SECURING WATER FOR FOOD

World Hope Impact Evaluation

Low-Cost Greenhouse Farming in Mozambique

NOVEMBER 2018

SECURING WATER FOR FOOD: A GRAND CHALLENGE FOR DEVELOPMENT

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ABSTRACT

World Hope International provides low-cost greenhouses to farmers in Sierra Leone and Mozambique – an agricultural innovation that has received monetary awards and support from Securing Water for Food. This report encompasses the monitoring and evaluation of the greenhouses installed in Mozambique's Gaza and Maputo provinces.

In June 2018, field visits and interviews were conducted with 47 users to assess the innovation and its associated benefits. Since 2015, 44 greenhouses have been built and 33 still were operational by the time of this study. Farmers benefit from directly growing crops at the greenhouses, buying seedlings from the greenhouses' owners, and learning new farming technique.

With the greenhouses, farmers can grow crops faster and all year round, using less water and fewer seeds. Crops and seedlings grown in the greenhouses are of better quality and have greater chances for survival, because the greenhouses protect the plants from weather variations and pests. Farmers had an overall positive attitude towards the greenhouses and 87 percent of those interviewed plan to continue using them.

I. INTRODUCTION

Weather variability makes farming a risky and uncertain investment for farmers. Even in areas where the climate is suitable for agriculture, heavy rain, severe droughts, and extreme temperature can damage crops. Farmers often lose entire crops to environmental stressors. With the addition of climate change, weather extremes are expected to increase even more. This situation makes rural populations more vulnerable in terms of income loss and food insecurity.

Greenhouses are a well-known way of making agriculture easier and safer. However, the greenhouses can be costly to build, and many farmers lack technical knowledge about best agricultural practices. World Hope International implemented the Greenhouse Revolutionizing Output (GRO) project with funds granted by Securing Water for Food (SWFF). The project consists of giving or selling innovative and affordable greenhouses to farmers to help them grow vegetables using less water.

The GRO project takes place in Sierra Leone and Mozambique. In Mozambique, World Hope built the greenhouses between 2015 and 2017 in the southern provinces of Gaza and Maputo. The greenhouses' average dimensions are 5.5 m x 6 m. After the first users, some design adaptations were made. World Hope changed the wood used for the structure. It also substituted netting for the original plastic cover material, which allows the air to circulate and avoids high temperatures inside the greenhouses. By 2018, however, World Hope had shut down its operations in Mozambique.

In the province of Maputo, World Hope partnered with ACDI/VOCA, a non-profit organization that fosters economic growth in communities worldwide. ACDI/VOCA aided many farmers in Mozambique by sharing technical know-how and offering agricultural inputs at lower costs. Specifically for GRO, ACDI/VOCA used its network and local knowledge to suggest potential customers for the greenhouses, including more farmers' associations.

To evaluate the impact and success of the project, 47 farmers were interviewed who either were growing crops in the greenhouses or buying seedlings from greenhouse users. The field visits and interviews helped assess the benefits of using the greenhouses as perceived by farmers and measure the innovation's impact on production and water consumption. This study ultimately provides information on how many greenhouses are still operational and the different ways farmers are using them.

II. METHODOLOGY

1. Sample selection

Data was collected through individual and group interviews with farmers who had benefited from World Hope's low-cost greenhouses. SWFF staff developed the questionnaire, but external evaluators were allowed to modify it with SWFF review. The interviews were conducted in Portuguese whenever possible, or in the local dialect, with the help of translators. All interviews took place where the greenhouses were located; i.e., farms, farmers' associations, the farmer's dwelling, a school, etc. The survey was done with the Fulcrum app on a smartphone. In addition, photographs were taken, and the interviews were recorded with a portable voice recorder.

According to World Hope, 44 greenhouses had been distributed among individual farmers and farmers' associations. However, as the field visits started, researchers noted that some greenhouses had been destroyed and were no longer operational, leaving a smaller sample of interviewees. Out of 44 greenhouses, 11 had been destroyed or abandoned. Reportedly, the greenhouses were destroyed by either strong winds or floods. Photos 1 to 3 show destroyed, abandoned, and damaged greenhouses found in the field.

As much as possible, interviews were conducted by phone. However, World Hope did not provide all phone numbers, or provided them later, during the work. When reaching out by phone proved to be unsuccessful, drop-in interviews were the fallback strategy. The drop-in strategy was successful in most cases, except when the provided coordinates were wrong or when the owner of a greenhouse was not around at the scheduled time. In farmers' associations, the first contact was always made, if possible, with the association president. In some cases, the president would indicate who was benefiting from the greenhouse, so that person could be interviewed.

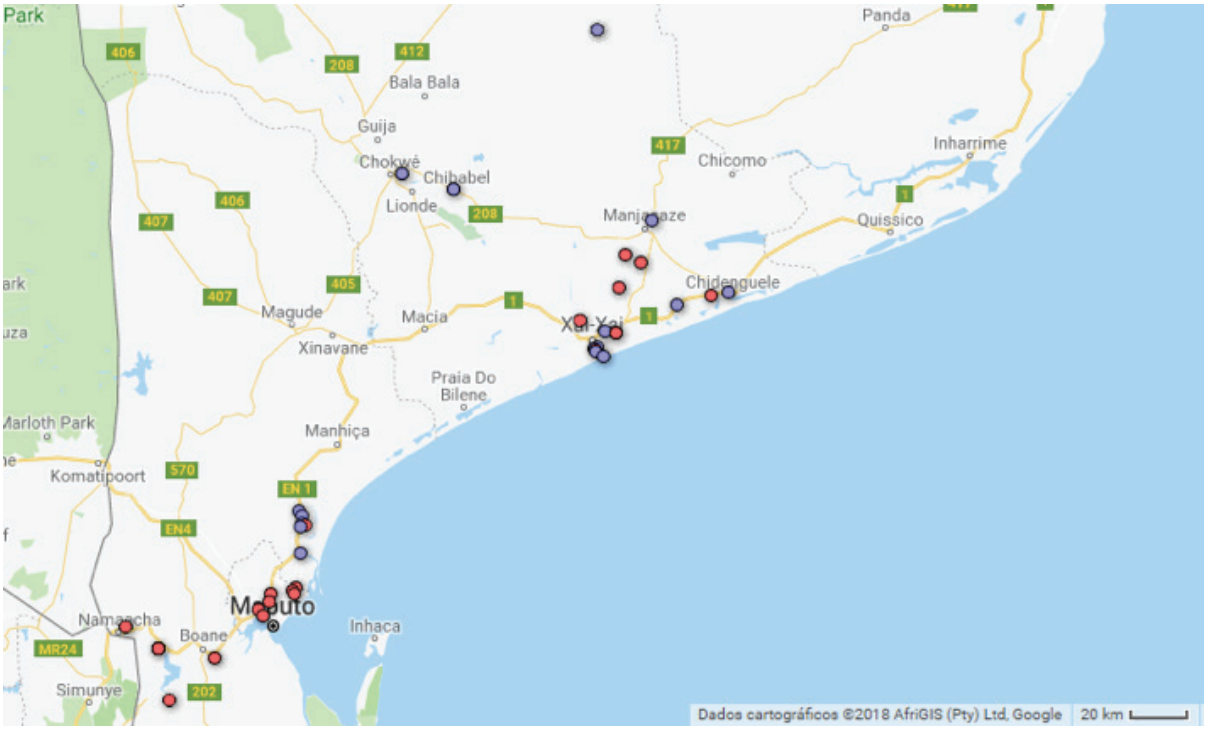
PHOTO 1. Destroyed greenhouse

PHOTO 2. Interior of abandoned greenhouse. The greenhouse was not damaged, but, as the picture shows, there was evidence someone had been cooking inside. The owner of the greenhouse was not found during the visit.

