HortiNigeria Baseline Report

Royal Tropical Institute (KIT), Amsterdam June 2022

Executive summary

This report presents and describes baseline data on approximately 1,000 farmers collected in May 2022 from a sample of target farmers that (self-)enrolled in the HortiNigeria programme. The primary aim of this programme – which is funded by the Embassy of the Netherlands in Nigeria and implemented by IFDC and EWS-KT with technical assistance from WUR and KIT - is *'to enhance smallholder farmers' social capital and contribute to their empowerment within the market. HortiNigeria particularly focuses its interventions on women and youth'*. To do so, the project aims to provide technical support to horticulture farmers, while improving market linkages and access to finance. As a result, the project is expected to boost in-country horticulture production, thereby improving agricultural productivity and incomes, food security and resilience. The key expected outcomes of the project are:

- 60,000 smallholder farmers, of whom 50% are youth and 40% are women, will have increased productivity and/or income;
- Acreage under sustainable land use will have increased by 15,000 hectares;
- At least 2,000 entrepreneurial farmers (50% youth and 40% women) will have adopted new knowledge and/or technologies;
- 50 horticulture-related small and medium-sized enterprises (SMEs) will have a business and investment plan to invest, trade or provide services; and
- Of these SMEs, 50% will be youth-owned and 40% will be female-owned.

Baseline data cover the crop seasons of 2021, and were collected through a field-based, structured survey. Interviews took place in May 2022, and the survey covered 22 LGAs, located in Kano state and Kaduna state in Nigeria. The data descriptives and analyses reveal that:

- Yield levels of all horticulture crops produced in the sample (but also the Nigerian averages) are lower compared to yields reported in neighbouring countries. This suggest large yield gaps, which are even more profound for younger and female farmers.
- Farmers' revenues derived from the sale of horticulture produce during their main crop season in 2021 range between 380 USD from okra to 1,068 USD from pepper on average. In other words, the agricultural income of target farm household ranged from slightly more than 1 USD per day to slightly less than 3 USD per day. Median values, however, are much lower, ranging from 262 USD from okra to 450 USD from peppers.
- The average farm household was food insecure for slightly more than one month in 2021 (mainly July and August), and the diets of women appear to be rather monotonous.

Overall, the effectiveness of the programme will primarily depend on its ability to improve on these main indicators over the next four years. Moreover, the data allow measuring several other indicators that will be used to benchmark and explain both the intended and unintended impacts that this programme may generate over time. This holds particularly for outcome indicators like farm practices that greatly impact productivity and consequently, income and food security.

At the moment, improved seed variety use is low, except for tomato and onion, while farmers often adopt practices (e.g. ridging, transplanting, NPK) with only a few implementing the practice according to what is recommended (by EWS-KT) to maximize yield. Together with low yield levels (when compared to other countries), this highlights the

potential positive impact that the HortiNigeria programme can have on the livelihoods of horticulture farmers in Nigeria.

Abbreviations

B2B	Business to business
CBO	Community Based Organisation
EKN	Embassy of the Kingdom of the Netherlands
EWS-KT	East-West Seed Knowledge Transfer
FAO	Food and Agriculture Organisation of the United Nations
GAP	Good Agricultural Practice
IFDC	International Fertiliser Development Centre
IFSM	Integrated Soil Fertility Management
KIT	Royal Tropical Institute
LGA	Local Government Area
MAHFP	Months of Adequate Household Food Provision
MDD-W	Minimum Dietary Diversity for Women
NGO	Non-Governmental Organisation
NPK	Nitrogen, phosphorus, and potassium fertilizer
ODK	Open Data Kit
ToC	Theory of Change
USD	United States Dollar
WUR	Wageningen Centre for Development Innovation

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1 Introduction

This report presents baseline data for the HortiNigeria programme. The data were collected in May 2022 among 2,000 farm-households located in Kano and Kaduna state, with the objective of assessing the performance of smallholding horticulture producers before the implementation of program-interventions.

HortiNigeria is a four-year (2022-2025) program, funded by the Embassy of the Kingdom of the Netherlands (EKN), and implemented by IFDC with the support of EWS-KT, WUR and KIT Royal Tropical Institute. The programme aims to reach and benefit 60,000 farmers within two particularly fragile states of Nigeria: Kano and Kaduna. Target farmers are expected to include some of the poorest, most food insecure and vulnerable in Nigeria. The programme strives to help these farmers improve their horticulture practices in such a way to increase their productivity, income, resilience, food security and nutrition. To do so, the programme provides technical assistance (including innovations) to horticulture farmers in combination with market linkages and access to finance. In addition to this, the programme intends to foster the development of private-sector clusters in 12 LGAs (local government area) within Kano and Kaduna state), as a strategy to promote and facilitate the integration of smallholding farmers into horticulture input-output supply chains.

As such, the key performance indicators presented and described in this report are specifically geared to measure farming practices, production and productivity, revenues and poverty, food security and nutrition, as well as the vulnerability and resilience of farmers, prior to actual programme implementation. Hence, the objective of this report is to provide a baseline assessment of farmers that will allow detecting program-related impacts (at endline).

Given the nature of the program, the main challenge for implementing this baseline study was to identify a sample of otherwise similar and like-minded farmers (comparison group) that will not be part of the programme (and will also not receive support from other initiatives in the area). Non-compliance and motivation bias are known to affect the evaluation of technical agricultural support programmes, where often farmers with specific characteristics (e.g. the poorest) are more likely to participate. As all farmers who are located in a target LGA are eligible to receiving support services from HortiNigeria, the comparison group was sampled from outside the target LGAs. Together with motivation bias, this complicates identifying a similar, like-minded group of farmers that serves as a counterfactual situation. Pre-existing baseline differences between both groups are therefore expected.

The results presented in this report only cover the approximately 1,000 treatment farmers who are located in one of the 12 LGAs in Kano and Kaduna State and consciously signed up for support from the HortiNigeria programme through EWS-KT's extension network. Results on the control group are not presented in the main text (although they are added to the Annex, in which also a comparison with the treatment group is made to assess similarity), as they come from different LGAs, and might therefore distort the findings of the report, which also serve as input to further fine-tune and improve the HortiNigeria programme. Once a second or endline survey of the same 2,000 farm-households will be completed, a comparison of the change that the treatment group and comparison group experienced between baseline and endline will provide the base for measuring impact of HortiNigeria at farmer level.

The next chapter presents the research methods, including the sampling procedure and the KPIs that are part of the baseline survey. In a subsequent chapter, farmer demographics are presented, followed by a chapter on horticulture crops cultivated and (good) agricultural practices (GAPs). A fifth chapter discusses production, land and productivity, and chapter six presents data on farmers' income while also focusing on buyers, price and crop revenue.

Sections on food security and nutrition and analyses on shocks, resilience and vulnerability conclude the baseline report.

As youth and gender form an integral part of the HortiNigeria program, especially with horticulture being a gateway for them to generate an income independently, most of the results are disaggregated by the two characteristics.

2 Research Methods

Baseline data were collected among farmers located across 22 LGAs: 11 LGAs in Kano State and 11 in Kaduna State. These include all 12 LGAs that were pre-identified as target (or treatment) areas for the program, as well as 10 control or comparison LGAs that were not initially targeted by the programme but had somewhat similar agro-ecological conditions and horticulture systems to target or treatment LGAs.

In each LGA, 77 to 109 farm households were surveyed by a team of well-trained Nigerian enumerators through face-to-face and field-based interviews, using a standardized, structured and digitized questionnaire (uploaded on electronic tablets using the ODK survey platform). Useful data were elicited among 1,976 horticulture farmers, equally located in Kano (N=990) State and Kaduna State (N=986).

Farmers from the treatment group were selected only if they were already cultivating horticulture crops prior to the survey. This makes measuring adoption of horticulture crops as a result of HortiNigeria not possible (i.e. potential beneficiaries starting with horticulture cultivation after having received technical support) but has as major advantage that information was elicited at baseline on horticulture KPIs like farm practices, production, yield, and revenues, which can eventually be compared with endline data. In target LGAs, farmers were selected from a sampling frame compiled by EWS-KT. This list included particularly progressive (or key) horticulture producers and their communities (of core farmers), which were deemed to be the most likely candidates to benefit from the HortiNigeria programme. In each LGA, about four communities were randomly sampled at a first sampling stage, after which approximately 20 farmers were randomly selected per community in a second stage. The team of enumerators eventually visited 52 target communities.

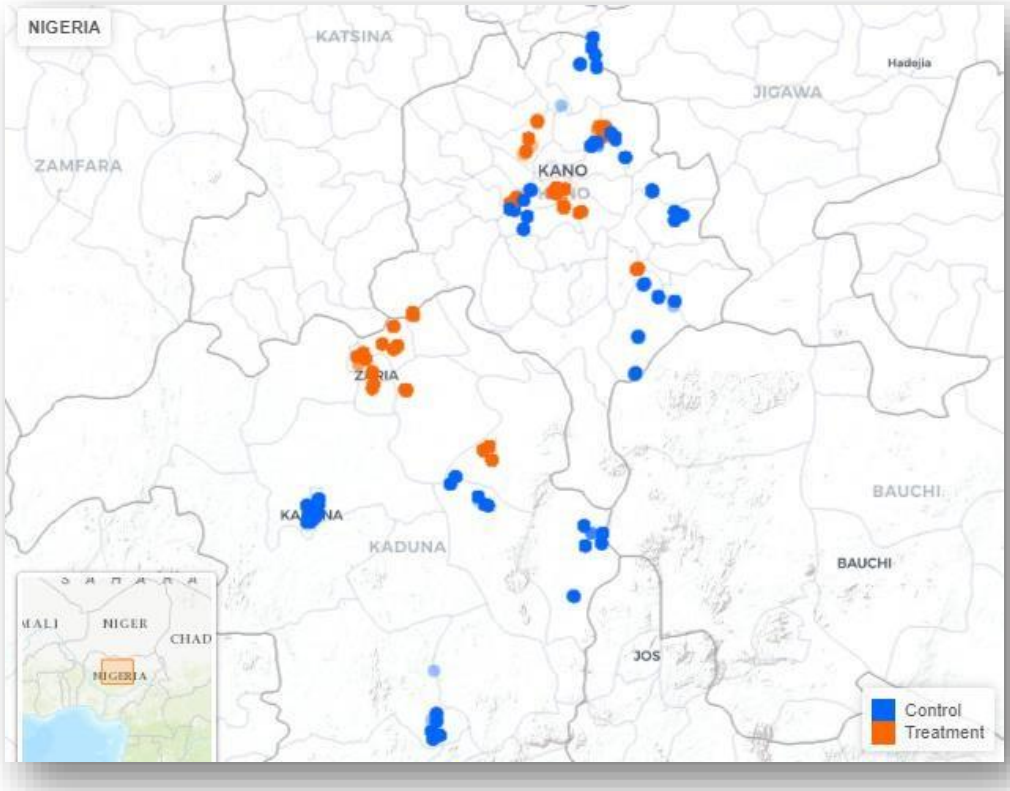
In control LGAs, lists of horticulture producing communities were drafted with the assistance of extension officers. Three selection criteria were relevant: the community needed to have a critical mass of horticulture farmers, needed to have access to water, and needed to produce similar horticulture crops as the target LGAs. Comparison communities were removed from the list if they shared the same market as the target communities, were covered by other agricultural extension programs (e.g. SDGP, 2-SCALE) and/or their region had security issues. In each LGA, about five communities were randomly sampled, leading to 49 comparison communities that the team visited. In a second step, approximately 20 farmers were sampled 'on-the-spot' from lists of horticulture producers provided by local authorities and village chiefs.

As farmers in the treatment communities self-enrolled in the programme, farmers in target and control LGAs might be different in terms of motivation (i.e. not all farmers in the control communities would have participated in HortiNigeria if they were offered the opportunity). This self-enrolment is not random, and therefore expected to introduce a selection bias causing pre-existing differences at baseline (see Annex I for a comparison between treatment and control). This needs to be corrected for with econometric estimation techniques (i.e. matched diff-in-diff) at endline in attempts to estimate the impact of the HortiNigeria programme on horticulture smallholders.

Figure 1 shows the geographical distribution of target and control LGAs, suggesting that spatial differences (that might translate into a different levels of market access, infrastructure, insecurity, weather events, and crop cultivation, amongst other characteristics) may be greater in Kaduna than Kano State. Particularly the regions between the cities Kaduna and Zaria and west of Zaria (southwest of Katsina State) were not selected as comparison communities due to security issues. In contrast, spill-over effects (induced by the programme outside its target areas and especially into control LGAs) may be greater in Kano than Kaduna State as comparison communities and treatment

communities are located closely to one another. Together with self-selection of farmers into HortiNigeria, future impact assessment analyses (at endline) should factor-in spatial differences and potential spill-over effects.

Figure 1. Baseline survey locations



In terms of target horticulture crops, the baseline survey included specific crop-modules on tomato, eggplant, okra, onions, pepper, cucumber, pumpkin, cabbage and watermelon. Each module asked about crop specific farm practices, production, land, quantities sold, price and buyers in the main crop season of 2021, ensuring that crop information relates to a period prior to the start of the HortiNigeria programme. As interviewing farmers on all horticulture crops that they cultivated would make the interview potentially too lengthy, they were asked about the two most important horticulture crops, with *important being defined as most important for income / production or food security*. Farmers did not report eggplants and pumpkin as important crops, which means that the baseline report does not present any descriptives on them.

The remaining seven horticulture crops appear to be unevenly distributed across the 22 LGAs. The number of horticulture crops produced (and considered 'important') in a given LGA can vary from a minimum of three to a maximum of six. Tomatoes, onions and pepper are produced in all 22 LGAs and are the most popular crops, followed by okra in 17 LGAs, cabbage in 12, cucumber in 7, and watermelon in only 3 (all located in Kano State). Nonetheless, these crops appear to be evenly distributed across target and control LGAs (in the sense that all crops are produced in both target and control LGAs, within each State).

