 7.6% did not attend school as shown in Figure 4. Most of the respondents reported that their highest level of education was secondary school followed by primary school, college and university. A total of 40.8% of the farmers reported secondary school as highest level of education attained; 36.3%, 7.6%, 5.7% and 1.9% reported primary school, college, university and vocational training, respectively as the highest education attained while 7.6% of the farmers never attended school. Regarding the agent-farmer category, 52.8% attended secondary school while 34.7% attended primary school, while 4.2% attended college, another 4.2% also attended university, while 4.2% of the farmers never attended school. For the agents, the trend was similar to the previous categories (farmers and farmer-agents). The agents that attained secondary school were 53.1%, primary school (30.6%), college (3.1%), university level (3.1%) and 10.2% of

the farmers never attended school. The larger number of non-educated agents were rather surprising, which was unlike the study findings states that the higher the maximum educational level attained by the household members, the more soil conservation practices were adopted, while Eaiene et al. (2009) asserts that education of the household head has a consistently positive relationship to most technology adoption decisions.

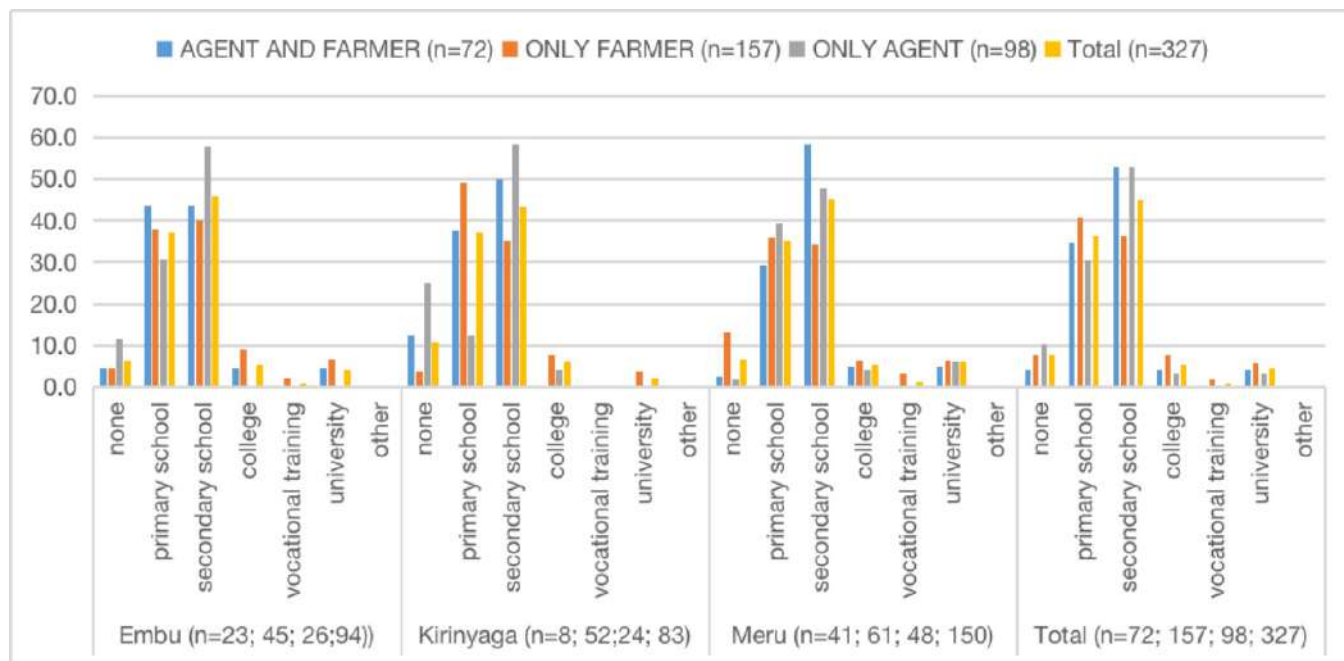


Figure 4: Level of education of farmers, farmer-agents and agents

3.1.1.3 Age

The average age of farmer is 60 years old currently which implies that the generation of farmers is getting old meaning and that more workforce is needed to support farming and food systems. Therefore, the world's opportunity to solve the problem of capital – such as labour, skills, education – in agriculture and food systems lies with the youth population (15-34 years old) noting that they form 60% of Kenya's population. According to the study, the averages age of the farmers (in years) was 42.4 years with a standard deviation of 11.4 years (Table 1).

According to Wawire et al., (2013) young people are most likely to be exuberant about new technologies, thus more likely to use the technology, as also reported by Diaz et al., 2021. They attribute their finding to the fact that young farmers are more willing to take risks and try out a new innovation than old farmers.

Table 1: Age of Respondents (in years)

County	Agent and Farmer			Only Farmer			Only Agent			Overall		
	n	Mean Age	Std. Dev.	n	Mean Age	Std. Dev.	n	Mean Age	Std. Dev.	n	Mean Age	Std. Dev.
Embu	23	40.7	12.7	44	54.7	15.8	26	40.5	13.1	93	47.3	15.9
Kirinyaga	6	52.5	6.9	51	50.7	14.8	17	47.7	10.4	74	50.2	13.4
Meru	41	41.9	10.6	61	48.3	16.2	48	39.6	9.3	150	43.8	13.3
Overall	70	42.4	11.4	156	50.9	15.8	91	41.4	11.0	317	46.3	14.3

3.1.1.4 Household size

Typically, a large household is associated with increased spending (Biru et al., 2020) which necessitates the adoption of technologies that provide higher incomes to meet household needs. The study shows that a larger household size provides cheaper labour by family members, thus increased productivity and consequently more produce to market. The average household size was four (4) as shown in Table 2.

Table 2: Household Size of Respondents in Meru, Embu and Kirinyaga Counties

County/ Param- eter	Only Farmer		Only Agent		Agent and Farmer		Overall	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Meru	4	2	4	1	4	2	4	2
Embu	4	2	4	2	4	1	4	2
Kirinya- ga	5	2	5	3	5	3	5	2
Overall	4	2	4	2	4	2	4	2

The study shows that 96% of the interviewed respondents were household heads in the three groups of population with a few sons and daughters (2.1%), grandparents (1.2%), cousins or uncles/aunts each 0.3%.

3.1.1.5 The Entities that Introduced Farmers and Farmer-Agents to Twiga Foods Digital Platform

Overall, the farmers who sold produce to Twiga foods either directly or indirectly, 23.9% of the farmers were introduced to Twiga foods by Twiga employees, 35.1% by other farmers, 18.0% by Twiga foods agents, 13.2% by family members and 5.9% by extension agents as shown in Figure 5. The figure also indicates that agents who sold produce to Twiga foods were introduced to Twiga foods by Twiga employees (36.3%), other farmers (24.2%) and other agents (29.3%), family members (5.7%) and by extension agents (3.2%). Data shows that farmer-agents were introduced by the same range of introducers of agents and farmers to Twiga foods. Figure 5 shows that 35.5% were introduced to Twiga foods by Twiga employees, 24.7% by other farmers, 18.3% by agents, 7.5% by family members and 10.8% by extension agents.

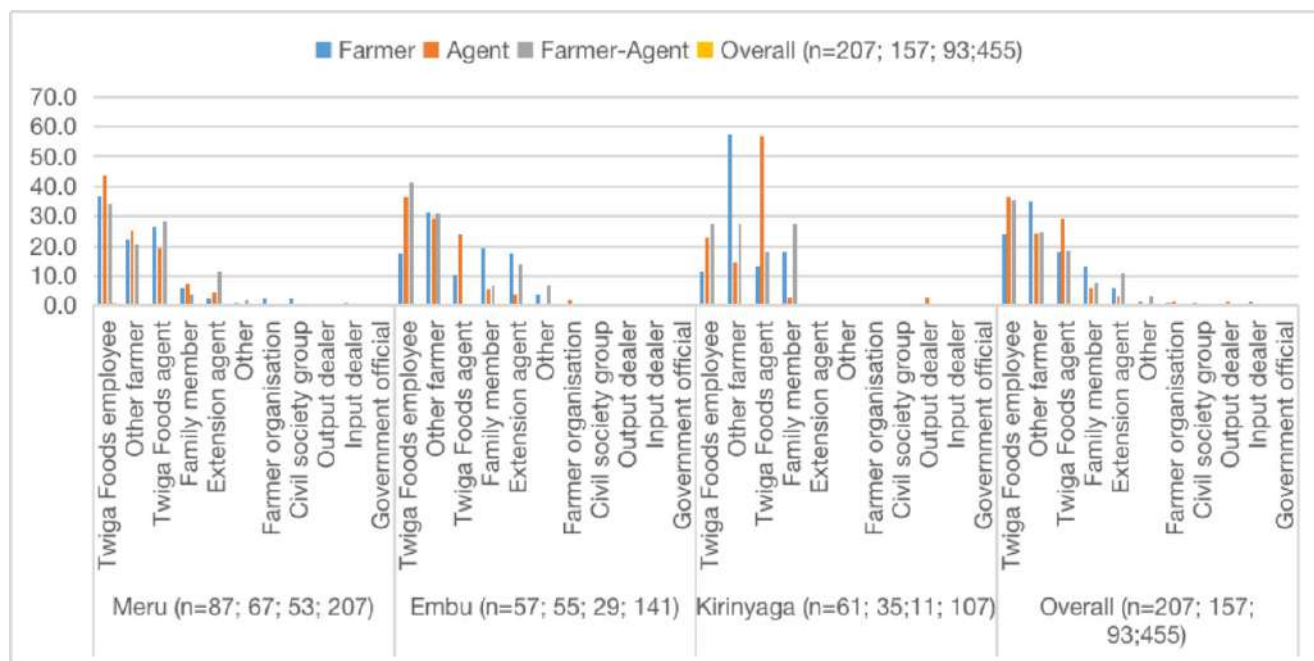


Figure 5: Entity that Introduced Farmers and Farmer-Agents to Twiga Foods

3.1.2 TWIGA Foods Farmers and Farmer-Agents

The category of farmers and farmer-agents represents the share of agricultural producers that engage with digital platform, Twiga Foods. They both produced and sold to Twiga Foods, but the farmer-agents also acted as a bridge between Twiga foods and the farmers, who could not sell directly, probably due to poor means of transportation to the collection centres. The farmers therefore sold indirectly through the agents or farmer-agents and in cases where one had the ability to take their produce to the Twiga Foods collection centre, they would sell directly but did not buy from other farmers and resell to Twiga foods. On average each of the farmers and farmer-agents across Meru, Embu and Kirinyaga Counties cultivated more or less the same as the land owned as shown in Table 3. It was only in Kirinyaga where the land cultivated was 2 acres against 1.9 acres owned pointing to a probable land lease/rent arrangement.

Table 3: Total Land under Cultivation and the Size Owned (Acres)

County	Land under cultivation (acres)						Land Cultivated and owned (acres)	
	Farmer-Agent		Farmer		Overall		Overall	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Embu	1.5	0.7	2.2	2.0	1.9	1.7	1.9	1.7
Kirinyaga	2.1	1.8	2.0	1.2	2.0	1.3	1.8	1.2
Meru	1.7	1.4	2.1	2.1	1.9	1.9	1.9	1.9
Total	1.7	1.3	2.1	1.8	1.9	1.7	1.9	1.7

Figure 6 indicates that most (93.9%) farmer agents were not members while only a few were members to farmers' organization (6.1%). This was unlike most of past study findings where membership in a farmer-based organization positively influenced technology uptake, and also in most cases the factor increased access to credit, and participation in agronomic training, increased farmers' propensity to adopt different digital agricultural solutions and increased the number of solutions adopted by farmers. Such was the finding by the study conducted by Quaye et al. (2022) where farmer-based organizations have been found as important channels for dissemination of technology for farmers.

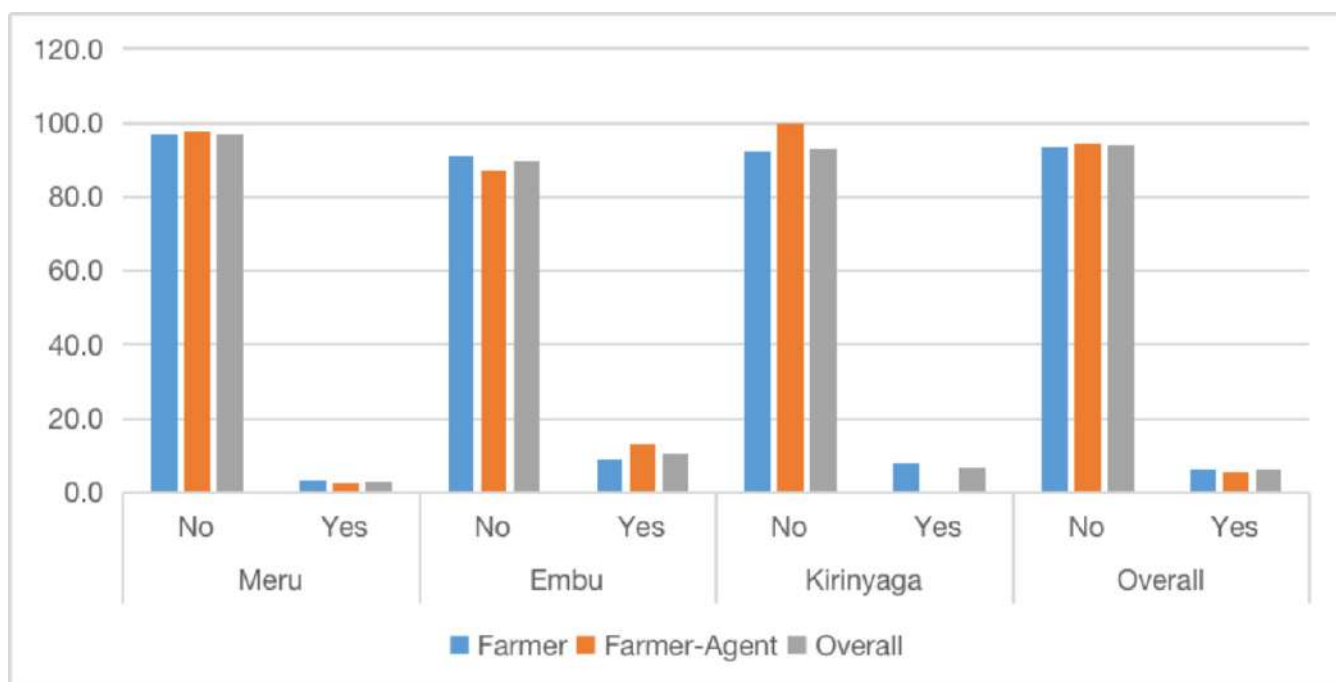


Figure 6: Membership to a Farmer Organization

Farmer groups/organizations are considered instrumental for social and economic purposes. They are formed to maximize the efficiency of agricultural production by disseminating newly developed technologies to farmers as well as setting up common goals and developing new strategies. Maximizing agricultural outputs is very crucial in a country like Kenya because it is one of the major sources of GDP growth (LDRI, 2022). Mwambi et al. (2021) found that being a member of producer organizations (POs) was important for achieving women empowerment mainly through promoting women's access to the organization's resources and services. However, the study found that by improving access to markets and technologies, household membership in POs often resulted in commercialization of smallholder farming, leading to women disempowerment as men took over control of the farm.

The farmers (6 years) and farmer-agents (4 years) in Embu had the highest average years of being a member of a Farmer Organization (FO) as indicated in Table 4. Meru County had the least average years of being a member of a Farmer Organization (FO) for both farmers (2 years) and farmer-agents (1 years).

Table 4: Number of Years as a Member to a Farmer Organization

County	Farmer		Farmer-Agent		Overall	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Meru	2	1	1	-	1	1
Embu	4	4	6	6	5	5
Kirinyaga	4	4	-		4	4
Overall	4	4	5	5	4	4

A study by Kukal and Irmak (2020) states that introduction of irrigation technology and its widespread use contributes to higher agricultural yields as it allows crop cultivation in regions where rainfall is insufficient to meet crop water demands. This as a result leads to more agricultural productivity as it provides a critical component of reducing poverty and food insecurity in Kenya. According to Jordán and Speelman (2020) irrigation technology is a key enabler for farmers to shift to commercial farming of more profitable crops thus hold agriculture as a business (agribusiness). The majority of the farmers and farmer-agents from the two counties, Meru (76.5%) and Kirinyaga (78%) irrigated their cultivated fields. However, just a few from Embu (13.2%) irrigated their fields (Figure 7).

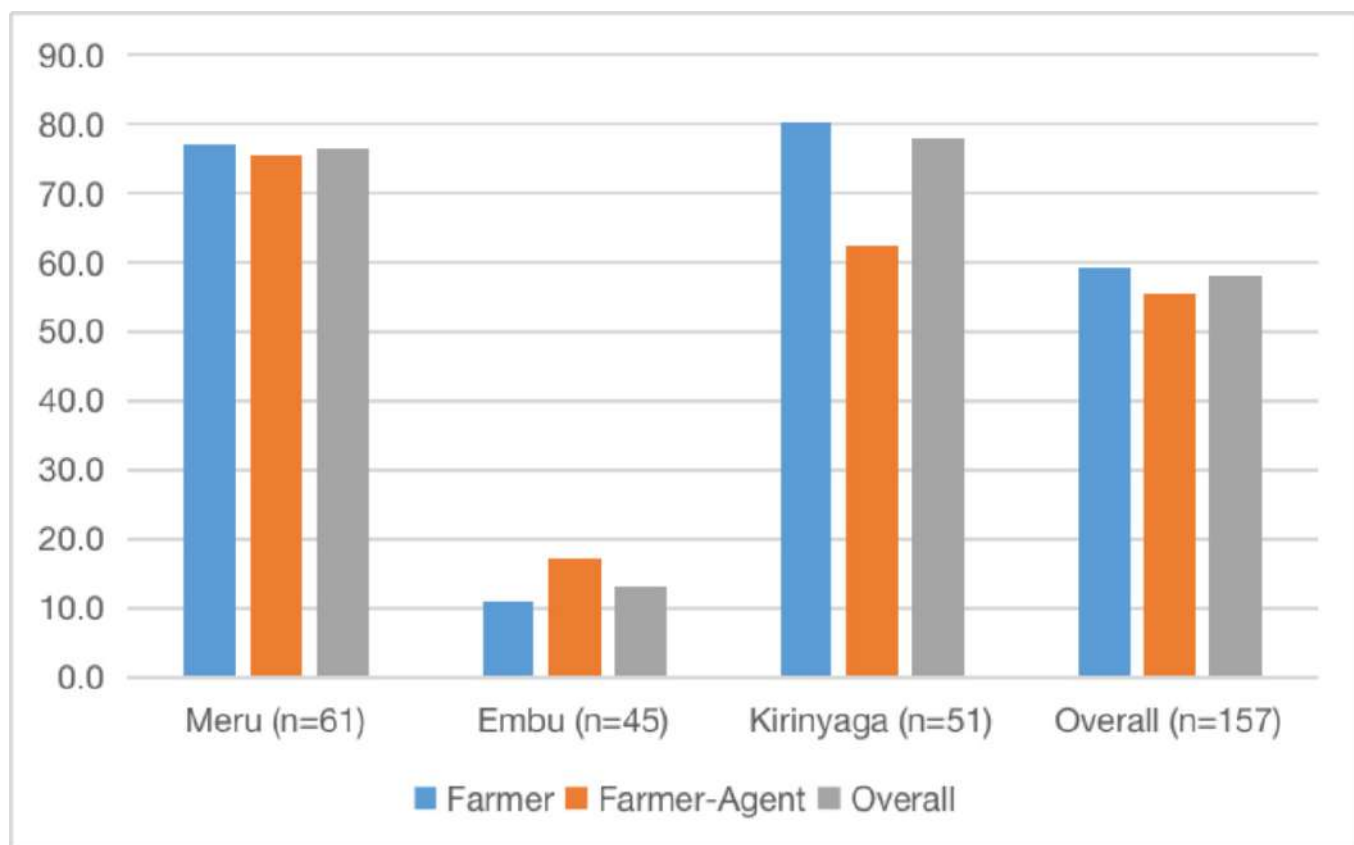


Figure 7: Farmers and Farmer Agents Irrigating their Fields

On average, each respondent farmer-agent who did irrigation had 1.79 acres of land irrigated as shown in Table 5. Embu County had the highest land under irrigation (2.5 acres) for farmers, while Kirinyaga County had the highest land under irrigation (2.3 acres) for farmer agents. Kirinyaga County had the lowest land under irrigation (1.71 acres) for farmers, while Embu County had the lowest land under irrigation (0.81 acres) for farmer-agents as indicated in Table 5.

Table 5: Size of Area Irrigated (Acres)

County	Irrigated Area (acres)					
	Farmer		Farmer-Agent		Overall	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Meru	1.85	1.91	1.72	1.32	1.80	1.69
Embu	2.50	3.14	0.81	0.55	1.75	2.42
Kirinyaga	1.71	1.16	2.30	1.44	1.77	1.19
Overall	1.82	1.69	1.70	1.31	1.79	1.58

The commodities produced by the farmer-agents included bananas, maize, livestock, green beans, sweet potato, cassava, tomatoes, rice, green grams/mung beans, soya beans, pigeon peas, cabbage, yams, wheat, groundnuts, onions, sorghum, melon, fish, macadamia, miraa, coffee, tea, sugarcane, khat, nappier grass, khat (muguka), water melon, sukuma, rabaii, pineapple, oranges, okra as well as kare-ra. Amongst them all the most commodities produced were bananas (29.0%), maize (23.9%), livestock (13.9%) followed by green bean (8.0%). They also produced other vegetables which included kales, spinach, coriander, pumpkin as well as other fruits such as avocado, mango, passion fruits, pawpaw as well as red berries. Vegetables and fruits mostly produced are kales (22.2%) and avocado (50%), respectively. The percentage of the respondent farmers and farmer-agents and the crops they cultivated across the three counties are shown in Table 6.

Table 6: Crops and Livestock Produced by Farmers and Farmer-Agents in Meru, Embu and Kirinyaga counties (%)

Commodity	County					
	Meru		Embu		Kirinyaga	
	Farmer	Farm- er-Agent	Farm- er	Farm- er-Agent	Farmer	Farm- er-Agent
Bananas	100	100	100	95.7	100	100
Maize	83.6	92.7	77.8	78.3	78.4	75.0
Livestock	73.8	65.9	24.4	30.4	31.4	37.5
Other commodities	13.1	14.6	57.8	65.2	15.7	0.0
Other fruits	19.7	19.5	22.2	17.4	0.0	0.0
Green beans	14.8	22.0	8.9	13.0	13.7	0.0
Sweet potatoes	13.1	12.2	6.7	8.7	19.6	12.5
Cassava	14.8	7.3	2.2	4.3	7.8	0.0
Tomatoes	6.6	2.4	0.0	0.0	13.7	12.5
Other vegetables	6.6	7.3	2.2	17.4	15.7	7.4
Green gams / mung beans	6.6	7.3	0.0	0.0	-	-
Cabbage	1.6	7.3	0	4.3	0	0
(Irish) Potatoes	4.9	2.0	6.7	4.3	2.0	0
Rice	0.0	0.0	0	0	17.6	37.5

Table 7 indicates all Farmer-agents from Embu and Kirinyaga counties sold bananas to Twiga Foods. Farmer agents from Embu County also sold coffee and macadamia to Twiga Foods as extra commodities. Overall, the main commodity produced from Meru, Embu and Kirinyaga counties and sold to Twiga Foods was banana which is 967.9% of the total commodities. Table 7 shows the percentage of the farmers and farmer-agents who produced each crop in the three counties.

Table 7: Crops Produced by Farmers and Farmer-Agents in the Embu, Kirinyaga and Meru Counties (%).

Commodity	Embu		Kirinyaga		Meru		Overall	
	Farm- er	Farmer Agent	Farm- er	Farmer Agent	Farm- er	Farmer Agent	Farm- er	Farmer Agent
Bananas	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.6
Maize	83.6	92.7	78.4	75.0	83.6	92.7	80.3	86.1
Livestock	73.8	65.9	31.4	37.5	73.8	65.9	45.9	51.4
Other commodities	13.1	14.6	15.7	0.0	13.1	14.6	26.8	29.2
Other fruits	19.7	19.5	0.0	0.0	19.7	19.5	14.0	16.7
Green beans	14.8	22.0	13.7	0.0	14.8	22.0	12.7	16.7
Sweet potatoes	13.1	12.2	19.6	12.5	13.1	12.2	13.4	11.1

Cassava	14.8	7.3	7.8	0.0	14.8	7.3	8.9	5.6
Tomatoes	6.6	2.4	13.7	12.5	6.6	2.4	7.0	2.8
Other vegetables	0.0	0.0	17.6	37.5	0.0	0.0	5.7	4.2
Green grams / mung beans	6.6	7.3	0.0	0.0	6.6	7.3	3.2	9.7
Cabbage	6.6	7.3	2.0	0.0	6.6	7.3	3.2	4.2
(Irish) Potatoes	0.0	4.9	2.0	0.0	0.0	4.9	2.5	4.2
Rice	0.0	2.4	7.8	0.0	0.0	2.4	2.5	1.4

Table 8: Agricultural Commodities Farmers Produced in Embu, Kirinyaga and Meru Counties (%)

County	Commodity	Farmer (%)	Farmer-Agent (%)	Overall (%)
Meru	Bananas	57.5	51.5	54.8
	Maize	15.0	25.8	19.9
	Livestock	22.5	18.2	20.5
	Other commodities	2.5	1.5	2.1
	Other fruits	1.3	1.5	1.4
Embu	Bananas	54.9	46.7	51.9
	Maize	19.6	26.7	22.2
	Livestock	5.9	3.3	4.9
	Other commodities	11.8	16.7	13.6
Kirinyaga	Bananas	43.1	55.6	45.0
	Maize	23.5	33.3	25.0
	Livestock	11.8	0.0	10.0
	Other commodities	5.9	0.0	5.0
Overall	Bananas	52.7	50.5	51.9
	Maize	18.7	26.7	21.6
	Livestock	14.8	12.4	13.9
	Other commodities	6.0	5.7	5.9
	Other fruits	2.2	1.9	2.1

Table 9 shows the five common vegetables produced across the three counties of Embu, Meru and Kirinyaga by the farmers and farmer-agents of Twiga Foods. Kales (55.6%) and spinach (22.2%) were the most common vegetables produced

Table 9: Five Common Vegetables Produced Across the Three Counties (%)

Type of vegetable	Percentage of farmer and farmer-agent
Kales	55.6

Spinach	22.2
Coriander	11.1
Pumpkin	5.6
Okra	5.6

3.1.2.1 Twiga Support to Farming Business

Digital transformation has helped agriculture not only to become more than just a tradition or a way to make money, but also an industry that relies on technology for its success and future growth. This study therefore, delved into the support that the digital platform Twiga Foods offers to its suppliers and producers, that is the farmers and the farmer-agents. As a result, the study found that farming businesses for the farmers and farmer-agents are supported by Twiga Foods through different ways as stated by the respondents from Meru, Embu and Kirinyaga counties. Such support included, buying of produce from them (directly or via an agent), arranging for transportation of their produce, enabling digital payments, providing advice on farming practices, providing information to assist with the management of farming, enabling access to production inputs (such as seeds, chemicals, protective equipment, farming tools, irrigation) in addition to providing ready markets for agent-farmer. These saved the farmers and farmer-agents the marketing and transportation costs thus improving efficiency. Table 10 shows the percentage of farmers and farmer-agents who enjoyed different types of support from Twiga Foods across the three counties.