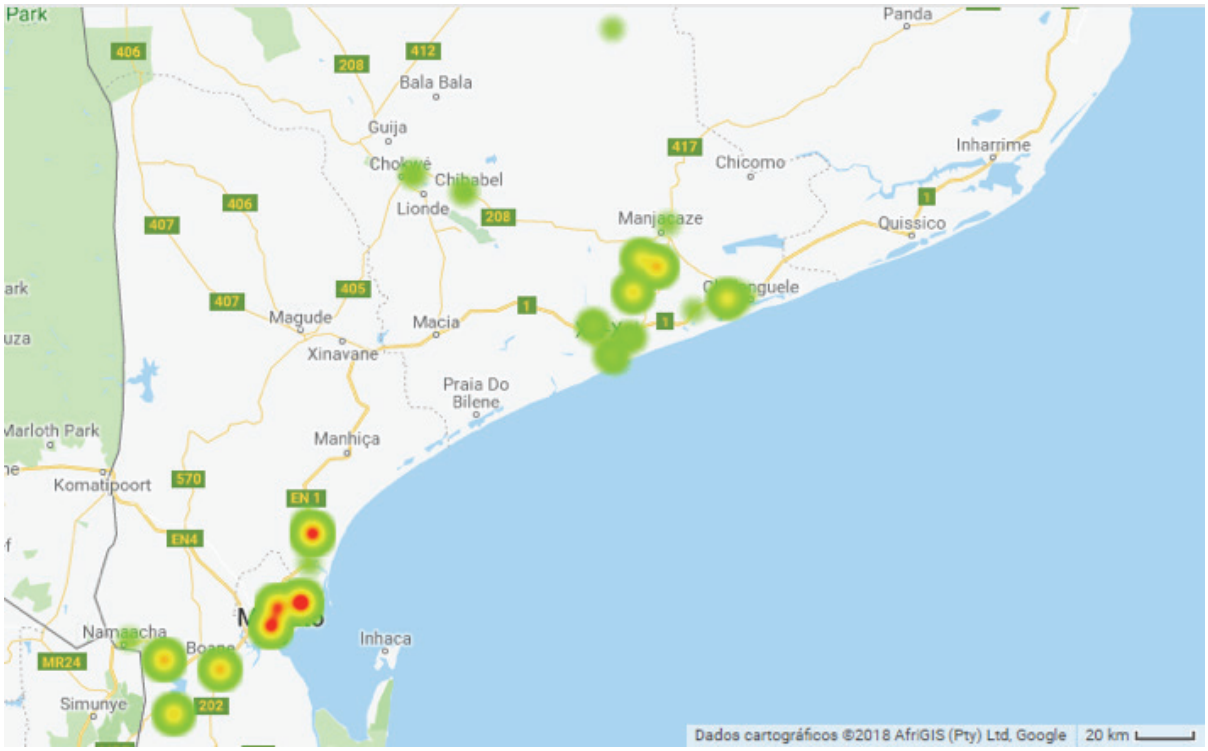
PHOTO 3. Damaged greenhouse. The greenhouse was out of use, but its owner has plans to fix it. It is not known when the greenhouse was damaged.

The coordinates of the greenhouses provided by World Hope were plotted on a map, using Google Fusion Tables. The greenhouses are spread over two provinces of Mozambique's Gaza and Maputo provinces, up to 55 km from Maputo's city center and up to 100 km from the town of Xai-Xai (Gaza). Twenty-five of the 44 greenhouses benefited more than one person, according to World Hope's list. In those cases, more than one individual interview was possible in the same location, regarding the same greenhouse. Map 1 shows the geographical distribution of greenhouses, while Map 2 shows a heat map weighted by the number of people benefited.

The heat map helps show that even though 21 of the listed end users (48 percent) were located in Gaza, they represented a small portion of the people benefited by the greenhouses. This is because greenhouses located in that province were given mostly to individual farmers, while most greenhouses located in Maputo Province were given to farmers' associations. For that reason, about 75 percent of all the people who benefited from the greenhouses in this project were located in Maputo. This distribution helped determine how many interviews researchers conducted in each of the two regions.



MAP 1. Geographical locations of greenhouses included in this project. The 19 blue dots represent greenhouses with only one end user, while 25 red dots represent greenhouses with more than one end user (mainly farmers' associations). Based on information provided by World Hope, with use of Google Fusion Tables. Some of the dots are not visible as they overlap each other.



MAP 2. Heat map of number of end users per greenhouse. The yellow and red colors represent higher concentrations of people. Based on information provided by World Hope, with use of Google Fusion Tables.

Table 1 provides the list of 44 end users, along with the number of interviews conducted or the reasons no interviews took place in that location. In some exceptional cases, group interviews were preferred to individual ones. Reasons for group interviews included (1) people were working together, sharing the greenhouse, and had similar views; (2) the president of the association was more articulate in speaking about the greenhouse than other members; and (3) association members did not speak Portuguese very well or were very shy. Researchers did not reach a few individuals, as shown in Table 1, because of time and logistical constraints.

In Table 1, 23 of the 44 interviewees have "ACDI" before their name; they happen to all be located in Maputo Province. This identifier indicates end users who have received the greenhouses through the partnership between World Hope and ACDI/VOCA. During the development of this study, some of the ACDI/VOCA technicians helped researchers locate and contact some of the associations.

Greenhouses that are still operational currently have the potential to benefit a total of 539 people. Although Table 1 shows the number of members of each association as if they are all benefiting from a greenhouse, the fieldwork proved not all members of an association are directly affected by it. That happens because some associations have decided to give responsibility for greenhouse operation to only one person, and that person ends up selling seedlings to other members. However, it is up to each member to decide whether he or she wants to purchase seedlings from the greenhouse. On the other hand, people who are not members of an association can purchase the seedlings also. So, in fact, it is very hard to precisely quantify how many people are being directly or indirectly affected by greenhouse use.

In total, 47 interviews were conducted and registered. Thirty-seven of them (79 percent) were conducted in Maputo Province, while 10 (21 percent) were conducted in Gaza Province. A statistical analysis of the interviews is presented in Section III: Results.

TABLE 1. LIST OF END USERS THAT HAVE RECEIVED WORLD HOPE'S GREENHOUSES, THEIR LOCATIONS, AND INTERVIEW CONSIDERATIONS. BASED ON DATA PROVIDED BY WORLD HOPE.

#	Name of stakeholder	No. of end users*	Type of stakeholder	Number of interviews	Type of interview	If group interview, number of interviewees	Province
1	Colégio Bíblico Emmanuel Wesleyano	3	School	1	Individual		Gaza
2	Daniel Chavango	1	Person	1	Individual		Gaza
3	Oldemiro Nhantumbo	1	Person	Not reached	-		Gaza
4	Francisca da Cruz	1	Person	1	Individual		Gaza
5	Ana Maria Salvadore	1	Person	1	Individual		Gaza
6	FDM: Fundo de Desenvolvimento da Mulher	2	Non-profit organization	1	Group	1 woman + 2 men	Gaza
7	FDM: Fundo de Desenvolvimento da Mulher	2					Gaza
8	Associação Tsakane	35	Farmers' association	Greenhouse destroyed	-		Gaza
9	Associação Psuka Unhima	7	Farmers' association	Greenhouse destroyed	-		Gaza
10	Associação Eduardo Mondlhane	50	Farmers' association	1	Group	3 women + 1 man	Gaza
11	Associação Tchemulane	27	Farmers' association	Greenhouse destroyed	-		Gaza
12	Domingos Tchemane	1	Person	Not reached	-		Gaza
13	Zefanias Tchauque	1	Person	Greenhouse destroyed	-		Gaza
14	Artur Mucatchua	1	Person	1	Individual		Gaza
15	Balbina Macamo	1	Person	1	Individual		Gaza
16	Ivo Marino Domingos	1	Person	Not reached	-		Gaza
17	Nildo Nhanpossa	1	Person	One big greenhouse found, but owner wasn't there	-		Gaza
18	Nildo Nhanpossa	1			-		Gaza
19	ACDI - Eduardo Mondhlane	81	Farmers' association	2	Individual		Maputo
20	ACDI - Cooperativa 25 de Setembro	52	Farmers' association	1	Individual		Maputo
21	ACDI - Associação 44ha	38	Farmers' association	1	Individual		Maputo