Table 1: Baseline sample by LGA and treatment level

LGA	Treatment	N	Most important vegetables (%)
Kaduna State			
Kubau	Treatment	83	Tomato (70%), Okra (8%), Onions (31%), Pepper (23%), Cucumber (6%)

Kudan	Treatment	84	Tomato (75%), Onions (43%), Pepper (17%), Cucumber (6%)
Makarfi	Treatment	81	Tomato (83%), Cabbage (19%), Okra (9%), Onions (21%), Pepper (19%)
Sabon Gari	Treatment	84	Tomato (61%), Cabbage (14%), Okra (17%), Onions (17%), Pepper (14%)
Soba	Treatment	81	Tomato (72%), Okra (11%), Onions (16%), Pepper (40%)
Zaria	Treatment	83	Tomato (41%), Cabbage (28%), Okra (18%), Onions (20%), Pepper (22%), Cucumber (7%)
Jaba	Control	100	Tomato (46%), Okra (27%), Onions (6%), Pepper (41%)
Kaduna North	Control	102	Tomato (39%), Cabbage (34%), Okra (25%), Onions (10%), Pepper (20%)
Kaduna South	Control	79	Tomato (43%), Cabbage (18%), Okra (29%), Onions (10%), Pepper (16%)
Kauru	Control	109	Tomato (61%), Okra (11%), Onions (12%), Pepper (51%)
Lere	Control	100	Tomato (52%), Okra (28%), Onions (12%), Pepper (42%)
Kano State			
Dawakin Kudu	Treatment	91	Tomato (52%), Cabbage (5%), Onions (74%), Pepper (22%)
Dawakin tofa	Treatment	83	Tomato (55%), Cabbage (6%), Okra (11%), Onions (39%), Pepper (42%)
Garko	Treatment	80	Tomato (31%), Cabbage (49%), Okra (10%), Onions (68%), Pepper (8%)
Kumbotso	Treatment	82	Tomato (74%), Cabbage (10%), Onions (29%), Pepper (6%), Cucumber (11%), Watermelon (9%)
Minjibir	Treatment	77	Tomato (47%), Onions (52%), Pepper (42%), Cucumber (6%), Watermelon (14%)
Rimin Gado	Treatment	80	Tomato (35%), Cabbage (22%), Okra (6%), Onions (65%), Pepper (8%), Cucumber (11%)

Danbatta	Control	98	Tomato (61%), Okra (6%), Onions (16%), Pepper (58%), Watermelon (20%)
Gaya	Control	100	Tomato (58%), Onions (30%), Pepper (53%)
Gezawa	Control	99	Tomato (53%), Cabbage (7%), Okra (7%), Onions (48%), Pepper (43%), Cucumber (5%)
Madobi	Control	101	Tomato (41%), Okra (13%), Onions (75%), Pepper (35%)
Sumaila	Control	99	Tomato (41%), Cabbage (5%), Okra (20%), Onions (62%), Pepper (32%)

3 Farmer Demographics

Changes in farm practices and performance that may occur over time will be attributed either to the program's interventions or to pre-existing differences in farmers' demographic and spatial indicators. As such, farmer- and household demographics causing changes in farming practices and performance (i.e. changes that do not result from program's interventions) are important indicators to control for when identifying and attributing the impact of the programme. In addition, an overview of farmers and households' demographics typifies the wider group of horticulture farmers benefitting from HortiNigeria. Information on their characteristics can therefore also help tailor and fine-tune the programme to increase its effectiveness.

The first row of Table 2 shows that 44% of the target farmers is female, while on average, target farmers are 32 years old. 43% of the farmers fall into the youth category. Youth is defined as individuals between the age of 15 and 29, following the official definition provided in the Nigerian National Youth Policy (Federal Republic of Nigeria, 2020). See Figure 2 for the age distribution. It should also be noted that no significant differences are observed in the age and prevalence of youth across male and female farmers, signifying that male and female horticulture farmers are similar age-wise.

Table 2: Gender, youth status and age

	Pooled	Male	Female	Gender difference
Female	44%	n.a.	n.a.	n.a.
Age (in years)	32.38 (10.39)	32.30 (9.71)	32.50 (11.21)	-0.20 (0.67)
Youth (<29 years old)	43%	41%	44%	-3%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate slightly due to rounding of numbers.

Looking closer at State level, Figure 3 reveals that gender and youth are not equally distributed over States. A larger proportion of the target farmers in Kaduna is female (52%) compared to the farmers in Kano (37%).[1] In contrast, a larger proportion of farmers in Kano (45%) is considered youth, compared to the farmers in Kaduna (40%).[2]

52% of the target farmers is not considered the head of the household, although a large statistically significant gender difference is found here. Among the 475 women, only 12% indicates that they are the head of the household, while 88% of men report to be a household head.[3] Among youth, only 28% is head of the household while for non-youth this percentage is 62%. Most farmers that are not a household head relate to the head as their spouse (60% - almost all are women), but oftentimes also as their parent (35% - of which the vast majority is a male/father).

[1] Results from a two sample test of proportions, statistically significant at the 1% level.
[2] Results from a two sample test of proportions, statistically significant at the 10% level.
[3] Results from a two sample test of proportions, statistically significant at the 1% level.

Figure 2: Age distribution

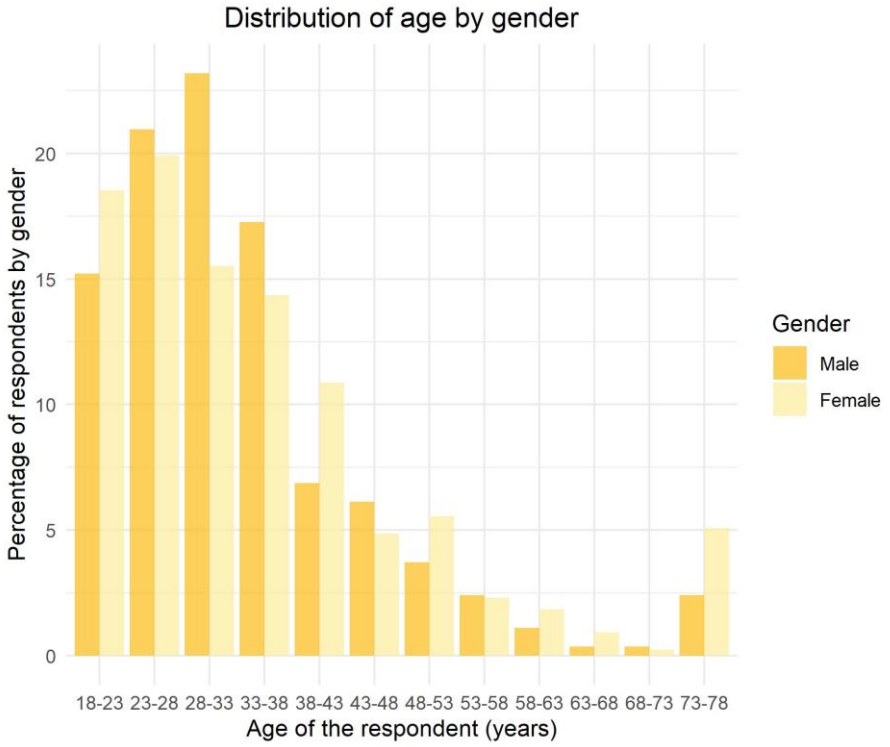


Figure 3: Gender and youth by State

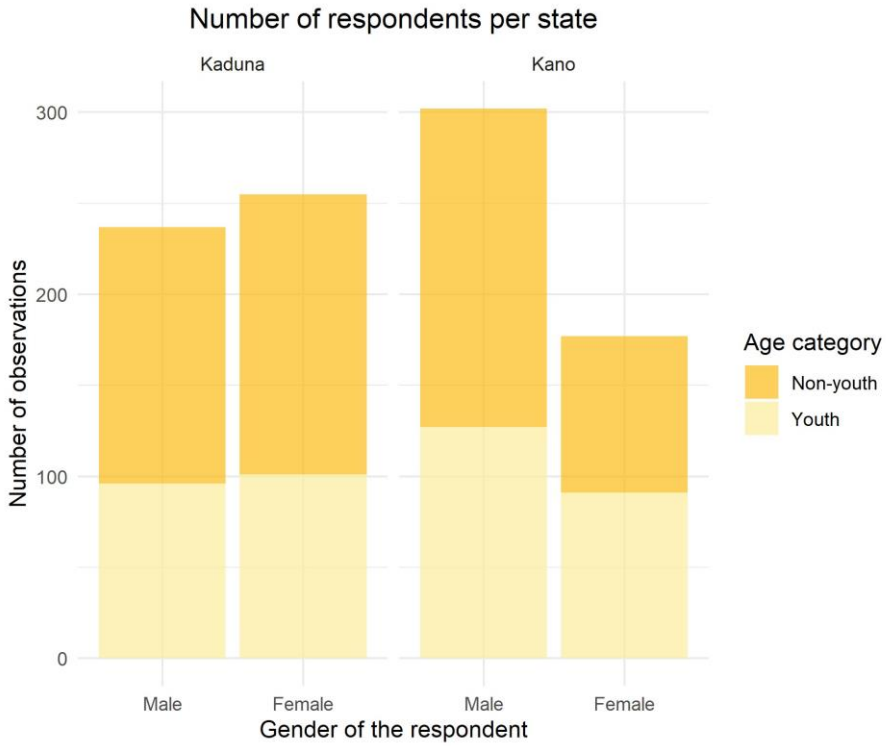


Table 3 indicates that 28% of the target farmers never attended school or only attended Koranic school, while 35% of the sample attended senior secondary school or higher education. Moreover, illiteracy (or the probability to have never attended school) is significantly higher among non-youth and female farmers, who are significantly more likely to attend Koranic than regular schools. In a similar vein, it shows that younger, male

farmers have significantly higher education levels: more than half of them (54%) attended senior secondary school or higher education. In contrast, older female farmers have lower education levels, with 46% of them never attended school or only Koranic school while only 20% attended senior secondary school or higher education.

Table 3: Education levels

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Never attended school	7%	3%	13%	10%***	5%	9%	4%**
Primary school	26%	25%	27%	2%	24%	28%	4%
Junior secondary school	10%	11%	9%	2%	13%	8%	4%**
Senior secondary school	26%	32%	20%	12%	35%	20%	15%
Tertiary education	9%	12%	5%	7%***	8%	9%	2%
Informal Koranic school	21%	17%	26%	9%***	16%	25%	9%***

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate slightly due to rounding of numbers.

The average household of the target farmers comprises of almost nine members, and household size tends to be significantly smaller (eight members on average) when the main farmer is considered a youngster as shown in Table 4. No gender differences are found in household size. Moreover, children (household members under the age of 18) account for 50% of the household members on average, but the households of youth horticulture farmers consists of relatively less children. The dependency ratio of the target farmers is almost 83 on average, which is in line with the Nigerian national dependency ratio of 86 as reported by the World Bank.[4] The dependency ratio is higher among households of nonyouth farmers, which is not surprising as their households consist of relatively more

[4] The dependency ratio is an indicator that reveals the proportion of non-working household members who are depending on members of 'working age; (between 15-65 years old). The indicator is constructed by dividing the number of children below the age of 14 years old and number of elderly of 65 years old or older, by the number of working household members. The Nigerian national average as reported by the World Bank can be found here: https://data.worldbank.org/indicator/SP.POP.DPND?locations=NG

children. No differences are found in the proportion elderly in youth and non-youth households.

Table 4: Household size

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Household size	8.9 (1.49)	9 (5.17)	8.7 (4.39)	0.3 (0.3)	8.3 (4.99)	9.3 (4.68)	1*** (0.3)
% of children	50% (19.81)	51% (19.78)	50% (19.89)	1% (1.28)	46% (19.67)	53% (19.53)	7% (1.28) ***
Dependency ratio	82.2 (69.52)	83.8 (68.33)	80.3 (71.38)	3.5 (4.5)	74.4 (66.81)	87.9 (71.25)	13.5*** (4.5)

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate slightly due to rounding of numbers.

The descriptives presented in Table 5 refer to all of the arable land available to farmers, including horticulture gardens as well as plots cultivated with other (non-horticulture) crops. In particular, it shows that the average farm household cultivates around 1.6 hectares of land, with 50% of the farmers (median) owning less than 1 hectare of land. Farmers own or hold on a more or less permanent basis about 1.1 hectare of land, but 50% of the farmers (median) own even less than 0.8 hectares of land. These findings suggest that farmers need to rent-in or borrow additional land (0.5 hectares on average) to fulfil their agricultural purposes. Table 5 also shows that the amount of land owned and cultivated by women and youth tends to be significantly smaller than that cultivated and owned by older and male farmers; on average, female farmers cultivate their crops on 38% less land than their male peers, while owning almost 46% less land. The boxplots in Figure 4 show the distribution of hectares of land cultivated, and reveal that own a small number of farmers have access to larger land areas, represented by the dots on the right-hand side of the graph.

In terms of land tenure, 82% of the male farmers indicate to own land, while 62% of the female farmers indicate to own at least a part of the land on which they currently cultivate. 80% of those who own land indicate to have inherited land from their family, while 30% purchased the land.

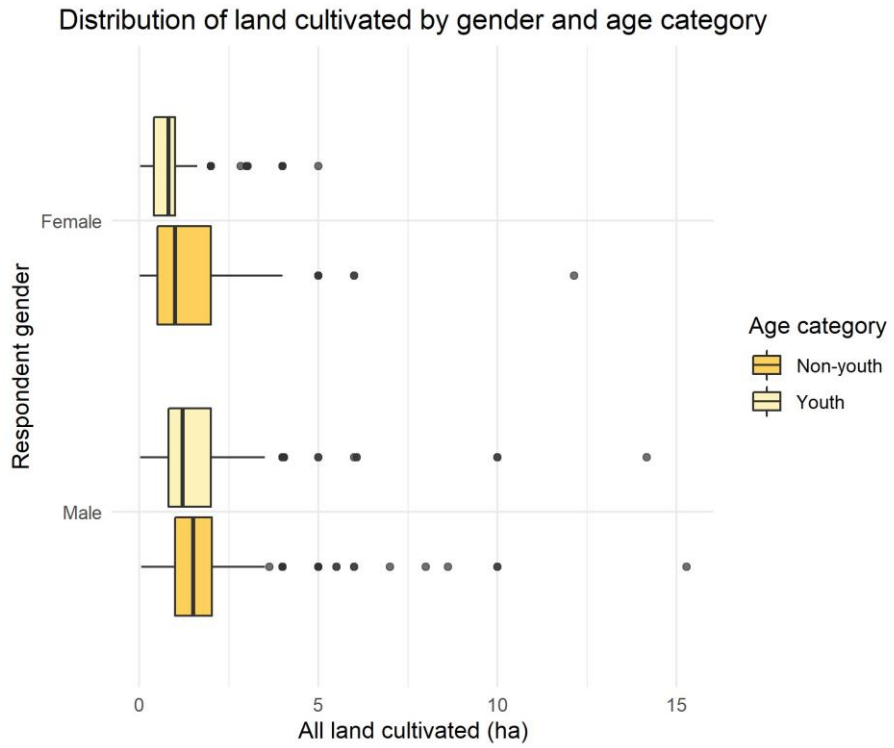
Table 5: Land holdings

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference
Land cultivated (ha)	1.55 (1.48)	1.83 (1.62)	1.14 (1.15)	0.69 (0.10 ***)	1.38 (1.39)	1.68 (1.55)	0.30 (0.10) ***
Land owned (ha)	1.08 (1.57)	1.33 (1.84)	0.72 (0.97)	0.62 (0.10) ***	0.82 (1.03)	1.27 (1.86)	0.45 (0.11) ***

Owns land (%)	74%	82%	62%	21% ***	66%	79%	-13% ***

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Figure 4: Distribution of land cultivated