Table 10: Type of Twiga Foods Support to Farmers and Farmer-agents

County	Type of Twiga Foods Support	Farmer (%)	Farmer-Agent (%)	Overall (%)
Meru	Buy the produce (directly or via an agent)	77.2	74.5	76.1
	Arrangement of transportation for the produce	11.4	3.6	8.2
	Enable digital payments	5.1	16.4	9.7
	Provide advice on farming practices	6.3	3.6	5.2
Embu	Buy the produce (directly or via an agent)	62.5	57.5	60.7
	Arrangement of transportation for the produce	13.9	15.0	14.3
	Enable digital payments	12.5	17.5	14.3
	Provide advice on farming practices	9.7	7.5	8.9
	Provide access to production inputs (seeds, chemicals, protective equipment farming tools, irrigation, etc.)	13.9	15.0	14.3
	Other services	12.5	17.5	14.3
Kirinyaga	Buy the produce (directly or via an agent)	66.2	57.1	64.8

	Arrangement of transportation for the produce	18.2	21.4	18.7
	Enable digital payments	10.4	14.3	11.0
	Provide advice on farming practices	2.6	0.0	2.2

The farmer and farmer-agents generally started selling their own-produced fresh foods to Twiga Foods at different periods, some as early as 2014 (3.5%), 2015 (3.1%) and 2016 (6.1%) as shown in Figure 8. Most of them joined in 2017, 2018, 2019, 2020, 2021 and 2022 with the percentages as 17%, 15.3%, 17.9%, 11.8%, 10.9% and 13.5 respectively. Most of the agents and farmer-agents joined in the year 2017, 2018 and 2020. Subsequently, there was a slight drop in 2019 and 2021 followed by a major drop in 2023 (0.9%).

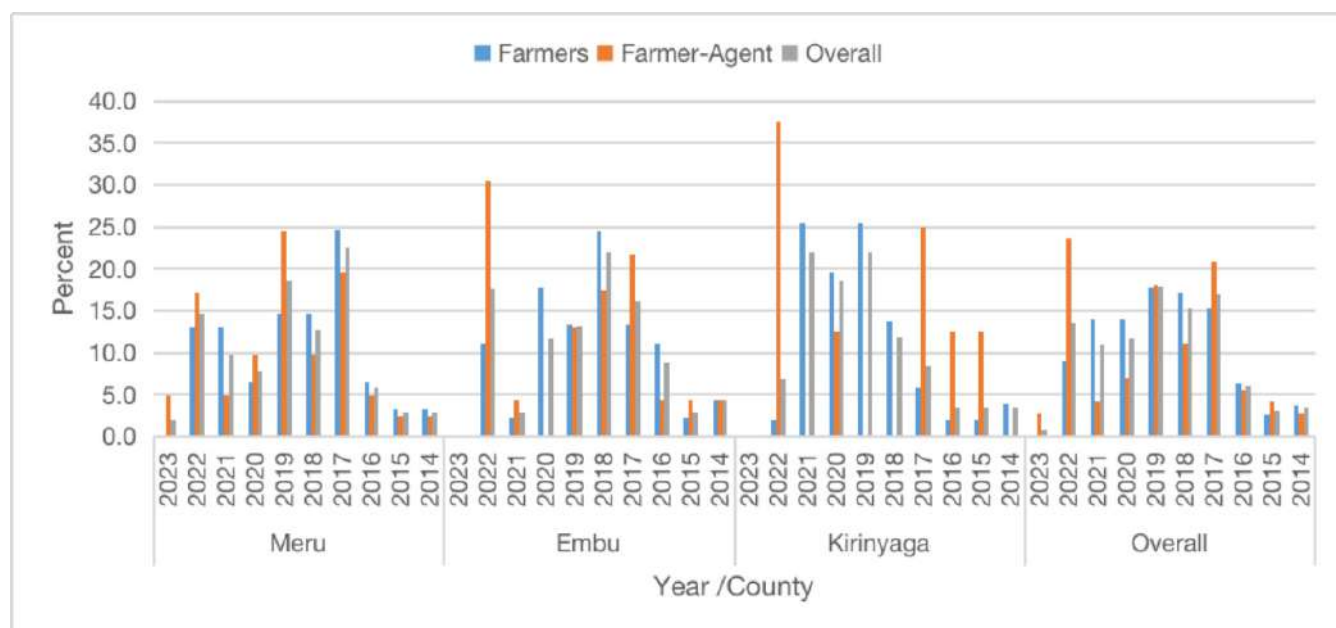


Figure 8: The Year Farmers and Farmer-Agents Started Selling Own Products to Twiga Foods by County

Table 11 shows the share of farmers and farmer-agents who were motivated by the listed reasons to sell their own produce to the digital platform, Twiga Foods and not to other potential buyers. The main reason mentioned across the three counties was that Twiga Foods gave better prices (above 50% for both farmers and farmer-agents) in Meru County, farmers (82.2%) and farmer-agents (52.2%) in Embu County and farmers (31.4%) and farmer-agents (50%) in Kirinyaga County.

Table 11: Reasons Farmers and Farmer-Agents Sold Own Products to Twiga Foods

County	Reason for Selling Own Products to Twiga Foods	Farmer (%)	Farmer-Agent (%)	Overall (%)
Meru	They have better prices	50.8	53.7	52.0
	Ready market for products	6.6	7.3	6.9
	They buy in kilograms which fetches high prices	13.1	17.1	14.7
	Twiga is good you always make profit	8.2	9.8	8.8
	They used to offer free transportation	3.3	7.3	4.9
	Source of income	14.8	2.4	9.8
	They are reliable	3.3	2.4	2.9

Embu	They have better prices	82.2	52.2	72.1
	They have better prices	4.4	30.4	13.2
	Ready market for products	8.9	13.0	10.3
	They buy in kilograms which fetches high prices	2.2	0.0	1.5
	Twiga is good you always make profit	2.2	4.3	2.9
Kirinyaga	They have better prices	31.4	50.0	33.9
	Ready market for products	39.2	12.5	35.6
	They buy in kilograms which fetches high prices	11.8	0.0	10.2
	Twiga is good you always make profit	5.9	12.5	6.8
	They used to offer free transportation	7.8	25.0	10.2
	They are reliable	3.9	0.0	3.4

All respondents from the three counties sold their bananas to Twiga Foods and a majority sold the whole share of their production/harvest. About 86% of the farmers sold all the bananas produced the previous season to Twiga Foods, 10% sold most of the production to Twiga Foods, and 3.9% sold half of their production to Twiga Foods. For the farmer-agents, some share of the commodities sold to Twiga foods was own production while for others all the produce sold was own production as shown in Figure 9.

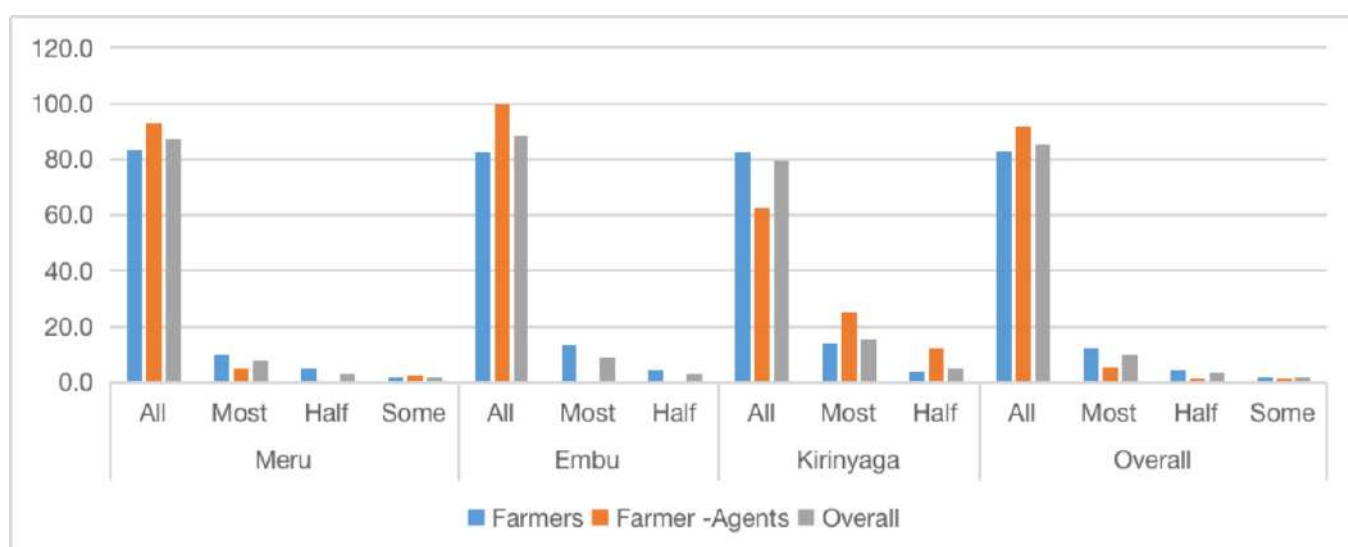


Figure 9: Share of Farmers and Farmer-Agents Harvest Produce Sold to Twiga Foods from the Previous Harvest Season

For farmers and farmer agents who did not sell all their produce to Twiga Foods, mainly sold to the local market (retailers, wholesalers and consumers) (40%) as illustrated in Figure 10. Others (21%) kept it for own consumption. While about 19% sold to consumers at the markets.

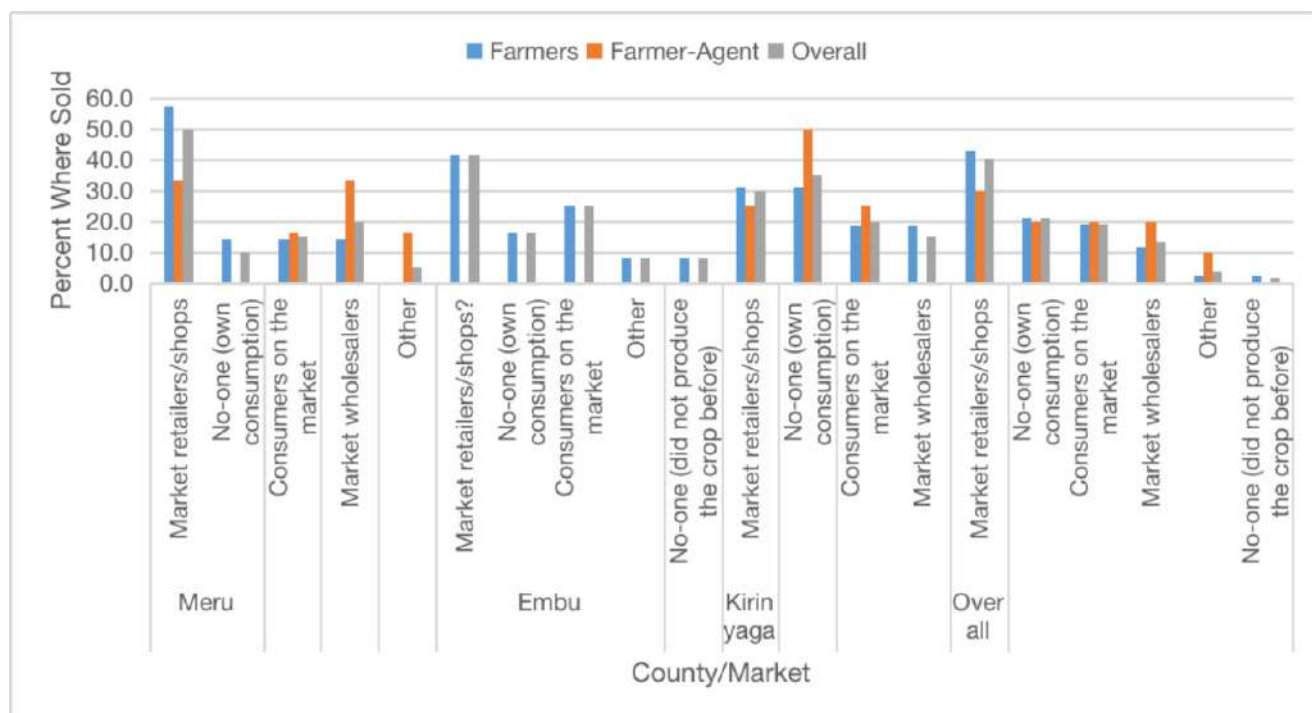


Figure 10: Where the Farmers and Farmer-Agents Sold the Remainder of the Harvest not Sold to Twiga Foods

The results of the study indicated that the farmers and farmer-agents who did not sell the whole share to Twiga Foods had different reasons as indicated in Figure 11. Overall, farmers reasons included: low prices per kg (40.7%), produce kept for own consumption (25.9%), Twiga Foods not able to buy some varieties (14.8%), grading and rejecting the small bananas (11.1%) and Twiga personnel not visiting the farm (7.4%). For farmer-agents, the reasons included: low prices per kg (50.0%), Twiga Foods not able to buy some varieties (16.7%), grading and rejecting the small bananas (16.7%) and bought by wholesalers in the market (16.7%)

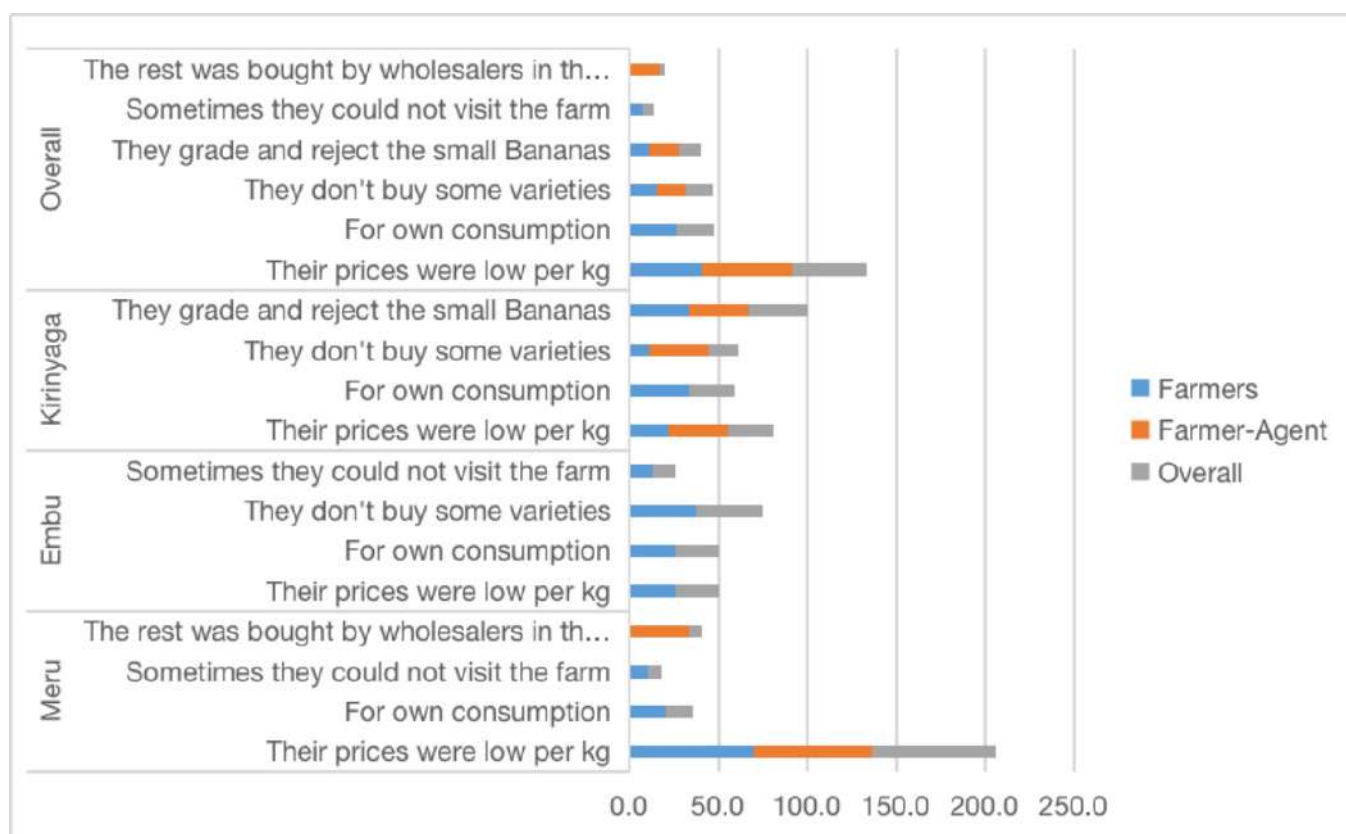


Figure 11: Farmers and Farmer-Agents not Selling all Their Produce to Twiga Foods

The farmers sold to Twiga foods through different channels. This was followed by sale directly at the Twiga collection center (36.5%), bulked with other farmers and transported to sell at the Twiga collection center (8.2%). Few farmers (1.8%) sold through output dealer(s) who were not Twiga agents (Table 12).

Table 12: Farmers Common Mode of Commodity Sale to Twiga Foods

County	Common commodities's channel/mode of sale	Percent
Meru	Sell to a Twiga agent	54.4
	Transport to and sell directly at the Twiga collection centre	42.6
	Cooperate with other farmers to collect, transport and sell at the Twiga collection centre	2.9
Embu	Sell to a Twiga agent	55.3
	Transport to and sell directly at the Twiga collection centre	42.6
	Cooperate with other farmers to collect, transport and sell at the Twiga collection centre	2.1
Kirinyaga	Sell to a Twiga agent	54.5
	Transport to and sell directly at the Twiga collection centre	23.6
	Cooperate with other farmers to collect, transport and sell at the Twiga collection centre	20.0
	Through output dealer(s) who are NOT Twiga agents	1.8

While the price of a product is known as the amount of money that one has to pay to get a particular produce, with agricultural products prices do not remain fixed as they are influenced by different factors which include but not limited to seasonality (whether the commodity is on or off season), the cost of production, demand and supply forces, quality of the produce, quantity of the produce as well as the price of substitutes and complimentary products (MDPI, 2022).

Farmers in Embu (73.5%) and Meru (46.1%) indicated that the prices offered by Twiga Foods was higher than prices offered by other buyers, but fewer farmers in Kirinyaga (13.6%) have the same opinion. However, a majority of farmers in Kirinyaga (62.7%) affirmed that Twiga Foods sometimes offered higher or lower than other buyers.

The buying prices of Twiga Foods compared to those of other buyers were evaluated by the farmers and farmer-agents from the three counties. Figure 12 shows that some farmer-agents (47.2%) said that Twiga Foods prices were generally higher than for other buyers, Twiga Foods prices were sometimes higher and sometimes lower than for other buyers (43.1%), Twiga Foods prices were generally lower than for other buyers (8.3%) while 1.4% stated that the prices were similar.

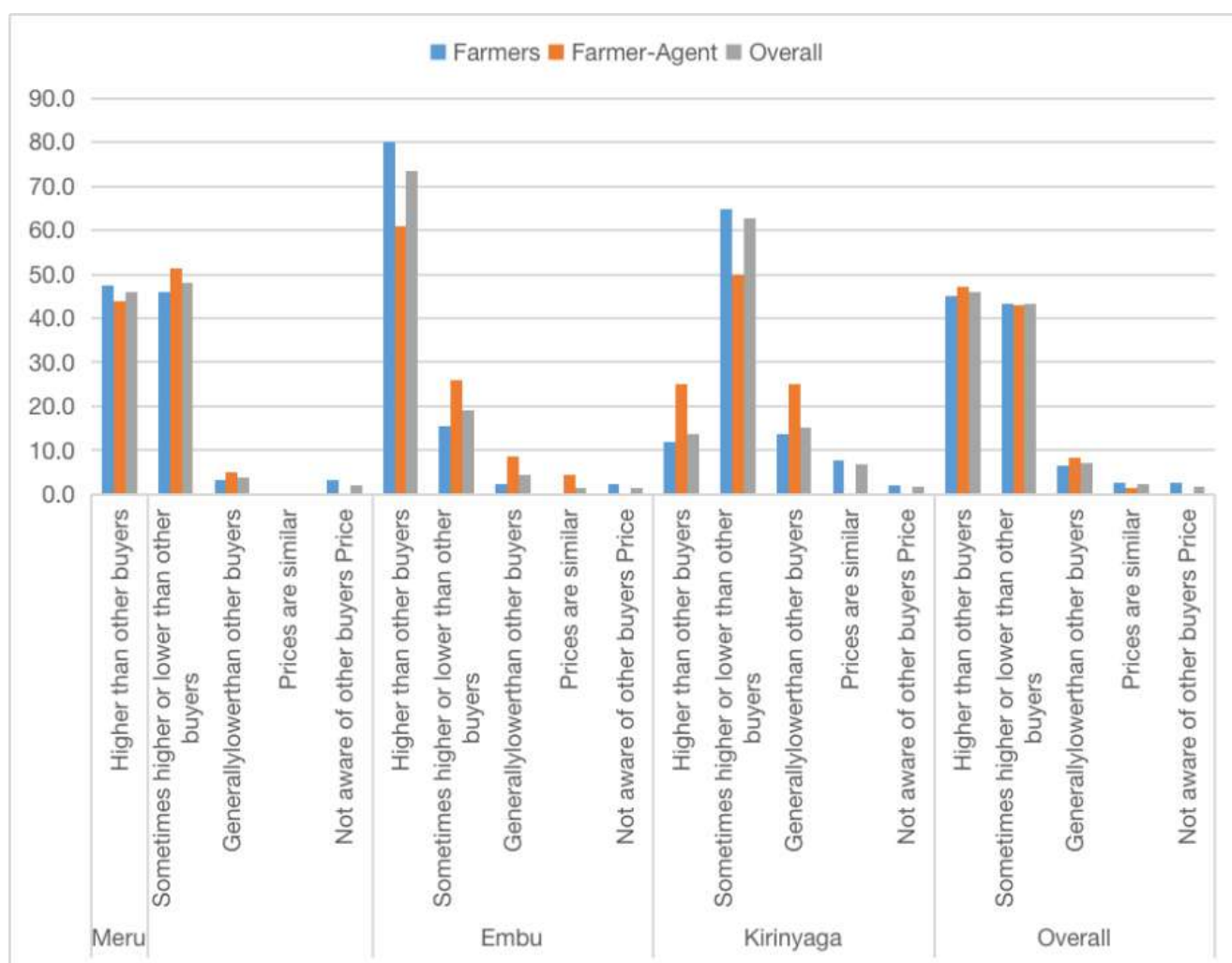


Figure 12: Comparison of Prices Between Twiga Foods and their Competitors by Farmers and Farmer-Agents

The study noted that before the operation of the digital platform by Twiga Foods farmers and Farmer-agents sold to other agricultural produce buyers. These included but not limited to, consumers at the market and in the neighbourhood, retailers and shops in the market places, wholesalers as well as some agents of other producers. Figure 13 that shows the percentage of the farmers and farmer-agents who sold to the different buyers.

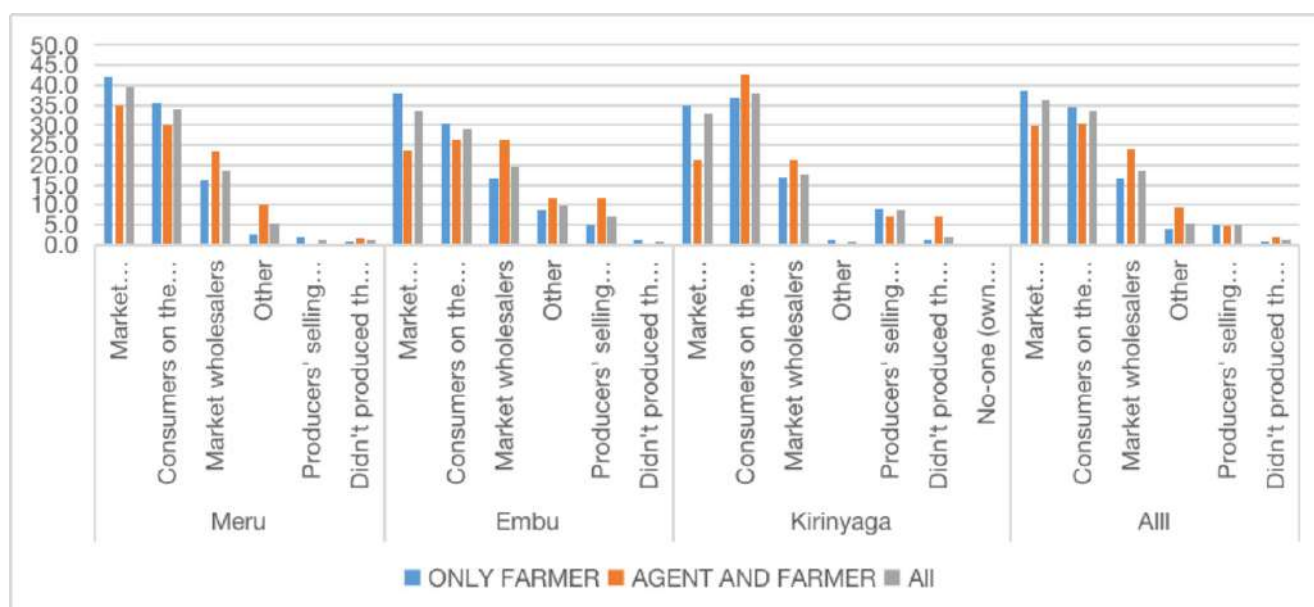


Figure 13: Buyers of Farmers and Farmer-Agents' Produce Prior to Engagement with Twiga Foods

When conducting business with Twiga Foods, farmers used different channels of communication such as Twiga agents, the staff at the Twiga collection centre (the centre manager, clerk, field officers etc.), other farmers who interacted with Twiga foods on their behalf, output dealers who sold the farmers' produce to Twiga Foods but were not Twiga agents as well as the Twiga App. On the use of the Twiga App, internet access in both urban and rural communities is critical to the uptake of digital agriculture and the use of Big Data analytics platforms (Weersink, 2018). Table 13 shows that both farmers and farmer-agents used Twiga agent (63.1%), Twiga staff (33.1%) and other farmers (16.6%) as their main communication channels when engaging with Twiga Foods. Few farmers used the Twiga App.