#	Name of stakeholder	No. of end users*	Type of stakeholder	Number of interviews	Type of interview	If group interview, number of interviewees	Province
22	ACDI - Associação Apmona	**	Farmers' association	8	Individual		Maputo
23	Devison Francisco Matias	1	Person	Greenhouse abandoned	-		Gaza
24	Associação Wapsuala	27	Farmers' association	1	Group	8 women + 3 men	Gaza
25	Marcus Alberto Matusse	1	Person	1	Individual		Gaza
26	ACDI - Associação Massacre de Mbusine KaMavota	35	Farmers' association	3	Individual		Maputo
27	ACDI - Assoc. 25 de Setembro	82	Farmers' association	1	Individual		Maputo
28	ACDI - Associação Djaulane	67	Farmers' association	4	Individual		Maputo
29	ACDI - Assoc. Agrícola de Albazine	8	Farmers' association	2	Individual		Maputo
30	ACDI - Assoc. Janete Mondlhane	51	Farmers' association	2	Individual		Maputo
31	ACDI - Assoc. Marcelina Chissano	27	Farmers' association	4	Individual		Maputo
32	ACDI - Assoc. Paz	**	Farmers' association	4	Individual		Maputo
33	ACDI - Marta Ngovene	1	Person	1	Individual		Maputo
34	ACDI - Zaida Chavier	1	Person	1	Individual		Maputo
35	ACDI - Maria Alice	1	Person	1	Individual		Maputo
36	ACDI - Paulo Nhantumbo	1	Person	1	Individual		Maputo
37	ACDI - Kyabo	10	Company	Company shut down	-		Maputo
38	ACDI - Kyabo	10			-		Maputo
39	ACDI - Kyabo	10			-		Maputo
40	ACDI - Kyabo	10			-		Maputo
41	ACDI - Kyabo	10			-		Maputo
42	ACDI - Roberto Buque	2	Person	Moved abroad	-		Maputo
43	ACDI - Lina Cossa	1	Person	1	Individual		Maputo
44	ACDI - Carlos Tembe	1	Person	Not reached	-		Maputo
		665* **		**47**			

*The number of end users was provided by World Hope. This information was not fully checked during the field work, so it has been not updated.

**Numbers were not provided in World Hope's original list.

***Excluding greenhouses that are not operational, the number of beneficiaries is actually 539.

2. Limitations

Any fieldwork has limitations regarding its methodology and the data collected. The information gathered in the field in June 2018 represents how the interviewees felt at that time and cannot be extrapolated to other time periods. After two to three years of the project, 11 greenhouses were not operational and more were damaged, but it is not possible to predict how many will continue operating in the coming years.

Some greenhouses were empty, and it was not possible to know how often farmers had been using them. A few farmers reported that they were not currently using the greenhouses because they needed to repair them or they lacked specific input (e.g., substrate to plant seedlings). Since the questionnaire did not include whether and how often the greenhouses were used, this was observed but not registered during the field work.

By the time this study was conducted, World Hope International had closed its operations in Mozambique. Two local former employees of the NGO were contacted. However, because they were no longer working for the NGO, this limited the amount of time and information they were willing to share, and it was one of the difficulties faced during the evaluation.

Another limitation was the reduced number of greenhouses that were still operational (33). To achieve a statistically significant number of interviews, more than one interview had to be conducted regarding the same greenhouse. This probably caused some overlap in the data collected, as the practices for one greenhouse are repeated in some interviews. Also, it was not possible to make a random sample of the greenhouses, because all of them were important for the result. Instead, randomization was achieved through the inaccessibility of some greenhouses and owners, and by the people available on the farms at the time they were visited.

III. RESULTS

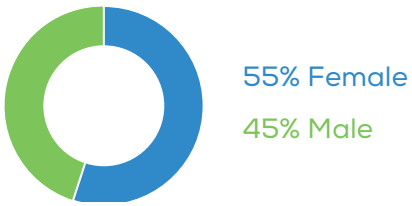
A. BACKGROUND

This section presents results that characterize the sample of farmers interviewed. Gender, occupation, and farming methods are addressed.

1. Gender

During the fieldwork, it was noted that the majority of respondents were women in agriculture, especially in the farmers' associations. This observation was reflected in the sample for this study, in which 55 percent (24 of 44) of the farmers interviewed were women (Graph 1). Photo 4 shows a large group of female farmers who belonged to Associação Tchemulane.

GRAPH 1. GENDER OF FARMERS INTERVIEWED
n=44



Farming land is locally called "*machamba*". After the socialistic revolution in Mozambique, the land was owned by the state and given to communal production. Women had an important role in leading cooperatives in *machambas*. In Mozambican society, women are the food providers in households and represent the greatest number of farmers.[1] Therefore, the large number of women in agriculture observed in the field is consistent with the country's reality.

Photo 4. Women from Associação Tchemulane listen to Daniel Chavango, former employee of World Hope. By the time of the study, this association's greenhouse already had been destroyed.

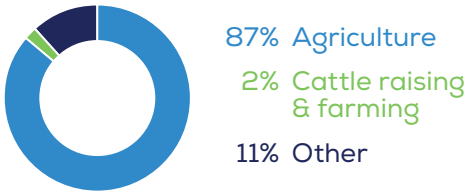
1 Vicente Eudes Lemos Alves, "A questão agrária brasileira e moçambicana: semelhanças e diferenciações," *GEOUSP: Espaço E Tempo 0, no. 29 (2011): 57-74, Directory of Open Access Journals, EBSCOhost* (accessed September 10, 2018).

2. Primary and secondary livelihoods

The majority of end users interviewed (40, or 87 percent) worked in agriculture as their primary livelihood, as shown in Graph 2 below. One person (2 percent) raised cattle and farmed as a primary source of income. Five people (11 percent) had other occupations as their main source of income: government employee, school teacher, unemployed business manager, retired NGO manager, and NGO employee. Those five people relied on farming as a secondary livelihood, and most had more than two occupations or sources of income. They also seemed to have a higher level of education.

GRAPH 2. PRIMARY LIVELIHOODS OF GREENHOUSE USERS

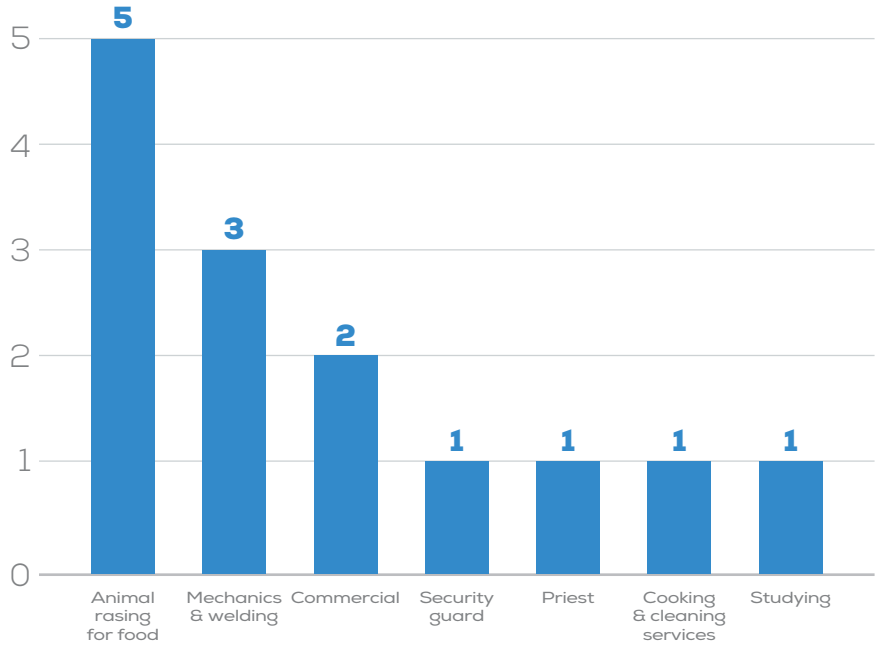
n=46



Out of the 41 farmers (including the cattle rearer) for whom agriculture is their primary livelihood, 13 of them, or 32 percent, also declared a secondary source of income. The secondary livelihoods are presented in Graph 3 below. The most common alternative source of income was raising animals (chicken, ducks, pigs, goats, rabbits) for food (5; 38 percent).