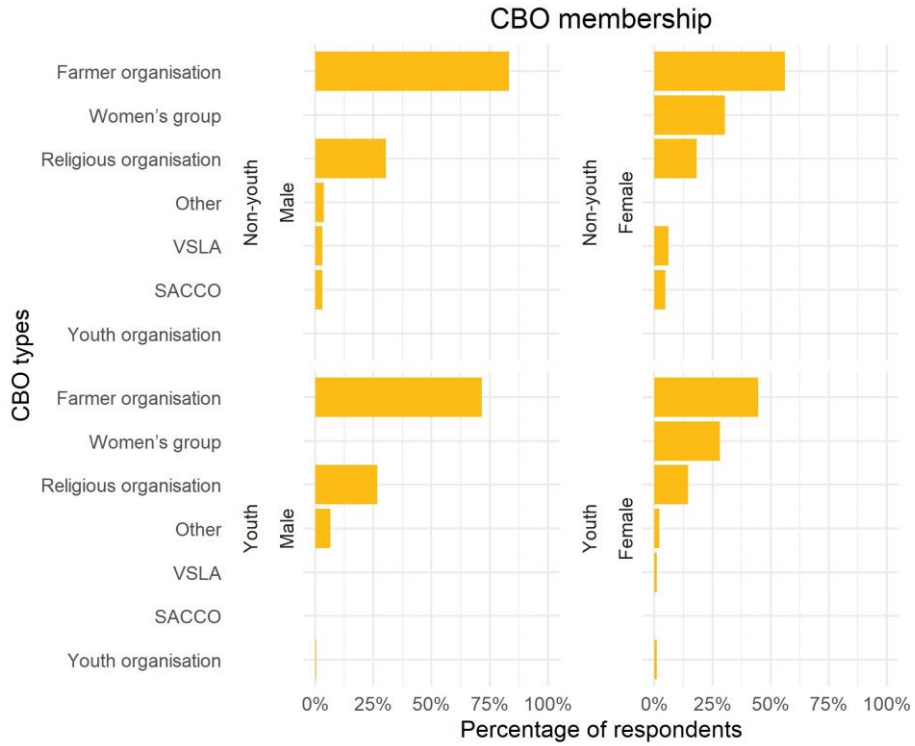


In rural societies, social capital has the potential to provide access to economic resources, knowledge and support (e.g. labour). Among the target farmers, 80% reports membership of a community based organisation (CBO). The most popular type of CBO is the farmer organisation with 66% of the farmers reporting membership, followed by membership of religious organisations (24%). 29% of the female farmers interviewed is member of a women's group, while 1% of the youngsters is member of a youth organisation. Interestingly, only 2% of all farmers is member of a savings and credit cooperative organisation (SACCO) and a village savings and loan association (VSLA), which signifies their limited access to (informal) finance. An overview of CBO membership by gender and youth is presented in Figure 5.

A statistically significantly larger proportion of male farmers report membership of an organisation compared to female farmers, which confirms that female farmers have less social capital than their male peers do.[5] This gender difference is reflected most profoundly in the membership of organisations like the farmer organisation, with 79% of the male farmers and 51% of the female farmers reporting membership. A larger proportion of men (29%) is also member of a religious organisation compared to women (16%).

[5] Results of a two sample test of proportions, statistically significant at the 1% level.

Figure 5: CBO membership

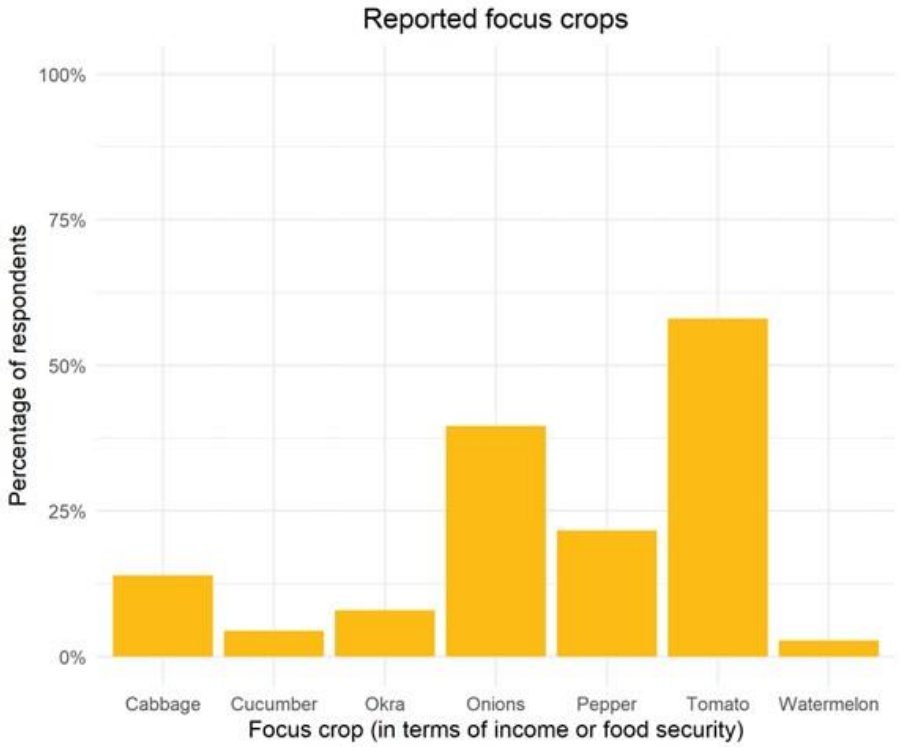


4 Farming Practices

To an extent, farming practices determine a farm's productivity and production. Adopting good agricultural practices can significantly increase horticulture yield levels while maintaining soil fertility using improved seed varieties, recommended planting practices, soil fertility management, pest management and irrigation. This chapter discusses first the proportion of target farmers that cultivate each crop (and which crops are considered as most *important* crops), followed by descriptions of seasonality, intercropping, GAPs, irrigation, and access to and use of extension services and formal financial services.[6]

Table 6 (Panel A) shows that the average farmer produces almost two horticulture crops, and that older (non-youth) and male farmers tend to cultivate significantly more of these crops, which is in line with the earlier finding that they also tend to cultivate more land.[7] In particular, tomatoes are produced by 65% of the farmers, onions by 46%, peppers by 30%, cabbages by 21%, okras by 14%, cucumbers by 10% and watermelons by 6%. Additional horticulture crops include eggplants and pumpkins, which are respectively produced by 2% and 1% of the farmers. Gender differences are found in crop cultivation, with larger proportions of male farmers cultivating tomatoes, onions, peppers and watermelon. Age differences are only found in tomato cultivation, with a larger proportion of older farmers reporting to cultivate the crop.

Figure 6: Reported focus crops



[6] GAPs are presented non-crop specific. However, in order to compute the average, each crop observation will count equally, implying that the GAP adoption averages are not computed taking the average of the average per farmer (if two crops are cultivated).

[7] When adding non-horticulture crops like maize, rice, millet and sorghum, male farmers cultivate on average almost five crops, while female farmers cultivate four crops (two sample t-test, statistically significant difference at the 1% level). Older farmers are more likely to produce more crops than youngsters (4.4 vs. 4.1 crops on average: two sample t-test, statistically significant difference at the 1% level).

Table 6: Vegetable cultivation

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference
PANEL A (horticulture crops produced)							
Tomato	65%	68%	62%	6%**	61%	68%	-8%**
Cabbage	21%	22%	20%	2%	19%	23%	-4%
Eggplant	2%	2%	1%	1%	1%	2%	-1%
Okra	14%	13%	14%	-2%	12%	14%	-2%
Onion	46%	54%	36%	18%***	45%	45%	1%
Pepper	30%	36%	21%	15%***	28%	31%	4%
Cucumber	10%	10%	10%	0%	10%	10%	0%
Pumpkin	1%	1%	0%	1%	1%	1%	0%
Watermelon	6%	8%	4%	4%***	6%	6%	0%
Total horticulture crops cultivated	1.9	2.1	1.7	0.4***	1.8	2.0	-0.2***
PANEL B (Most important horticulture crops)[a]							
Tomato	58%	58%	58%	0%	55%	60%	-6%*
Cabbage	14%	14%	14%	0%	13%	15%	-1%
Eggplant	0%	0%	0%	0%	0%	0%	0%
Okra	8%	7%	10%	-3%*	7%	8%	-1%
Onion	40%	46%	32%	13%***	41%	38%	3%

Pepper	22%	26%	16%	10%***	21%	22%	-1%
Cucumber	4%	4%	5%	-1%	5%	4%	1%
Pumpkin	0%	0%	0%	0%	0%	0%	0%
Watermelon	3%	4%	1%	2%**	4%	2%	2%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers. [a] Maximum of two crops, with importance being defined in terms of quantity/income or food security.

Table 6 (Panel B) provides a similar analysis of available data for the target farmers, but limits crop cultivation to only the horticulture crops that are reported as most important crops in terms of production quantity/income or food security. The results in Panel B demonstrate that for almost no farmers, eggplants and pumpkins were an important key horticulture crop. Consequently, further descriptives and analyses on these two crops have been left out in the remainder of the report. For more than half of the farmers (58%), tomato is an important crop, followed by onion (46%) and pepper (22%). Interestingly, the gender difference found in the cultivation of tomato has disappeared when focusing on most important crops only, although the differences between male and female farmers on onion, pepper and watermelon remain. As male farmers cultivate a larger number of horticulture crops, they can potentially also identify more crops as important compared to female farmers.

Next to horticulture crops, the largest proportions of farmers report to cultivate staple crops like maize (80%), rice (43%) and millet (27%) (not included in Table 6). In combination with horticulture crops, our results show that maize correlates positively with tomato and pepper, meaning that tomato and pepper farmers are more likely to also cultivate maize, possibly through intercropping.

When assessing the combination of cultivating multiple horticulture crops, we find a positive correlation between onion and other vegetables, except for okra. The proportions are the highest for onion-tomato (28%), onion-pepper (15%) and onion-cabbage (11%), which shows that onion farmers often cultivated another vegetable horticulture crop, or onion is often cultivated as additional (secondary) horticulture crop. Except for tomato, the cultivation of all other horticulture crops has a negative correlation with one another, meaning that farmers are less likely to cultivate okra, watermelon, cabbage, pepper and/or cucumber simultaneously.

Figure 7: Most popular cropping season

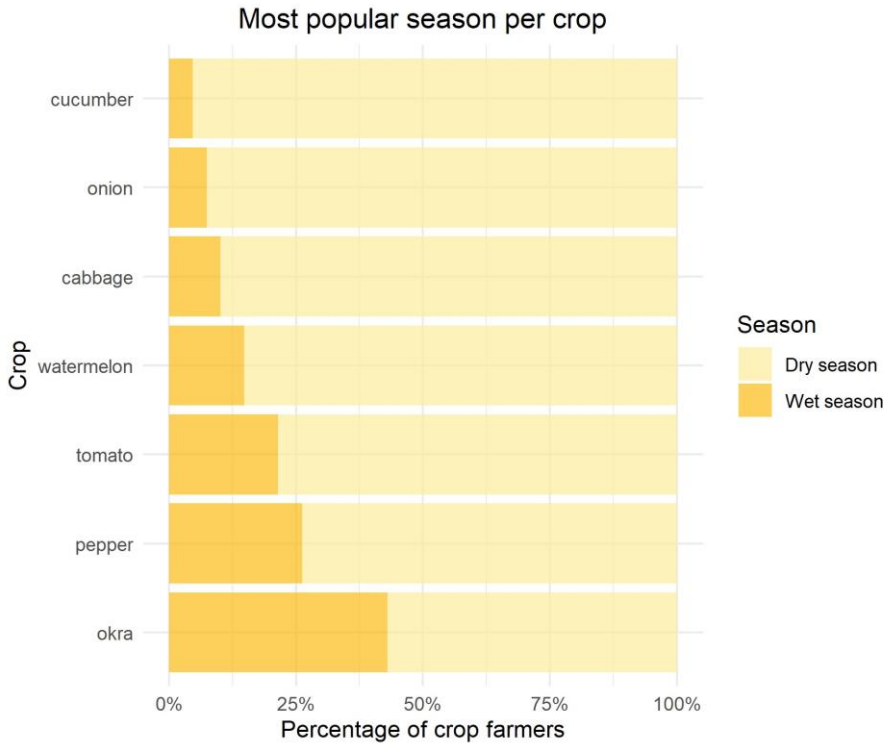


Figure 7 shows that the vast majority of farmers report to cultivate tomato, onion, pepper, cabbage cucumber and watermelon in the dry season. The only exception is the cultivation of okra, which farmers report to cultivate equally in both the rainy and dry season. In summary, this signifies that farmers cultivate horticulture only in one crop season, which could be extended to all year round with relevant knowledge and practices. The focus on the dry season can also affect crop prices, as produce enters the market at the same time, making timing of production also an important instrument to increase crop revenue.

Intercropping

As stated earlier, 80% of the farmers report to cultivate maize next to horticulture crops, while some farmers also produce rice (43%), sorghum (31%), millet (27%), cowpea (17%) and groundnut (17%). However, intercropping with horticulture crops is done by only 29% of the farmers, on only 29% of their horticulture land. Male farmers are more likely to intercrop than female farmers, which is in line with the finding that they also cultivate more (horti- and non-horticulture) crops. No age differences were found in intercropping. The crop with which horticulture is intercropped the most is maize.

Table 7: Intercropping

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Intercropping (no/yes)	29%	38%	18%	20% ***	30%	28%	1.5%
Horticulture land intercropped (%)	29.96 (23.07)	28.19 (22.75)	30.98 (23.91)	-2.79 (3.09)	30.82 (23.10)	27.66 (22.16)	3.16 (2.82)

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Seed variety use

As demonstrated in Table 8, horticulture crops are mainly planted as seedlings, except for okra. Consequently, only few farmers recycle seed for direct planting or acquire new seed. Nonetheless, it can be concluded that recycling is common practice among horticulture farmers through the use of seedlings. Seedling proportions for cucumber and watermelon are not reported in Table 8, as only 44 farmers report to cultivate cucumber as important crop and 27 farmers cultivate watermelon as important crop. In the remainder of the report, descriptives on crop specific practices, production, yield, land and revenues will not be provided for these two crops due to the low number of observations, making them sensitive to outliers and limiting their external validity.

The sub-share that did use newly acquired seeds, most often used seeds that were bought at the market (53% - tomato, 46% - cabbage, 64% - okra, 55% - onion, 44% - pepper). Other channels for acquiring seeds were mainly informal (farmers acquired seeds through acquaintances), followed by input traders (24% - tomato, 34% - cabbage, 7% - okra, 12% - onion, 34% - pepper).