Table 13: Farmers and Farmer-agents Channels of Communication with Twiga Foods

Channel of Communication with Twiga Foods	County			
	Meru (n =61) (%)	Embu (n=45) (%)	Kirinyaga (n =51) (%)	Overall (n=157) (%)
Twiga agent	63.9	60	64.7	63.1
Twiga staff	45.9	33.3	17.6	33.1
Other farmers	9.8	11.1	29.4	16.6
Another channel	1.6	2.2	2	1.9
Twiga App	0	2.2	0	0.6

On average, two Twiga agents were in contact with the farmers on a regular basis whereby during planting season the frequency of contact is shown in Table 14. On average, farmers in all the three counties had slightly less than monthly contact (26%), followed by every two weeks contact (20%) and weekly contact (19%).

Table14: Frequency of Contact with Twiga Foods Agents during Planting Season (%)

Frequency contact with Twiga agent	County			
	Meru (n=39) (%)	Embu (n =27) (%)	Kirinyaga (n =33) (%)	Overall (n=99) (%)
Slightly Less than monthly	21	33	27	26
Every two weeks	10	15	36	20
Weekly	21	15	21	19
Monthly	26	15	6	16
Not at all	13	7	6	9
Daily	10	15	3	9
Total	100	100	100	100

The frequency of contact with Twiga Foods agents during the harvesting season is as shown in Table 15. On the average, 31.3% of the farmers in all the three counties had weekly contact, followed by every two weeks contact (27.3%), monthly contact (18.2%) and daily contact (14.1%).

Table 15: Frequency of Contact with Twiga Foods Agents during Harvesting Season (%)

Frequency	County			
	Meru (n =39)	Embu (n =27)	Kirinyaga (n =33)	Overall (n=99)

Weekly	38.5	22.2	30.3	31.3
Every two weeks	20.5	22.2	39.4	27.3
Monthly	12.8	29.6	15.2	18.2
Daily	15.4	22.2	6.1	14.1
Slightly Less than monthly	12.8	3.7	9.1	9.1
Total	100	100	100	100

The communication channels of the farmers and farmer-agents with Twiga Foods agents was as follows; in-person meetings (52.5% of the respondents), Voice calls (via the phone or apps) (44.4%), telephone short message service (SMS) (1.9%), text messaging (such as WhatsApp, Facebook messenger) (0.6%) while the Twiga App had only 0.6% of the respondents. The most frequently used channel to communicate with Twiga agents and Twiga employee was meetings-in-person.

In most households of the farmers and farmer-agents only the farmers themselves interacted with Twiga agents while in some cases spouses (23.6% of the farmers and farmer-agents households), daughters\sons (6.6% of the farmers and farmer-agents), parents (3.6% of the farmers and farmer-agents), while other relatives and employees (0.9% of the farmers and farmer-agents) interacted with Twiga Foods agents. The purpose of farmers' interaction with the Twiga Foods agents was to sell fresh produce, arrange transport of products to Twiga Foods collection centre, receive information about prices from Twiga Foods, receive information about Twiga Foods' demand for products, receive information about farming methods as well as to receive information about financial flows related to their farming business (such as cost of production, income from sales). Some farmers and farmer-agents interacted with Twiga Foods employees from time to time during different seasons of farming. The frequency of interaction during planting season was as shown in Table 16.

Table 16: Frequency of Farmers Interaction with Twiga Foods Employees during Planting Season

Frequency	County			
	Meru (n =28)	Embu (n =15)	Kirinyaga (n =9)	Overall (n=52)
Not at all (%)	28.6	33.3	55.6	34.6
Monthly (%)	32.1	13.3	22.2	25
Slightly Less than monthly (%)	17.9	33.3	22.2	23.1
Weekly (%)	14.3	6.7	0	9.6
Every two weeks (%)	7.1	6.7	0	5.8
Daily (%)	0	6.7	0	1.9
Total	100	100	100	100

The communication channels used to interact with the Twiga employees were Voice calls (via the phone or apps) (for 41.1% of the farmers and farmer-agents), in-person meetings (for 38.4% of the farmers and farmer-agents), SMS (for 16.1% of the farmers and farmer-agents) in addition to text messaging (WhatsApps etc.). Similar to the case of agents, most farmers interacted with the Twiga employees directly while in some cases the spouses, daughters\sons, parents, other relatives and employees. The

purpose of interaction with Twiga Foods employees were the same as those mentioned for interaction with Twiga Foods, which included but not limited to: buying of the farmers' fresh produce was the main purpose followed by receiving information about prices paid by Twiga Foods. The two channels mainly used were in-person meetings and voice calls. Figure 14 shows the use of the two channels of communication across the three counties of Meru, Embu and Kirinyaga.

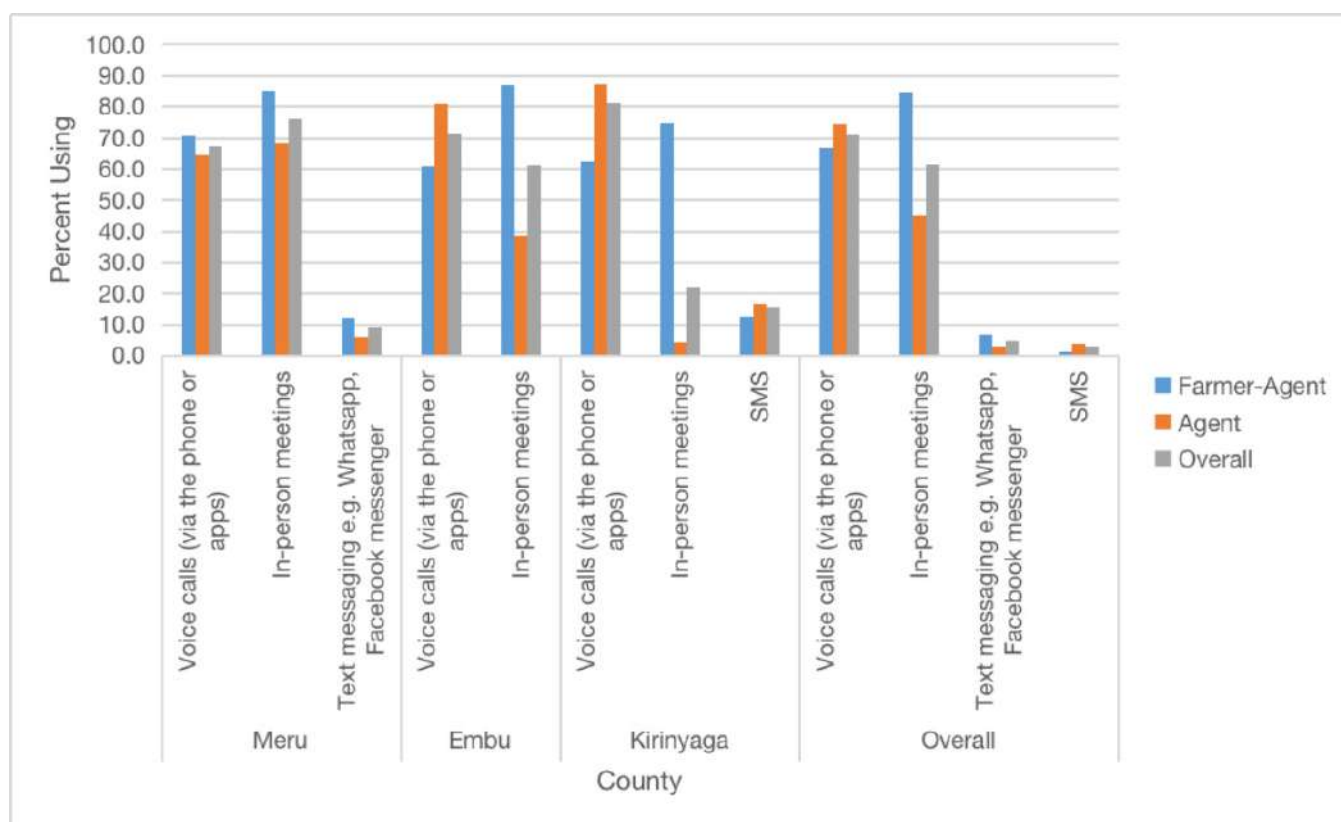


Figure 14: Farmers Using Voice Calls and In Person Meetings

Some farmers were aware of other digital agricultural platforms such as Simple Meru Green Ltd, which was known by 24.2% of the respondents, Sky Link Ltd. Was known by 17.7%, Mount Kenya Milk Ltd. By 17.7%, P and P by 16.1%, WhatsApp businesses (6.5%), Delmonte (4.8%) and Soko Fresh (1.6%). Others included; Naivas (1.6%), KALRO (1.6%), Icow (1.6%), Facebook business (3.2%) and Farm Works Company Limited (1.6%). Facebook business was more popular among farmers from Meru County and Kirinyaga County while Farm Works Company Ltd. and Naivas were known to farmers from Kirinyaga County. From the study, 81.5% of the farmers and farmer-agents did not share information received from Twiga Foods employees/agents with other farmers who did not engage with Twiga Foods apart from a smaller percentage 18.5% who did. The information shared hereby included prices, prevailing banana supply, farming advice and some encouraged them to sell bananas to Twiga Foods. The Twiga App was used in Embu County by farmers to place their orders but the App was not used in Meru and Kirinyaga counties. The possibility of the respondent farmers knowing other farmers who would like to engage with Twiga Foods was captured as shown in Figure 15.

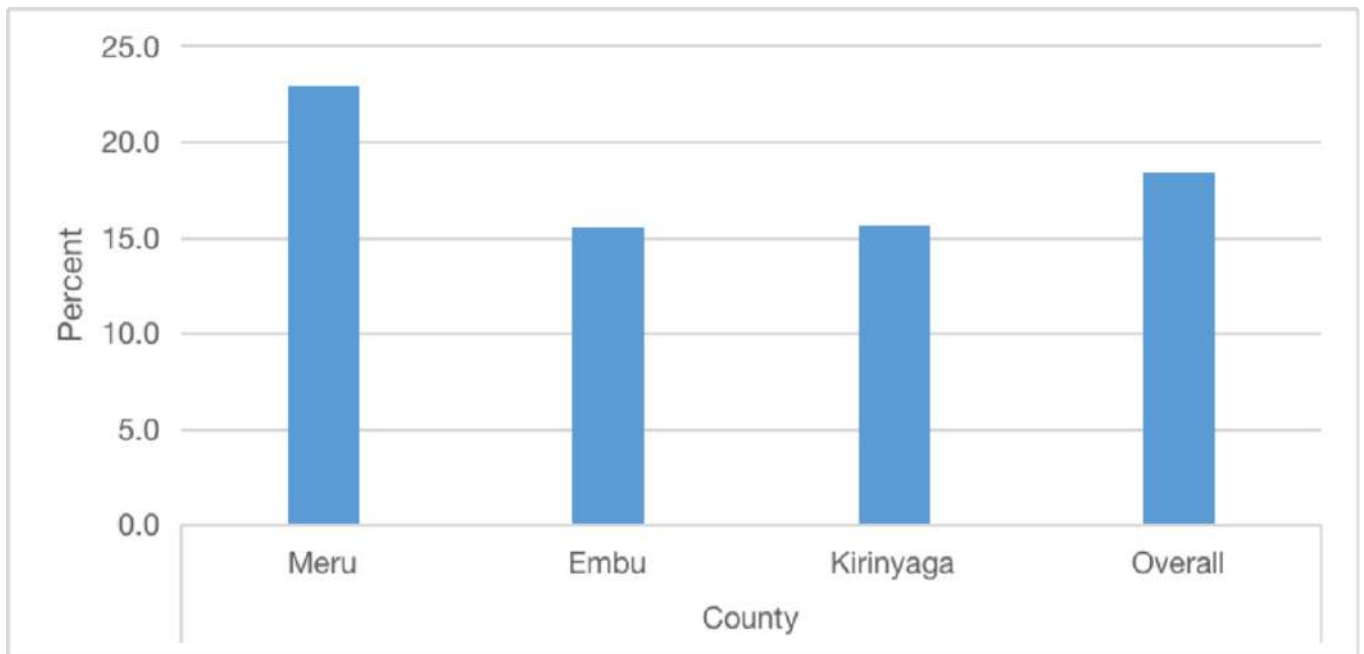


Figure 15: Farmers Expressing the Possibility of Knowing Farmers

Who Would Like to Engage with Twiga Foods

3.1.3 Twiga Foods Agents and Farmer-Agents

Digital agriculture is the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders to improve their products and processes. Such stakeholders include the agents and farmer-agents working for Twiga Foods. They bought fresh products from farmers to sell to Twiga Foods, while the farmer-agents sold their products directly and also worked for Twiga Foods as agents. Figure 16 shows the year that agents and farmer-agents started working for Twiga Foods.



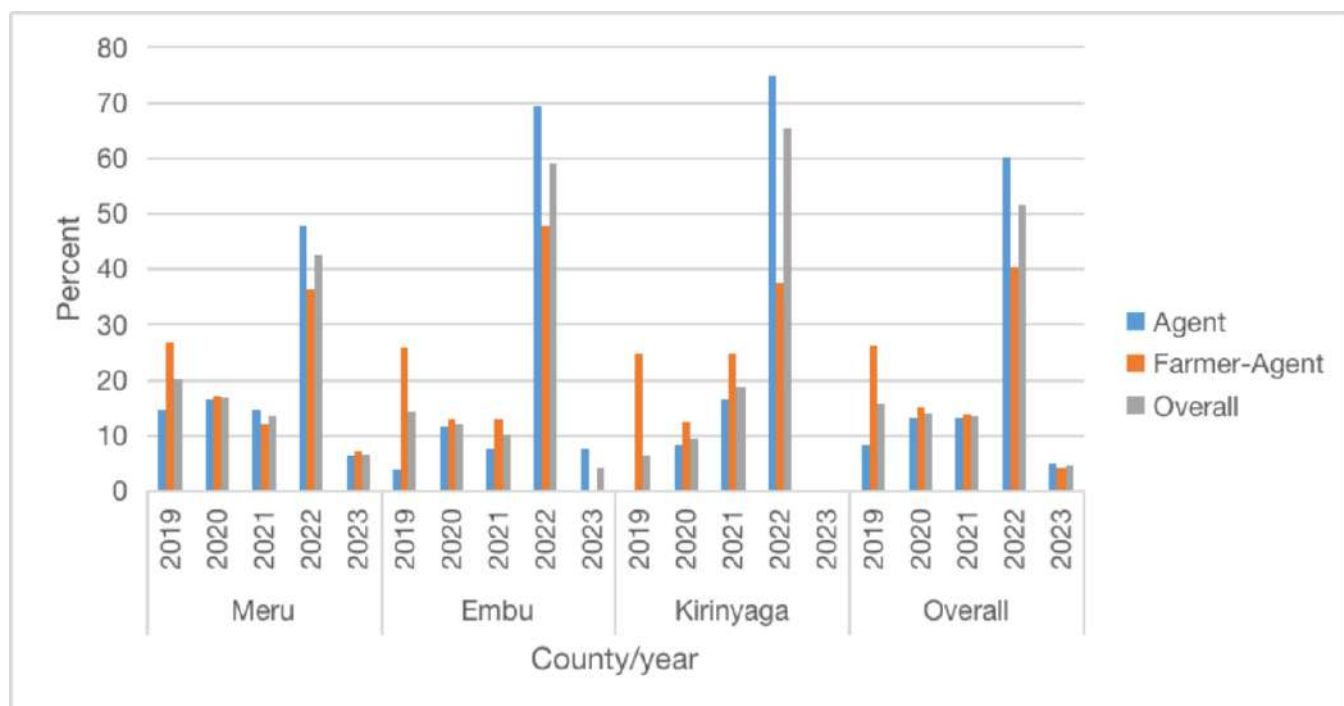


Figure 16: The Year Agents and Farmer-Agents Started Working for Twiga Foods

As indicated in Table 17, overall farmers were motivated to start selling to Twiga Foods by such reasons as better prices (53.5%), ready markets for the products (16.6%), Twiga Foods bought in kilograms thus they could fetch higher prices (11.5%) and that farmers made more profits (5.7%). On the other hand, farmer-agents were motivated to start selling to Twiga Foods by such reasons as better prices (52.8%), ready markets for the products (13.9%), Twiga Foods bought in kilograms thus they could fetch higher prices (6.9%) and that they made more profits (6.9%) as indicated in Table 17.

Table 17: Farmers- and Farmers-Agents' Main Reasons for Selling Produce to Twiga Foods

County	Main reason for selling produce to Twiga Foods	Farmers (%)	Farmer-Agents (%)	Overall (%)
Meru	They have better prices	50.8	53.7	52.0
	Ready market for products	6.6	7.3	6.9
	They buy in kilograms which fetches high prices	13.1	17.1	14.7
	Twiga is good you always make profit	8.2	9.8	8.8
	Source of income	14.8	2.4	9.8
Embu	They have better prices	82.2	52.2	72.1
	They have better prices	4.4	30.4	13.2
	Ready market for products	8.9	13.0	10.3
Kirinyaga	They have better prices	31.4	50.0	33.9
	Ready market for products	39.2	12.5	35.6
	They buy in kilograms which fetches high prices	11.8	0.0	10.2
	Twiga is good you always make profit	5.9	12.5	6.8
	They used to offer free transportation	7.8	25.0	10.2

County	Main reason for selling produce to Twiga Foods	Farmers (%)	Farmer-Agents (%)	Overall (%)
Overall	They have better prices	53.5	52.8	53.3
	Ready market for products	16.6	15.3	16.2
	They buy in kilograms which fetches high prices	11.5	13.9	12.2
	Twiga is good you always make profit	5.7	6.9	6.1

Table 18 shows that agents (72.7%) and farmer-agents (95.2%) in Meru County mainly bought banana from farmers. In Embu County, agents (65%) and farmer-agents (85.2%) bought banana and more maize than Meru County agents (32.5%) and farmer-agents (3.7%). In Kirinyaga County, the purchase of bananas from farmers by agents (48%) and farmer-agents (77.8%) was lower than the other counties, while maize purchases were higher (agents (30%) and farmer-agents (11.1%)). This result indicates that the agents and farmer-agents from Meru were more specialized than the other two counties, indicating the importance and volumes of the banana demand by Twiga Foods.

Table 18: Commodities Agent and Farmer-Agent Buy from Farmers and Sell to Twiga Foods

County	Commodity bought from farmers and sold to Twiga Foods	Agent (%)	Farmer-Agent (%)	Overall (n=234) (%)
Meru (n=108)	Bananas	72.7	95.2	81.5
	Maize	15.2	2.4	10.2
	Cassava	1.5	0.0	0.9
	Livestock	6.1	0.0	3.7
	Other commodity	0.0	2.4	0.9
	Sweet potatoes	1.5	0.0	0.9
Embu (n=67)	Bananas	65.0	85.2	73.1
	Maize	32.5	3.7	20.9
	Cassava	0.0	3.7	1.5
	Livestock	0.0	0.0	0.0
	Other commodity	2.5	7.4	4.5
Kirinyaga (n=59)	Bananas	48.0	77.8	52.5
	Maize	30.0	11.1	27.1
	Cassava	8.0	0.0	6.8
	Livestock	2.0	0.0	1.7
	Other commodity	0.0	11.1	1.7
All (n=234)	Bananas	62.8	89.7	71.8
	Maize	24.4	3.8	17.5
	Cassava	3.2	1.3	2.6
	Livestock	3.2	0.0	2.1
	Other commodity	0.6	5.1	2.1

County	Commodity bought from farmers and sold to Twiga Foods	Agent (%)	Farmer-Agent (%)	Overall (n=234) (%)
	Sweet potatoes	1.3	0.0	0.9

The farmer-agents who did not sell all their produce to Twiga Foods consumed or sold the remainder to other buyers like market retailers/shops (30% of the respondents), consumers in the markets (20%), market wholesalers (20%), while some from Meru and Embu counties sold to middlemen (10%) (Figure 17)

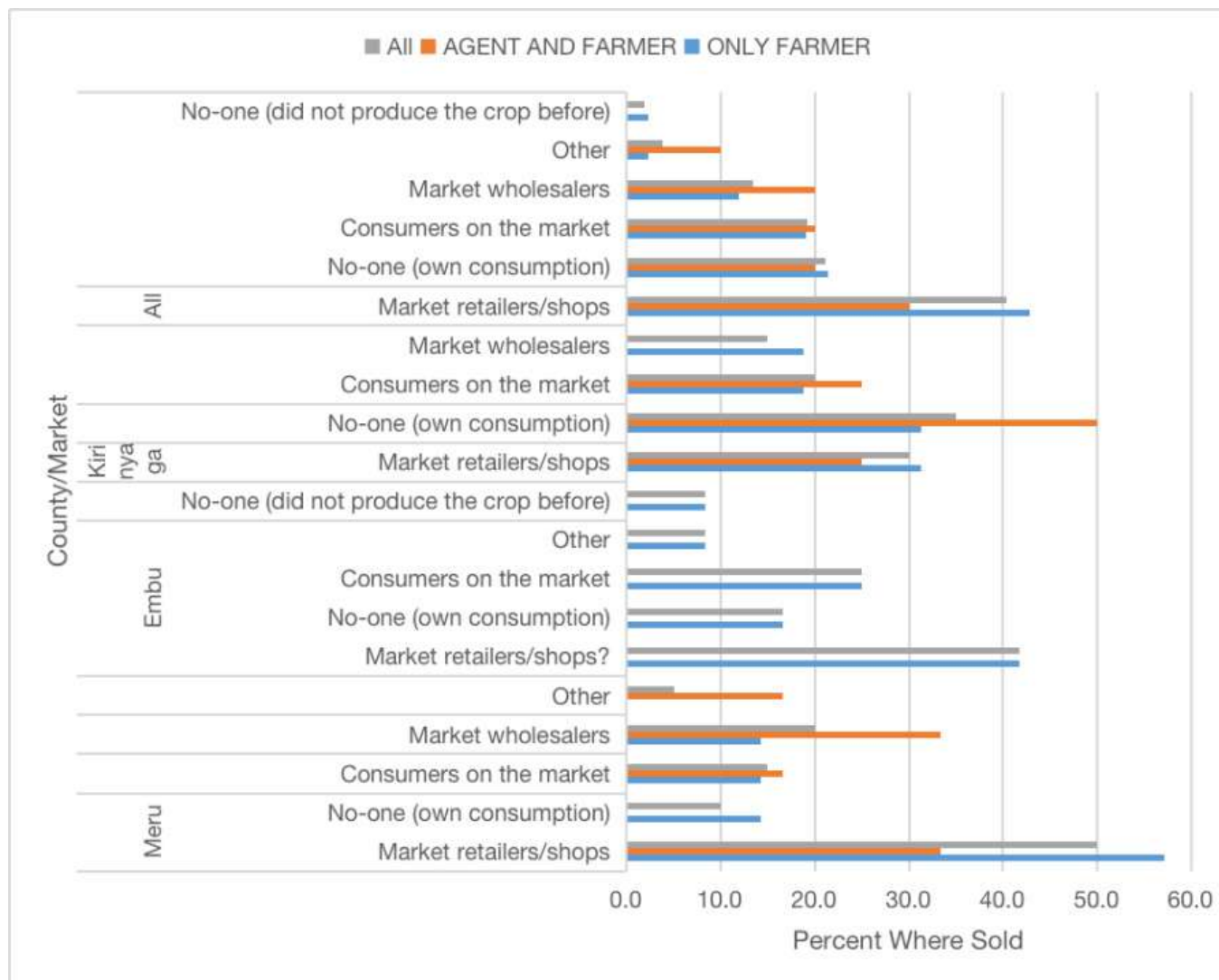


Figure 17: Percentage of Farmers/Farmer-agents and Where They Sold the Remainder of the Harvest

The study revealed that they were demotivated to sell all their harvests to Twiga foods due to various reasons. Figure 18 indicates that such reasons as lower prices per kilogram (42.4%), Twiga foods did not buy some varieties (15.2% of the respondents), they graded the bananas and left the small-sized ones (12.1%), at times they did not visit the farms (6.1%) and some produce were left for own consumption (21.2%).



Figure 18: Percentage of Farmers/FarmerAgents with Their Reasons for Not Selling to Twiga Foods

Comparison of Prices by the Farmer-Agents

Figure 19 indicates how the farmer-agents sold their produce to different buyers before engaging with Twiga Foods. The overall main buyers in both counties included market retailers/shops (36%), consumers in the market (33.5%) and market wholesalers (18.6%). Other minor buyers included producerselling agents and others said they were not into farming initially. In addition, farmer-agents in Meru and Embu counties sold to middlemen whenever available.