GRAPH 3. SECONDARY LIVELIHOODS OF FARMERS

n=14



3. Subsistence farming and commercialization

The researchers asked farmers how much of what they produced was consumed within their households and how much they sold. Graph 4 shows that 86 percent of the farmers (37) sold most of the crops they harvested (more than 70 percent of production). Three farmers (7 percent) sold between 40 percent and 60 percent of their production, while another three mostly consumed what they produced (subsistence farming). Field observations showed that farmers, even if their main purpose was selling their produce, would always retain a small portion of food for their families. Most farmers argued that that they produced too much to use harvests solely for family consumption.

GRAPH 4. MAIN PURPOSE OF FARMERS' PRODUCTION

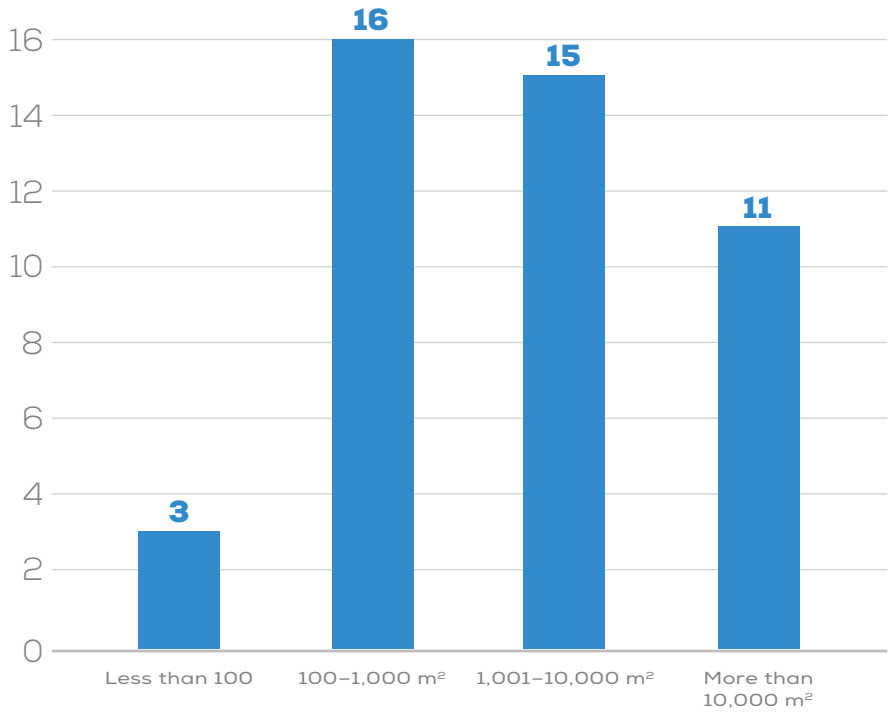
n=43

4. Farm size

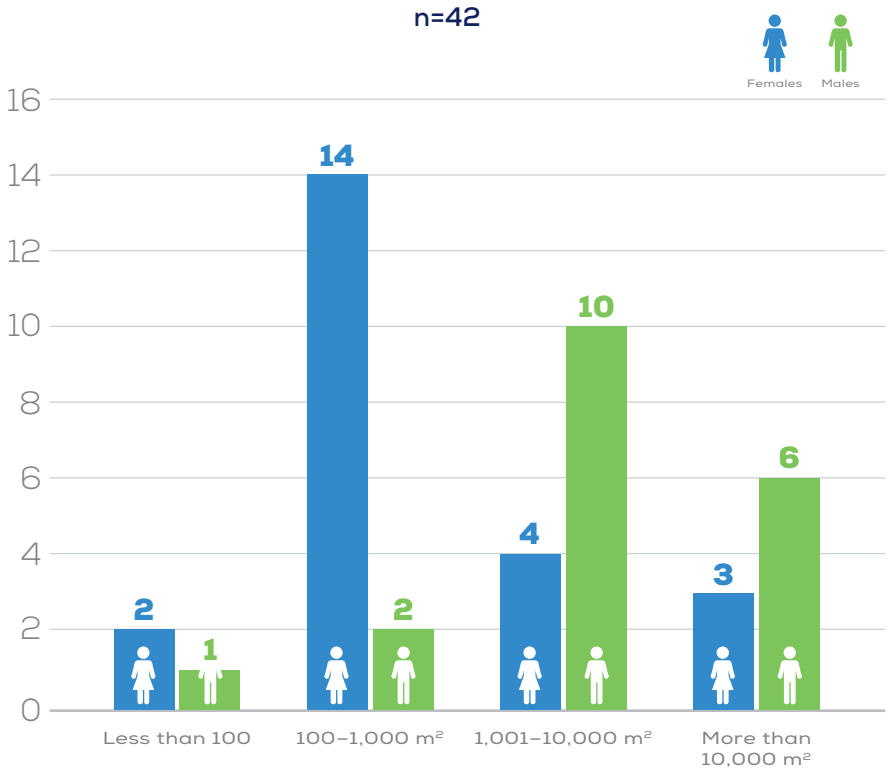
Graph 5 shows the categorized results of farm size. The majority (76 percent) of respondents have farms smaller than 1 hectare (10,000 m²). Thirty-six percent of the farmers (16 out of 45) have farms between 100 and 1,000 m², and 33 percent (15) have farms between 1,001 and 10,000 m². The average farm size is 11,042 m² and the median is 2,000 m². Women interviewees have smaller farms than men: 16 out of 23 women (36 percent of 45 respondents) have farms smaller than 1,000 m², while 16 out of 19 men (36 percent) have farms bigger than 1,000 m², as shown in Graph 6.

GRAPH 5. NUMBER OF FARMERS BY FARM SIZE

n=45



GRAPH 6. NUMBER OF FARMERS BY GENDER AND FARM SIZE

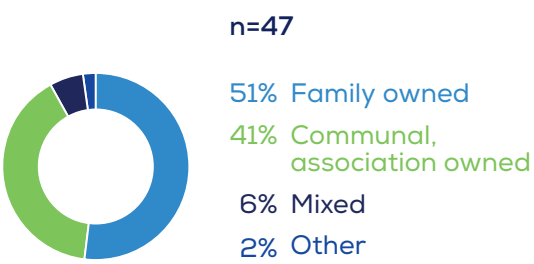


5. Land ownership

In Mozambique, due to its socialist heritage, the land belongs to the state. Farmers and cooperatives can claim possession of the land, but not ownership. When farmers were asked to whom the land belongs, the answer was often dubious, as associations might be formed around *machambas* that belong to each farmer, or associations might own land that is divided between the members. The results shown in Graph 7 likely are not precise, because no possession documents were verified during the field visits.

Land belongs to farmers or their families for 51 percent of interviewees (24). Forty-one percent of farmers (19) said they work at communal *machambas*, which often belong to their farmers' associations. Three farmers (6 percent) had mixed ownership: Part of their land was their property, while the other part belonged to an association. One interviewee (2 percent) was paid as an employee to work on someone else's land without possessing any of it.

GRAPH 7. LAND OWNERSHIP OR POSSESSION

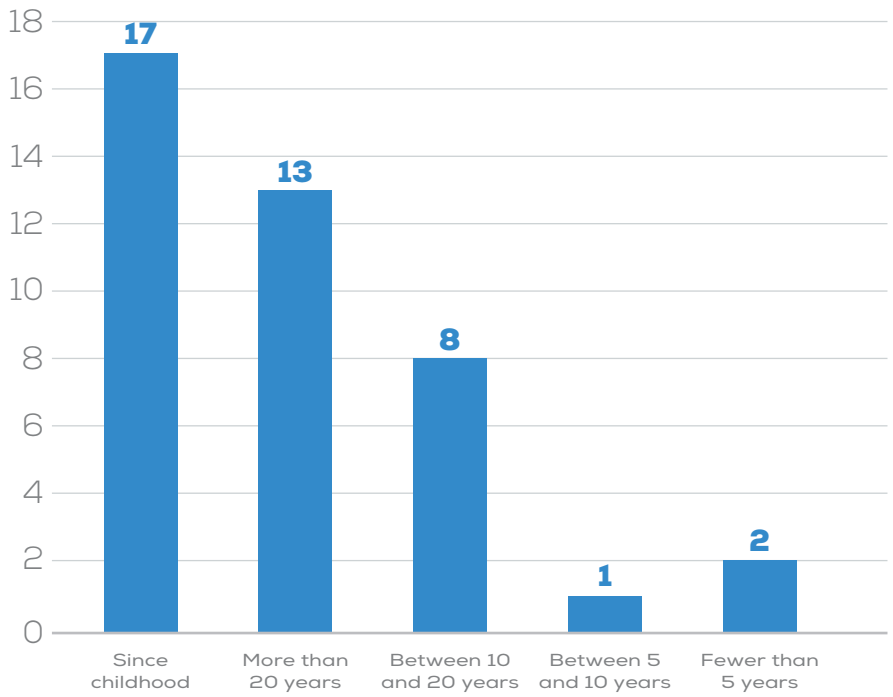


6. Farmers' experience

All farmers interviewed had worked in agriculture before they received the greenhouses. Graph 8 shows that, overall, interviewees had a lot of experience in farming (more than 10 years for 93 percent of them). Forty-one percent of the farmers (17) had worked in agriculture since childhood, and 32 percent (13) had farmed for more than 20 years. In contrast, only one interviewee (2 percent) had been farming for five to 10 years, and two (5 percent) had farmed for fewer than five years.