Table 8: Seedling use

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Seedlings: tomato	81%	80%	82%	-1%	78%	82%	-4%
Seedlings: cabbage	75%	83%	66%	17%**	84%	69%	15% *
Seedlings: okra	14%	17%	10%	7%	20%	11%	9%
Seedlings: onion	79%	79%	79%	0%	79%	78%	1%
Seedlings: pepper	74%	78%	66%	12% *	67%	80%	-13% **

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

The use of a seedling nursery is a recommended farm practice for tomato, cabbage and pepper, but not for okra and onion. Table 9 shows that out of the farmers who cultivate one of these three crops, 82% uses a nursery to grow their seedlings. The adoption of an improved nursery, defined as a nursery with shade and raised beds for better soil aeration and water drainage, is done by 72% of the target sample, although a smaller proportion of male farmers uses an improved nursery compared to female farmers. Improved nurseries are also used more by older farmers.

Onion farmers are advised to grow the seedlings in seedbeds rather than nurseries. Seedbeds are raised but not lifted from the soil, other from the recommended nurseries. The seedlings are covered from the sun until emergence, after which they continue to be covered only during the hottest moments of the day. Of the interviewed onion farmers, 64% indicates to use such seedbeds – no significant differences are found between men and women or youth and non-youth.

Table 9: Seedling production

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference
Use of nursery[1]	82%	85%	80%	-5%	79%	85%	6%
Use of improved nursery[2]	72%	67%	77%	9%*	63%	77%	-14%***

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers. [1] Only crops for which nursery use is a recommended practice (not okra and onion). [2] Of those farmers who used a nursery

Table 10 shows that the use of hybrid varieties and OPVs is limited for horticulture crops, except for tomato and cabbage where 75% and 55%, respectively, uses an improved variety. For the other crops, the vast majority of the farmers use a local variety or does not know what kind of variety they use. Large gender differences are found in tomato seed use, with a lower proportion of women using OPVs for tomato and cabbage. Gender differences in hybrid seed variety use are only found in pepper and tomato cultivation, where larger proportions of women report their use. For all horticulture crops, 99% of the households indicate that they are able to cultivate their preferred variety, which is remarkable, as many farmers do not know which variety they cultivate.

Table 10: Seed variety use

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Tomato							
Hybrid	14%	12%	17%	5%*	18%	12%	6%*
OPV	61%	67%	53%	14%***	56%	64%	8%*
Local variety	6%	7%	5%	2%	7%	6%	1%
Do not know	19%	14%	25%	11%***	19%	18%	1%
Cabbage							
Hybrid	26%	23%	29%	6%	25%	26%	0%
OPV	29%	45%	11%	33%***	22%	35%	13%
Local variety	3%	4%	2%	2%	4%	2%	1%
Do not know	42%	28%	58%	30%***	49%	37%	12%
Okra							
Hybrid	8%	11%	5%	6%	3%	11%	7%
OPV	13%	19%	7%	12%	10%	15%	5%

Local variety	23%	28%	20%	8%	23%	23%	0%
Do not know	56%	42%	68%	27%**	63%	51%	12%
Onion							
Hybrid	5%	5%	5%	1%	2%	7%	5%**
OPV	12%	14%	9%	6%	11%	13%	2%
Local variety	34%	33%	36%	3%	38%	31%	7%
Do not know	49%	48%	50%	2%	49%	49%	1%
Pepper							
Hybrid	9%	5%	15%	10%**	8%	9%	1%
OPV	4%	3%	6%	3%	6%	2%	3%
Local variety	34%	35%	31%	4%	32%	35%	3%
Do not know	54%	57%	48%	9%	55%	53%	1%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Land preparation and planting

The next stage of the crop cultivation cycle is land preparation and (trans)planting. The results in Table 11 illustrate that slightly over half of the target farmers apply mulch to their land, while also half of the farmers prepares ridges before planting. Gender differences are found in mulching and ridging, with larger proportions of female farmers applying both practices. Of the farmers that apply mulch, 99% indicate that the mulch is organic. This number is the same across gender and age groups.

Table :

HortiNigeria prescribes specific guidelines for ridging.[8] Beds are advised to be thirty centimetres high in the wet season and twenty centimetres high in the dry season. The width of the individual beds should be one meter, whereas the path in between the beds should be no wider than fifty centimetres as to support irrigation and drainage. Those recommended ridging practices are universal across the focus crops. Although the majority of the respondents indicates to ridge, no more than 1% of the target farmers applies ridging according to the recommended guidelines. Also, only 1% of the target farmers applies the recommended fertilizer, being NPK and Urea, before (trans)planting.

11 Land preparation practices

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference
Mulch application[1]	52%	49%	55%	-6%*	52%	51%	0%
Ridging	48%	45%	52%	-7%***	45%	50%	-5%*
Applies fertilizer before (trans)planting	1%	1%	1%	0%	1%	1%	0%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers. [1] For onion, mulching is not a recommended practice, so values are made missing. [1]Onion is excluded since mulching is not recommended

The next set of recommendations refers to the practices around sowing or (trans)planting the vegetables into the field. HortiNigeria recommends spacing the seeds or seedlings fifty centimetres apart for all vegetables except onion and okra, which are supposed to be ten and 75 centimetres apart respectively. Comparing the actual implemented spacing to the crop specific recommended spacing shows that a mere 11% of the target farmers complies, with little difference between gender or age group. Highest levels of compliance are found among cucumber (26%) and onion (19%) farmers. Lowest levels of compliance are found among okra (3%) and tomato farmers (9%).

Of those farmers who sow their seeds directly into the field, 62% of the farmers do line planting. Note that direct sowing is only recommended for okra and watermelon (although

[8] Not necessarily HortiNigeria, but EWS-KT through their technical assistance. This holds for all the 'recommended' practices mentioned in this chapter.

seedlings for the latter may also be produced using nurseries). Looking at sowing methods for only these two crops, usage of line planting decreases even slightly to 60%.

The HortiNigeria programme prescribes various best sowing practices, albeit only for crops for which direct sowing is recommended. For okra and watermelon two seeds per hole are advised to be planted two centimetres into the ground. Farmers should thin their seedlings when they have reached a height of ten centimetres. None of the farmers currently applies all these planting practices. Specifically, thinning appears to be the major limitation for farmers to compliance, as many farmers do not apply thinning at all, or thin too early (typically when the seedling is only five centimetres tall).

Vegetables grown in a nursery (tomato, cabbage, pepper watermelon and cucumber) or in a seedbed (onion) need to be transplanted into the field. For watermelon and cucumber, this is supposed to happen after eight to ten days, for cabbage after 14 to 21 days, for tomato after 21 to 28 days, for pepper after 25 to 28 days, and for onion after 35 to 45 days. Of the target farmers, 41% currently transplants the seedlings at the recommended timing, although this indicator is potentially subject to recall bias. Likely, farmers transplant their seedlings when the plants reach a certain height or stage of germination rather than after a predetermined number of days, and might therefore not remember precisely how many days had passed before transplanting.

Table :
12 (Trans)planting practices

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference
Use recommended spacing	11%	12%	11%	1%	10%	13%	3%
Line planting (direct sowing)	62%	59%	65%	6%	57%	66%	8%
Applies recommended planting practices	0%	0%	0%	0%	0%	0%	0%
Transplanting at recommended timing	41%	41%	40%	1%	43%	39%	4%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Use of fertilizer for the production of vegetable crops is extremely common in the target population of HortiNigeria. Almost 100% of the respondents indicate to have used fertilizer in the relevant planting season of 2021 for their focus crops – all but three okra farmers and two onion farmers.

The most popular fertilizer type is NPK (specifically of the 15:15:15 blend, also recommended in the HortiNigeria programme for all vegetables). 93% of the pooled farmers applies NPK. Whilst women are significantly less likely to do so, the application rate among the subgroup is still high at 90%. The second most popular fertilizer is Urea, again also recommended in the HortiNigeria program, although at a pooled application rate of 79% slightly less popular than NPK. Again, women are significantly less likely to apply the fertilizer type at 74% against 83% amongst men. Noteworthy however is the underutilization of the third fertilizer recommended by the HortiNigeria program, potassium (in a 0:0:60 blend), which is applied by none of the target farmers.

HortiNigeria recommends the use of each fertilizer at set moments and quantities, specified per crop. In this analysis, we use the frequency of fertilizer application as a proxy for each of those measures, and compared it to the frequency recommended by HortiNigeria. In this analysis, application frequency is allowed to deviate 20% maximum from the recommended frequency to still be considered on target. NPK is applied at the recommended frequency in 10% of the cases, where youth is slightly more likely to apply according to the recommendations then non-youth. Urea (which is normally recommended to be applied less often, in many cases only once) is applied according to recommendations in 25% of the cases. All this suggest that there is room for improvement among the target farmers in their application practices, even when application of NPK and urea is high.

Table

13 Fertilizer application and soil fertility

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference
Application of NPK	93%	95%	90%	5%***	93%	93%	0%
Application of NPK at recommended frequency	10%	10%	9%	1%	12%	9%	3%*
Application of Urea	79%	83%	74%	9%***	81%	78%	2%
Application of Urea at recommended frequency	25%	26%	25%	1%	23%	27%	4%
Application of Potassium	0%	0%	0%	0%	0%	0%	0%
Application of Potassium at recommended frequency	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Integrated Soil Fertility Management	29%	30%	28%	2%	27%	31%	4%*
Soil fertility test	7%	7%	7%	0%	7%	7%	0%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers. A 20% deviation from the recommended frequency of fertilizer application is still considered within the recommended frequency bandwidth.

Integrated soil fertility management (ISFM) is a blended approach to maintain soil fertility, assuming that neither organic- and inorganic fertilizer and planting material in itself is sufficient for long-term soil health. In this baseline study, ISFM is defined as combining improved seeds, organic fertilizer and inorganic fertilizer in the cultivation cycle. [9] 29% of the target population applies ISFM practices, non-youth being slightly more likely to do so than youth.

The ease of compliance to fertilizer recommendations depends on the crops. For example, pepper requires NPK fertilizer application at seven distinct moments in the planting cycle,

[9] Vanlauwe, B., Bationo, A., Chianu, J., Giller, K. E., Merckx, R., Mokwunye, U., Ohiokpehai, O., Pypers, P. Tabo, R., Shepherd, K., Smaling, E., Woomer, P. & Sanginga, N. (2010).

Table :

whereas for onion only one moment of application suffices. Therefore, any (lack of) differences in compliance between gender and age groups might be a result of the difference in crop preference. Table 14 shows the prevalence of compliance to frequency recommendations per crop, for NPK and urea. Compliance is most prevalent for cabbage, onion and watermelon, for both types of fertilizer. Table 6 in the previous section showed that onion and watermelon are disproportionally often cultivated by men, suggesting that women cultivate more 'complicated' crops, whilst scoring similar on compliance indicators. Indeed, NPK and urea are recommended to be applied once for onion cultivation, and twice for watermelon (after transplanting), indicating that these recommendations are relatively easier to comply to. Men are also overrepresented in the group of pepper farmers, which has perhaps the most extensive fertilizer schedule and lowers compliance rates.

14: Fertilizer recommendations' compliance by crop

	cabbage	cucumber	okra	onion	pepper	tomato	watermelon
NPK frequency compliance	13%	n.a.	7%	26%	1%	3%	23%
Urea frequency compliance	44%	41%	30%	43%	7%	15%	26%

Crop protection

Finally, there are conservation practices with regard to crop management. These include intercropping (the cultivation of two crops, usually cereals and legumes, in the same field) and crop rotation (cultivation of different crops between cropping cycles). Table 7 already provided that 29% of the target population applies intercropping, men being far more likely to intercrop than women are. Table 15 adds that crop rotation is the more popular crop management practice, with on average 81% of the crops being grown on fields where frequently other crops are grown. Again, male farmers are far more likely to apply this practice than female farmers.

Application of agro-chemicals is common. Insecticides are used for 85% of the crops, with non-youth being more likely to do so than youth; herbicides are used for 60% of the crops (women being more likely to do so than men); and fungicides are used for 43% of the crops (again, youth being less likely to do so). HortiNigeria recommends the use of protective gear whilst applying agro-chemicals, in order to protect the eyes, respiratory tract and bare skin. This is common practice already among the target population: 78% reports to use relevant gear at agro-chemical application.

In addition to high application rates of herbicides, respondents overwhelmingly indicate to apply weeding to control undesired vegetation and boost plant growth. 96% indicates to apply weeding throughout the planting cycle, female farmers being more likely to do so than male farmers.

Table 15: Crop protection

	Pooled	Male	Female	Gender difference	Youth	Nonyouth	Youth difference

Table

Insecticides	85%	86%	85%	1%	83%	87%	-5%**
Herbicides	60%	56%	64%	-8%***	61%	59%	-2%
Fungicides	43%	43%	44%	-1%	39%	46%	-7%***
Protective gear (for agrochemicals)	78%	76%	81%	-5%*	78%	78%	0%
Weeding	96%	95%	97%	-2%*	96%	96%	0%
Crop rotation	81%	85%	75%	11%***	82%	81%	1%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers. Only crops for which the soil fertility

practices are recommended are included in the table. Integrated soil fertility management (ISFM) is defined as combining inorganic fertilizer use, organic fertilizer use, and improved seed variety use.

Irrigation

The HortiNigeria programme does not prescribe any explicit recommendations for the use of irrigation systems. However, the type of irrigation used may give an indication for potential investment opportunities to upscale production under component three of the programme.

18% of the target population has no access to any form of irrigation and solely relies on rainfall, making it vulnerable to irregular or insufficient rainfall – especially since all crops but okra are mainly cultivated in the dry season. Female farmers are significantly more likely to depend solely on rainfall than male farmers are.

Of the various irrigation systems, engine driven pumps are the most common together with the use of floods and basins, followed by the use of furrows. Men are more likely to have such irrigation systems at their disposal than women, who are more likely to irrigate the field manually.

Table 16: Irrigation types

	Pooled	Male	Female	Difference	Youth	Nonyouth	Difference
Drip	6%	6%	7%	1%	5%	7%	1%
Furrow	25%	28%	21%	8%***	25%	25%	0%
Flood/basin	33%	34%	30%	4%	34%	30%	5%*
Rain fed / no access to irrigation	18%	15%	21%	6%***	17%	18%	1%
Pouring water by hand	4%	1%	8%	6%***	3%	5%	1%
Water hose	22%	22%	23%	1%	22%	23%	1%
Sprinkler	1%	0%	2%	2%***	1%	1%	0%
Electric or diesel pump	33%	35%	29%	6%**	32%	33%	1%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level;

*** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Extension- and formal financial services

Through its first component, HortiNigeria offers technical assistance, building the capacity of vegetable farmers and knowledge dissemination through key farmers to core- and neighbouring farmers. Table 17 displays what the extension intervention landscape looks like.

Although estimations of the ratio of extension workers to farmers vary with the definition of the former, the Africa Seed Access Index estimates that in Nigeria one extension worker is employer per 7,500 farmers, among the lowest on the continent. As such, it may come as no surprise that the majority of the target farmers had not even met an extension worker in 2021. The 38% of the target respondents that did meet an extension officer were evenly distributed across gender and age groups.
Of the official extension service providers, the government is the most dominant. 32% of the participants who did meet with an extension officer in 2021 indicated that the agent was government employed. Second most prevalent type of official extension service provider are NGO's, at 24% of the reported service providers. Interestingly, government- and NGO led extension services are not very successful at reaching women and youth. Informal networks appear to be far more successful in doing so, specifically through leadfarmer structures.