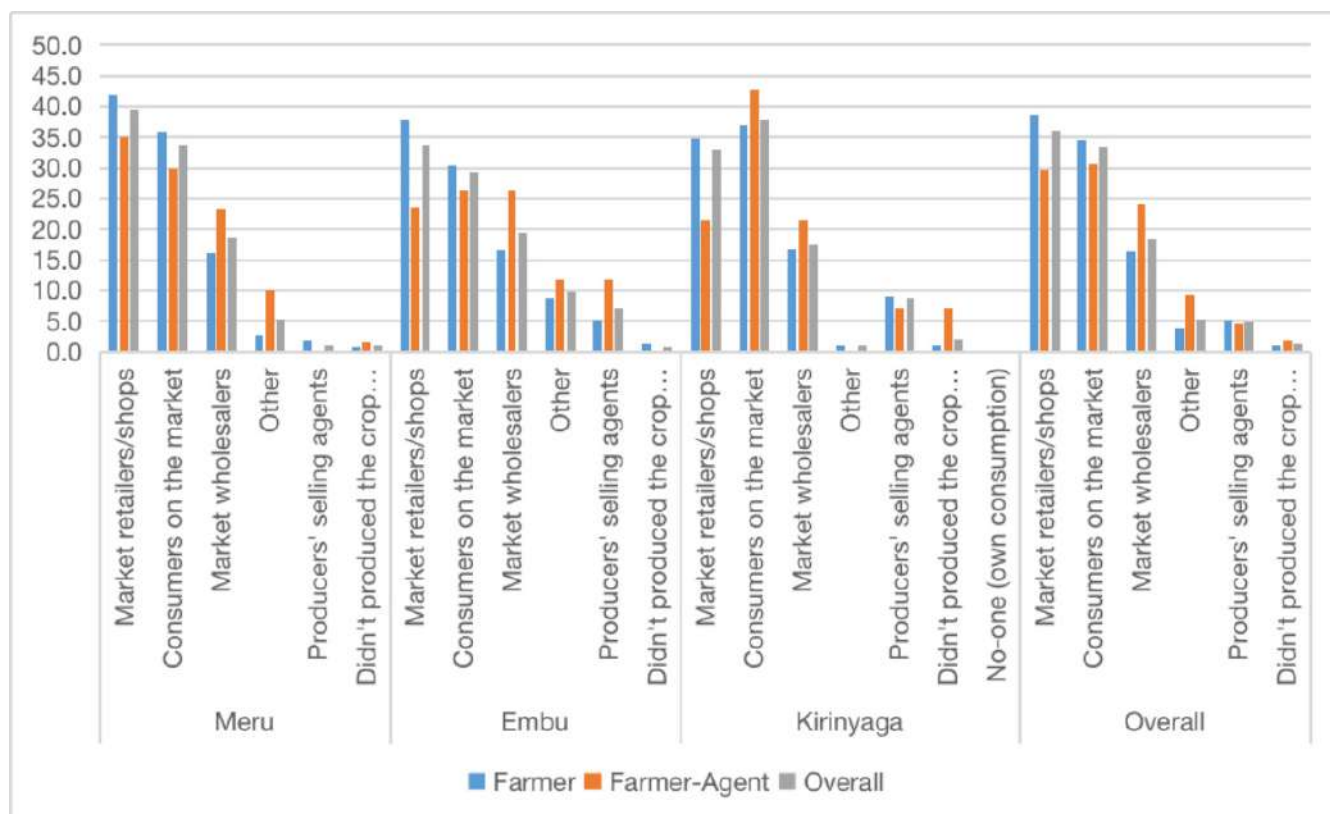


Figure 19: Farmers/farmer Agents Point of Sale for their Produce Prior to Engaging with Twiga Foods

Figure 20 shows that some of the agents and farmer-agents started working for Twiga Foods from 2019. However, the majority (40.3%) joined in the year 2022 others started in 2019, 2020, 2021 and 2023 with the percentage as 26.4%, 15.3%, 13.9% and 4.2%, respectively.

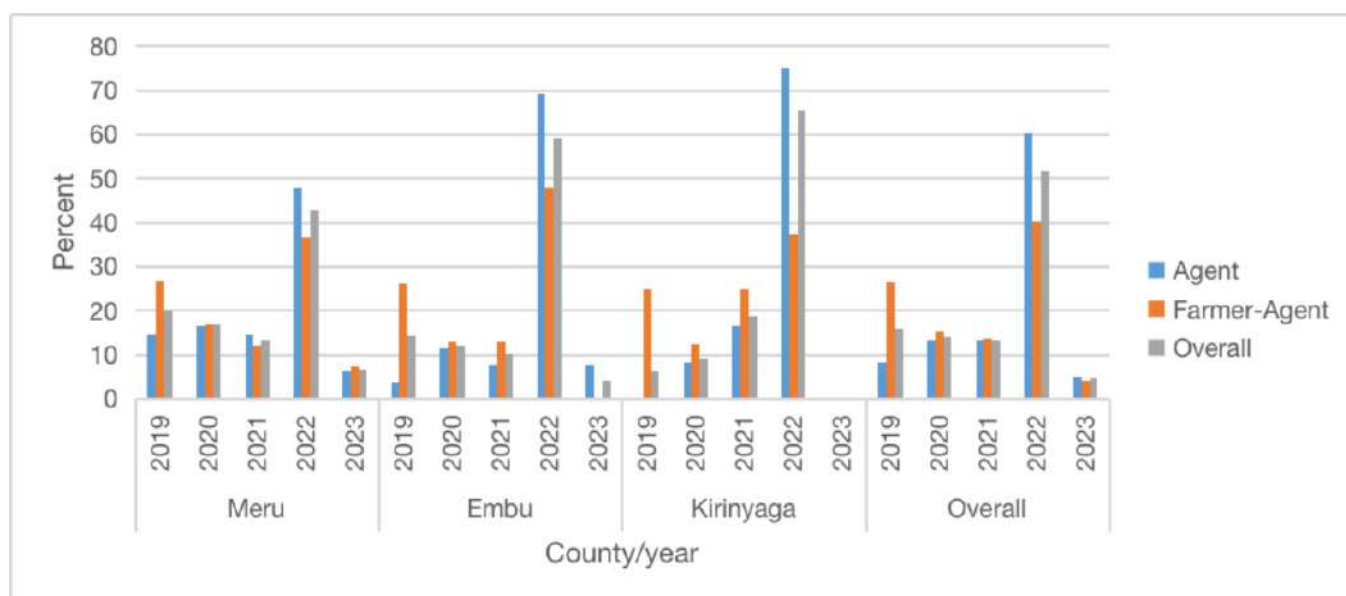


Figure 20: The Year Agents and Farmer-Agents Started Working for Twiga Foods as Agents

The agents and famer agents were mainly motivated by factors such as earning profits (36.1%), and Twiga Foods as: source of income (26.5%), good business (19.4%) and offering better prices (6.9%) for their produce (Figure 21). Other reasons included that Twiga Foods as a ready market for the commodities was guaranteed, the payments were not delayed, the fact that they could their commodities directly to Twiga Foods with no intermediary, and that Twiga Foods was straightforward to work with while others saw Twiga Foods as been able to receive the large quantities of bananas they had access to

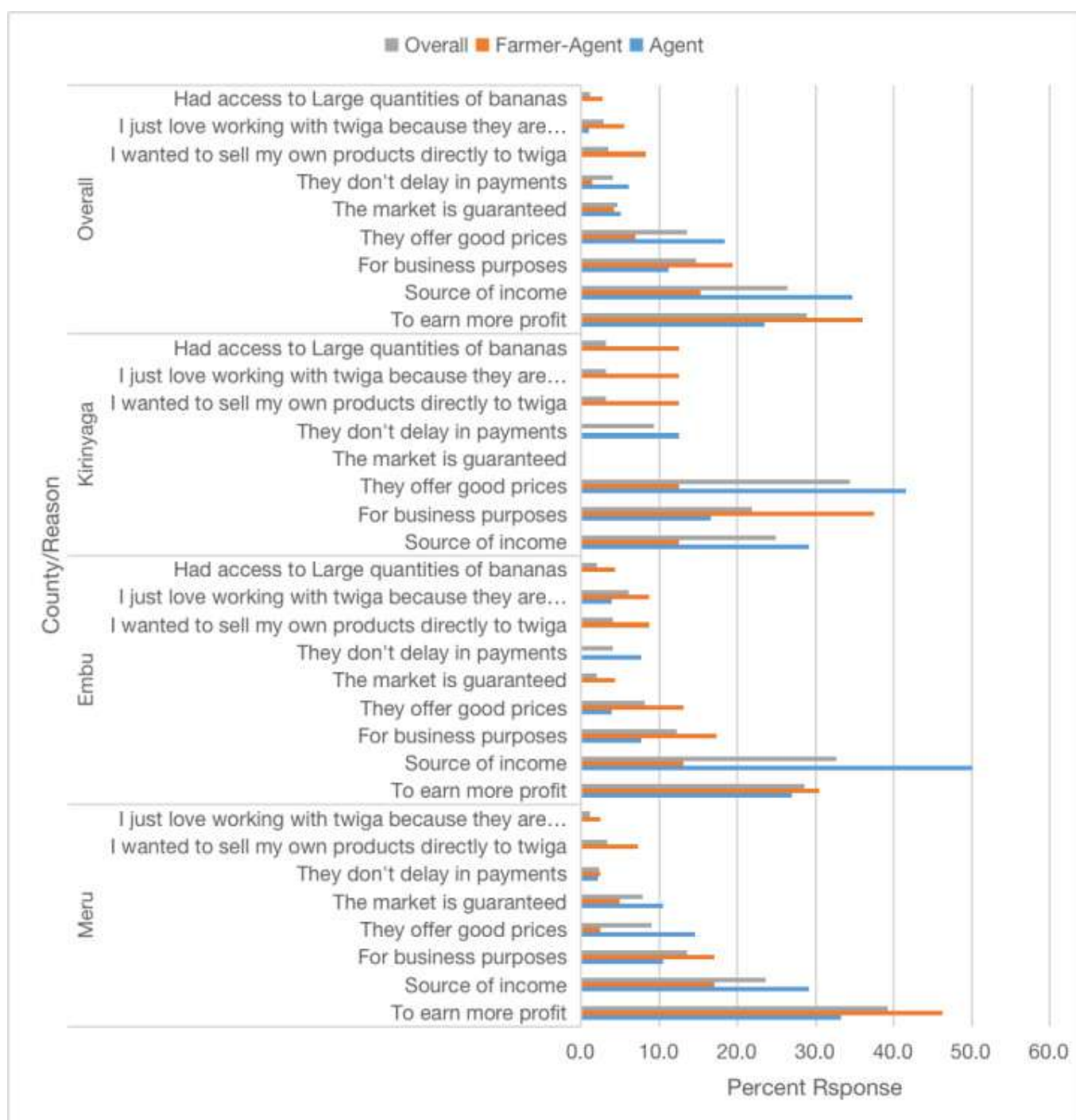


Figure 21: Reasons for Working for Twiga Foods as Agents

The common commodities bought from farmers and sold to Twiga Foods and other buyers by the agents and farmer-agents from the three counties were bananas (71.8%), maize (17.5%), spinach and Sukuma wiki as well as avocado. From Meru County they also dealt with cassava, livestock, sweet potatoes and okra in addition. Agents and farmer-agents from Embu County also dealt with additional commodities as Miraa and Macadamia. While in Kirinyaga County the additional commodities were; green grams/mung beans, wheat, sorghum and cow peas. Occasionally, agents and farmer-agents did not sell commodities to other buyers apart from a few who sold to market retailers/shops, consumers in the market, market wholesalers as well as processors as shown in Figure 22.

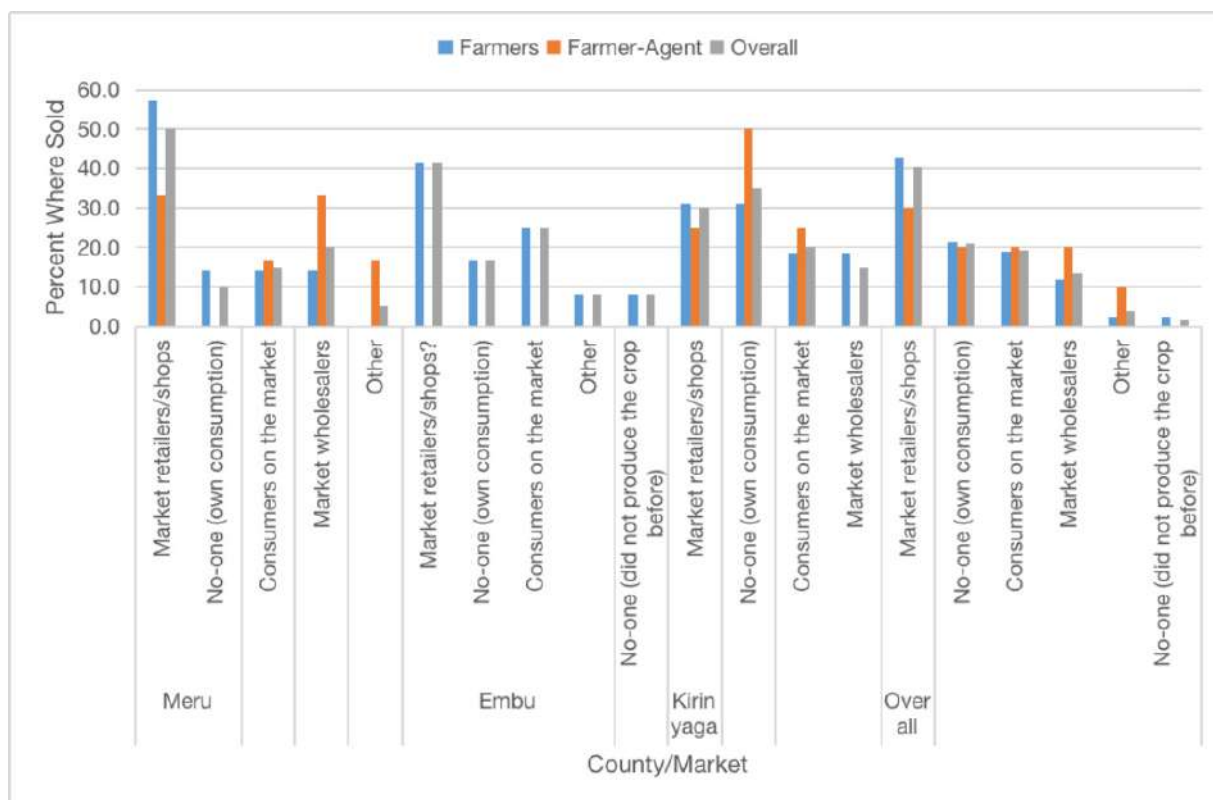


Figure 22: Other Buyers and Use of Commodities for Farmers/Farmer-Agents

About 98% of the agents and farmer-agents sold bananas as the main commodity. Most of them (90%) sold all the commodities bought from farmers to Twiga Foods. In addition, 6.5% sold most of their commodities, 2.9% sold some of the commodities while 0.6% sold half of their commodities to Twiga Foods. The few who did not sell all their produce to Twiga foods gave several reasons for not doing so. Some argued that Twiga Foods offered lower prices compared to other buyers, others said that Twiga Foods did not buy some varieties, and that there was no difference between the prices for Twiga Foods and those for other buyers. Others preserved some commodities for consumption (Figure 23).

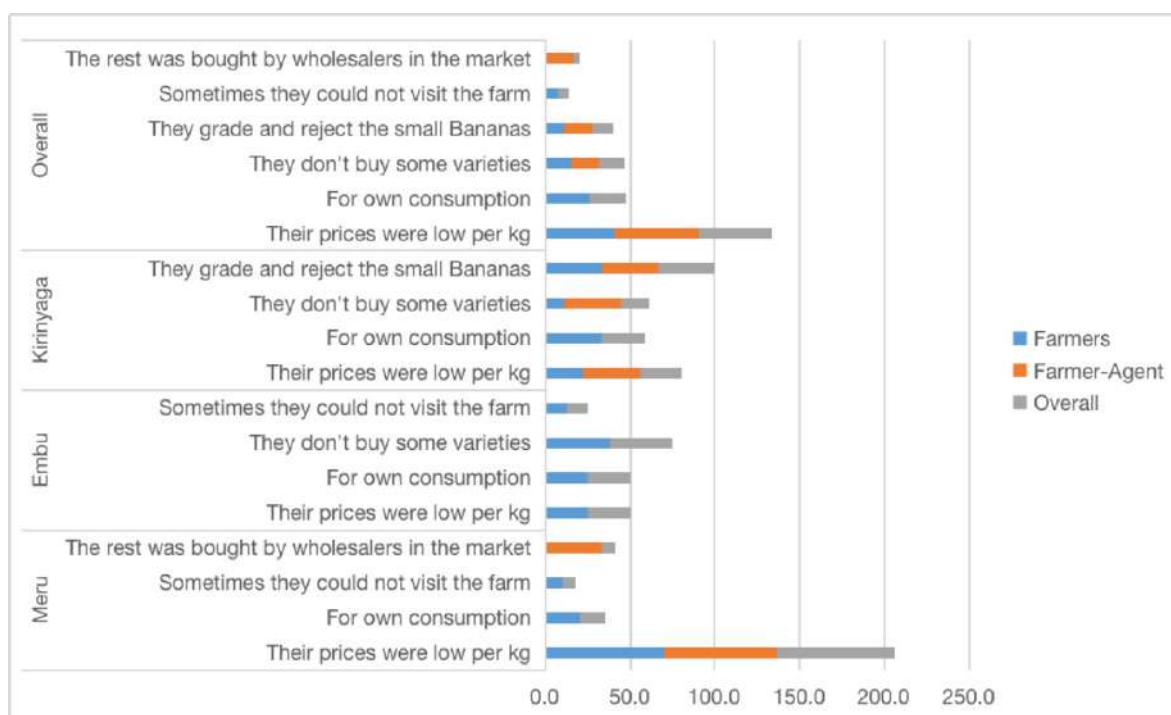


Figure 23: Reasons for Not Selling all the Commodities to Twiga foods

Figure 24 indicates the types of bananas sold to Twiga Foods by farmers, agents and farmer-agents. The farmer-agents (91.7%) more than farmers and agents indicated that they sold all sizes of bananas with a few (6.9%) indicating that they sold large bananas and very few (1.4%) indicating that they sold only small/medium bananas. The farmers the next in affirming that they sold all sizes of bananas (78.3%) with a few (20.4%) indicating that sold large bananas and very few (1.3%) indicating that they sold only small/medium bananas. Lastly the agents (67.3%) indicated that they sold all sizes of bananas with a few (20.4%) indicating that sold large bananas and (12.2%) indicating that they sold only small/medium bananas. The results indicate that the agents were probably more selective that the other categories.

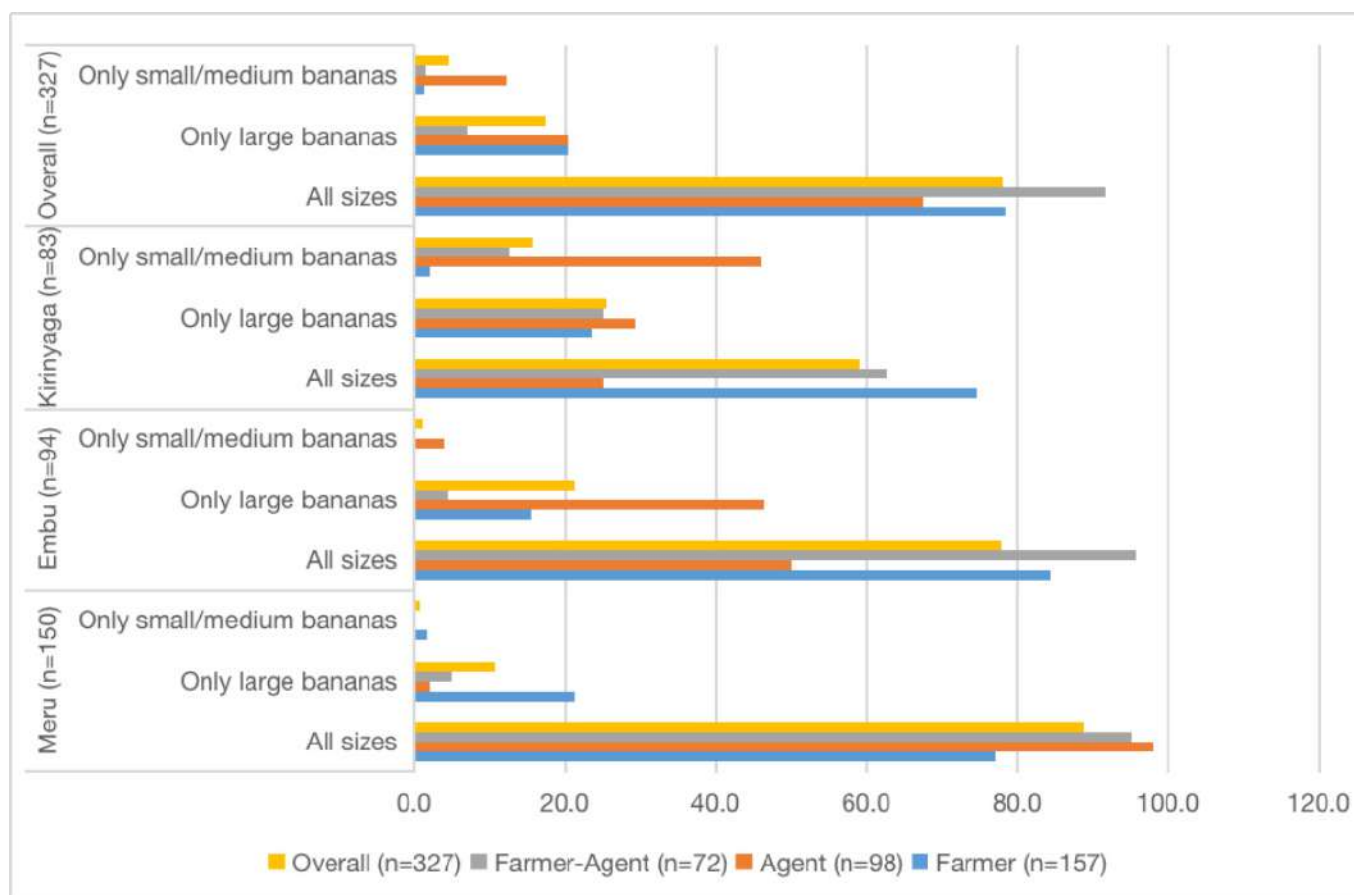


Figure 24: Types of Bananas Sold to Twiga Foods

From a few of the respondent agents and farmer-agents from Meru, Embu and Kirinyaga counties, most of them did not work as middlemen (brokers) before working as agent for Twiga foods. They mostly sold all size bananas while some just bought and sold specifically large or small/medium size bananas. Agents and farmer-agents from Meru County sold to Mitunguu and Igoji Twiga Foods collection centres, those from Embu County sold to Kivwe and Kagio collection centre while those from Kirinyaga County sold to Kagio collection centre. Kivwe had the highest number of people selling among above mentioned Twiga Foods collection centres.

Table 19 shows that the average distance (in Km) that the agents and farmer-agents travelled to the collection centres in Meru County was 6.11Km or 22 minutes in terms of time taken to get there. In Embu County the average distance was 5.5 Km and 28.5 minutes using a motorcycle, and lastly in Kirinyaga County 11.9 Km had to covered and it took 30 minutes with a motorcycle. On average the distance to the collection centre was 7.83 Km. The distance to the nearest market where agents and farmer-agents could have sold the commodities instead of in Meru County was 6.35 Km and 22 minutes as time taken on average. In Embu County distance covered was 3.62 Km and 21.5 minutes as time taken, while in Kirinyaga it was 8.96 Km and 20.5 minutes as time taken, and an overall average distance to the market place was 6.31 Km.

Table 19: Average Distance (Km) and Time Taken (Minutes) to Travel to Twiga Foods Collection Centres

Distance	Farmer		Agent		Farmer Agent		Overall	
Distance (km)	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Meru	5.5	6.1	7.3	6.3	5.0	6.7	5.9	6.4
Embu	7.0	10.0	5.0	5.3	6.0	9.9	6.2	8.9
Kirinyaga	14.1	13.0	9.3	11.7	14.5	13.4	12.7	12.7
Overall	8.7	10.6	7.2	7.8	6.4	9.1	7.7	9.5
Travel Time (Minutes)								
Meru	17.1	14.2	24.4	20.2	20.7	22.3	20.4	18.8
Embu	25.3	39.4	26.1	25.0	31.3	31.8	27.0	33.9
Kirinyaga	37.9	33.5	26.4	36.0	34.4	16.8	34.2	33.1
Overall	26.3	30.9	25.3	25.8	25.6	25.6	25.8	28.3

Each agent or farmer-agents from either of the three counties was in contact with an average of 18 farmers on a regular basis. During the planting season, 24.7% of them were in contact with the farmers on daily basis, 23.5% were in contact less frequently than monthly, 22.45% weekly, 15.9% on a monthly basis, 4.75% every two weeks while a few (8.8%) were not in contact with the farmers at all. During the harvesting season the agents and farmer-agents were in contact with the farmers on different basis; 32.9% on a daily, 26.5% weekly, 25.3% monthly, 12.4% every two week basis, 1.2% less frequently than monthly while 1.8% were not in contact at all. They communicated with the farmers through diverse channels such as voice calls (via the phone or apps)-about 45.4% of them, 37.8% did in-person meetings, 15.2% used short message services while 1.5% through text messaging e.g., WhatsApp, Facebook messenger. Among these, the two mainly used channels were voice calls and in-person meetings in all of the three counties. Most of the agents and farmer-agents never shared information about the prices that Twiga Foods pays for products with the farmer while some did sometimes, other always or mostly shared as illustrated in Figure 25.