GRAPH 8. FARMERS' AGRICULTURAL EXPERIENCE

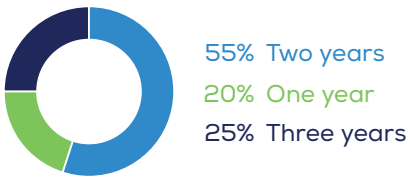
n=41



The greenhouses were built between 2015 and 2017, so farmers had been using them for between one and three years. As shown in Graph 9, the majority of farmers interviewed used the greenhouses for two years (24; 55 percent). Only nine farmers used the greenhouses for one year (20 percent) and 11 for three years (25 percent). Of the nine farmers interviewed in Gaza Province, five of them (56 percent) used the greenhouses for three years. This is probably because World Hope's office is located in Xai-Xai and the project started from there, then later expanded to Maputo province and capital.

GRAPH 9. LENGTH OF TIME FARMERS HAD BEEN USING THE GREENHOUSES

n=44

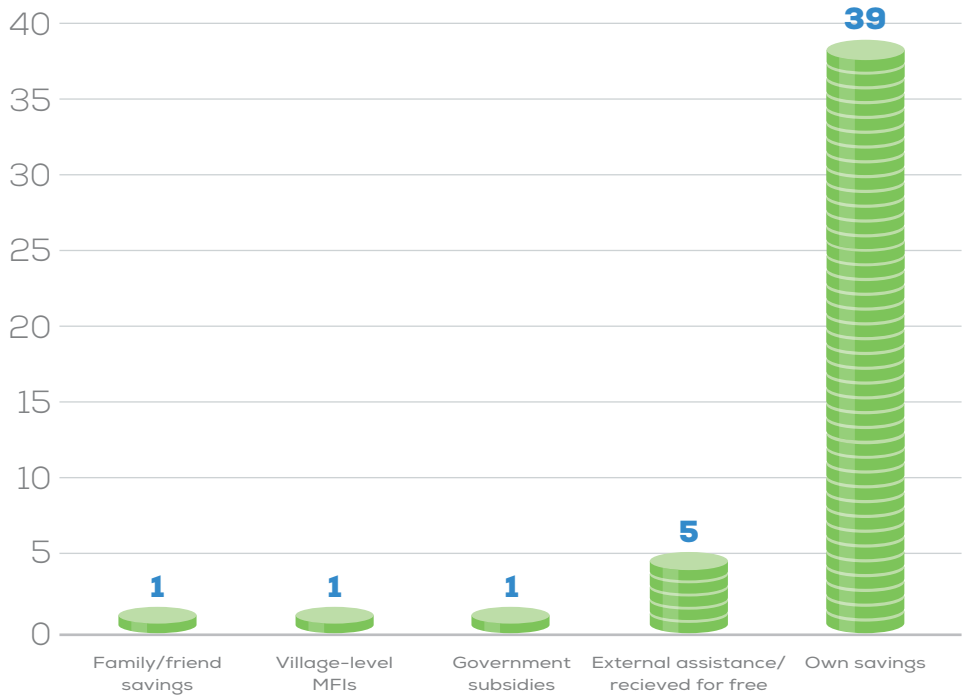


7. Financing of agricultural activities

As presented in Graph 10, all respondents said they rely on their own savings to finance agricultural activities (39). Five farmers (13 percent) claimed they also received some sort of external assistance, usually agricultural inputs (e.g., seeds) donated by NGOs. Only 3 percent of the farmers relied on savings from friends and family, loans from micro-finance institutions, or government subsidies. Overall, farmers reported they do not get support from the government and they prefer not to get loans from banks.

GRAPH 10. SOURCE OF FINANCE FOR AGRICULTURAL ACTIVITIES

n=39



B. EXPERIENCE WITH INNOVATION

The low-cost greenhouses can be considered a farming tool. Farmers have used them in different ways, with varying degrees of success. Farmers received some orientation or training about the benefits of the greenhouses, and, in some cases, about how to grow seedlings in trays. The cultivation techniques used in the greenhouses are: growing directly in the greenhouse soil (Photo 5); growing seedlings in trays (Photo 6); and growing lettuce using hydroponics (Photo 7). The technique used in each greenhouse was, in fact, not the farmer's choice. World Hope and ACDI/VOCA have not provided trays and substrate for all farmers, and only two greenhouses were awarded the hydroponics system.

There were also differences in the work dynamics of those who used the greenhouses that belonged to associations and cooperatives. In most cases, the association would nominate a member to oversee the greenhouse. That person usually would be someone who actively engaged in the association's activities and was interested in learning new techniques. The greenhouse supervisor then would use his or her own money and effort to grow seedlings in the greenhouse and sell the seedlings to other farmers, members of the association, or nonmembers.

In some cases, the greenhouse was shared among more people, or the association members would work on it together, as a commonly owned resource. The work dynamic was, therefore, a choice of each association that received the greenhouse. In this study, it was possible to include the different usage configurations of the greenhouses, including seedling producers and buyers.

PHOTO 5: Crops planted directly in the greenhouse soil. Farmers often either grew seedlings to be transplanted outside or grew tomatoes, which are sensitive to weather variations.

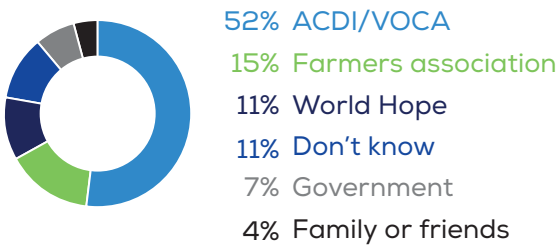
PHOTO 6: Seedlings planted in trays. Each tray has approximately 200 spaces, so the greenhouse's capacity is bigger with this technique, compared with planting directly in the soil. A huge variety of crops were planted as seedlings. Most of the greenhouses visited by the researcher used this technique.

PHOTO 7: Hydroponics system. Water is pumped from a water tank into the blue pipes. No soil is needed, and less fertilizer and pesticide usually were used. The quality of the water has to be controlled, but the system is a closed circuit. The two farmers who used this system were growing lettuce only.

Graph 11 shows how farmers became aware of the project. The majority of farmers interviewed (52%) were informed about the project by ACDI/VOCA (24). Seven (15%) were informed by the association to which they belonged, five (11%) were informed by World Hope, and another five did not know or could not remember the name of the organization that informed them.