The average reported distance to input suppliers is low at just over 30 minutes. This intricate network of agro-dealers might be one of the drivers among high prevalence of fertilizer- and agrochemical use. Financial inputs appear to be far less accessible, especially to women. Only 26% of that group indicates to have a bank account, far less than the 45% of men who reported the same. A similar contrast in access surfaces comparing youth and non-youth among the respondents, of whom 30% versus 42% report to have a bank account. The lack in access to formal financial services is further echoed in the limited number of respondents who took out a formal loan to finance agricultural activities. Only 10% of all participants have done so, women significantly less often than men.

Table 17: Access to extension services and formal financial services

	Pooled	Male	Female	Difference	Youth	Nonyouth	Difference
Visit from extension officer	38%	38%	38%	0%	37%	39%	0%
Government	32%	38%	26%	12%**	26%	38%	12%**
Company	15%	17%	12%	5%	18%	13%	5%
NGO	24%	26%	23%	3%	25%	24%	1%
Key/lead farmer in community	55%	50%	62%	12%**	56%	54%	2%
Cooperative	5%	5%	4%	1%	4%	5%	2%
VBA (village-based advisor)	8%	7%	10%	4%	9%	8%	0%

Number of visits	2.5 (3.01)	2.3 (1.42)	2.8 (4.24)	0.5 (0.3)	2.4 (2.53)	2.7 (3.34)	0.3 (0.3)
Received promotional seed pack	14%	12%	17%	5%**	13%	15%	2%
Distance to input supplier (min)	31.86 (27.48)	30.93 (28.36)	32.98 (26.36)	2.05 (1.81)	32.18 (26.46)	31.72 (28.30)	0.46 (1.83)
Logbook use	12%	12%	12%	0%	11%	13%	2%
Has bank account	37%	45%	26%	19%***	30%	42%	12%***
Took out a formal loan for agricultural purpose	10%	13%	7%	6%***	9%	11%	3%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

5 Production & Productivity

Table 18 presents descriptives on land under cultivation, the average production and the average yields for each horticulture crop separately for the main cropping season.[10] It should be noted that horticulture farmers have small plots of land on which they cultivate, compared to the plots of land for staple crop cultivation. In combination with a recall method, these small land sizes increase the probability and size of measurement bias, especially when farmers do not accurately know the size of their land and estimate their land in steps or m^2. Although all values in land area, production and yield have been checked on outliers (also in combination to one another (e.g. small land size but unrealistic yield levels means that the observation for land is considered erroneous), the averages presented in this chapter are still estimations of true values and should be treated as such. Moreover, as the data will show, variety in production and yield - and later in income - will be large (mean-SD ratio of 1:1 or more). That also means that large, observed differences between gender and youth categories will not always be marked as statistically significant.

Starting with tomato as most popular horticulture crop among target farmers, farmers cultivate tomato on 0.5 hectare on average. The plots on which female farmers cultivate tomatoes are a third smaller than the plots of male farmers. The average production per farmer was 2,449 kilograms of tomatoes. This value is subject to a large standard deviation (resulting from very high production values up to 23,920 kg). Since these values were generally reported for large land areas (resulting in reasonable yields), they are not expected to be outlier values and are therefore included in the analysis. To help interpret production data better due to the large variation in the sample, the median tomato production is also reported on. The median production is 1,520 kg. Average tomato yield is 6,486 kg/ha (with a median value of 3,900 kg/ha).[11]

Male- and female farmers cultivate tomatoes on significantly different land areas, and as a result, the tomato production of male farmers is on average 874 kg higher than the production of female farmers. These differences in land and production do not to translate in a statistically significant difference in yield levels.

Similar to tomatoes, cabbage is cultivated on half a hectare of land. No gender differences and youth differences are found in the land area used for cabbage cultivation. The average production of cabbage is estimated at 2,666 kg (median value of 2,000 kg), with a large significant difference between male and female farmers. In addition, older farmers produce significantly more cabbage than the youth cohort does. Cabbage yield is on average 6,962 kg/ha (median value of 5,000 kg/ha), and the earlier found difference in production while cultivating on the same amount of land translates into a large gender yield gap of more than 4194 kg/ha: the yield of female farmers is on average almost half of the yield of male farmers.

[10] Please note that very few farmers cultivate the horticulture crop in a second crop season.

[11] To remove outliers in yield, values that are five times the interquartile range to the 3rd and 1st quartile are removed from the dataset. For example, tomato yields will still go up to 47,840 kg/ha, which seems highly unlikely. Nevertheless, it was decided to use a very conservative cut-off point (five*IQR) and to report on these values in order to prevent data mining.

_____

Table 18: Plots, production and productivity

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Tomato							
Land under cultivation (ha)	0.53 (0.45)	0.62 (0.50)	0.42 (0.36)	0.20 (0.04) ***	0.50 (0.46)	0.56 (0.45)	-0.06 (0.04)
Production (kg)	2448.89 (2924.51)	2834.85 (3320.36)	1960.95 (2245.42)	873.90 (264.57) ***	1921.16 (2279.22)	2854.39 (3287.21)	-933 (269.95) ***
Yield (kg/ha)	6485.54 (7430.81)	6601.84 (7959.97)	6345.14 (6723.01)	256.69 (686.46)	5995.79 (6927.14)	6908.67 (7842.61)	-912.88 (699.27)
Cabbage							
Land under cultivation (ha)	0.55 (0.54)	0.61 (0.64)	0.47 (0.40)	0.14 (0.09)	0.46 (0.37)	0.60 (0.63)	-0.14 (0.10)
Production (kg)	2996.17 (3515.90)	3972.65 (4111.43)	1564.00 (1550.60)	2408.65 (624.66) ***	2292.26 (3124.39)	3492.54 (3722.98)	-1200.28 (689.97) *

Yield (kg/ha)	6951.90 (7232.14)	8683.47 (8427.36)	4489.21 (4016.21)	4194.25 (1354.12) ***	6229.16 (8204.71)	7544.83 (6639.14)	-1315.66 (1446.72)
Okra							
Land under cultivation (ha)	0.41 (0.31)	0.53 (0.34)	0.31 (0.24)	0.22 (0.07) ***	0.31 (0.25)	0.48 (0.33)	-0.17 (0.07) **

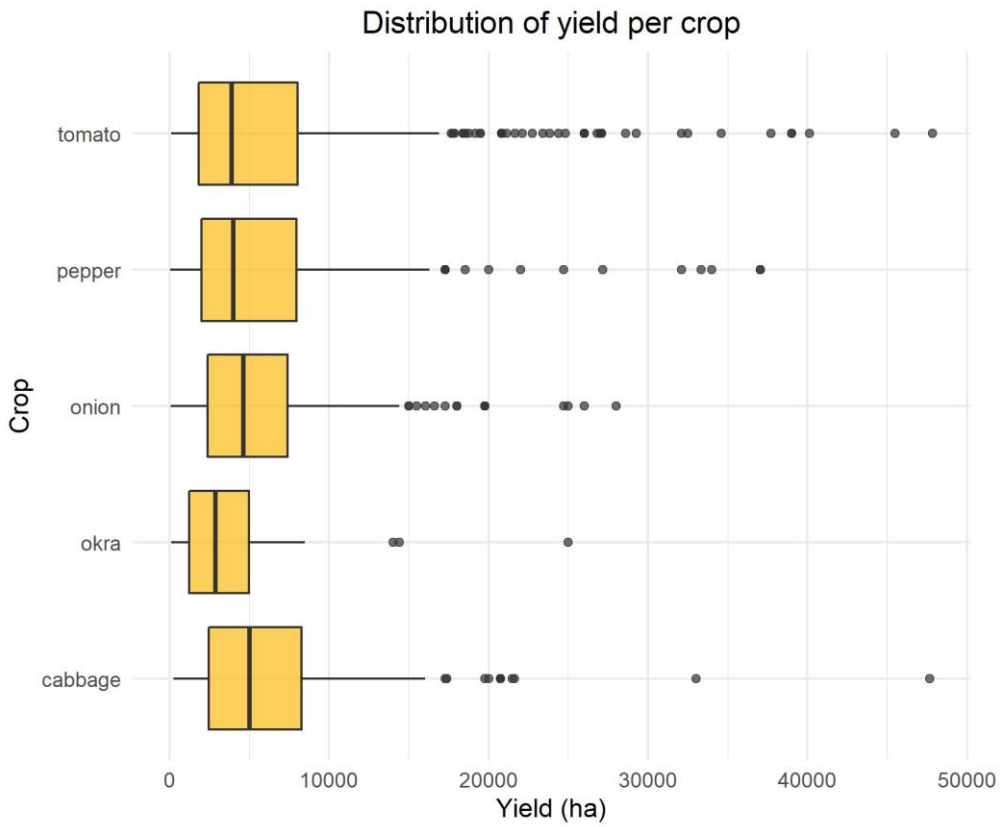
Production (kg)	1328.28 (1519.10)	1718.06 (1788.01)	937.50 (1131.64)	780.56 (375.74) **	755.58 (576.84)	1762.57 (1827.03)	-1006.99 (371.41) ***
Yield (kg/ha)	3751.41 (4006.14)	4390.66 (4847.64)	3030.61 (2930.72)	1360.05 (1005.58)	4292.26 (5296.80)	3440.31 (2848.01)	851.94 (1032.72)
Onion							
Land under cultivation (ha)	0.54 (0.41)	0.60 (0.44)	0.44 (0.32)	0.16 (0.04) ***	0.47 (0.38)	0.60 (0.43)	-0.13 (0.04) ***
Production (kg)	2569.74 (2392.16)	2978.22 (2609.07)	1793.31 (1665.04)	1184.91 (261.45) ***	1909.80 (1725.29)	3106.84 (2704.90)	-1197 (253.25) ***
Yield (kg/ha)	5433.24 (4396.95)	5837.39 (4671.16)	4675.87 (3732.54)	1161.52 (495.91) **	4781.45 (3586.17)	6049.00 (4955.51)	-1267.55 (484.91) ***

Pepper							
Land under cultivation (ha)	0.56 (0.45)	0.62 (0.47)	0.45 (0.39)	0.16 (0.07) **	0.52 (0.42)	0.59 (0.47)	-0.07 (0.06)
Production (kg)	3278.42 (5610.53)	4108.26 (6652.10)	1792.23 (2360.54)	2316.03 (854.09) ***	2812.95 (3422.16)	3576.93 (6712.48)	-763.98 (851.77)
Yield (kg/ha)	6281.45 (6924.38)	6925.09 (7435.74)	5122.21 (5829.31)	1802.88 (1084.70) *	7374.50 (8430.29)	5564.26 (5663.75)	1810.24 (1061.90) *

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Okra is produced on smaller plots than tomato or cabbage, with 0.4 hectare of land on average. Again, male okra farmers have significantly larger plots of land than female okra farmers do, while older farmers cultivate okra on more land than their younger peers do. On average, okra farmers produce 1,328 kg (median value of 1,000 kg), with male farmers and older farmers producing significantly more than female and younger farmers. Average okra yield is approximately 3,751per hectare, and although female farmers produce almost 1.4 tonnes per hectare less, the difference is not statistically significant (due to the large variance – see introduction of the chapter).

Figure 8: Distribution of yield



Onion, the second most popular crop among target farmers, is cultivated on 0.5 hectares of land, and similar to other horticulture crops discussed, male farmers and older farmers have a larger land area available than female farmers and youngsters. Average production per farmer is 2,570 kg, with female farmers and youth farmers producing on average almost 1,200 kg less than men do and older farmers. Onion yield is 5,433 kg/ha on average, and the earlier found gender and age differences also transpire to productivity.

Last, the land area used for pepper cultivation is 0.6 hectares of land, making it the 'largest' land area used for horticulture crop cultivation. Production is on average 3,278 kg per farmer (median value of 1,388 kg), with again a large gender difference between men and women. Average yield is 6,281 kg/ha, and male farmers' yield is more than 1 tonnes higher than the yield of female farmers.

These results demonstrate that women and younger farmers have smaller land areas for crop cultivation on average, and as a result, they produce significantly less of the crop compared to male and older farmers. This does not need to transpire in lower yield, but as

large significant differences are also observed in crop productivity, female farmers have lower productivity. The previous chapter on farm practices revealed that a smaller proportion of women uses improved seed varieties for some of the crops, they are less likely to use NPK than men and implement crop rotation less. On the other hand, smaller proportions of female farmers intercrop, more of them have better land preparation practises and use improved nurseries. [12] Furthermore, for technical assistance and knowledge, female farmers rely greatly on informal networks and information from lead farmers in their community, while relatively less of the female farmers are visited by official extension officers (e.g. from the government) compared to male farmers. Last, they also have less access to formal financial services, limiting their ability to invest in horticulture.

Comparison of yield data

Due to its high dependence on climate, input use, agricultural practices and weather conditions, it is relevant to asses this productivity data in relation to neighbouring countries and national averages. For this reason, data on horticulture yields are compared with reference data from FAO on yields in Nigeria as well as its neighbouring countries.[13] The values are shown in Table 19.

The table shows that, with average tomato yields of 6,486 kg/ha, farmers in our sample perform better than the average farmer in Nigeria (4,374 kg/ha). However, farmers (both in our sample and in the national average) have lower yields than their colleagues in surrounding countries such as Burkina Faso do. Cameroon and Niger. Average cabbage yields of target farmers are also lower compared to country averages of Cameroon, Niger and Togo. The average okra and onion yields of the target farmers are better than the Nigerian averages, while the average pepper yield is slightly below the national average. However, the yields of all horticulture crops are lower than most of their colleagues in surrounding countries. In sum, these data show that there is still a significant yield gap for the average farmer in our sample (as well as other Nigerian horticulture farmers), reemphasizing the need to adopt advanced agricultural technologies – for example through the HortiNigeria programme.

Table 19: Secondary and cross-country data on horticulture productivity

Country	Tomato yield (kg/ha)	Cabbage yield (kg/ha)	Okra yield (kg/ha)	Onion yield (kg/ha)	Pepper yield (kg/ha)
Nigeria (our sample, 2021)	6486	6952	3751	5433	6281
Nigeria (national average)	4374	n.a.	1146	2100	7520
Burkina Faso	10449	n.a.	7312	n.a.	4920
Cameroon	12301	24822	2680	12338	2135
Ghana	7849	n.a.	21293	17402	8292
Niger	27031	29830	1259	35008	18196
Togo	4148	10958	n.a.	n.a.	n.a.

[12] Female farmers also report lower labour costs than male farmers, (in log transformation for all horticulture crops except onion) and difficulties accessing affordable labour can also impact their productivity.

[13] This data is, unfortunately, not yet available for 2021. Consequently, 2020 data are used as reference values. Also, for some countries, no data are available on crop yield.