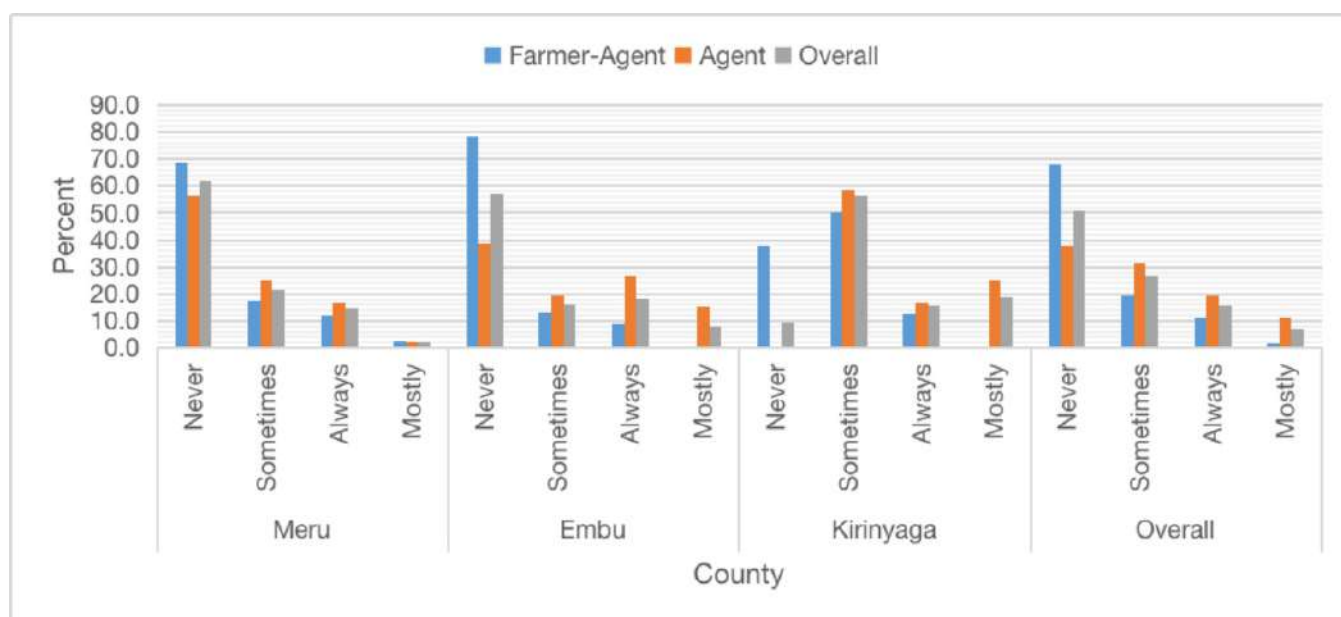


Figure 25: Possibility of Sharing Price Information with Farmers

During planting seasons, the agents and farmer-agents were in contact with their colleagues either on a daily basis 38.9%, weekly (22.2%), less frequently than monthly (20.4%), monthly (9.3%), every two weeks

(5.6%) or not at all (3.7%). Table 20 shows that the average number of other Twiga agents in contact with farmer-agents was 3 for Meru County, 5 for Embu County and 3 for Kirinyaga County. For agents, it was 3 for Meru County, 6 for Embu County and 4 for Kirinyaga County.

Table 20: Number of Other Twiga Agents in Contact with Agents and Farmer-Agents on a Regular Basis

County	Farmer-Agent		Agent		Overall	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Meru	3	3	3	3	3	3
Embu	5	7	6	7	6	7
Kirinyaga	2	1	4	3	3	3
Overall	3	5	4	5	4	5

Figure 26 shows how frequently agents and farmer-agents were in contact with other Twiga agents during the planting season. During plating seasons, the agents and farmer-agents were in contact with other agents mainly on daily basis (38.9%), some on a weekly basis (22.2%) and more than monthly (20.4%)

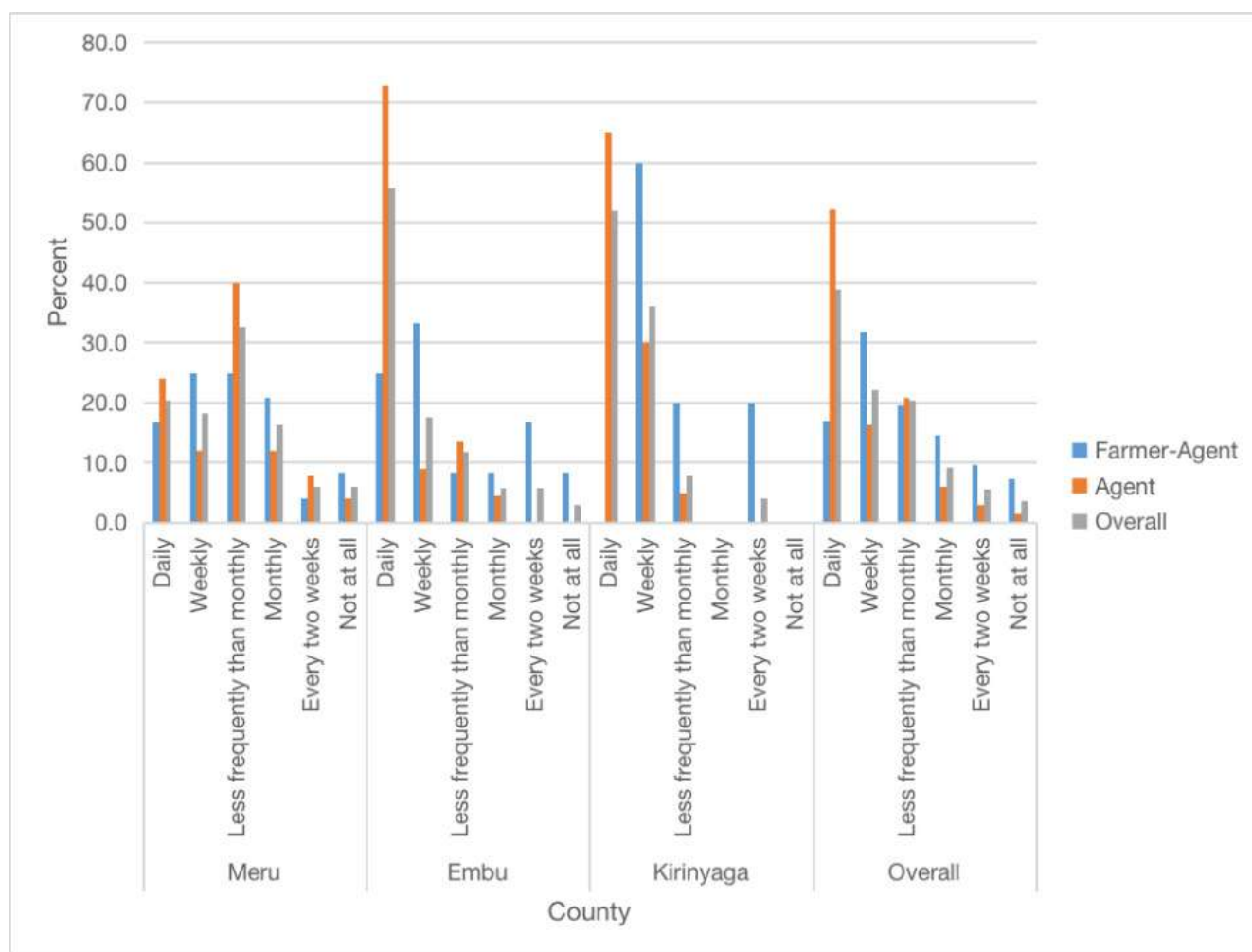


Figure 26: How Frequently Agents and Farmer-Agents Contact Other Twiga Agents During the Planting Season

During harvesting seasons, the agents and farmer-agents were mainly in contact with other agents on daily basis (44.4%), some on a weekly basis (29.6%) and monthly (16.7%) as indicated in Figure 27. Other

frequency of contact included every two weeks (6.5%), less frequently than monthly (1.9%) while some did not contact agent (0.9%). It is noteworthy that the frequency of agents and farmer-agents getting in contact with other agents during harvesting appeared higher than during the planting season.

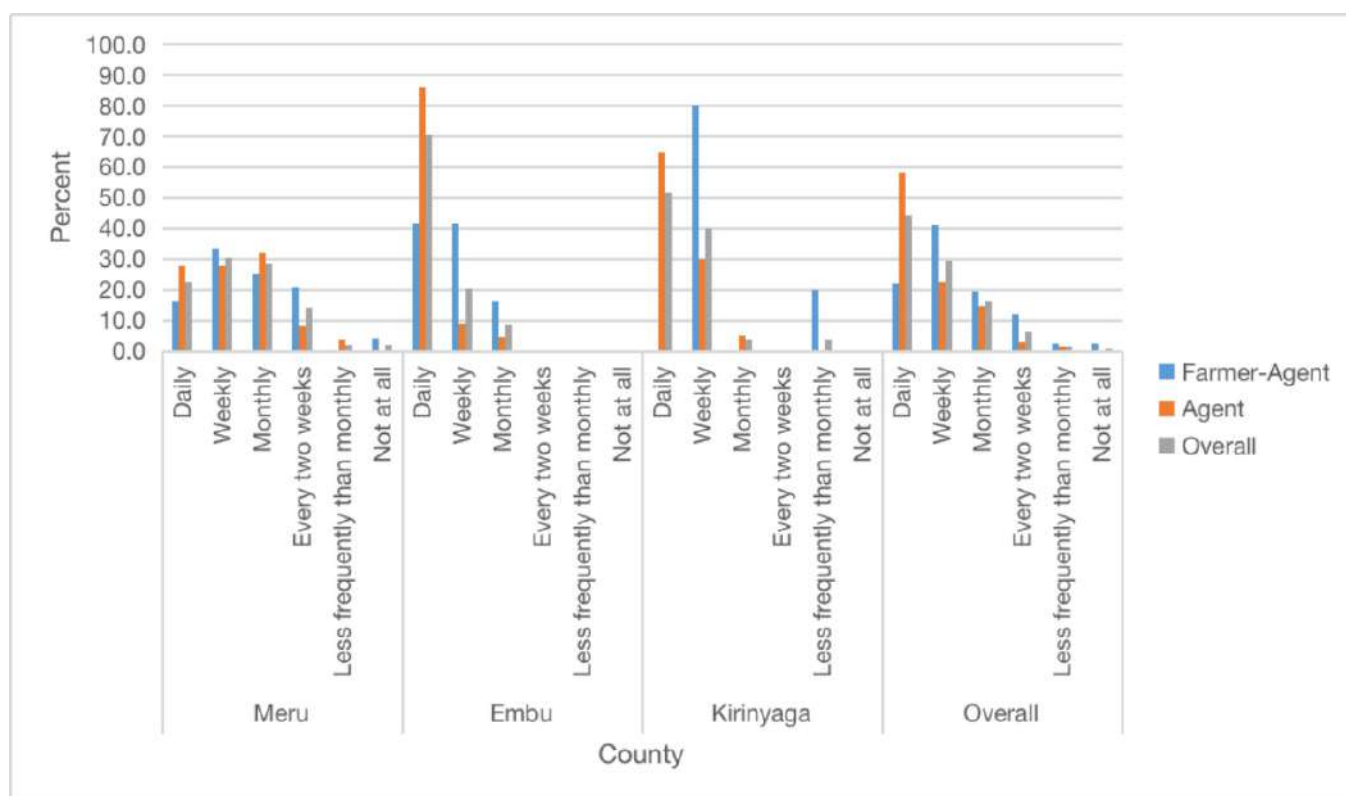


Figure 27: The Frequency of Contact of Agents and Farmers-Agents with Other Twiga Agents During Harvesting Season

During harvesting, communication was mainly through voice calls (63.3%) and in-person meetings (33.8%). They met for such reasons as business purposes, to know prices of produce, prices discussion, share information about farmers who always have bananas in bulk, delivery of produce to the collection centre, search for and to buy bananas, share experiences with Twiga Foods, to make orders, to know how the supply was at the field, to know prices of produce, to discuss benefits and problems of Twiga foods, to discuss farmers' position as far as banana market was concerned, discussion and comparison of the prevailing farm prices for bananas, social life activities, to sell at the Twiga Foods at the collection centre, to know prices of products in the market, discussion about farmers' comments about the services of the agents and farmer-agents to them and comparing prices in Twiga Foods and that of other non-Twiga buyers.

The two frequently used channels for communication between the agents/farmer-agents and the Twiga Foods employees are voice calls (via the phone or apps) and in-person meetings across the three counties, while voice calls (via the phone or apps) and short message services are used rarely as shown in Figure 28. In Meru, 71.7% of farmer-agents used voice calls (via the phone or apps) while 64.6% of agents used same, while in Embu 60.9% and 80.8% of farmer-agents and agents, respectively also used voice-calls and in Kirinyaga 62.5% of farmer-agents and 87.5% of agents used voice-calls. In-person communication in Meru was used by 85.4% of farmer-agents and 68.8% of agents while in Embu it was by 87.0% of farmer-agents and 38.5% of agents, while in Kirinyaga 75.0% of farmer-agents and only 4.2% of agents used in-person communication.

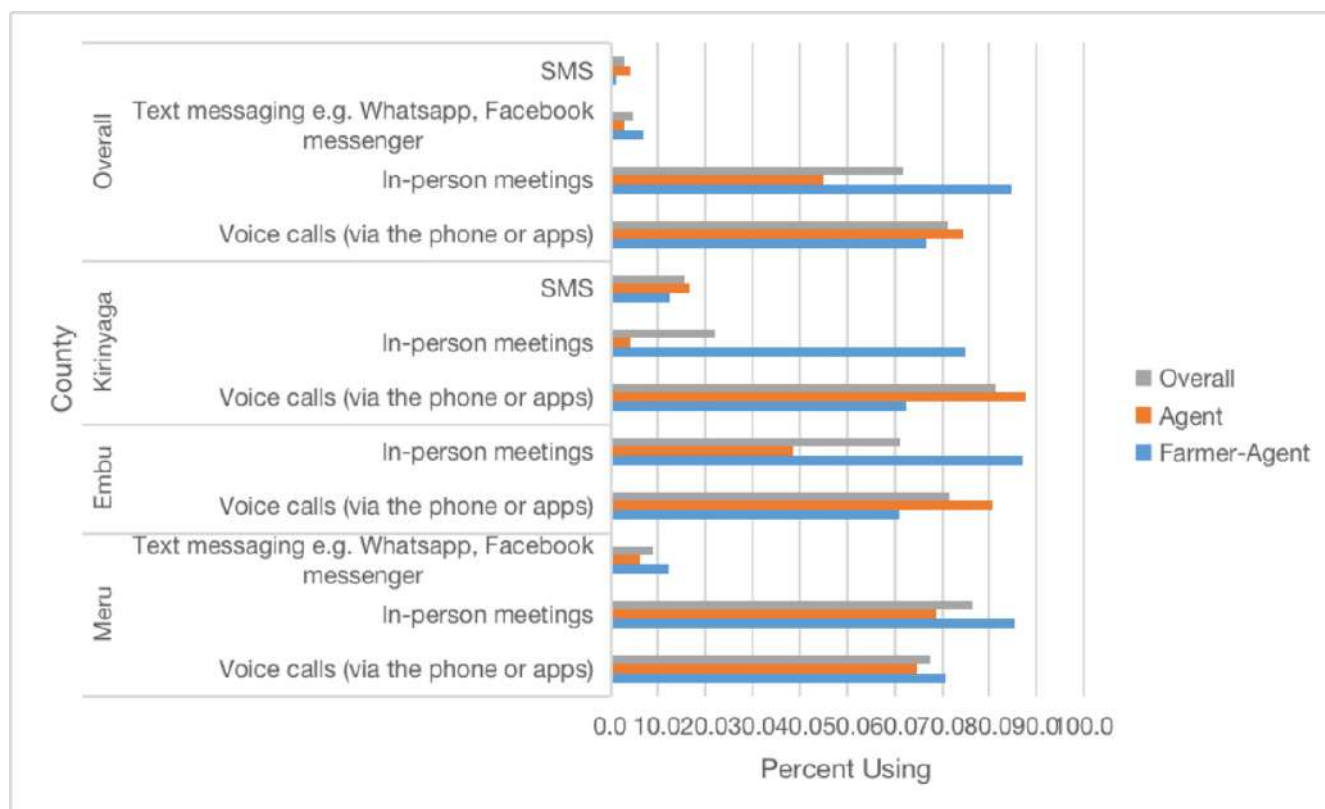


Figure 28: The Two Most Frequently Used Channels by Agents and Farmers-Agents

There were other farmers that some (18%) respondents knew who would have joined Twiga Foods but did not. These were discouraged by some factors as reasoned and stated by the respondents as; Twiga prices are low compared to what other traders offer, Twiga rejects farmers produce when they do grading, Twiga does not pay them promptly, the need to be registered in order to sell produce directly to Twiga, wrongly calibrated weighing scales used by some Twiga Foods agents, some preferred to do value addition, other brokers order and place deposit for bananas before they mature and others had some personal reasons.

Market linkage tools formalize agricultural value chains by allowing crop producers and buyers to connect through a mobile-based online platform for examples, [Twiga](#) and [Tulaa](#) (Digital agriculture in Kenya, 2019). However, a few among the farmer-agents and agents (8.9%) from Meru County did WhatsApp businesses and about 7.6% were interested in joining other digital platforms but had not for some reason as lack of know how in joining the platform, lack of smartphone in addition to lack of sufficient farm products to serve all the other platforms. A prominent example of a one stop shop that enable third-party agricultural service providers to offer their services directly to farmers registered on the hub, while farmers can take orders directly from buyers, is Digi-Farm for Consumer (Digital agriculture in Kenya, 2019).

3.2 Focus Group Discussions with Non-TWIGA Foods Farmers (plus Control Group)

Through the discussions, the study observed the impacts and benefits to the farmers majorly producing fresh products like fruits and vegetables. This was focused on the effects on the price of the inputs, availability of the inputs, the markets, means of distribution to the target market, price of the outputs, quality of infrastructure in the target locations (for instance transport, marketing, cold chains, electricity as well as mobile connectivity), access to information especially for the farmers that do not sell to the digital platforms like Twiga foods. Discussions were held with groups of farmers who did not sell to the digital platform from around the collection centers of Twiga foods across Kirinyaga County, Embu

County as well as Meru County. Details of the discussions are presented in Annex 1

Factors that contribute to non-participation in the digital platforms

High technology costs, low digital literacy, limited infrastructure access, and a weak enabling policy environment are the primary constraints to adoption of digital agricultural solutions (The CGIAR Platform for Big Data in Agriculture, 2019).

Respondents expressed different reasons why they were not participating in the digital platform (Twiga Foods). But the most common reason why the farmers did not join the digital platform was the high grading systems that Twiga utilise. So many small sized bananas were left rejected thus a loss to the farmers. Secondly, all the respondents complained of the delay in payments after Twiga collected the produce unlike the brokers who pay instantly at the farm gate and sometimes actually pay deposits before the bananas mature and in some few cases engage in contractual farming. These conditions usually specify the price to be paid to the farmer, the quantity and quality of the product demanded by the buyer, and the date for delivery to buyers. In some cases, the contract may also include more detailed information on how the production will be carried out or if inputs such as seeds, fertilizers and technical advice will be provided by the buyer (FAO, 2023). This is usually done in order to secure a regular supply of raw materials that meet their needs in terms of quality and quantity.

Initially, Twiga was offering transportation of bananas from the farms to the collection centres but this was not sustained. Since then, farmers reported an added cost on their operation hence demotivating them from joining the platform. Brokers and bulk buyers then began to collect the bananas from the farms.

In Kirinyaga, 100% of the farmers in the discussion group reported that Twiga Foods only bought bananas from their registered farmers unless the unregistered farmer sells through an agent where the agent will definitely pay lower. This was reported to be a reason why most farmers had not joined the digital platform.

Non Twiga farmers also reported that Twiga was not buying some varieties of bananas which they produced especially the cooking varieties. While the agricultural digital platforms aim and operate towards consumer access to high-quality products as well as supply chain traceability and management, some of the products that do not match the desired quality and varieties of the produce had to be left behind which translated to huge losses to the farmers. Although the farmers used these varieties for consumption, in a case of large-scale production the losses could be very heavy for the farmers to bear and they therefore opted to sell their harvests to the brokers who were not very choosy about the banana varieties.

3.3 Survey of Twiga Foods Vendors

Food security poses a significant problem in Kenya, Africa and across the globe. Twiga Foods mission remains to; transform the African food retail market by improving every step of the supply chain with better technologies and so works towards addressing the food problems in digitalized way, and vendors therefore play a huge role. Twiga Foods vendors are business people who buy fresh products or packed products or both from Twiga Foods and sell them to final consumers. For a vendor to join the platform, they are required to sign up after which sales representative from Twiga visit the vendors and register them. The vendor places order with the representative and Twiga then delivers the produce directly to the vendor's shop. Twiga Foods network of small-business proprietors on the platform includes at least

17,000 farmers and 8,000 vendors as found by a study conducted by Koech et al. (2024).



Visiting a Twiga Foods Vendor in Nairobi Suburbs

The survey involved vendors from Nairobi (72.1%) and Machakos (27.9%) counties. The respondents indicated that they sold fresh produce and also packaged goods (Figure 29). Vendors started buying fresh products from Twiga Foods in 2019. The overall average number of years of working as a vendor in Nairobi and Machakos Counties were seven and eight years, respectively. All the vendors from the counties were aware about the existence of Twiga Foods and they bought products from Twiga Foods either fresh or packaged products although, they mostly dealt with fresh products (83.3%) which included fruits and vegetables while 16.7% sold packaged final products.

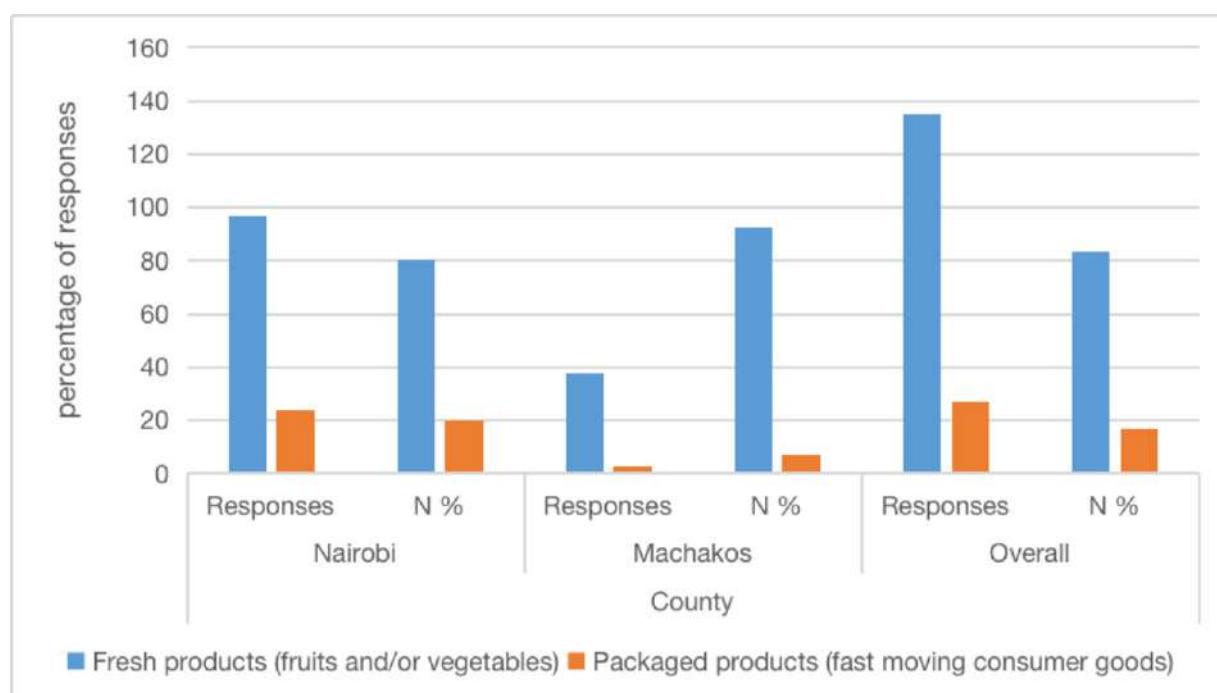


Figure 29: Types of Products Sold by Vendors

Vegetable(s) mostly sold by the vendors in the two counties were spinach (by 26.5% respondents), kales (22.9%) and amaranth (5.3%) and fruits such as oranges, avocados, mangoes, pawpaw and pineapples. In addition to these, vendors in Nairobi County dealt in pepper, pumpkin leaves, couette, carrots, butternut, avocado, dhanian, coriander, capsicum, broccoli, potatoes, pawpaw, managu, green bananas, garlic, French beans, cucumber, cauliflower, cabbages, bringles and bringers other fresh products as yams, peppers, peas, green maize, ginger and fruits like apples, coconut, pineapples, tangerine, tamarind, grapes, thorn melon, pixies, lemon and lime. The tables below illustrates the share of the Twiga Foods as they traded different vegetables across the two counties (Table 21)

Table 21: Vegetable(s) Mostly Sold by the Vendors

Vegetable	County		
	Nairobi (%)	Machakos (%)	Overall (%)
Spinach	46.9	100.0	56.4
Kales	37.5	100.0	48.7
Pepper	3.1	42.9	10.3
Amaranth	9.4	14.3	10.3
Pumpkin leaves	9.4	0.0	7.7
Courgette	9.4	0.0	7.7
Carrots	9.4	0.0	7.7
Butternut	9.4	0.0	7.7
Avocado	9.4	0.0	7.7
Dhanian	6.3	0.0	5.1
Coriander	6.3	0.0	5.1
Capsicum	6.3	0.0	5.1
Broccoli	6.3	0.0	5.1
Potatoes	3.1	0.0	2.6
Pawpaw	3.1	0.0	2.6
Managu	0.0	14.3	2.6
Green bananas	3.1	0.0	2.6
Garlic	3.1	0.0	2.6
French beans	3.1	0.0	2.6
Cucumber	3.1	0.0	2.6
Cauliflower	3.1	0.0	2.6
Cabbages	3.1	0.0	2.6
Bringles	3.1	0.0	2.6
Bringers	3.1	0.0	2.6

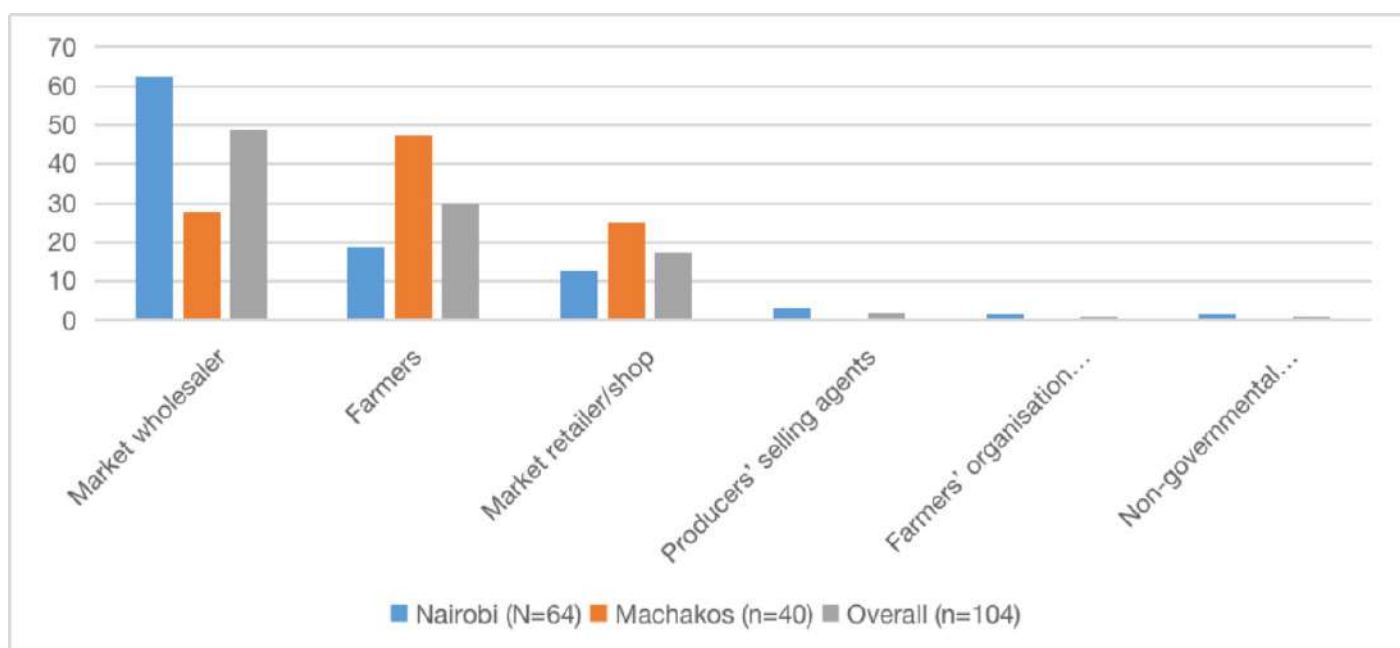
In general, the study determined the agricultural products that Twiga Foods vendors traded were the most common products. These were onions (Nairobi (51.1%) and Machakos (90%)), cabbage (Nairobi (44.4%) and Machakos (85%)), tomatoes (Nairobi (33.3%) and Machakos (85%)) and bananas (Nairobi (33.3%) and Machakos (70%)), as indicated in Table 22.