GRAPH 11. HOW FARMERS BECAME AWARE OF THE PROJECT

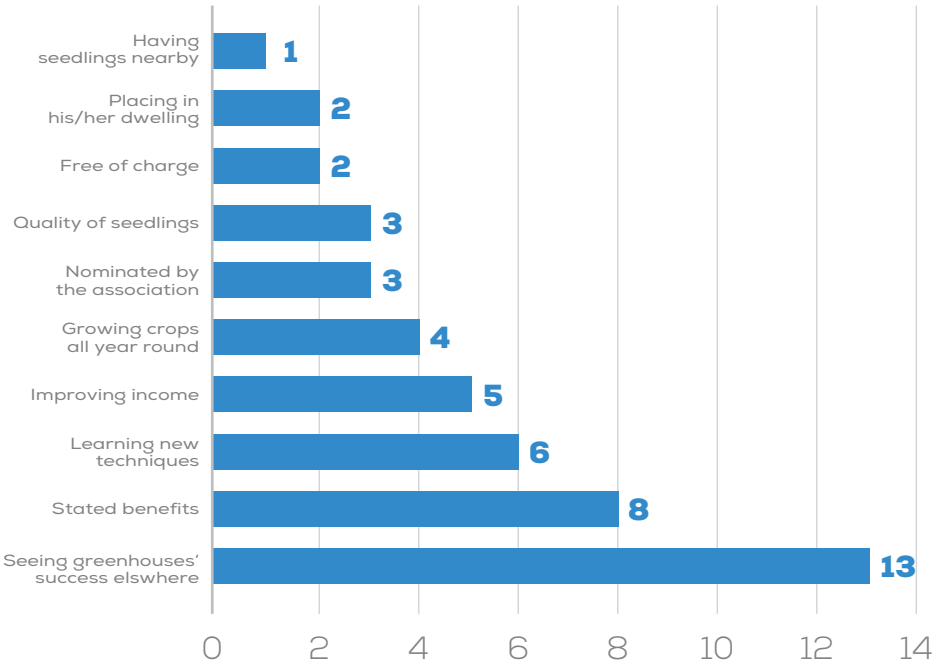
n=46



Once informed about the GRO project, farmers had different reasons why they accepted the greenhouses (Graph 12). Of a total 42 farmers, 13 (31 percent) had seen a greenhouse before in previous work experiences or on other farms nearby or abroad. Eight of the farmers (19 percent) were convinced of the greenhouse's benefits once World Hope or ACDI/VOCA explained them. Fewer people were motivated by specific benefits, such as an opportunity for learning (6), improving their income (5), and growing crops all-year round (4). Three farmers were nominated to be greenhouse supervisors by the association they belonged to, while another three chose to purchase the greenhouse seedlings because of their high quality.

GRAPH 12. WHAT INFLUENCED FARMERS TO AGREE TO USING THE GREENHOUSE/ PURCHASING SEEDLINGS

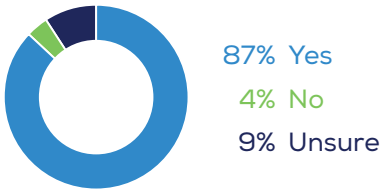
n=42



The farmers interviewed seem to be satisfied with the greenhouses, as 87 percent of them (40) plan on continuing to use or invest in them. Four farmers (9 percent) were unsure, while two (4 percent) stated they would not use them in the future. Graph 13 presents these results.

GRAPH 13. CONTINUITY OF GREENHOUSE USE

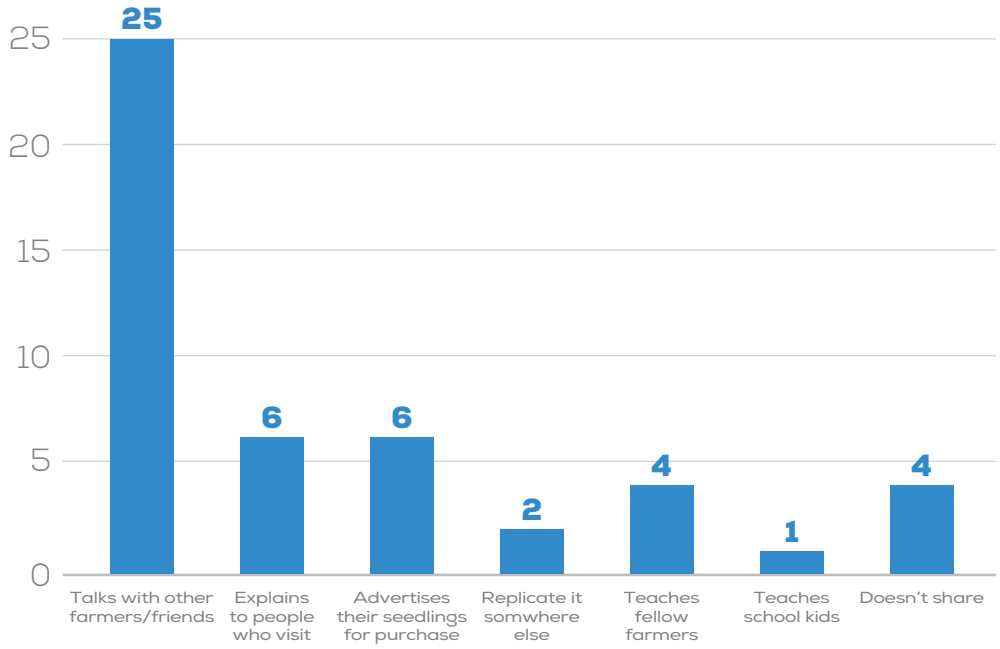
n=46



Farmers showed an overall willingness to share the knowledge they gained about the greenhouses. Only 8 percent of the interviewees (4) did not share information with other people, as shown in Graph 14. The majority of farmers (31) mention the greenhouses and their benefits to other farmers, friends, family and people who visit. To get customers, six farmers advertised the seedlings they produced. Fewer farmers collaborated and engaged in other methods of knowledge-sharing: receiving visitors interested in the greenhouse (6), teaching the techniques to other farmers (4) and school kids (1), and replicating the project by suggesting or helping build greenhouses for farmers elsewhere (2).

GRAPH 14. HOW FARMERS SHARED KNOWLEDGE AND INFORMATION ABOUT THE GREENHOUSES

n=48



C. BENEFITS OF INNOVATION

1. Benefits overview

Farmers were asked to explain what benefits they gained from using the greenhouses. Most mentioned more than one benefit, and they gave a variety of answers. All the benefits mentioned by farmers, along with the frequency of each response, can be found in Table 2.

Of the 47 interviewed farmers, almost half (22) mentioned that crops grow stronger, more resistant, and more likely to survive inside the greenhouse. That is related to the greenhouse providing a controlled climate for the crops' growth; the walls are a physical barrier against strong sun, winds, and heavy rains. The humidity and temperature inside the greenhouse usually are maintained at a more constant level, which benefits the crops' growth. Thirty-eight percent of the farmers (18) mentioned the greenhouse protects their crops against weather variations and climate change. This aspect of the greenhouses allows farmers to grow their crops throughout the whole year, regardless of the season, according to 17 percent of the farmers (8). Reportedly, few farmers are able to grow food during summer due to excessive heat, extreme temperatures, and water scarcity. Keeping humidity inside the greenhouses saves water, as 21 percent of the farmers (10) mentioned. Farmers need to water the crops inside the greenhouses fewer times per day than crops grown outside.

The greenhouses' controlled climate also contributes to faster growth, according to 32 percent of the farmers (15). Crops produced inside the greenhouses were of better quality for 34 percent of the interviewees (16). The greenhouses are a physical barrier against pests for 30 percent of the farmers (14), and against invading animals for 6 percent of the farmers (3).

Twenty-one percent of the respondents (10) perceived the possibility of growing seedlings in trays inside the greenhouses as a benefit. That technique requires that one seed be placed in each hole of a tray, along with substrate. The tray, therefore, contributes to farmers saving seeds, as 17 percent (8) stated, compared with planting seeds directly in the soil where some seeds do not develop into plants. It was reported that, when seedlings are transplanted to the soil outside of a greenhouse, the substrate also is transplanted so there is less damage to the roots. Seedlings from the greenhouses are of better quality and less vulnerable to weather variations even after being transplanted. Because of that, some farmers and associations are able to sell seedlings, and 13 percent of the farmers (6) saw this additional income as a benefit. One association even rented their greenhouse when they were not using it.