(FAOSTAT, 2020)

6 Revenues & Poverty

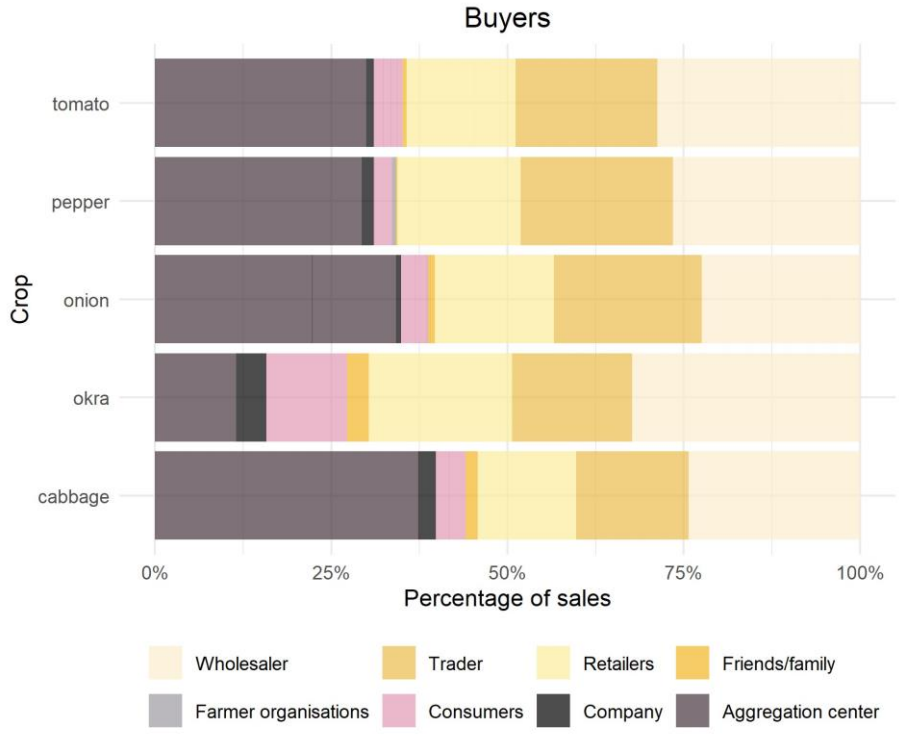
This chapter discusses the different buyers to which the horticulture farmers sell their produce, followed by the descriptives on the average price and amount sold, the months in which the crops are sold, and gross revenue from the horticulture crop. The chapter continues with a discussion of household income, extrapolated on the base of income from horticulture and the contribution of horticulture to the total income of the household. Last poverty status is discussed using the Poverty Probability Index (PPI) that captures the probability that a farmer falls below the Nigerian national poverty line (2018).

Buyers

Across all crops, the buyers to which the farmers sell the most are wholesalers, traders, aggregation centres and retailers. Direct selling to friends, neighbours and other consumers happens, especially among okra farmers (6%), but its occurrence is rather limited for the other crops. Across crops, very few differences in buyer types are observed. Okra farmers (13%) sell significantly less to aggregation centres than farmers growing the other crops do. For of onion (38%) and cabbage (39%) farmers the large proportions report selling to so-called *Dillali's*, making them the most common buyers of these horticulture crops.

Figure 9 presents the average share of the total amount of produce sold per buyer. It reiterates the previous results on the 'popularity' of some of the buyers. Moreover, the graph reveals that substantial amounts of the crop are sold to four main buyers: aggregation centres, retailers, traders and wholesalers. What further stands out is that approximately 10% of the okra produce is sold directly to customers, family, and friends.

Figure 9: Average allocation of crops sold by buyer types



Crop income

Table 20 shows the average prices per kg reported, as well as the proportion of the harvest sold and total revenues derived from crop sales. It is important to note that this information only holds for the most important season (as reported on by the respondent), and is not averaged over both crop seasons as most farmers cultivate the crop in one season only.

Farmers received on average 0.36 USD per kilogram of tomatoes (median value 0.28 USD). On average, a farmer sold 82% of their harvest and earned 584 USD from tomato sales during the main season. This is rather high, and subject to a large standard deviation. The median value for tomato sales is 355 USD.

For 0.23 USD on average per kg, cabbage is sold at a lower price than tomato. Approximately 84% of the cabbage harvest is sold, leading to a crop revenue of 503 USD on average (with a median value of 332 USD). Gender and youth differences are not found in price and the proportion of harvest sold, but female farmers' revenue is on average 446 USD less than that of male farmers. Older farmers also have higher revenues than their younger peers do. This finding confirms previous results on production, showing that female farmers produce significantly less than male farmers do, although the land area on which they cultivate is not significantly different.

Okra is sold for 0.35 USD per kg, and youth farmers receive a significantly higher price than older farmers do. A potential explanation could be that 26% of the older farmers sell directly to consumers, possibly resulting in a lower price, while only 7% of the youth farmers do so. 82% of the harvest is sold, leading to a gross crop revenue of 380 USD (median value of 262 USD). Also in okra revenues, a gender difference is found as women produce less than men do, transpiring in lower gross crop income.

The price of onions is 0.36 USD per kg, and compared to the other horticulture crops, a lower percentage of the harvest is sold (76%). Gross crop revenue from onion is on average 683 USD (with a median value of 403 USD) and next to a gender difference (with women having lower gross crop incomes than men), a large difference of 420 USD is found between the older farmers and the youth cohort.

Pepper is the most expensive horticulture crop with 0.50 USD per kg. 81% of the harvest is sold, resulting in a gross crop income of 1,068 USD. This is also the highest average crop income among all horticulture crops in this baseline study, but when looking at the median value (due to a very high standard deviation), the results show that 50% of the pepper farmers earn less than 450 USD. Women's income is on average significantly lower, and they earn only half of the amount of their male peers.

In summary, the table shows that male farmers and older farmers are clearly better off. The revenues of (older) men are, on average, for all horticulture crops higher than those of (younger) female farmers. Given that prices and the proportions of the harvests sold were equal among all farmer groups, all gender and youth differences in crop revenues can be explained by statistically significantly larger production volumes of male farmers and older farmers.

Table 20: Crop prices and revenues for main crop season

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Tomato							
Price (USD/kg)	0.36 (0.29)	0.38 (0.34)	0.34 (0.21)	0.05 (0.02) *	0.36 (0.27)	0.36 (0.30)	0.00 (0.03)
% of harvest sold	81.80 (13.55)	81.95 (13.08)	81.68 (14.15)	0.27 (1.27)	80.70 (13.65)	82.67 (13.42)	-1.97 (1.29)
Crop revenue (USD)	583.97 (725.27)	721.76 (890.67)	409.82 (366.45)	311.94 (67.89) ***	471.10 (608.56)	670.15 (798.88)	-199.05 (70.10) ***
Cabbage							
Price (USD/kg)	0.23 (0.18)	0.25 (0.18)	0.20 (0.19)	0.04 (0.04)	0.26 (0.22)	0.21 (0.16)	0.04 (0.04)
% of harvest sold	83.56 (14.68)	84.45 (13.94)	82.30 (15.80)	2.16 (2.90)	81.24 (15.51)	85.16 (14.15)	-3.93 (2.96)

Crop revenue (USD)	503.45 (568.77)	666.97 (641.04)	220.59 (223.04)	446.38 (109.20) ***	344.12 (366.25)	605.09 (650.32)	-260.97 (116.73) **
Okra							
Price (USD/kg)	0.35 (0.19)	0.37 (0.20)	0.32 (0.19)	0.05 (0.05)	0.43 (0.22)	0.29 (0.16)	0.14 (0.05) ***
% of harvest sold	82.11 (15.93)	80.64 (19.13)	83.71 (13.74)	-3.07 (4.13)	79.58 (17.88)	83.37 (14.42)	-3.79 (4.14)
Crop revenue (USD)	380.04 (464.71)	514.51 (572.08)	231.58 (254.27)	282.93 (117.43) **	295.40 (291.01)	443.36 (546.65)	-147.95 (124.11)

Onion							
Price (USD/kg)	0.36 (0.24)	0.37 (0.28)	0.34 (0.17)	0.03 (0.03)	0.33 (0.22)	0.38 (0.26)	-0.04 (0.03)
% of harvest sold	75.99 (17.48)	75.05 (18.61(	77.85 (14.92)	-2.90 (2.03)	74.76 (17.20)	76.96 (17.58)	-2.19 (1.96)
Crop revenue (USD)	683.40 (907.44)	788.83 (1044.52)	478.45 (494.47)	310.37 (106.70) ***	451.70 (513.79)	871.30 (1098.92)	-419.61 (102.97) ***
Pepper							

Price (USD/kg)	0.50 (0.43)	0.50 (0.41)	0.51 (0.49)	0.02 (0.07)	0.49 (0.45)	0.51 (0.43)	0.02 (0.07)
% of harvest sold	81.44 (17.20)	82.57 (16.01)	78.98 (19.34)	3.59 (2.77)	78.88 (18.73)	83.30 (15.91)	4.42 (2.66) *
Crop revenue (USD)	1068.29 (1681.64)	1288.23 (1927.87)	661.31 (979.57)	626.93 (270.07) **	830.47 (967.48)	1215.32 (2006.27)	-384.85 (266.85)

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Months of selling crop

Table 21 shows a basic analysis of the months in which (regardless of the crop season), the horticulture crop was sold. It shows that without exception, most farmers report to sell in the months between January and May, with a strong peak in February, March and April, after the harvest of the dry season. Some farmers report to sell pepper and tomato in October, November and December, while okra is also sold in August, September and October. This table signifies that horticulture crops are currently being offered on the market at more or less the same time, affecting prices for farmers. This suggests that interventions that stimulate crop cultivation in the rainy season, and interventions that give proper attention to the timing of crop cultivation, bear strong potential to increase the incomes of horticulture farmers.

Table 21: Months in which crop is sold (most important and second most important season combined)

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Tomato	12%	30%	44%	27%	14%	8%	5%	4%	6%	8%	12%	11%
Cabbage	10%	30%	37%	31%	14%	5%	5%	3%	8%	7%	3%	5%
Okra [a]	10%	21%	39%	28%	13%	5%	5%	15%	18%	13%	7%	6%
Onion	8%	25%	45%	35%	15%	8%	5%	5%	2%	3%	4%	6%
Pepper	14%	25%	41%	31%	10%	8%	2%	2%	7%	13%	17%	12%

Household income

Table 22 shows households' average revenues from the sale of horticulture crops. Households earned, on average, 962 USD on an annual basis from the sales of (all) horticulture crops.[14] However, the high standard deviation (1,338 USD) shows that there is a lot of variation in the sample. A small share of households reported very high incomes (over 10,000 USD annually). It is unsure whether these values represent the actual sales incomes, or whether they result from measurement errors. The median income from horticulture crop sales was 559 USD.

Households were also asked to estimate the share of their income derived from horticulture crops. On average, households estimate to obtain about 54% of their income from the sale of their focus crops. The share of income derived from agricultural sales was used to extrapolate the total annual household income. We estimate the average annual income of a household in the sample to lie around 1,820 USD. However, we want to express caution in the interpretation of this figure, as it is based on estimates and recall data, and does not include horticulture crop production costs. Again, there is large variation in the sample, hence why we also report the median value (1,158 USD).

Besides the sale of horticulture crops, common sources of income for households in the sample include the sale of non-horticulture crops, the sale of livestock products and running a small business (including agro-processing, trading, boutique, etc.) – see Figure 10.

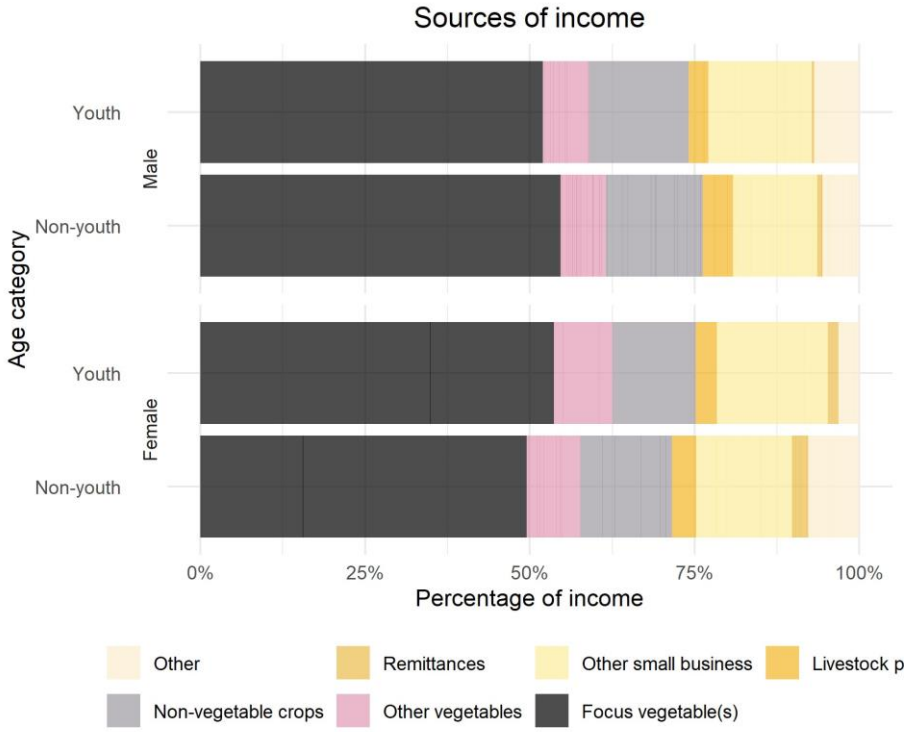
[14] Data was collected in Nigerian Naira, but were later converted to USD using the 2021 average exchange rate (380 Naira = 1 USD), since the USD is a more stable currency.