Table 22: Common Products tha Twiga Foods Vendors Traded

Commodity	County		Commodity	County	
	Nairobi (%)	Machakos (%)		Nairobi (%)	Machakos (%)
Onions	51.1	90.0	Cassava	0.0	20.0
Cabbage	44.4	85.0	Sweet pota-toes	4.4	5.0
Tomatoes	33.3	85.0	Cow peas	2.2	10.0
Bananas	33.3	70.0	Green beans	2.2	5.0
Other vege-tables	33.3	25.0	Green gams/mung beans	4.4	0.0
Melon	26.7	25.0	Other fresh products	4.4	0.0
Other fruits	33.3	0.0	Rice	2.2	0.0
(Irish) pota-toes	13.3	15.0	Soy beans	2.2	0.0
Maize	2.2	25.0			

The Agricultural Products Mostly Traded by the Vendors from Twiga Foods

The vendors in both counties sourced some fresh commodities from other sources other than Twiga Foods from whom they sourced even before Twiga Foods' operation. Figure 30 indicates that such other sources included, market wholesalers (for 49.0% of the vendors), farmers (29.8%) and market retailers (17.3%) while those from Nairobi also sourced from producers' selling agents (3.1%), farmers' organizations (1.6%) as well as non-governmental institutions (1.6%). Such commodities included onion, cabbages, tomatoes, bananas and to a lesser extent melon, Irish-potatoes, maize, sweet potatoes, cow peas, green beans, green gams/mung beans, rice and soy beans. Altogether, the study revealed the prices of fresh products from Twiga Foods were fair compared to prices of other suppliers in the two counties.

**Figure 30: Other Sources of the Packaged Products**

Nairobi vendors were motivated to buy products from Twiga Foods by factors such as delivery in the shop which reduced transportation cost as indicated in Figure 31. In Machakos vendors were motivated

by good quality products, reliable transport, advertisement, quick delivery of products, free delivery of products, timely delivery, and the fact that Twiga Foods offered Soko loans payable after three days. Possibility of buying packed products from other sources was brought about by the lower buying prices from other sources. Mostly means of interaction with Twiga Foods was through meeting with Twiga agents, phone calls and SMS with Twiga agents. Nairobi vendors also interacted with the Twiga territory managers, (mainly for consultancy and other reasons as placing orders and seeking refunds in case they were not satisfied by the deliveries), through personal meeting, phone call and short message services. Some used the Twiga app mainly to apply for loans and also check the prices of various products, compare the prices to that of other wholesalers and for loan application. The vendors' main reasons for interacting with the Twiga agents were to order placement (mainly), consultancy, to do marketing as well as to register complaints. However, some vendors disliked using the Twiga app due to inaccurate product delivery, lack of smartphone (was the major factor), others preferred agents and territory managers over the app. Aside of the agents, the vendors placed orders through the Twiga delivery lorries, phone calls as well as the sales agents.

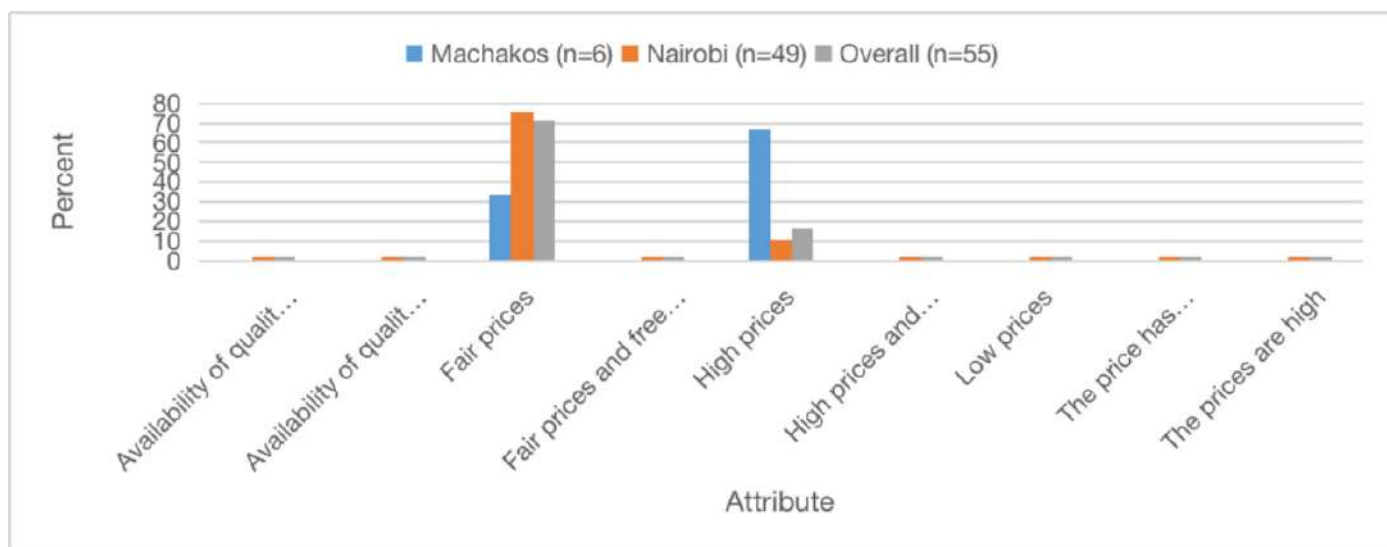


Figure 31: Factors that Encouraged Vendors to Trade with Twiga Foods

Figure 32 indicates that some of the vendors from Nairobi County took loans from Twiga Foods under the motivation of such factors as affordability (14.3% of the vendors) where they argued that in comparison to other money lenders, Twiga Foods loans were more cost-effective. Other encouraging factors as the study shows were availability, such that the vendors could get the loans anytime they needed it, having met the requirements, easy accessibility as they needed not to travel a lot for them to acquire the loans, the agents and Twiga Foods employees/staff helped greatly, low interest rates, Twiga Foods was more reliable, they gave an allowance and supplied products on credit. The figure that follows presents the factors more clearly and shows the share of the vendor's for each of the factors.

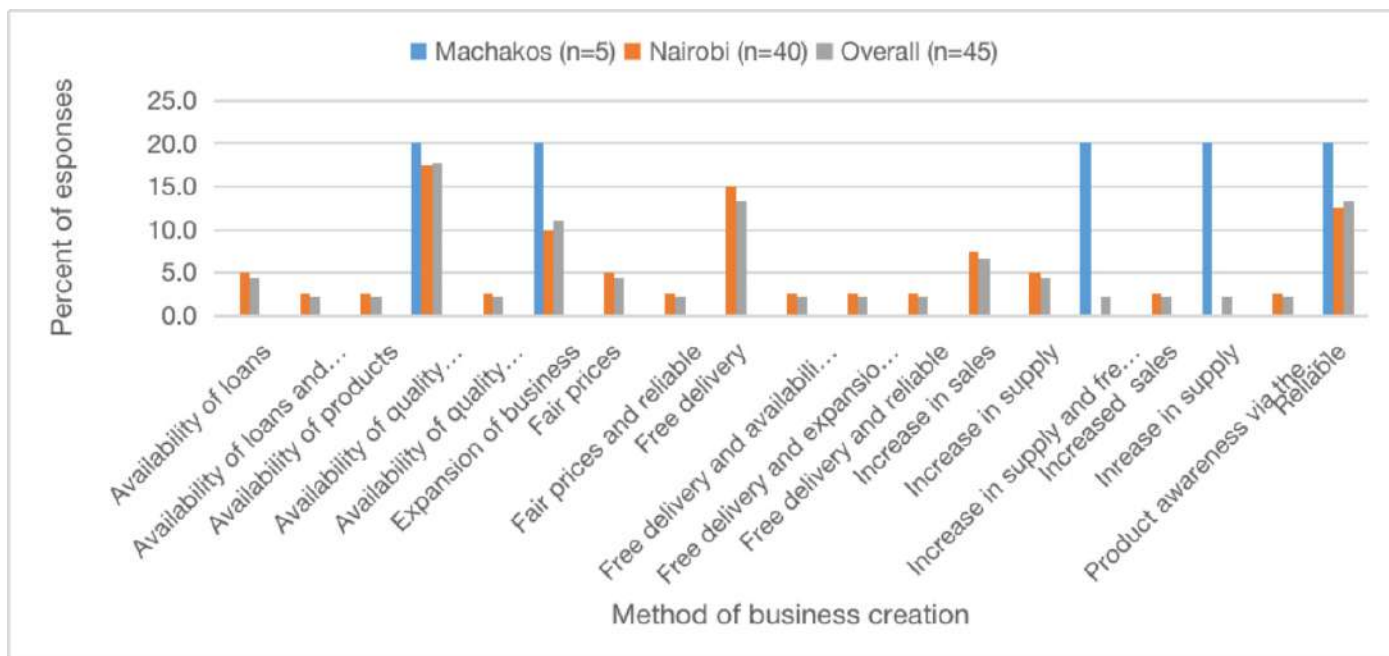


Figure 32: Factors that Encouraged Vendors to Take Twiga Loans

Some vendors from both Nairobi and Machakos Counties also took loans from other sources such as friends and family members, banks and informal lenders.

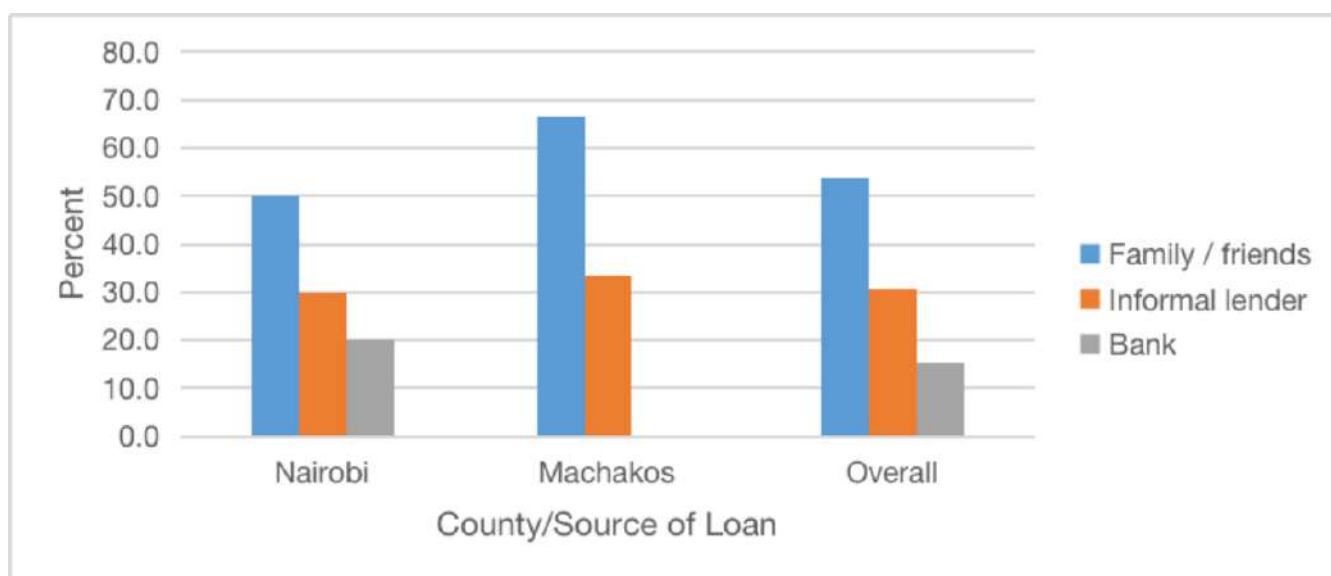


Figure 33: Other Lenders Who Offered Loans to the Vendors

The study showed that there were other digital agricultural platforms that operated across the two counties. Figure 34 shows that in Machakos County other digital platforms were Ugatuzi deliveries and Soko deliveries. In Nairobi County the platforms were Taimba, Zao, Nyamakima, Brand bakers and others. Taimba and Zao were the most common as shown in Figure 34 below.

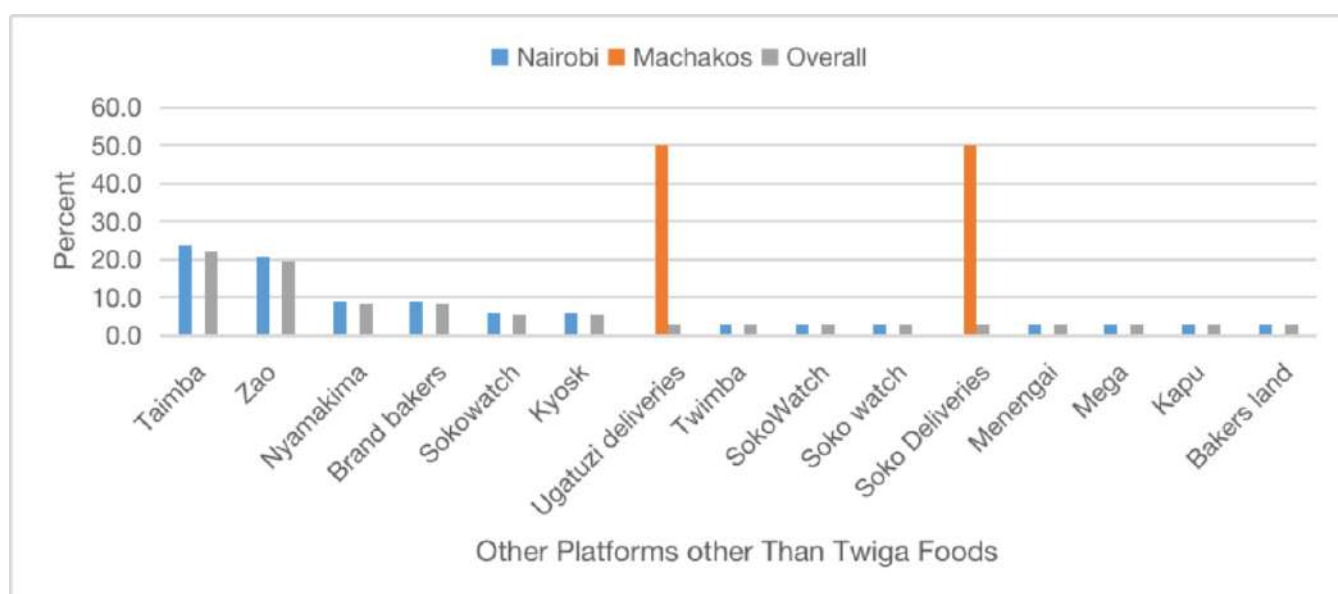


Figure 34: Other Digital Agricultural Platforms

3.4 Benefits and Challenges in Engagement with Twiga Foods

3.4.1 Benefits from Engagement with Twiga Foods

The study investigated the benefits that the farmers, farmer-agents and agents derive from using the digital agricultural platform. Findings from the conducted interviews in addition to further research showed a myriad of benefits enjoyed by the actors who engaged with the digital agricultural platform in one way or the other. Such benefits included; major increase of use of digital payments when selling outputs for the farmer-agents, speed of receiving payments for the outputs and amount of output sold thus more income. Further results from the study conducted by GSMA (2017), revealed additional conveniences of the digital platforms to the agricultural value-chain actors as developing markets, fostering business performance improvements, uptake of better agricultural practices and skills development not to forget allowing for more transparency and visibility for farmers. The platforms aid in enabling greater incomes for smallholder farmers, more employment opportunities especially to the youth thus promoting and improving the economic inclusion of youth and women. The digital agricultural platforms benefit both large and small agribusinesses as well as build climate resilience (World Bank, 2020). Table 23 presents the benefits as observed by the farmers, agents and farmer-agents. The complete list of benefits is presented in Annex 3.

Table 23: Three Important Benefits from Engaging with Twiga Foods

County	Benefit	Farmer	Agent	F a r m - er-Agent	Overall
	Free transportation	3.3	0.0	0.0	1.3
Meru	It's source of income	4.9	8.3	10.0	7.4
	None	63.9	66.7	62.5	64.4
	Ready market for produce	18.0	20.8	22.5	20.1
	The payment arrange- ments is perfect	6.6	0.0	0.0	2.7
Embu	It's source of income	6.8	7.7	21.7	10.8

County	Benefit	Farmer	Agent	F a r m - er-Agent	Overall
	None	47.7	61.5	13.0	43.0
	Ready market for produce	31.8	15.4	30.4	26.9
	Twiga is very informative about production	9.1	0.0	13.0	7.5
Kirin-yaga	Free transportation	11.8	0.0	0.0	7.2
	None	37.3	70.8	75.0	50.6
	Ready market for produce	29.4	4.2	0.0	19.3
	Relatively higher buying price	7.8	4.2	12.5	7.2
Over-all	None	50.6	66.3	47.9	54.8
	Ready market for produce	25.6	15.3	22.5	21.8
	It's source of income	4.5	8.2	14.1	7.7
	Relatively higher buying price	5.1	2.0	4.2	4.0
	The payment arrangements is perfect	4.5	4.1	2.8	4.0

The benefits that the digital platforms bring were not enjoyed in the rural regions and also in some urban areas. For instance, a study revealed that KCB Mobigrow, which commenced in 2016, had 400,000 registered users on their platform who accessed savings, input loans, supply chain finance, farming advisory services, market information in addition to financial education.

3.4.2 Challenges from Engagement with Twiga Foods

As it is obtainable in many nations in Africa, most rural regions in Kenya encounter problems with issues that relate to lack of infrastructure, such as Internet connectivity and electricity and in turn, makes it difficult to appropriately implement digital technology in agricultural practices, the absence of fundamental infrastructure in many rural areas represent a major constraint for farmers to access and utilize digital technology, such as instruments for precision agriculture and mobile applications

Table 24 indicated that some agents and farmer-agents stated that they never faced challenges in their engagement with Twiga foods. Some stated that they encountered a few challenges like too many (produce) rejects, sudden price shifts, poor communication, delayed payments, late collection of the produce after harvest, wrongly calibrated weighing scales, poor hygiene at the collection centre, non provision of fertilizer loans as well as very high cost of production to produce high quality products. The complete list of challenges are presented in Annex 4.

Table 24: Important Challenges as a Result of Engaging with Twiga Foods

County	Challenges	Farmer (%)	Agent (%)	F a r m - er-Agent (%)	Overall (%)
Meru	None	55.7	33.3	22.0	39.3

County	Challenges	Farmer (%)	Agent (%)	F a r m - er-Agent (%)	Overall (%)
	The rejects were too many	16.4	20.8	34.1	22.7
	Transportation costs is very high	3.3	22.9	22.0	14.7
	Sudden price shifts	8.2	16.7	7.3	10.7
Embu	None	46.7	61.5	34.8	47.9
	The rejects were too many	28.9	15.4	39.1	27.7
	Transportation costs is very high	8.9	19.2	17.4	13.8
	Sudden price shifts	6.7	3.8	8.7	6.4
Kirinya-ga	None	27.5	91.7	12.5	44.6
	The rejects were too many	0.0	0.0	0.0	0.0
	Transportation costs is very high	21.6	8.3	37.5	19.3
	Sudden price shifts	31.4	0.0	25.0	21.7

3.4.3 Impact of the Extra Income as a Result of Engaging with Twiga Foods

As mentioned by the farmers, farmer-agents and agents of Twiga Foods, one of the benefits enjoyed was an increase in the income earned from their outputs which was facilitated by an increase in the harvest quantity. The study therefore sought to reveal whether the income positively impacted their livelihoods and how they used the increased portion. The findings showed that the farmers, farmer-agents and the agents were positively impacted as their basic needs are easily met and settled. Such needs included payment of school fees, thus more quality education and more children got the chance to acquire education even to the tertiary level, more food available thus promoting the food security goal, expansion of the farming activities thus gradual increase on the scale of production which means more agricultural production. The more the agricultural production improved the more opportunities to expand off-farm businesses, save as well as improved living standards for the farmers, farmer-agents and agents. Table 25 shows the magnitude of the expenditure the extra-income addressed for the farmers, farmer-agents and agents. Expanded table is presented in Annex 5.

Table 25: Three Major Reasons for Increased Expenditure Arising from Higher Income as a Result of Engagement with Twiga Foods

County	Expenditure Item/Line	Farmer (%)	Agent (%)	F a r m - er-Agent (%)	Overall (%)
Meru	Pay school fees	23.7	25.4	23.4	24.1
	Buy more food	22.4	23.1	21.9	22.5
	Expand farming activities	23.1	11.5	13.9	16.5
Embu	Pay school fees	25.0	22.6	22.9	23.8
	Buy more food	20.5	22.6	25.7	22.5
	Expand farming activities	25.0	12.9	14.3	18.9

Kirinya-ga	Pay school fees	25.0	38.2	23.1	28.5
	Buy more food	21.1	23.5	23.1	22.0
	Expand farming activities	19.7	2.9	23.1	15.4
Overall	Pay school fees	24.4	26.5	23.2	24.7
	Buy more food	21.5	23.0	23.2	22.4
	Expand farming activities	23.0	10.6	14.5	17.1

3.5 Perceived Impact after Engagement with Twiga Foods

3.5.1 Impacts of Farmers' Engagement with Twiga Foods

The digitization of agriculture would be expected to lead to increased production for fewer inputs in addition to a reduction in toxins from agrochemical use due to more precise chemical applications according to Basso and Antle, 2020; and Shepherd et al., 2020. With regard to the production of commodities, the farmers' engagement with Twiga Foods had impacts on some farming exercises; brought about 10% increase in the use of fertilizer. The perceptions of farmers regarding the future of digital services vary significantly by gender, duration in agriculture, level of education, income, membership in associations, and access to extension (Abdulai et al., 2023). Digital agricultural technology impacts greatly on factors that as well influence the operations of the actors as it presents an opportunity for improved productivity and environmental benefits through sensitization about more efficient use of natural resources and this matches the results of a studies by Newell and Taylor (2018) and Rose and Chilvers (2018).

The engagement also resulted to a great decrease; of involvement of the middlemen in the selling process, time used in finding information about output prices, time used in finding buyers, time and cost of transporting commodities to buyers. With regards to income and financial resources, engagement with Twiga Foods has led to an increase in the overall amount of income from business activities with Twiga Foods and the stability/reliability of income to a great extent. There was no much change on the savings for most respondents (31.8%) but there was an increase for 31.2%, 52% of the respondents did not experience much change with loans at the same time 17.1% experienced a slight decrease. With debts, 45.9% of agents and farmer-agents did not feel a change while 20.2% got a slight decrease. The agents and farmer-agents enjoyed additional benefits from engagement with Twiga foods like free transportation, good security at the collection centres, source of income, ready market for produce, reduced cost of delivery, reduction of brokers, relatively higher buying price, perfect payment arrangements, and the rejected bananas were fed to animals and that Twiga provided information about production.