TABLE 2. PERCEIVED BENEFITS FROM THE GREENHOUSES, AND FREQUENCY OF RESPONSES

Perceived benefits	Frequency (absolute / %)	
Crops grow stronger and more resistant	22	47%
Controlled climate; protected from weather variations	18	38%
Better quality of produce	16	34%
Crops grow faster	15	32%
Easier pest control; protected from pests	14	30%
Saves water	10	21%
Possibility of growing seedlings in trays	10	21%
Possibility of growing food in all seasons of the year	8	17%
Saves seeds	8	17%
Learning new practices	8	17%
Source of income (selling seedlings or renting the greenhouse)	6	13%
Safer; reduces uncertainty about farming; fewer losses	5	11%
Increased productivity; efficiency	5	11%
Less pesticide	4	9%
Broader impact, ability to help other farmers	4	9%
Protected from animals nearby (chickens, dogs, etc.)	3	6%
Increases hope and motivation among farmers	3	6%
Better customers (hotels, restaurants) with hydroponic system	2	4%
Saves money	1	2%
Saves time	1	2%
Less work	1	2%
Provision of healthy food	1	2%
Grow different crops from before	1	2%
Possibility of selling produce before others (crops grow faster)	1	2%
Good price for seedlings from the greenhouse	1	2%
Learning tools for new or potential farmers; e.g., school children	1	2%
Greenhouse use independent of organization that provided it	1	2%
Good reputation for the farmers' association	1	2%
Avoids gene-crossing by wind; crops are purer	1	2%
Cleaner production; farmer doesn't get dirty	1	2%

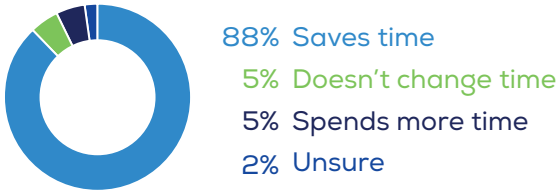
Seventeen percent of interviewees (8) were happy to be learning new practices with the greenhouses. Nine percent of the respondents (4) said the knowledge they gained and the technology itself created a broader impact, affecting other farmers positively. Eleven percent (5) of the farmers believed the greenhouses caused fewer losses and represented more certainty that what was being planted would be harvested. Higher confidence increased hope and motivation for 6 percent of the farmers (3). Other relevant benefits: increased productivity or efficiency (5 farmers, or 11 percent) and reduced use of pesticide (4 farmers, or 9 percent). See other benefits mentioned by one or two farmers on Table 2.

2. Agricultural activity benefits

Changes in agricultural activities were measured by asking farmers how much the greenhouses changed the amount of time they dedicated to agriculture. See results in Graph 15. For 39 farmers (89 percent), the greenhouses saved time. Two farmers declared they spend more time in agriculture, because they have to work both at the greenhouse and at their own farms. Two other farmers did not feel the greenhouses changed the amount of time they spent in agricultural activities, and one farmer was unsure about it.

GRAPH 15. PERCEIVED CHANGES, WITH GREENHOUSE, IN AMOUNT OF TIME SPENT IN AGRICULTURE

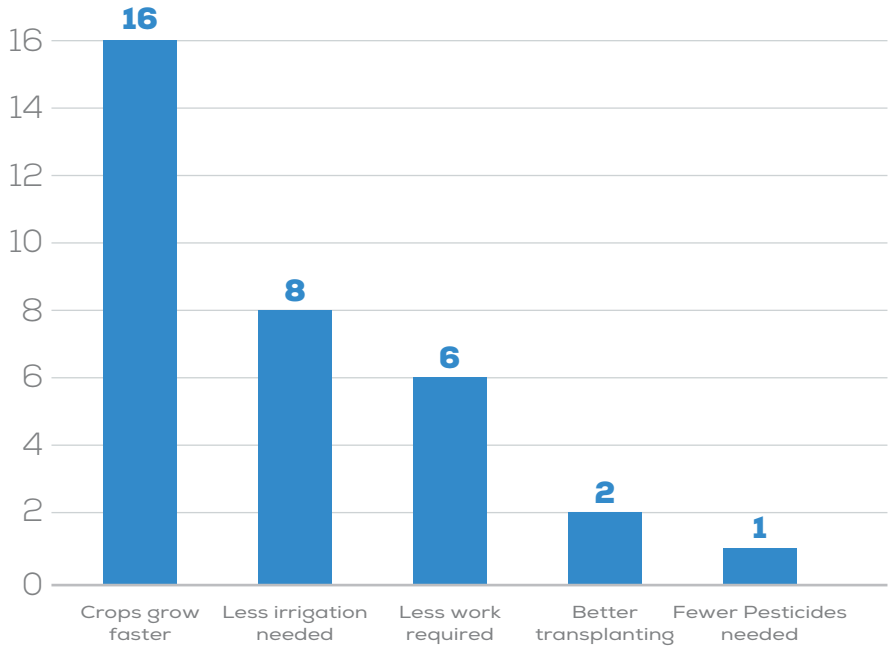
n=44



Of the 39 farmers who said the greenhouses save time, 31 gave reasons why they think so. Most farmers (16) believe the greenhouses saved time because crops grew faster and therefore produced harvests earlier. Eight farmers (26 percent) said they save time because less irrigation is needed. Nineteen percent of the farmers (6) feel that operating the greenhouses is relatively easy and therefore requires less work. Two farmers feel they save time when transplanting seedlings, because the plants are damaged less and require less time to recover and continue growing after being transplanted. One farmer also saves time by not using as much pesticide.

GRAPH 16. REASONS THE GREENHOUSES CONTRIBUTE TO SAVING TIME

n=44



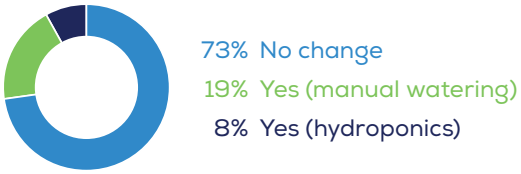
3. Water benefits

The water sources for interviewed farmers ranged from borewells, rivers, and dams, to the public water supply. Most farmers used watering cans to manually irrigate their crops, while some rely on gravity through irrigated canals excavated in the soil. Watering inside the greenhouses is done manually, because of its reduced size, except for the two greenhouses that have an automated hydroponics system. Most farmers do not pay for water; the exceptions are when they pay for public water service or when they pay a small fee to the farmers' associations to maintain a well or for fuel/electricity to run the pumps. Some farmers complained about water scarcity, especially during the summer.

Using the greenhouses did not cause a major change in irrigation method, as Graph 17 shows. Only around a quarter of the respondents began using a different irrigation method with the greenhouses – either hydroponics (3) or manual watering (7). Twenty-seven farmers (73 percent) did not change their irrigation method after the greenhouses were built.

GRAPH 17. CHANGES IN IRRIGATION METHOD AFTER GREENHOUSES WERE BUILT

n=37

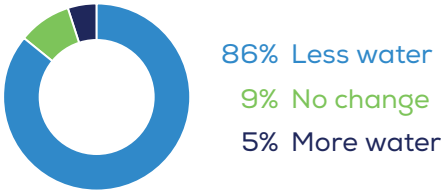


As shown in Graph 18, most of the farmers interviewed (37; 86 percent) said watering crops in the greenhouses required less water than usual. Two farmers (5 percent) believed they were using more water with the greenhouses, but that may be because they use tap water in the greenhouses (and therefore have to pay for water) but not for crops on their open-air land. Three farmers (7 percent) did not see changes in water consumption related to the greenhouses.

Of the farmers who said they saved water, seven saved up to 50 percent of the water they used for crops, and one saved 25 percent (Graph 19). This calculation is based on the fact that farmers had to water the greenhouses two times less frequently than the rest of their farms. Nevertheless, 78 percent of the farmers who perceived water savings could not estimate how much water was saved (29).