Table 22: Horticulture and household income

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Revenue from horticulture sales (main & lean season) (USD)	962.48 (1337.63)	1244.36 (1590.21)	589.10 (756.18)	655.27 (98.96) ***	726.56 (920.73)	1142.50 (1564.67)	415.95 (101.61) ***
% of income derived from sale of horticulture (focus crops only)	54%	54%	53%	1% (1.65)	53%	54%	-1% (1.66)
Inferred annual gross income of household (USD)	1819.60 (2361.57)	2393.88 (2867.59)	1084.68 (1110.02)	1309.20 (186.10) ***	1443.81 (1852.39)	2113.57 (2662.57)	669.77 (192.45) ***

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Figure 10: Relative (household) income by source

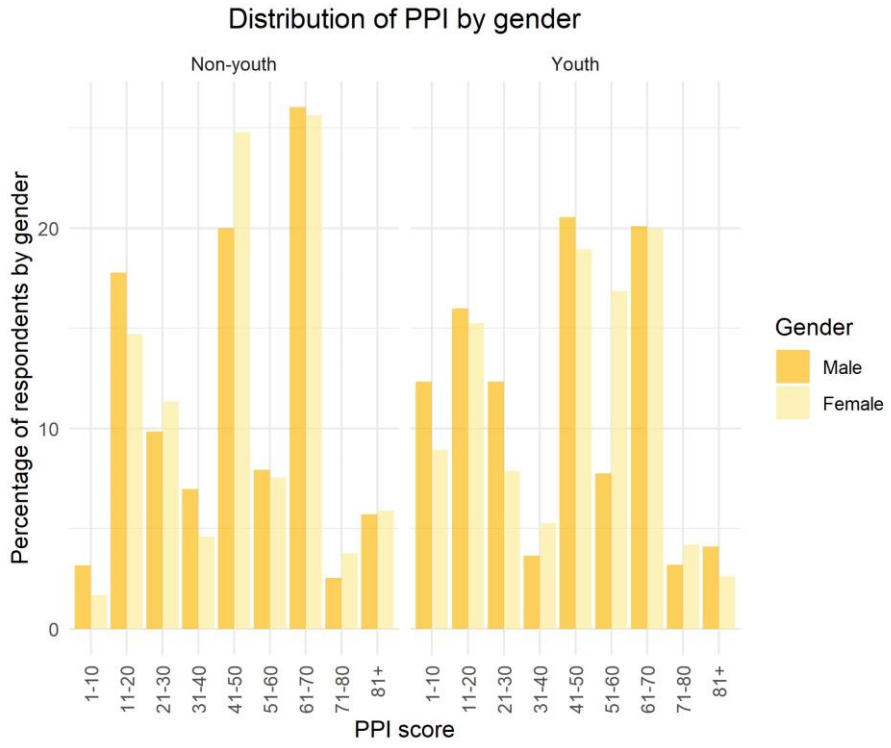


On average, 54% of the household incomes of farmers interviewed comes from horticulture crop cultivation (limited to their focus crops). No gender and youth differences are found in the extent to which the household of the farmer relies on horticulture crops for their income. This implies that although many of the farmers are not considered the household head (only 52% is head), their income generating activity adds approximately half to the income of the household. No difference in horticulture contributions are found between the farmers who are household head and those who are not. There are statistically significant differences between states. In Kaduna State, households rely more on horticulture crops for their income with 57% compared to households in Kano State, who rely for 50% of their total income on the sale of horticulture crops.

Poverty Probability Index

To measure poverty, the poverty probability index (PPI) is used as indicator. Based on consumption, asset ownership, household size and location, the PPI estimates the probability that a household falls below the rural national poverty line of Nigeria (2018). Figure 11 shows the distribution of the PPI by gender. On average, the probability that a household of the target farmers falls below the rural Nigerian poverty line is 45%. The probability is similar for the households of male and female farmers. However, despite having higher gross crop revenues, the households of older farmers are more likely to fall below the national poverty line (47%) compared to the households of younger farmers (42%).[15] A large difference in poverty level is also found between states, where the probability that households in Kano fall below the national poverty line is 53%, whereas the probability for households in Kaduna is significantly lower at 37%.[16]

Figure 11: Distribution of PPI



[15] Two sample t-test: statistically significant at the 1% level.
[16] Two sample t-test: statistically significant at the 1% level.

7 Food Security & Nutrition

In this baseline study, food security is assessed in two ways. The quantity of food accessible to the household, and its spread over the year, is measured using the number of Months of Adequate Household Food Provision (MAHFP). Over time, this indicator can capture changes in the household's ability to address vulnerability in such a way as to ensure that food is available above a minimum level year round. Measuring the MAHFP has the advantage of capturing the combined effects of a range of interventions and strategies, such as improved agricultural production, storage, and interventions that increase the household's purchasing power (Bilinsky and Swindale, 2010.) Data to construct this indicator is collected for a recall period of 12 months, starting from the date of the survey. For each month, households are asked to indicate whether they had enough food available to meet their family's needs.[17]

Table 23: Food security and nutrition

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Number of months of Adequate Household Food Provision (MAHFP)	11.28 (1.11)	11.38 (1.03)	11.16 (1.20)	0.22 (0.07) ***	11.38 (1.0)	11.21 (1.17)	0.18 (0.0.07) **
Minimum Dietary Diversity Index for Women (MDD-W)	35%	n.a.	35%	n.a.	36%	33%	3% (0.05)
Number of food groups consumed in 24 hours before interview (MDD-W)	4.63 (1.75)	n.a.	4.63 (1.75)	n.a.	4.67 (1.86)	4.60 (1.64)	0.07 (0.18)

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Table 24 shows that the MAHFP score is 11.3, indicating that households in the sample can meet their food needs during 11.3 months per year. The vast majority of the sample (64%) is not food insecure at all. When looking at the severity of food insecurity for those households that did experience shortages (thus excluding the 64% without problems), we observe that shortages typically last for about two months. Food insecurity primarily occurs in the months July and August (22% and 57% of farmers that report food shortages, respectively). Differences are found between the households of youth (11.4) and older farmers (11.2), with the latter having lower food security of 0.2 months.[18] Moreover, the households of female farmers have lower food security (11.2) compared to male farmers

[17] For data quality purposes, these questions were asked to the household member who is responsible for cooking, also if this person was somebody else than the main respondent.

[18] Results of a two sample t-test: statistically significant at the 5% level.

(11.4).[19] Furthermore, respondents that are in a polygamous marriage report a statistically significantly lower number of months (0.3) of adequate household food provisioning compared to those who are single or in a monogamous marriage. This holds for both male and female respondents.[20]

The number of MAHFP seems similar across the states, yet there is a minimal (but statistically significant) difference. The MAHFP Index score is slightly higher in Kaduna State (11.3), compared to Kano State (11.2) (see Table 24).[21]

Table 24: Number of Months of Adequate Household Food Provisioning by State

State	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Kaduna	11.35 (1.11)	11.56 (0.96)	11.15 (1.21)	0.41 (0.10) ***	11.42 (1.05)	11.29 (1.15)	0.14 (0.10)
Kano	11.21 (1.12)	11.24 (1.06)	11.18 (1.20)	0.07 (0.11)	11.34 (1.02)	11.11 (1.18)	0.23 (0.10) **

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

In addition to assessing the quantity of food available throughout the year, we also measure the quality and diversity of food intake using the Minimum Dietary Diversity Index for Women (MDD-W).[22] The indicator is based on food intake data over a recall period of 24 hours. This indicator is calculated based on the number of different food groups consumed by the female respondent (of reproductive age) the last 24 hours.[23] The reason for focusing on the dietary diversity of women lies in the strong emphasis on female inclusion in the HortiNigeria program, while the expectation that horticulture directly adds to household nutrition, given that half of the target farmers is not the household head, is less evident.

Out of the 433 female farmers interviewed in the treatment group, 40 (9%) were fasting the day before the interview (as part of the *Shawwal* after Ramadan). Most of them were located in Kaduna (N=30). Consequently, they were not interviewed on their dietary intake 24 hours prior to the interview.

On average, the 35% of the female farmers consumed more than five different food groups (out of the 10 food groups) in the 24 hours preceding the interview, which is considered the minimum dietary diversity. No age and state differences are detected in the MDD-W. To provide more nuance to the MDD-W, the number of food groups is also included in Table 23. On average, women consume only 4.6 different food groups in the 24 hours prior to the interview, explaining why 65% of the women does not meet the minimum dietary

[19] Results from a two sample t-test, statistically significant at the 1% level.

[20] When regressing MAHFP on marital status, respondent's age, respondent's gender, location (state level) and number of hectares under crop cultivation using a linear regression model with robust standard errors, respondents in a polygamous marriage remain to have a lower MAHFP (0.3 months lower) compared to respondents that are single or in a monogamous household. Moreover, the regression results also show that female farmers report less MAHFP (0.2 months) compared to male farmers while farmers who are based in Kano report 0.1 MAHFP less than their peers in Kaduna. Land used for crop cultivation also correlates positively with MAHFP, and each hectare of land under crop cultivation (horticulture and non-horticulture) increases the MAHFP with 0.06 months).

[21] Results from a two-sample t-test, significant at the 10% level.

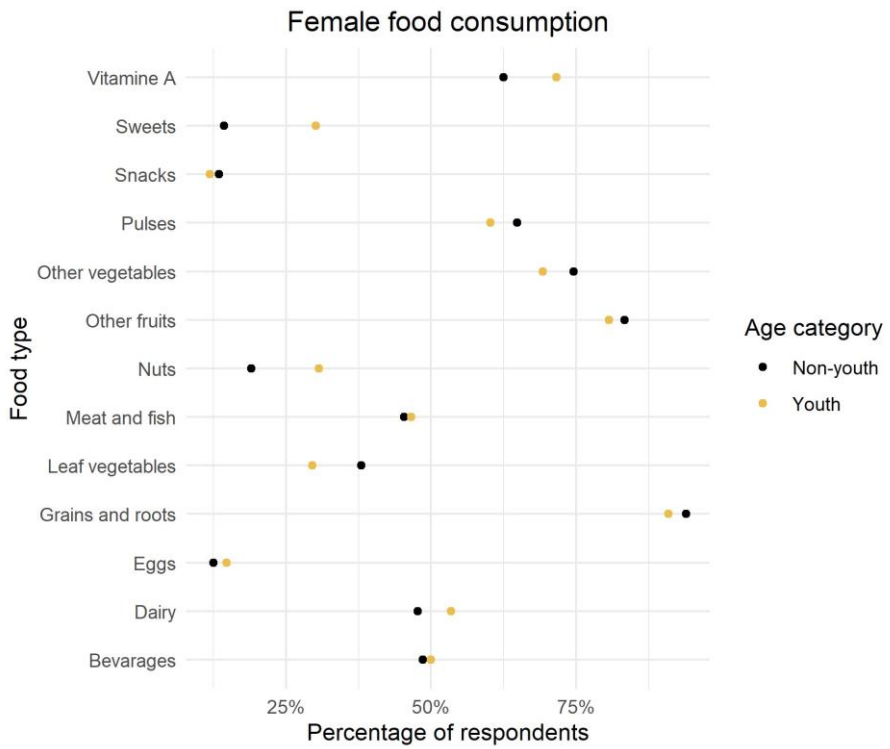
[22] See https://www.fao.org/nutrition/assessment/tools/minimum-dietary-diversity-women/en/

[23] In order to collect data for this indicator, the interviewer mentions 10 different food groups (each including a broad range of examples) and asked the respondent whether people in the household have consumed it during the last 24 hours (yes/no).

diversity. The number of different food groups consumed does not differ by state, nor by youth status.

Figure 12 shows the dietary diversity of households in more detail. Next to the ten food groups that construct the MDD-W, sweets, snacks and beverages are added as food groups to the graph. It shows that a large majority of households consumed grains, tubers and roots (such as bread, rice, noodles, biscuits or any other food made from grains, millet or sorghum) and vegetables. Pulses like beans and lentils were also commonly eaten, as was food that is rich in Vitamin A (like carrots and mango). Foods such as eggs and nuts were almost not consumed the day before the interview. The same holds for sweets and snacks.

Figure 12: MDD-W: food categories



8 Shocks & Resilience

This final chapter presents an overview of most common shocks, self-perceived resilience and vulnerability of the target farmers of HortiNigeria. Table 25 shows that farmers indicate experiencing a variety of shocks during the last year. The shocks that occurred most frequently were increases in food prices (32%), increases in input prices (29%), death of a relative (18%), and crop failure (12%). A remarkable finding was that 42% of all farmers interviewed did not indicate to have experienced any shocks at all. The order of shocks changes slightly when looking at the order of importance, with increasing input prices and death of a relative being reported as most important shocks.

Table 25: Prevalence of shock categories

Shock	Shock reported	Most important shock [a]	Coping strategies (if most important shock) reported
Increase in food prices	32%	18%	Used savings (49%), received help from friends and family (48%), engaged in additional work (46%), decreased food consumption (37%).
Increases in input prices	29%	29%	Used savings (65%), engaged in additional work (36%), received help from friends and family (27%).
Death of a friend or relative	18%	20%	Did nothing (57%), received help from friends and family (36%), used savings (20%).
Crop failure	12%	8%	Did nothing (31%), engaged in additional work (16%), sold livestock (9%).
Failure or bankruptcy of business	6%	4%	Used savings (64%), received help from friends and family (60%), engaged in additional work (28%).
Theft, fire or destruction of household	6%	4%	Received help from friends and family (55%), engaged in additional work (25%), did nothing (25%)/
Decrease in remittances and support	6%	2%	Engaged in additional work (63%), received help from friends and family (55%).
Other	n.a.	15%	n.a.
No shock experienced	42%	n.a.	n.a.

Notes. [a] percentage is based on subsample of farmers who report at least one shock.

The last column of Table 25 reveals that using savings, relying on friends and family, and engaging in more work are the most common strategies reported to cope with the shocks experienced. What further stands out in Table 25 is the decrease in food consumption to deal with increasing food prices. Moreover, not having the means to cope with shocks is especially prominent when farmers face the death of friends or relatives (in the household), when farmers face crop failure, and when they experience theft, fire or destruction of the household.

A larger proportion of male farmers (33%) report an increase in input prices as a shock that they have experienced than the proportion of female farmers (24%).[24] In addition, a larger proportion of male farmers also report increasing input prices as their most important shock compared to the share of female farmers (36% vs. 20% of farmers who report at least one shock). A significant gender difference is also found in the experience of crop failure, with a larger proportion of male farmers (15%) reporting to have experienced the shock than female farmers (9%). They also report it relatively more (11%) as most important shock than female farmers (4%).[25] Although no differences are found in the proportion of male and female farmers dealing with an increase in food prices in general as one of the shocks experienced, a larger proportion of female farmers (27%) report increasing food prices as their most important shock than male farmers (11%) (i.e. male farmers experienced increasing food prices, but they report it relatively less as their most important shock than female farmers do). No other gender differences are found.

Youth differences are found in the experience of increased input and food prices and crop failure, with older farmers reporting the shocks significantly more than younger farmers do.[26] However, in the importance of the shocks no differences are found.

Since health status and agriculture performance are two main components used to measure rural resilience, the prevalence of agricultural- and health-related shocks is assessed (crop failure and death of friend/relative in the household). To do this, households were classified in the following three categories:

1. Resilient: affected by neither agricultural nor health shocks.
2. Subsistent: affected by either an agricultural or a health shock.
3. Vulnerable: affected by both agricultural and health shocks.

The results of this classification are shown in Table 26. More than quarter of the farmers experienced at least one shock related to agriculture or health. Interestingly, female farmers and youth are less vulnerable than male and older farmers.

Table 26: Vulnerability

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Resilient	74%	72%	77%	-5% (0.03)*	77%	71%	6% (0.03) **
Subsistent	22%	23%	21%	1% (0.03)	21%	24%	-3% (0.03)
Vulnerable	4%	5%	2%	3% (0.01) ***	2%	5%	3% (0.01) **

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level;

[24] Results from a two sample test of proportions, statistically significant at the 1% level.
[25] Results from a two sample test of proportions, statistically significant at the 1% level.
[26] Results from two sample tests of proportions, statistically significant at the 10% level (increased input prices), 10% level (increased food prices) and 1% level (crop failure).

*** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Almost half of the horticulture farmers report to have a high, or very high ability to deal with shocks. Table 27 reveals that a statistically significantly smaller proportion of female farmers (30% and 12%) report to have a high or very high ability to deal with shocks compared to male farmers (36% and 20%). This signifies that female farmers consider themselves less able to absorb the impact of a shock compared to men. No youth differences are found in the ability to deal with shocks.

Table 27: Self-reported ability to deal with shocks

	Pooled	Male	Female	Gender difference	Youth	Non-youth	Youth difference
Very low ability	13%	10%	15%	-5% (0.02) **	13%	12%	0% (0.02)
Low ability	38%	34%	43%	-9% (0.03) ***	38%	38%	0% (0.03)
High ability	33%	36%	30%	7% (0.03) **	34%	33%	1% (0.03)
Very high ability	16%	20%	12%	8% (0.02) ***	15%	17%	2% (0.02)

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.

Figure 13: Capacity to deal with shocks by vulnerability levels

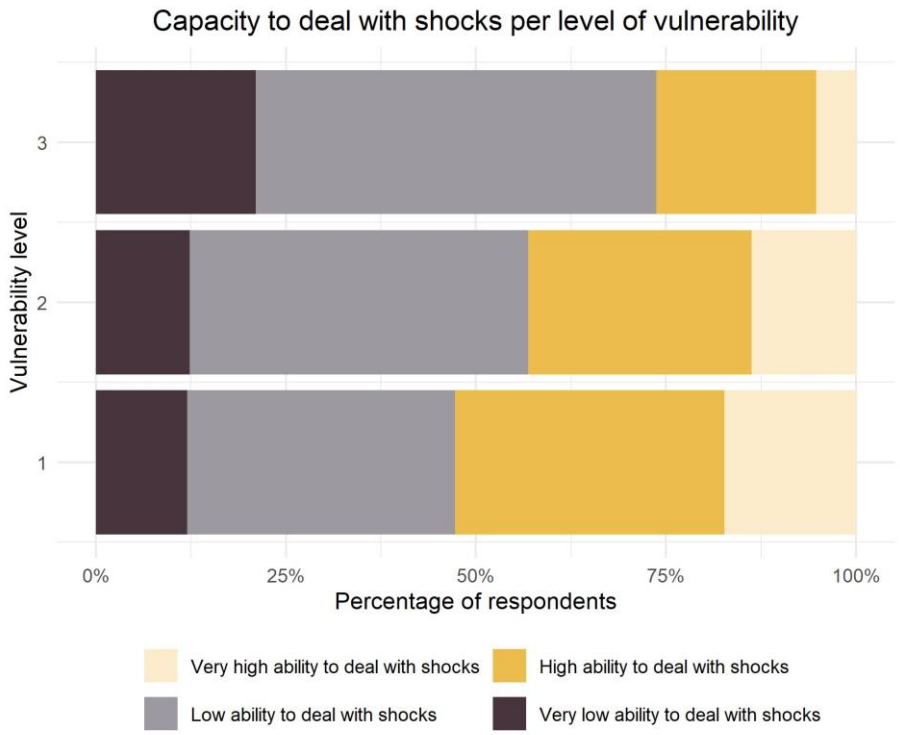


Figure 13 illustrate a very strong correlation between the self-reported ability to deal with shocks and the vulnerability indicator, which signifies that a larger proportion of farmers typified as subsistent or vulnerable also report to have a lower ability to deal with shocks (71% of the farmers typified as subsistent or vulnerable report to have a low or very low ability to deal with shocks, compared to 57% of the farmers typified as resilient).[27] Naturally, as the ability to deal with shocks and vulnerability affect one another, causality cannot be established.

[27] Results from a chi-square test, statistically significant at 1% level.

9 Conclusions & Recommendations

This report presents and describes baseline data on approximately 1,000 farmers sampled from the target population of the HortiNigeria programme in Nigeria. The primary aim of this programme – which is funded by the Embassy of the Netherlands in Nigeria and implemented by IFDC and EWS-KT with technical assistance from WUR and KIT - is to promote horticulture production and increase income levels and food security of horticulture farmers. To do so, the project is aimed at providing technical support (including innovations) to farmers, combined with improved access to markets and finance. As a result, the project is expected to boost in-country horticulture production, thereby increasing agricultural productivity, as well as rural incomes, nutrition and resilience of women and youngsters in particular.

Baseline data were collected through a field-based and structured survey, and interviews took place in May 2022. The survey covered 22 LGAs in Nigeria, located in the States of Kano and Kaduna. The sample was restricted to horticulture farmers, and selected from the list of farmers who enrolled in the HortiNigeria programme earlier in the year. Control farmers were selected from other horticulture producing non-treatment LGAs, needed to have access to water, while areas where other horticulture programs were active were excluded from the sampling frame. Although included in the annex, the results of the control group are not discussed in this report as the comparison between treatment and control becomes more relevant at endline. That is the moment when we assess whether the change over time that target farmers experienced is different from the change over time of farmers located in the control LGAs. Nonetheless, the comparison provided in Annex I reveals several pre-existing baseline differences, which need to be corrected for using advanced econometric estimation techniques like matched-difference-in-difference.

In this report, the quality of data collected was assessed against the presence of:

- Random measurement errors resulting in large variability among observations and low accuracy of mean values;
- Non-random measurement errors introducing a bias among observations and undermining the consistency of results.

In particular, the data on horticulture productivity and income analysed in this report appear to be characterised by low efficiency but high consistency. Especially with regards to land under crop cultivation, farmers sometimes estimated their land area resulting in erroneous outcomes that also generated invalid yield levels. This means that the data analyses presented in the previous chapters (especially in the production and income sections) tend to be affected by large variability (i.e. large standard deviations) and therefore introduce increased margins of error in the estimation of mean values. Inefficiencies in data analysis were openly acknowledged throughout the report and addressed by computing median values, as well as by comparing our results with secondary data. Nonetheless, estimated mean values allowed us to derive conclusions that appear to be overall consistent.

The data presented in this report show that agricultural productivity in Nigeria (both among the farmers in this study as well as the national Nigerian average) appears to be considerably lower than that in most neighbouring countries. This demonstrates a large yield gap in horticulture in Nigeria, which is especially significant for female farmers and younger farmers. Furthermore, analysis shows that horticulture farmers tend to cultivate very small plots of land for their horticulture crops (i.e. half a hectare on average), especially when compared to land areas used to cultivate field crops. These land areas are not different for younger or female farmers, and given that prices and proportions of harvest sold are more or less equal, lower production values and crop income levels are primarily caused by significantly lower productivity levels.

The practice of recycling own seeds and seedlings is very common, and illustrates that farmers do not buy seeds from the market on a regular basis. As a result, the use of local seed varieties is common practice for the cultivation of almost all crops, with the exception of tomato and cabbage. Often, farmers also do not know what kind of seed variety they use. What further stands out in farm practices is the low proportion of farmers that applies a farm practice according to the recommended guidelines (as provided by EWS-KT). For example, 93% of farmers uses NPK as fertilizer, but only 10% of the farmers applied it at the recommended frequency. The same holds for land preparation, where half of the sample mulched and ridged, but only 1% of the farmers ridged according to the recommended guidelines, and almost no farmer fertilized the land before (trans)planting. Moreover, farmers often cultivate the horticulture crop in only one crop season, while horticulture can be grown all year round with the right farm practices. In addition, with deliberate timing of planting, this can also prevent horticulture produce being offered to buyers at the same time in the months Feb-April, potentially affecting crop prices. These examples demonstrate the potential of the technical assistance provided through the HortiNigeria programme.

In terms of existing extension outreach and access to formal financial services, more than 60% of the farmers has never received any technical assistance, and those that did, mainly received support from lead farmers in their community or from official extension officers from the government. Financial access is especially limited to female farmers, with only 26% having a bank account and 7% taking out a formal loan for agricultural purposes.

The average farm household appears to be food insecure for about less than a month a year, with the months of July and August being the most insecure months, and the diets of women are slightly monotonous, indicating that nutrient intake is limited. Only a third of the female farmers in the sample has a minimum dietary diversity. Diets are typically high in carbohydrates but low in proteins. Significant gender and youth differences in terms of food security were detected, and might correlate with the differences in agricultural performance of the groups. Nonetheless, vulnerability - measured on the basis of intrahousehold mortality and crop failure - appears to be significantly more prevalent among older, male farmers.

Overall, this report provides a first and general overview of baseline data, project areas and target population. Based on this report, IFDC and KIT are planning to produce more in-depth analyses geared towards assessing project risks and inform and guide project implementation moving forward.

From March 2022, IFDC and KIT will also start gathering quarterly data from farmer and extension workers to monitor progress and participation in component 1 of the programme for which this report constitutes the baseline. Ultimately, farmers are expected to benefit also from component two (on innovations for smallholder farmers), component 3 (access to finance), and component 4 (market linkages). Therefore, activity- and outcome level data will further be collected through programme partners (e.g. financial service provider, upstream supply chain actors, downstream supply chain actors, suppliers of greenhouses) in those components, to give a comprehensive overview of all developments affecting farmer wellbeing.

References

Bilinsky, Paula; and Swindale, Anne. 2010. Months of Adequate Household Food Provisioning (MAHFP) for Measurement of Household Food Access: Indicator Guide (v.4). Washington, D.C.: FHI 360/FANTA.

FAO (2021a) Minimum dietary diversity for women. An updated guide to measurement - from collection to action. Rome: FAO. Retrieved from: https://www.fao.org/documents/card/en/c/cb3434en

FAO (2021). FAOSTAT Statistical Database. *Crops and Livestock Products.* Rome: FAO. Retrieved from: https://www.fao.org/faostat/en/#data/QCL

Federal Republic of Nigeria (2020) National Youth Policy. Enhancing Youth Development and Participation in the context of Sustainable Development. Retrieved from: https://www.prb.org/wp-content/uploads/2020/06/Nigeria-National-Youth-Policy2019-2023.pdf

World Bank (2021). *World Bank staff estimates based on age distributions of United Nations Population Division's World Population Prospects: 2019 Revision,* The World Bank Group, retrieved from: https://data.worldbank.org/indicator/SP.POP.DPND

Vanlauwe, B., Bationo, A., Chianu, J., Giller, K. E., Merckx, R., Mokwunye, U., Ohiokpehai, O., Pypers, P. Tabo, R., Shepherd, K., Smaling, E., Woomer, P. & Sanginga, N. (2010). Integrated soil fertility management: operational definition and consequences for implementation and dissemination. *Outlook on agriculture*, 39(1), 17-24.

Annex I. Treatment – control comparison

Indicator[28]	Control	Treatment	Difference

[28] The list of indicators is limited to farmer demographics and extension/support services, crop cultivation, and impact indicators like production, yield, income, food security/nutrition and resilience. Crop specific indicators on cucumber and watermelon are not included due to low N, making them sensitive to outliers.

Female (%)	48%	44%	4%*
Age of farmer (in years)	34.19 (10.65)	32.37 (10.39)	1.81 (0.48) ***
Head of household (%)	52%	48%	4%*
Land cultivated (ha)	1.72 (1.86)	1.55 (1.48)	0.16 (0.08)**
Land owned (ha)	1.20 (1.85)	1.08 (1.60)	0.12 (0.08)
Number of visits from extension officer (%)	2.25 (1.43)	2.54 (3.01)	-0.29 (0.28)
Distance to input supplier (minutes)	38.23 (34.27)	31.86 (27.48)	6.40 (1.44) ***
Has bank account (%)	46%	36%	9% ***
Took out formal loan for agriculture (%)	1%	1%	0%
Focus crop: tomato (%)	50%	58%	-8% ***
Focus crop: cabbage (%)	7%	14%	-7% ***
Focus crop: okra (%)	17%	8%	9% ***
Focus crop: onion (%)	28%	40%	-11% ***
Focus crop: pepper (%)	40%	22%	18% ***
Focus crop: cucumber (%)	1%	4%	-3% ***
Focus crop: watermelon (%)	3%	3%	0%
Tomato land cultivated (ha)	0.61 (0.67)	0.53 (0.45)	0.07 (0.04) **

Cabbage land cultivated (ha)	0.37 (0.33)	0.54 (0.54)	-0.18 (0.07) **

Okra land cultivated (ha)	0.27 (0.24)	0.41 (0.31)	-0.14 (0.04)
Onion land cultivated (ha)	0.68 (0.58)	0.54 (0.41)	0.14 (0.04) ***
Pepper land cultivate (ha)	0.55 (0.78)	0.56 (0.45)	-0.01 (0.06)
Tomato production (kg)	3986.07 (8922.62)	2448.89 (2924.51)	1537.18 (428.51) ***
Cabbage production (kg)	4353.02 (4344.40)	2996.17 (3515.90)	1356.85 (604.97) **
Okra production (kg)	1321.26 (1953.07)	1328.28 (1519.10)	-7.02 (274.93)
Onion production (kg)	3030.95 (4063.50)	2569.74 (2392.16)	461.21 (265.65) *
Pepper production (kg)	2904.92 (5176.23)	3278.42 (5610.53)	-373.50 (490.61)
Tomato yield (kg/ha)	8122.61 (8100.34)	6485.54 (7430.81)	1637.07 (524.75) ***
Cabbage yield (kg/ha)	16767.53 (12867.15)	6951.90 (7232.14)	9815.63 (1531.24) ***
Okra yield (kg/ha)	6026.59 (5218.78)	3751.41 (4006.14)	2275.18 9734.75) ***
Onion yield (kg/ha)	6103.79 (5464.92)	5433.23 (4396.95)	670.56 (412.64)
Pepper yield (kg/ha)	7065.01 (6850.59)	6281.45 (6924.38)	783.56 (642.66)
Tomato revenue (USD)	1077.68 (2325.10)	583.97 (725.27)	493.71 (116.18) ***
Cabbage revenue (USD)	766.49 (879.75)	503.45 (568.77)	263.04 (114.17) **
Okra revenue (USD)	358.49 (410.42)	380.04 (464.71)	-21.55 (66.83)
Onion revenue (USD)	725.07 (1036.23)	683.40 (907.44)	41.67 (84.77)
Pepper revenue (USD)	960.77 (1642.60)	1068.29 (1681.64)	-107.51 (160.68)
MAHFP	11.40 (1.02)	11.28 (1.11)	0.11 (0.05) **
MDD-W	31%	35%	-3%
Very low ability to deal with shocks	12%	13%	-1%
Low ability to deal with shocks	40%	38%	2%

High ability to deal with shocks	31%	33%	-2%
Very high ability to deal with shocks	17%	16%	1%
Resilient	76%	74%	2%
Subsistent	20%	22%	-2%
Vulnerable	3%	4%	-1%

Notes. For categorical variables, a two-sided test of proportions is used to test for differences. For continuous variables, a two-sided t-test is used. * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. For continuous variables, the standard deviation and standard error (for t-test) are reported in parentheses. Differences might deviate due to rounding of numbers.