Some other benefits derived by the farmers out of the engagement with the Twiga Foods included ready market for produce (22.6%) -this was ranked the highest among the other benefits 22.6%, earned more income (7.0%), better prices hence more profits (4.6%), no delayed payments (3.1%), free transportation cost (2.8%), and provision of information about production (2.4%). Digital agriculture goes many steps further by connecting farm equipment to software platforms (Mehrabi et al., 2021). Proponents of digital agriculture argue that the use of technology simplifies the complexity of agricultural activities because there is availability of more detailed and precise information to support complex decision-making on-farm, this on the other hand enables the move "from precision to decision" (Shepherd et al., 2020). Twiga Foods was more reliable (1.8%), they were able to network with other farmers (0.9%) and the rejected bananas were fed to the livestock thus no loss experienced as a result according to some farmer respon-

dents (0.6%). Nevertheless, some farmer respondents experienced some challenges from engagement with Twiga Foods which included rejection of more bananas (20.5%), high transportation cost (17.1%), fluctuating prices (13.1%), delayed payments in some cases (2.8%), poor communication (2.1%), delayed collection (2.1%), wrongly calibrated weighing scales (1.8%) and high production cost (1.8%). The research also showed that the respondent farmers used the extra income earned from the engagement with Twiga Foods to settle different needs which included school fees (24.7%), food (22.4%), expansion of farming activities (17.1%), expansion of off-farm business activities (13.7%), other amenities for the home (10.1%), added savings (6.2%), purchase of means of mobility (e.g., motorbike, truck) (4.1%), payback loans (1.5%) as well as to buy more livestock (0.3%). Older farmers and rural farming communities could be excluded from the agricultural digital revolution due to lack of accessible training and internet connectivity; some as well might not always understand the data obtained from digital devices (Rotz et al., 2019; Weersink, 2018). The application of digital agricultural technologies and associated training must consider potential harm, farmers' concerns, as well as ensure equity considerations and the sharing of benefits from the technology (Wiseman et al., 2019).

On the use of fertilizer, the farmers and farmer-agents reported no change (85.2%), while 10% reported a little increase. However, some respondent indicated a little decrease (3.1%) in Table 26. The study revealed that engagement with the digital platform helped the farmers and farmer-agents to make more appropriate decision with regards to pesticides application in the course of the production. For instance, most farmers used organic manure to grow banana and this led to an increase in the health-quality standard of the outputs.

Table 26: Impacts on Use of Fertilizers

Changes	County			
	Meru (n=102)	Embu (n =68)	Kirinyaga (n =59)	Overall (n=229)
No change (%)	82.4	89.7	84.7	85.2
Increase a little (%)	12.7	7.4	8.5	10
Decrease a little (%)	2	2.9	5.1	3.1
Don't know (%)	2	0	0	0.9
Don't want to say (%)	0	0	1.7	0.4
Increase a lot (%)	1.0	0.0	0	0.4
Total (%)	100	100	100	100

On the use of pesticides, most of the farmers and farmer-agents (86.5%) reported no much change as well but a little increase to some respondent farmers (5.2%) and a little decrease to other respondent farmers (2.2%) as shown in Table 27.

Table 27: Impacts on Use of Pesticides

Use of Pesticides	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
No change (%)	91.2	86.8	78.0	86.5
Increase a little (%)	1.0	8.8	8.5	5.2
Don't know (%)	5.9	1.5	3.4	3.9
Increase a lot(%)	0.0	0.0	8.5	2.2

Decrease a little (%)	2.0	2.9	1.7	2.2
Total (%)	100.0	100.0	100.0	100.0

Most respondents (69.4%) reported that engagement with Twiga Foods has not resulted in any change in their use of irrigation and while 16.6% reported to have been impacted to some extent (Table 28). Some respondents (11.8%) indicated lack of knowledge of any changes, while others indicated a lot of increase in irrigation (11.8%).

Table 28: Perceived Impact Related to Irrigation Use

Use of irrigation	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
No change (%)	59.8	89.7	62.7	69.4
Increase a little (%)	22.5	7.4	16.9	16.6
Don't know (%)	13.7	2.9	18.6	11.8
Increase a lot (%)	13.7	2.9	18.6	11.8
Decrease a little (%)	2.0	2.9	1.7	2.2
Total (%)	100.0	100.0	100.0	100.0

Since the major product sold to Twiga foods was banana, use of farm machinery such as tractor was not greatly influenced because the cultivation does not require much use of machinery. Therefore, majority of the farmers and farmer-agents (83%) indicated that there was no change on the use of machinery (Table 29).

Table 29: Impacts on use of Machinery In production

Use of Machinery	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
No change (%)	76.5	91.2	84.7	83.0
Increase a little (%)	14.7	5.9	10.2	10.9
Increase a lot (%)	4.9	2.9	0.0	3.1
Don't know (%)	3.9	0.0	0.0	1.7
Decrease a little (%)	0.0	0.0	5.1	1.3
Total (%)	100.0	100.0	100.0	100.0

Engagement with Twiga Foods was reported not have much impact on use of hired labour in the farm in all the counties as reported by about 73% of the respondents (Table 30). The study revealed that this was because banana cultivation had no much labour demand considering that it was the major commodity traded with Twiga Foods across the three counties. Family labour was largely used which technically reduced the need for hired labour. However, in some instances the need for hired labour increased a little (17%) and increased a lot (5.7%).

The use of hired labour in farming activities was as follows

Table 30: Impacts on Use of Hired Labour

Use of Hired Labour	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
No change (%)	74.5	77.9	66.1	73.4
Increase a little (%)	16.7	14.7	20.3	17.0
Increase a lot (%)	5.9	4.4	6.8	5.7
Don't know (%)	3.9	0.0	0.0	1.7
Decrease a little (%)	0.0	1.5	5.1	1.7
Decrease a lot (%)	.0	1.5	0.0	0.4
Total (%)	100.0	100.0	100.0	100.0

Investment in digital agricultural platforms would be expected to increase agricultural production and productivity in general due to the influence that results. However, results of the study depict that the yields of the commodities were also impacted although not to such a great extent according to Table 31.

Table 31: Impacts on Commodity Yields

Extent of Change	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
No change (%)	52.0	38.2	44.1	45.9
Increase a little (%)	26.5	35.3	33.9	31.0
Increase a lot (%)	16.7	25.0	10.2	17.5
Don't know (%)	2.9	0	8.5	3.5
Decrease a little (%)	2.0	1.5	3.4	2.2
Total (%)	100	100	100	100

With regards to sales of commodities produced by the farmers, their engagement with Twiga Foods had some impacts. A study by Abdulai (2023) found that farmers perceive digitalization as transitioning their everyday activities across the farming spectrum, which this study underscores as an increase in yields which implied to more sales.

a) Amount of output sold

Table 32: Impacts on Amount of Output Sold

Amount of Output Sold	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
No change (%)	9.8	5.9	16.9	10.5
Increase a little (%)	55.9	48.5	67.8	56.8
Increase a lot (%)	33.3	42.6	8.5	29.7
Don't know (%)	0	0	1.7	0.4
Decrease a little (%)	1	2.9	1.7	1.7
Decrease a lot (%)	0	0	3.4	0.9
Total (%)	100	100	100	100

b) With the Technical Centre for Agricultural and Rural Cooperation (2019)

Digital technologies provide greater market access for agricultural products as it enables creation of more information about farms producing the different products, thus more transparency and traceability through the use of verifiable records and labelling in complex food supply chains (Shepherd et al., 2020). Table 33 indicates that the overall selling of output increased a lot (61.1%) whereas other respondents indicated it increased a little (27.5%). Respondents in Embu County indicated the highest “Increased a lot” at 80.9%.

Table 33: Impacts on Selling the Outputs

Selling the output	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Increase a lot (%)	55.9	80.9	47.5	61.1
Increase a little (%)	26.5	14.7	44.1	27.5
No change (%)	16.7	4.4	3.4	9.6
Don't know (%)	1	0	1.7	0.9
Decrease a little(%)	0	0	1.7	0.4
Decrease a lot (%)	0	0	1.7	0.4
Total (%)	100	100	100	100

c) Speed of Receiving Payments for Outputs

Use of the digital devices for money transfer resulted to an increase in the speed of receiving payments for the farmers, farmer-agents and agents. This was to a great extent a positive impact the study found. The respondents indicated in Table 34 that there was a lot of increase (52.4%) compared to “increased a little” (27.5%). Respondents in Embu returned the highest response of increased a lot at 58.8%.

Table 34: Impacts on Speed of Receiving Payments for Outputs

Speed of receiving payments	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Increase a lot (%)	53.9	58.8	42.4	52.4
Increase a little (%)	24.5	23.5	37.3	27.5
No change (%)	16.7	16.2	8.5	14.4
Decrease a little (%)	2.9	1.5	10.2	4.4
Don't know (%)	2	0	0	0.9
Don't want to say (%)	0	0	1.7	0.4
Total (%)	100	100	100	100

d) Use of Digital Payments When Selling Outputs

A good share of the farmers, farmer-agents and agents experienced an increased use of the digital payment systems when selling their products to Twiga Foods. Overall, “Increase a lot” was 45% compared to “increase a little” at 32.3% as indicated in Table 35. Meru County had the highest “Increase a lot” (53.9%) compared Kirinyaga County (23.7%). However, Kirinyaga County had the highest “increase a little” at 45.8% compared Meru County (27.5%).

Table 35: Impacts on Use of Digital Payments when Selling Outputs

Speed of receiving payments Use of digital payments when selling outputs	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Increase a lot (%)	53.9	50	23.7	45
increase a little (%)	27.5	27.9	45.8	32.3
No change (%)	14.7	19.1	28.8	19.7
Don't know (%)	3.9	0	0	1.7
Decrease a little (%)	0	1.5	1.7	0.9
Decrease a lot (%)	0	1.5	0.0	0.4
Total (%)	100	100	100	100

e) Involvement of Middlemen in the Selling Process

Involvement of middlemen in the selling process was also halted by engagement of the farmers, farmer-agents and agent with Twiga Foods as the brokers were discouraged greatly apart from a few who persisted even with the competition posed by the digital platform.

Table 36: Impacts on Involvement of Middlemen in the Selling Process

Involvement of Middlemen	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Decrease a lot (%)	43.1	48.5	30.5	41.5
No change (%)	29.4	20.6	30.5	27.1
Decrease a little (%)	8.8	17.6	18.6	14
Increase a little (%)	10.8	4.4	6.8	7.9
Increase a lot (%)	3.9	8.8	6.8	6.1
Don't know (%)	3.9	0	6.8	3.5

With regards to time spent on finding information about prices, buyers and transportation of the commodities, the results of the engagement of the farmers from Meru, Embu and Kirinyaga counties with Twiga Foods are presented in the tables below;

1) Finding information about output prices

Table 37: Impacts of Engagement with Twiga Foods on Finding Information About Output Prices

Attribute	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Finding information about output prices				
Decrease a little (%)	20.7	31.9	24.1	24.8
Increase a lot (%)	27.3	9.6	20.5	20.5
Decrease a lot (%)	14.7	31.9	7.2	17.7
No change (%)	17.3	16	20.5	17.7
Increase a little (%)	17.3	10.6	19.3	15.9
Don't want to say (%)	0	0	8.4	2.1
Don't know (%)	2.7	0	0	1.2
Total (%)	100	100	100	100

2) Engagement with Twiga Foods led to a great decrease on the time used by the farmers and farmer-agents to look for buyers of their products.

The table below shows how finding buyers for agricultural commodities was influenced;

Table 38: Impacts of Engagement with Twiga Foods on Finding Buyers for Agricultural Commodities

Attribute	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Change in Finding buyers				
Decrease a lot (%)	32	19.3	30	27.1
Decrease a little (%)	18	37.2	18.1	23.5
Increase a lot (%)	20	9.6	28.9	19.3
No change (%)	20.7	10.6	25.3	19
Increase a little (%)	8	5.3	6	6.7
Don't know (%)	1.3	1.1	0	0.9
Don't want to say (%)	0	0	2.4	0.6
Total (%)	100	100	100	100

3) Transporting the commodities to buyers.

The farmers who engaged with Twiga Foods did not need to transport to the buyers since the farmer-agents and/or agents collected the commodities from the farm gates thus saved the farmers the trouble. On the other hand, the farmer-agents and agents increased the transportation activity as they moved the products to the Twiga Foods collection centers, this reduced the time needed to transport the outputs to the buyers.

Table 39: Impacts of Engagement with Twiga Foods on Transporting the Commodities

Attribute	County			
	Meru (n= 102)	Embu (n= 68)	Kirinyaga (n=59)	Overall (n= 229)
Transporting The Commodities				
No change (%)	35.3	15.7	28.7	28.4
Increase a little (%)	6.7	9.6	12	8.9
Increase a lot (%)	32	18.1	32.5	28.1
Don't want to say (%)	0	0	3.6	0.9
Don't know (%)	1.3	0	1.2	0.9
Decrease a little (%)	10.7	21.3	18.1	15.6
Decrease a lot (%)	14	22.3	16.9	17.1
Total	100	100	100	100

With regards to the farmers' income and financial resources, engagement with Twiga Foods had an effect on overall amount of income, reliability of income, savings, loans as well as debts. These impacts are well illustrated on the tables below.

a) Overall amount of income from business activities with Twiga Foods

With the increase of outputs and sales, as well as saved costs that could have been incurred in the transportation and search of buyers, the farmers and farmer-agents realized more income from engagement with Twiga Foods. The agents on the other hand earned more income as it paid to bridge the gap between the farmers and the digital-agricultural platform Twiga Foods.

b) Stability / Reliability of Income

Table 40 shows that respondents indicated that there was little rise in the stability and/or reliability of income of farmers (46.5%), farmer-agents and agents' engagement with Twiga Foods since it was guaranteed of the ready market and payment. Kirinyaga respondents registered the highest affirmation of the increase (51.8%)

Table 40: Impacts on Overall Amount of Income

Attribute	County			
	Meru (n =150)	Embu (n =94)	Kirinyaga (n =83)	Overall (n=327)
Overall Amount of Income				
Increase a little (%)	47.3	40.4	51.8	46.5
Increase a lot (%)	39.3	40.4	7.2	31.5
No change (%)	13.3	16.0	26.5	17.4

Decrease a little (%)	0.0	3.2	8.4	3.1
Don't want to say (%)	0.0	0.0	4.8	1.2
Decrease a lot (%)	0.0	0.0	1.2	0.3
Total (%)	100.0	100.0	100.0	100.0

c) Savings

The study found out that the farmers, farmer-agents and agents' savings rose for the majority. This was possible with the rise in income as well as reliability and stability of income that came with engagement with Twiga Foods as shown in Table 43.

Table 41: Impacts on Savings

Attribute	County			
	Meru (n=150)	Embu (n =94)	Kirinyaga (n =83)	Overall (n=327)
No change (%)	30	26.6	41	31.8
Increased a little (%)	32	34	26.5	31.2
Increased a lot (%)	33.3	36.2	15.7	29.7
Don't want to say (%)	0	1.1	10.8	3.1
Decreased (%)	2.7	1.1	3.6	2.4
Decrease a little (%)	2.7	1.1	3.6	2.4
Don't know (%)	2	1.1	2.4	1.8
Total (%)	100	100	100	100

d) Loans

The study established that Twiga Foods had quite uninformed impact on loan borrowing for the farmers, farmer-agents and the agents across the three counties of focus as presented in Table 42.

Table 42: Impacts on Loans

Attribute	County			
	Meru (n=150)	Embu (n =94)	Kirinyaga (n =83)	Overall (n=327)
Loans				
No change (%)	53.3	50	51.8	52
Decrease a little (%)	19.3	17	13.3	17.1
Decrease a lot (%)	10	24.5	6	13.1

Increase a little (%)	5.3	3.2	18.1	8
Don't know (%)	7.3	3.2	1.2	4.6
Don't want to say (%)	1.3	2.1	7.2	3.1
Increase a lot (%)	3.3	0	2.4	2.1
Total (%)	100	100	100	100

e) Debts

Debt is a key mechanism that farmers engage in to acquire an agricultural technology of a specific brand and system (McMichael, 2013; Rotz et al., 2019). According to 45.9% respondents there was no change on debts while 20.2% respondents argued that the rate of debt decreased a little as shown by the Table 43.

Table 43: Impacts on Debts

Attribute	County			
Loans	Meru (n =150)	Embu (n =94)	Kirinyaga (n =83)	Overall (n=327)
No change (%)	49.3	43.6	42.2	45.9
Decrease a little (%)	22.7	16	20.5	20.2
Decrease a lot (%)	14.7	30.9	6	17.1
Don't want to say (%)	2.7	4.3	25.3	8.9
Don't know (%)	5.3	4.3	4.8	4.9
Increase a little (%)	4	1.1	1.2	2.4
Increase a lot (%)	1.3	0	0	0.6
Total (%)	100	100	100	100

3.5.2 Impacts of Agents and Farmer-Agents' Engagement with Twiga Foods

The agents and farmer-agents were able to meet different needs with the additional income as a result of their engagement with Twiga Foods. For example, some (24.7%) used the additional income for paying of school fees, 22.45% bought food, 17.1% were able to expand farming activities, 13.7% expanded off farm business activities, 10.1% bought home amenities, bought livestock, 6.2% added to their savings, some bought vehicles (e.g., motorbike, truck) while others (1.5%) used the money to pay back loans. This further had a general effect on their way of life that led to a better quality of living as they could educate their young ones, acquire and afford a balanced diet on their tables more easily than before the engagement with Twiga Foods. The study revealed that even the domestic quarrels due to financial challenges declined to a great extent and the community became a better place to live for the farmer-agents as well as the agents. For those who started engaging with Twiga Foods in the earlier years,

the study found that the difference between them and those that joined was so noticeable in the ways of life and interactions. Some of them already had built quality permanent houses and/or driving cars all out of the effort they put in engagement with Twiga Foods which clearly depicts the obvious good the digital agricultural platform brought to the rural society.

3.5.3 Impacts of Vendors' Engagement with Twiga Foods

Engagement with Twiga Foods benefited the businesses of the vendors from Nairobi and Machakos Counties in a myriads of ways such as free product delivery, more sales, good quality products as well as quick delivery of the products. In addition to all these, the vendors from Machakos County enjoyed fair prices and product variety, increased profit margin and reliable source of products, business expansion as result of more profit, increased availability of bananas and more customers. In Nairobi County, the vendors stated some more positive impacts as free delivery and increased demand.

With the positive impacts as far as income is concerned, the vendors from both counties got some extra income to spend on expansion of their businesses (29.1%), payment of school fees (20.5%), more food (17.9%), more home amenities (16.6%), savings (11.3%), pay back loans (4%) and some vendors from Nairobi (0.8%) bought vehicles e.g., motorbike, trucks. Some even started off-farm businesses which were enhanced due to the support from the income earned from the engagement with Twiga Foods.

3.5.3.1 Challenges Faced by Vendors

Engagement with Twiga Foods had some negative effects on businesses of some vendors in that there was stiff competition among the vendors and some made very low sales as a result in both counties. From Machakos County, the vendors also reported some more negative impacts of Twiga Foods such as high prices of the products, poor delivery, lack of products replacement in case of dissatisfaction by the vendors, poor quality products and untimely delivery. Figure 35 shows the challenge faced by vendors from Nairobi County.

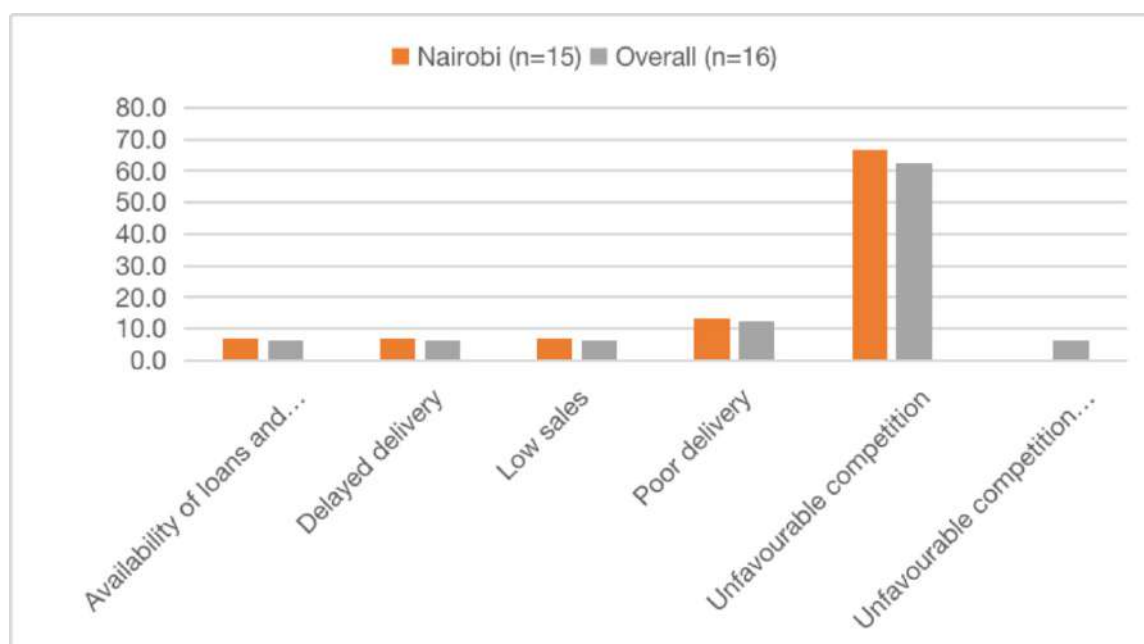


Figure 35: Challenges Experienced by Nairobi Vendors

In a nutshell the arrival of Twiga Foods resulted to an average of 20% increase of the quantities of commodities in the shelves of the vendors' businesses (increased volumes) as well as increased sales, thus more availability of the products, more product varieties, fair prices for the products, reliability about products delivery improved. Majority of the vendors from both counties concluded that their involvement with Twiga Foods led to creation of additional businesses through availability of loans, d quality products at fair prices, free consistent delivery, increased sales and more reliable supply of products. On the other hand, Twiga Foods' arrival took away some businesses due to 80% increase in unfavourable competition amongst themselves (an increase in the number of vendors in the business), and some complained about rise in prices of fresh products. Some vendors from Machakos County (13.3%) argued that poor and delayed delivery, low sales were as a result of the arrival of Twiga Foods.

3.5.4 Impacts Perceived by Non Twiga Foods Farmers per FGD Discussions

3.5.4.1 Impact of Twiga Foods on Input Prices.

Generally, the arrival of Twiga Foods across the three counties was found to have no impact on input prices except for Meru where 100% of the respondents reported that the arrival of Twiga Foods triggered an increase in the price of manure. Mostly farmers used only manure, water and planting materials as inputs for banana production. Water was always dependent on the amount of rainfall in the area. Planting materials (banana suckers) came from the existing banana plants but farmers did not have livestock bought organic manure.

3.5.4.2 Impact of Twiga Foods on the Availability of Inputs

The arrival of Twiga Foods was reported to have affected the availability of inputs in Meru specifically for the organic manure which was reported to have been scarce in Egoji and more available in Mitunguu. In Egoji, 100% of the respondents reported that most farmers ventured in banana farming since they were motivated by the ready market therefore more banana were planted and existing ones were maintained and adequately manured. The demand for organic manure increased and supply was limited whereas in Mitunguu most of the livestock farmers ventured in to manure business and so the supply met demand and organic manure was reported to be more available than before.

3.5.4.3 Impacts of the Arrival of Twiga Foods on the Choice of Farmers to Sell to the Different Buyers of the Fresh Produce

Almost 100% of the non-Twiga farmers/respondents across the three counties reported that the arrival of Twiga Foods did not have any significant impact on who they sold their output to, since after weighing the factors that came with Twiga Foods they still sold stack of produce to brokers. They continued to sell their bananas to brokers/middlemen and bulk buyers who later transported the bananas to larger markets like Nairobi, Kisumu and Mombasa etc. The remaining bananas were sold locally to wholesalers and consumers in the local markets within the counties.

3.5.4.4 Impacts of the Arrival of Twiga Foods on How the Farmers Sold their Outputs

Twiga Foods came in with a unique strategy of buying bananas from the farmers, using measuring scales (on per Kg basis) rather than the old way of estimating the price of bananas from the physical size of the bunch. Among the non-Twiga respondents across the four counties it was reported that there was a significant transitioning to selling the bananas in kilograms even when selling to brokers and bulk buyers. This strategy motivated farmers to maintain their banana plants so that they could produce bigger and heavier bananas thus attracting more income.

3.5.4.5 Impacts of the Arrival of Twiga Foods on the Prices That the Farmers Received for the Output

When Twiga Foods arrived, they came in with higher prices for bananas, hence they became a potential competitor to the existing buyers in the market place. As a result, all the other buyers had no other option but to increase the price offered so as to meet the standards Twiga Foods had set to attract sellers. In addition, selling bananas in kilograms was reported to have better prices than when sold in bunches. Respondents reported that prices actually increased from as low as KSh.8 to Ksh.23 per kilogram which was quite a significant increase.

3.5.4.6 Impacts of the Arrival of Twiga Foods on Quality of Infrastructure

Twiga Foods was reported to have zero impact on the infrastructure of the area except for Mitunguu area in Meru. At the same time, some roads were reported to have opened up in the interior parts for transporting bananas to the collection centres. Although the roads were still poor, this triggered a more vibrant boda-boda (motorcycle) business for transportation. The roads were still very poor especially in the interior parts. Electricity was also not well distributed but only those people living along the roads were privileged to have electricity. Cold rooms for storage of bananas were not found across the research sites. Generally, Twiga Foods did not have significant influence on the quality of infrastructure across the three counties.

3.5.4.7 Exchange of Information

Given the relatively low quality, low yield and the challenges faced by farmers as regards climate change, farmers could benefit from more accurate and timely information and as a result, significantly impact levels of agricultural productivity (Digital-Farming-in-Kenya, 2019). 100% of the non-Twiga farmers did not receive any information about farming methods from farmers who transacted with digital platforms. According to the responses provided by the non-Twiga farmers, Twiga Foods did not take time to train their farmers on the appropriate farming methods or good agricultural practices rather the only business they had with the farmers was buying and selling of the bananas.

4.0 Conclusions and Recommendations

4.1 Conclusions

The objectives of the study were: 1) to identify the drivers of different types of digital platforms, 2) Document the distributional effects of digital agriculture platforms, 3) Understand how the growth of the platforms impacts markets. In general, all the objectives of the study were achieved, through an in-depth analysis of the supply and demand sides of Twiga Foods products, especially the role of the digital platform used for transaction.

Previously, the Twiga-Model was based on direct contact of Twiga Foods employees with farmers (collection of produce and exchange of information and inputs). This model proved to be too costly to Twiga due to excessive transaction cost. Twiga Foods therefore abandoned the model and adopted an agent model, where agents interacted with farmers and collected produce for delivery to Twiga Foods Collection Centres. Twiga Foods digital model worked relatively well for both producers, farmer-agents, agents and vendors. This was evident especially in payment time for producers and delivery/payment time for vendors. Efficient communication flow between the company and the clients was attributable to the widespread ownership of phones by the farmers, agents and vendors with more than 90% ownership and occasionally 100% in some counties and also existence of other digital platforms in both agriculture and non-agricultural sectors. As a result, distribution efficiency response to supply and payment did not elicit much complain from the respondents.

However, the major issue raised by respondents was the low unit price and the grading system which resulted in substantial rejections of bananas due to size. While the grading system that resulted in substantial rejections of produce may not have any relationship with the digital platform, the unit price and the digital platform was expected to have positive correlation. Increased use of digital platform was expected to reduce transaction costs, resulting in higher unit price, but according to the respondents there was no effect. Farmers indicated that they preferred to sell produce to Twiga Foods because it offered better but lower price. Thus, it was concluded that the major effect of the digital platform was reduced payment period, close to real time, and improved quality of products because of daily collections with minimal storage.

In Kenya the growth of digital platforms has been exponential covering every aspect of the economy. In the agricultural sector it has impacted various aspects of the markets. The study of the Twiga models shows that it has resulted in the growth of the market with daily deliveries to the processing factory from as much as 300 kilometres away, this is considered unimaginable without the platform. This market spans three counties in Kenya and various outlets for the products. The wide reach of the market was not only geographical but also increased proximity to consumers, around high population areas in Nairobi City County and its environs. Twiga Foods started with a few vendors, but in less than 4 years and by the time of this study it was operating with slightly over eight thousand vendors in urban and peri-urban areas of Nairobi and the surrounding Counties.

Engagement with Twiga Foods is of great benefit to the farmers, agents as well as the farmer-agents. The benefits outweighs the challenges it posed or rather the problems encountered in the course of the engagement. The benefits that were enjoyed included provision of ready market for produce, steady income, very good payment arrangements as well as provision of production information. However, some challenges to the farmers, farmer-agents and agents were losses due to high number of rejects, sudden price shift, and high transportation cost from farm to aggregation centres. Finally, it is noteworthy that the digital platform needs to support farmers in productive activities, aggregation of produce and efficiency of delivery of produce to the markets, which is a work in progress. The system needs to be supported since there are potential benefits if the system is functional along the agricultural value chains.

4.2 Recommendations

The model of using agents needs to be reviewed to be more producer friendly because it seemed to eat into the farmers' profits, especially farmers who were far-flung. Cooperative model or more aggregation centres would probably enhance the digital platform's operations.

The grading system resulted in high rejections and probably the company and the public sector may need to offer advisory services to the farmers on good agricultural practices to improve the quality of the produce. Service providers could take advantage of the extensive digital platform available to provide extension services to the farmers.

One of the factors cited that depresses use of digital platforms was high technology costs. While ownership of phones was high, majority of the respondents (>50%) owned basic phone which may not support Apps used by companies such Twiga Foods. The reason for low ownership of enabled phones (smart or feature phones) was the high cost of smart and feature phones. To increase use of digital platforms, we recommend policy shifts geared towards making smart phones affordable through tax reductions and affordable credits.

Another factor cited in this study and other studies that drives use of digital platforms is digital literacy irrespective of level of education. As a result, there is need for capacity building, especially training on the use of digital platforms and use of feature enabled devices. There is also need for continual flow of research based on advisory content to ensure farmers adoption of technology and good agricultural practices.

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Annexes

Annex 1 Level of Education for TWIGA FOODs Farmers, Farmer-Agents and Agents)

County	Level of Education	AGENT AND FARMER (n=72)	ONLY FARMER (n=157)	ONLY AGENT (n=98)	Total (n=327)
Embu (n=23; 45; 26;94))	none	4.3	4.4	11.5	6.4
	primary school	43.5	37.8	30.8	37.2
	secondary school	43.5	40.0	57.7	45.7
	college	4.3	8.9	0.0	5.3
	vocational training	0.0	2.2	0.0	1.1
	university	4.3	6.7	0.0	4.3
	other	0.0	0.0	0.0	0.0
Kirinyaga (n=8; 51;24; 83)	none	12.5	3.9	25.0	10.8
	primary school	37.5	49.0	12.5	37.3
	secondary school	50.0	35.3	58.3	43.4
	college	0.0	7.8	4.2	6.0
	vocational training	0.0	0.0	0.0	0.0
	university	0.0	3.9	0.0	2.4
	other	0.0	0.0	0.0	0.0
Meru (n=41; 61; 48; 150)	none	2.4	13.1	2.1	6.7
	primary school	29.3	36.1	39.6	35.3
	secondary school	58.5	34.4	47.9	45.3
	college	4.9	6.6	4.2	5.3
	vocational training	0.0	3.3	0.0	1.3
	university	4.9	6.6	6.3	6.0
	other	0.0	0.0	0.0	0.0
Total (n=72; 157; 98; 327)	none	4.2	7.6	10.2	7.6
	primary school	34.7	40.8	30.6	36.4
	secondary school	52.8	36.3	53.1	45.0
	college	4.2	7.6	3.1	5.5
	vocational training	0.0	1.9	0.0	0.9
	university	4.2	5.7	3.1	4.6

	other	0	0	0	0
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Annex 2 Focus Group Discussions

2.1 Kagio FGD, Kirinyaga

Questions (Check-list)	Responses	Rationale
When was Twiga Foods collection centre in Kirinyaga opened		
How the arrival of Twiga Foods affected input prices	The arrival of Twiga did not affect the input prices in any way. The commonly used input was water and this was entirely dependent on the amount of rainfall since they never irrigated the bananas.	There was no change in the input prices
How the arrival of Twiga Foods affected the availability of inputs	100% of the respondents reported that the arrival of Twiga foods did not affect the availability of the inputs since banana production needed very few inputs for production i.e. water, manure and suckers.	100% of the respondents depended on the rains for irrigation of bananas, secondly, they were using the farm yard manure from their households to top up the bananas and finally, they utilized their own suckers for planting new banana plants. The arrival of Twiga had no impact on the availability of the inputs.
How the arrival of Twiga Foods affected who you sell your output to	100% of the respondents in the FGD reported to be selling their output to brokers.	Twiga arrival highly affected banana business positively. When they came, they used to buy bananas in kilos and farmers would fetch high profits from bananas, so most of the farmers started selling their bananas to Twiga. After sometime banana market price shoot and it was even higher than that of Twiga.
How arrival of Twiga Foods affected how you sell your outputs	The arrival of Twiga foods highly influenced how the banana were being sold. Initially, brokers used to buy bananas in bunches according to the physical size of the banana. But Twiga came in with kilos and since then bananas were being sold in kilos.	Most farmers shifted from selling their bananas in terms of physical size to selling in kilos.
How the arrival of Twiga foods affected the prices that you receive for your output	Arrival of Twiga foods positively affected the banana prices in Kirinyaga since before Twiga arrived, the prices was around Ksh8 per kilo and after Twiga came, the price increased to around Ksh28 per kilo	There was a positive impact on price because competition was high.

How the arrival of Twiga foods has affected the quality of infrastructure in your area	Infrastructure remained the same. Poor roads and poor network.	Twiga arrival had no impact on the infrastructure of the area.
Do you receive information about farming methods from farmers who participate in the digital platforms	100% of the respondents did not receive any information about farming methods.	The only relationship with Twiga and farmers was buying and selling bananas. Twiga did not do any agronomic training to the farmers.
Why don't you participate in the platform	<p>-Twiga only bought from large scale farmers who produced large sized bananas thus rejecting small scale farmers who were willing to sell directly to them.</p> <p>-Twiga has very high grading thus rejecting many small sized bananas which go to waste and it's a loss to the farmer.</p> <p>-Twiga was reported to delay payments unlike the brokers who pay instantly at farm gate and some actually leave a deposit even before the bananas matured.</p> <p>- Transportation cost is very high since Twiga stopped picking the produce at the farm.</p> <p>- Twiga did not buy some banana varieties which farmers produced like the cooking varieties.</p>	<p>-Very high grading, Twiga foods only bought large to medium sized bananas.</p> <p>- Delayed payments</p> <p>-High transportation costs</p> <p>-Selective on the varieties of bananas as they bought.</p>

2.2 Egoji FGD, Meru

Questions	Response	Rationale
When was Twiga Foods collection centre in Egoji opened		
How the arrival of Twiga Foods affected input prices	Input prices increased and specifically for manure.	Due to the availability of ready market for bananas, many residents planted more banana plants, and also improved the maintenance of the existing ones thus the demand for organic manure went high and so is the price

How the arrival of Twiga Foods affected the availability of inputs	<p>Organic manure which is the commonly used input became scarce since the arrival of Twiga Foods</p> <p>Other inputs like planting materials and water were readily available</p>	Since many farmers increased the number of banana plants, organic manure became quite scarce than before
How the arrival of Twiga Foods affected who you sell your output to	The arrival of Twiga did not affect who they sold their output to. 100% of the FGD respondents were selling their outputs locally to brokers/middlemen and also some took them to the local markets in the area.	There was no change in regard to who bought the output to the farmers.
How arrival of Twiga Foods affected how you sell your outputs	Before the arrival of Twiga, generally all bananas were being sold in terms of bunches and not kilos but lately most buyers buy in kilos.	Twiga foods came in with the idea of buying bananas in kilos and so other buyers changed from buying in bunches to kilos which was an added advantage to farmers with bananas which were well maintained and had weight.
How the arrival of Twiga foods affected the prices that you receive for your output	The prices of bananas generally increased since the arrival of Twiga foods from around KSh.12 to KSh.23 per kilo	Twiga came in as a potential competitor to the existing brokers, so the brokers had to increase their prices
How the arrival of Twiga foods has affected the quality of infrastructure in your area	There was no change reported on the infrastructure of the area. Roads were very poor thus it triggered a rise in number of motorcycles in the area which were being used to transport bananas to the collection centres. Electricity was only found in farms where the owner could afford but Twiga had no influence at all on its availability.	The infrastructure of the area remained the same including roads, markets, electricity and mobile connectivity
Do you receive information about farming methods from farmers who participate in the digital platforms	100% of the respondents did not receive any information on the farming methods from farmers who participated in the digital platforms but they only received information on the prices.	Twiga foods did not train farmers on farming methods. They only came in to buy the products from the farmers.

Why don't you participate in the platform	<p>-Twiga foods only select the large and medium bananas thus leaving behind the small ones as rejects</p> <p>-Twiga foods delay the payment of the bananas unlike the brokers and other buyers who pay instantly</p> <p>-Twiga foods stopped offering transport to the collection centres thus making it expensive for farmers to transport the bananas to the collection centres and especially where the collection centre is far from the farm and roads are bad.</p> <p>-Since Twiga foods use agents to buy the bananas from the farmers, the agents offer lower prices to farmers thus the farmers' preferred brokers offer.</p> <p>-Twiga only bought from their registered farmers so if you were not registered, they could not buy your bananas.</p> <p>-Brokers left deposits for bananas even before they matured so the farmers had no authority to sell them to Twiga.</p>	Brokers and other local buyers buy the whole bunch irrespective of the size of the bananas so there is no reject.
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2.3 Mitunguu FGD, Meru

Questions	Responses	Rationale
When was the Twiga Foods collection centre in Mitunguu opened?	Layout plans started in 2015 but publicity and operations began in 2016	
How has the arrival of the Twiga Foods platforms affected:		

Input Prices	<p>Cultivation of bananas requires adequate supply of organic manure and water, thus a rise in the prices for the organic manure. Twiga Foods brought about an increase in banana production in Mitunguu.</p> <p>There was no much change in the prices for the planting materials as the farmers used suckers from their neighbours or/and their own formerly planted plants.</p>	<p>The prices for the organic manure increased due to a rise in the demand as many farmers ventured into banana production.</p> <p>No change in the prices of planting materials.</p>
Availability of Inputs	<p>Many people ventured into supplying the organic manure as a result of the rising demand while some make it at homes and only buy to supplement what they already have, thus making it more available.</p>	<p>An increase in the availability of inputs.</p>
Who you sell your outputs to	<p>Initially the farmers used to sell their outputs to the consumers in the markets or the brokers. Currently the non-Twiga farmers still sell to the two groups. The brokers afterwards sell in other far-off places like Nairobi and Mombasa while most of the consumers are available in the open-air markets like Kachege in Nkubu, Meru County.</p>	<p>No much change on the target buyers as the market still exists</p>
How you sell your outputs	<p>Twiga Foods have reduced the negotiations for prices by the brokers since the prices are standardized by Twiga Foods! The brokers are more common in the farms to make purchases by themselves reducing the farmers' transportation cost to the market.</p>	<p>A slight change on the distribution channels, as the brokers do the transportation.</p>
The price that you receive for your outputs	<p>With the standards already set Twiga Foods the brokers had to increase their prices in order to get farmers (sellers). The prices have increased from the sale of bananas; the brokers offer better prices to try and match the standards.</p>	<p>An increase in the output prices as the brokers offer better prices than Twiga foods in this particular place.</p>

<p>The quality of infrastructure in your area (transport, marketing, cold chains, electricity, mobile connectivity)</p>	<p>More rural access roads are getting opened up and more being improved. There are no cold chains for produce storage; products like bananas are only cut and sold. The markets for sales are still less and not enough making reliance on brokers highly paramount. Electricity and mobile connectivity are still poor in most interior parts of the county but have improved within the market centres.</p>	<p>The quality of the roads has improved as a result.</p> <p>No change in the state of the cold chains, electricity and mobile connectivity</p>
<p>Do you receive information about farming methods from farmers who participate in the digital platform?</p>	<p>The farmers on the platform don't receive any agricultural education and extension but rely on the existing agricultural practices generally carried out in the community</p>	<p>No shared information</p>

<p>Why don't you participate in the platform</p>	<p>Prices at Twiga Foods vary depending on the size of a banana unlike with the brokers and in the open-air market where a whole bunch is sold at an agreed price without digging into a specific banana size and discarding it or accepting it.</p> <p>Payment from sales in the open-air market or from brokers is instant unlike with Twiga Foods where there are delays with the payments.</p> <p>Sales especially to the brokers who come to the farms saves the farmers from the transport cost unlike the Twiga Foods who nowadays don't get to the farms for the produce unless through the agents who buy at lower prices than the brokers.</p> <p>Twiga Foods grades the harvest and only takes the high-quality produce and rejects the rest as waste reducing the sales made from Twiga Foods. The brokers or open-air sales take the entire bunch without regard to the quality of individual bananas in the bunch.</p>	<p>In Twiga foods, Prices vary with the size of the bananas while with the brokers the prices are uniform.</p> <p>Delayed payments</p> <p>Transportation cost</p> <p>High rate of rejects depending on the quality.</p>
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2.4 Kivwe FGD, Embu

Questions	Responses	Rationale
<p>When was Twiga Foods collection centre in Embu opened</p>		

How the arrival of Twiga Foods affected input prices	The arrival of Twiga had no impact on the input prices used in banana production since the main inputs used was water and it was never bought.	Twiga did not have any effect on the input prices.
How the arrival of Twiga Foods affected the availability of inputs	Twiga foods had no effect on the availability of inputs since inputs like planting materials were readily available from the existing banana plants and water was dependent on the amount of rainfall	Arrival of Twiga did not affect the availability of inputs.
How the arrival of Twiga Foods affected who you sell your output to	Farmers sold their produce to brokers/middlemen who later transported the bananas to other large markets in Nairobi, Kisumu, and Mombasa etc. Bananas which remained were sold locally to consumers.	Twiga foods did not affect who the respondents sold their output to.
How arrival of Twiga Foods affected how you sell your outputs	<p>Respondents reported that the arrival of Twiga foods affected how they sold their output since farmers opened their minds on the importance of selling their products in kilos and not blindly with just the size of bunches.</p> <p>Farmers now sold bananas in kilos only.</p>	Arrival of Twiga foods introduced the system of buying bananas in kilos.
How the arrival of Twiga foods affected the prices that you receive for your output	Twiga came with better prices than brokers. Brokers had to increase their prices so as to match the standards set by Twiga.	Prices that farmer received for bananas increased.
How the arrival of Twiga foods has affected the quality of infrastructure in your area	Arrival of Twiga foods did not affect infrastructure of the area. Roads are still poor electricity is also not well spread as only households along the roads have electricity. Network coverage is also still very poor.	Twiga foods did not have any impact on infrastructure in any way.
Do you receive information about farming methods from farmers who participate in the digital platforms	100% of the respondents did not receive any information about farming methods from farmers who participated in the digital platform but the only information they received was only on the prices of the bananas.	Twiga foods did not offer any information about farming methods to farmers. Their only business with farmers was to buy bananas.

Why don't you participate in the platform	The amount of the rejected bananas was reported to be on the higher side thus being a big loss to the farmer. Respondents suggested that Twiga should come up with a way of utilizing the small sized bananas like value addition to avoid such losses.	High grading thus rejecting a lot of small sized bananas.
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Annex 3 Benefits from Engaging with Twiga Foods

County	Benefit	Farmer	Agent	Farmer-Agent	Overall
Meru	Free transportation	3.3	0.0	0.0	1.3
	It's source of income	4.9	8.3	10.0	7.4
	Networking with farmers	0.0	2.1	0.0	0.7
	None	63.9	66.7	62.5	64.4
	Ready market for produce	18.0	20.8	22.5	20.1
	Reduced cost of delivery	0.0	0.0	0.0	0.0
	Relatively higher buying price	3.3	0.0	2.5	2.0
	The payment arrangements is perfect	6.6	0.0	0.0	2.7
	The reject bananas I feed animals	0.0	2.1	2.5	1.3
	Good security at the collection centres.	0.0	3.8	4.3	2.2
Embu	It's source of income	6.8	7.7	21.7	10.8
	Networking with farmers	0.0	0.0	4.3	1.1
	None	47.7	61.5	13.0	43.0
	Ready market for produce	31.8	15.4	30.4	26.9
	Relatively higher buying price	4.5	3.8	4.3	4.3
	The payment arrangements is perfect	0.0	7.7	8.7	4.3
	Twiga is very informative about production	9.1	0.0	13.0	7.5
Kirinyaga	Free transportation	11.8	0.0	0.0	7.2
	It's source of income	2.0	8.3	12.5	4.8
	Networking with farmers	0.0	4.2	0.0	1.2
	None	37.3	70.8	75.0	50.6

County	Benefit	Farmer	Agent	Farmer-Agent	Overall
	Ready market for produce	29.4	4.2	0.0	19.3
	Reduced cost of delivery	2.0	0.0	0.0	1.2
	Reduction of brokers	2.0	0.0	0.0	1.2
	Relatively higher buying price	7.8	4.2	12.5	7.2
	The payment arrangements is perfect	5.9	8.3	0.0	6.0
	Twiga is very informative about production	2.0	0.0	0.0	1.2
Overall	Free transportation	5.1	0.0	0.0	2.5
	Good security at the collection centres.	0.0	1.0	1.4	0.6
	It's source of income	4.5	8.2	14.1	7.7
	Networking with farmers	0.0	2.0	1.4	0.9
	None	50.6	66.3	47.9	54.8
	Ready market for produce	25.6	15.3	22.5	21.8
	Reduced cost of delivery	0.6	0.0	0.0	0.3
	Reduction of brokers	0.6	0.0	0.0	0.3
	Relatively higher buying price	5.1	2.0	4.2	4.0
	The payment arrangements is perfect	4.5	4.1	2.8	4.0
	The reject bananas I feed animals	0.0	1.0	1.4	0.6
	Twiga is very informative about production	3.2	0.0	4.2	2.5

Annex 4 The Challenges From Engaging with Twiga Foods

County	Challenges	Farmer	Agent	Farmer-Agent	Overall
Meru	None	55.7	33.3	22.0	39.3
	The rejects were too many	16.4	20.8	34.1	22.7
	Transportation costs is very high	3.3	22.9	22.0	14.7
	Sudden price shifts	8.2	16.7	7.3	10.7
	Their communication is poor	4.9	2.1	0.0	2.7
	Delay in payments	1.6	2.1	4.9	2.7

County	Challenges	Farmer	Agent	Farmer-Agent	Overall
	Late collection of my produce after harvesting	1.6	0.0	2.4	1.3
	Wrongly calibrated weighing scales	3.3	0.0	2.4	2.0
	Poor hygiene at the collection centre	0.0	0.0	4.9	1.3
	No loans offered, no fertilizers	3.3	0.0	0.0	1.3
	Very high cost of production to produce high quality products	0.0	2.1	0.0	0.7
	The rejects are too many	1.6	0.0	0.0	0.7
Embu	None	46.7	61.5	34.8	47.9
	The rejects were too many	28.9	15.4	39.1	27.7
	Transportation costs is very high	8.9	19.2	17.4	13.8
	Sudden price shifts	6.7	3.8	8.7	6.4
	Their communication is poor	2.2	0.0	0.0	1.1
	Delay in payments	2.2	0.0	0.0	1.1
	Wrongly calibrated weighing scales	2.2	0.0	0.0	1.1
	Poor hygiene at the collection centre	2.2	0.0	0.0	1.1
Kirinyaga	None	27.5	91.7	12.5	44.6
	The rejects were too many	0.0	0.0	0.0	0.0
	Transportation costs is very high	21.6	8.3	37.5	19.3
	Sudden price shifts	31.4	0.0	25.0	21.7
	Their communication is poor	5.9	0.0	0.0	3.6
	Delay in payments	3.9	0.0	12.5	3.6
	Late collection of my produce after harvesting	7.8	0.0	0.0	4.8
	Wrongly calibrated weighing scales	2.0	0.0	0.0	1.2
	Transportation costs are very high	0.0	0.0	12.5	1.2
Overall	None	43.9	55.1	25.0	43.1
	The rejects were too many	14.6	14.3	31.9	18.3
	Transportation costs is very high	10.8	18.4	22.2	15.6

County	Challenges	Farmer	Agent	Farmer-Agent	Overall
	Sudden price shifts	15.3	9.2	9.7	12.2
	Their communication is poor	4.5	1.0	0.0	2.4
	Delay in payments	2.5	1.0	4.2	2.4
	Late collection of my produce after harvesting	3.2	0.0	1.4	1.8
	Wrongly calibrated weighing scales	2.5	0.0	1.4	1.5
	Poor hygiene at the collection centre	0.6	0.0	2.8	0.9
	No loans offered, no fertilizers	1.3	0.0	0.0	0.6
	Very high cost of production to produce high quality products	0.0	1.0	0.0	0.3
	Transportation costs are very high	0.0	0.0	1.4	0.3
	The rejects are too many	0.6	0.0	0.0	0.3

Annex 5 Increased Expenditure Arising from Higher Income as a Result of Engagement with Twiga Foods

County	Expenditure Item/Line	Farmer	Agent	Farmer-Agent	Overall
Meru	Pay school fees	23.7	25.4	23.4	24.1
	Buy more food	22.4	23.1	21.9	22.5
	Expand farming activities	23.1	11.5	13.9	16.5
	Expand off-farm business activities	17.3	16.9	16.1	16.8
	Buy other amenities for the home	4.5	10.8	8.0	7.6
	Save money	5.1	6.2	8.0	6.4
	Buy transport (e.g. motorbike, truck)	2.6	4.6	4.4	3.8
	Pay back loan	0.6	1.5	4.4	2.1
	Other purpose	0.6	0.0	0.0	0.2
Embu	Pay school fees	25.0	22.6	22.9	23.8
	Buy more food	20.5	22.6	25.7	22.5
	Expand farming activities	25.0	12.9	14.3	18.9
	Expand off-farm business activities	11.6	19.4	8.6	12.7

County	Expenditure Item/ Line	Farmer	Agent	Farmer-Agent	Overall
	Buy other amenities for the home	11.6	8.1	14.3	11.5
	Save money	4.5	6.5	10.0	6.6
	Buy transport (e.g. motorbike, truck)	0.9	6.5	4.3	3.3
	Pay back loan	0.9	0.0	0.0	0.4
	Other purpose	0.0	1.6	0.0	0.4
Kirinyaga	Pay school fees	25.0	38.2	23.1	28.5
	Buy more food	21.1	23.5	23.1	22.0
	Expand farming activities	19.7	2.9	23.1	15.4
	Expand off-farm business activities	3.9	2.9	15.4	4.9
	Buy other amenities for the home	22.4	5.9	7.7	16.3
	Save money	3.9	8.8	0.0	4.9
	Buy transport (e.g. motorbike, truck)	1.3	17.6	7.7	6.5
	Pay back loan	2.6	0.0	0.0	1.6
Overall	Pay school fees	24.4	26.5	23.2	24.7
	Buy more food	21.5	23.0	23.2	22.4
	Expand farming activities	23.0	10.6	14.5	17.1
	Expand off-farm business activities	12.5	15.5	13.6	13.7
	Buy other amenities for the home	10.8	9.3	10.0	10.1
	Save money	4.7	6.6	8.2	6.2
	Buy transport (e.g. motorbike, truck)	1.7	7.1	4.5	4.1
	Pay back loan	1.2	0.9	2.7	1.5
	Other purpose	0.3	0.4	0.0	0.3



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