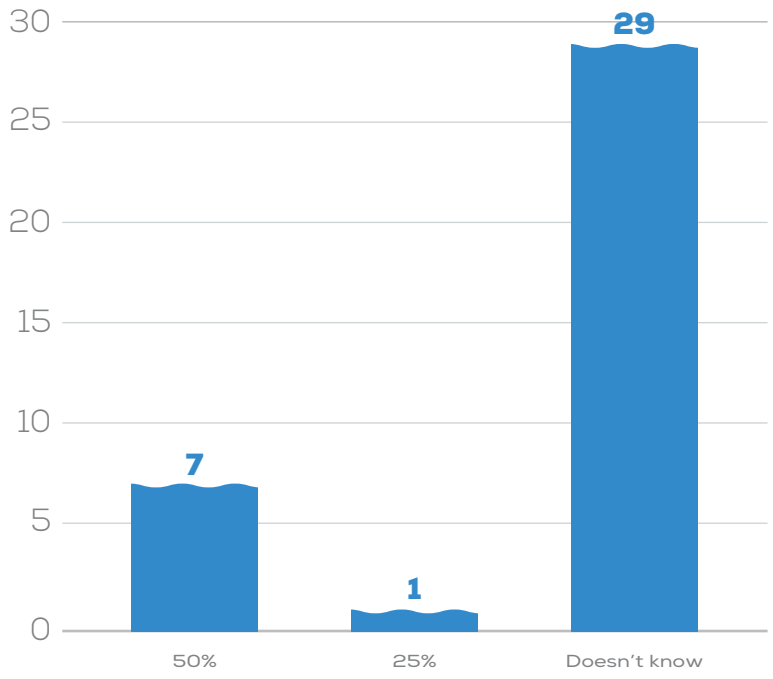
GRAPH 18. CHANGES IN WATER CONSUMPTION AFTER GREENHOUSES WERE BUILT

n=43



GRAPH 19. WATER SAVINGS AFTER GREENHOUSES WERE BUILT

n=37

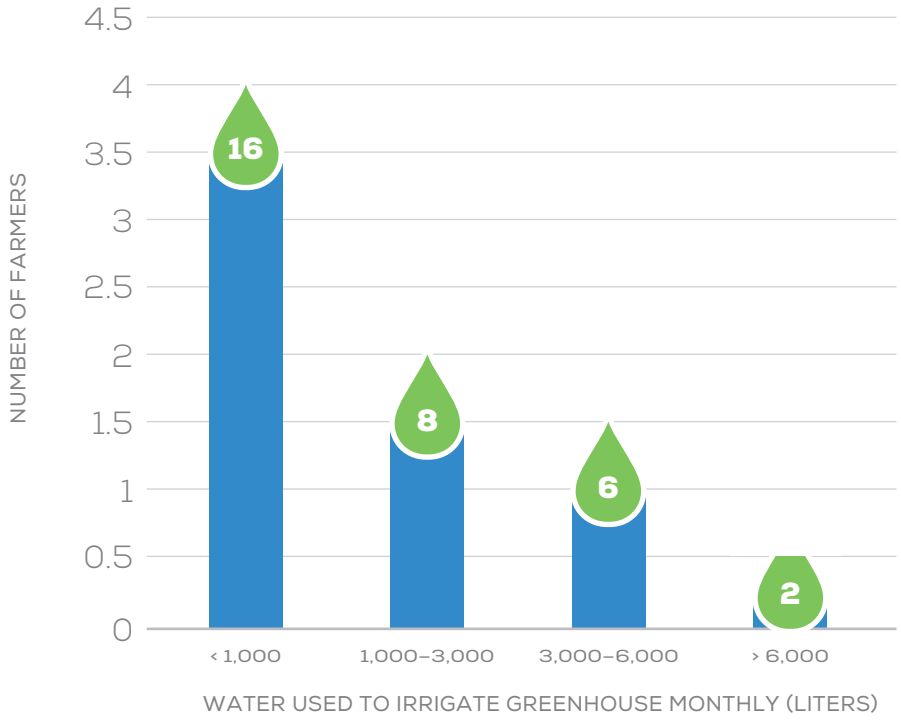


Comparing amounts of water used in the greenhouses and in the *machambas* is complicated, because planting techniques in both situations can differ (e.g., planting seedlings in trays takes a lot less space than growing crops directly in the soil). Imprecise water consumption measurements also are caused by variability in watering practices by season. Farmers might water their crops once every two days or up to three times per day. For the calculations, higher values are used to overestimate rather than underestimate monthly water consumption.

The greenhouses were the same size (33 m^2), but the amount of water used by farmers differed, ranging from 167 to 15,000 liters per month. Graph 20 shows distribution of water consumption in the greenhouses, as reported by 13 farmers. Based on their answers, the average amount of water used was 3,875 liters per month, and the median is 2,400 liters.

GRAPH 20. AMOUNT OF WATER USED PER MONTH TO IRRIGATE CROPS INSIDE THE GREENHOUSES

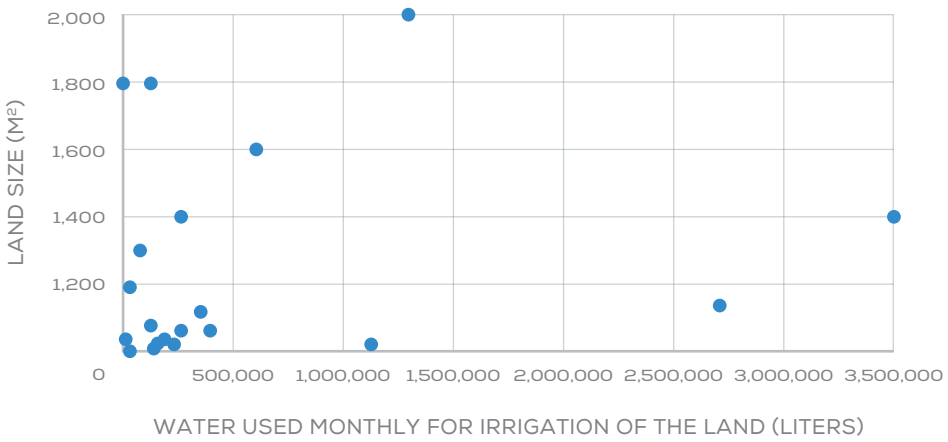
n=13



The amount of water used in the *machambas* varied from farmer to farmer, probably according to size of land, type of crops, water availability, and knowledge/common practices. Graph 21 presents a scatter plot of the amount of water used per month and the respective land area. Values range from 4,500 liters to 3,600,000 liters per month. The average monthly amount of water used to water *machambas* is 510,706 liters, and the median is 198,000 liters.

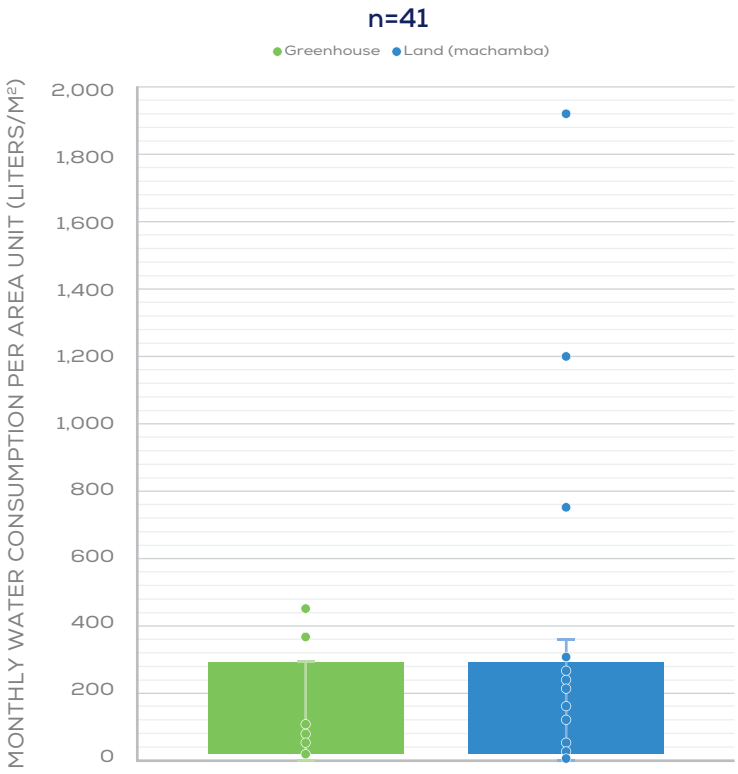
GRAPH 21. AMOUNT OF WATER USED PER MONTH TO IRRIGATE CROPS IN MACHAMBAS, BY LAND SIZE

n=21



To more precisely compare water consumption for both situations (greenhouse and *machamba*), researchers normalized the amount of water used by the irrigated area. Graph 22 shows that the greenhouses were more water-effective than open-air land, although different practices influence land-use efficiency in each of the situations. Greenhouses consume an average 117 liters/m² of water, while land requires an average 284 liters/m². Therefore, on average, greenhouses save 59 percent of water in comparison with open-air land for irrigating the same area.

GRAPH 22. COMPARISON OF WATER CONSUMPTION

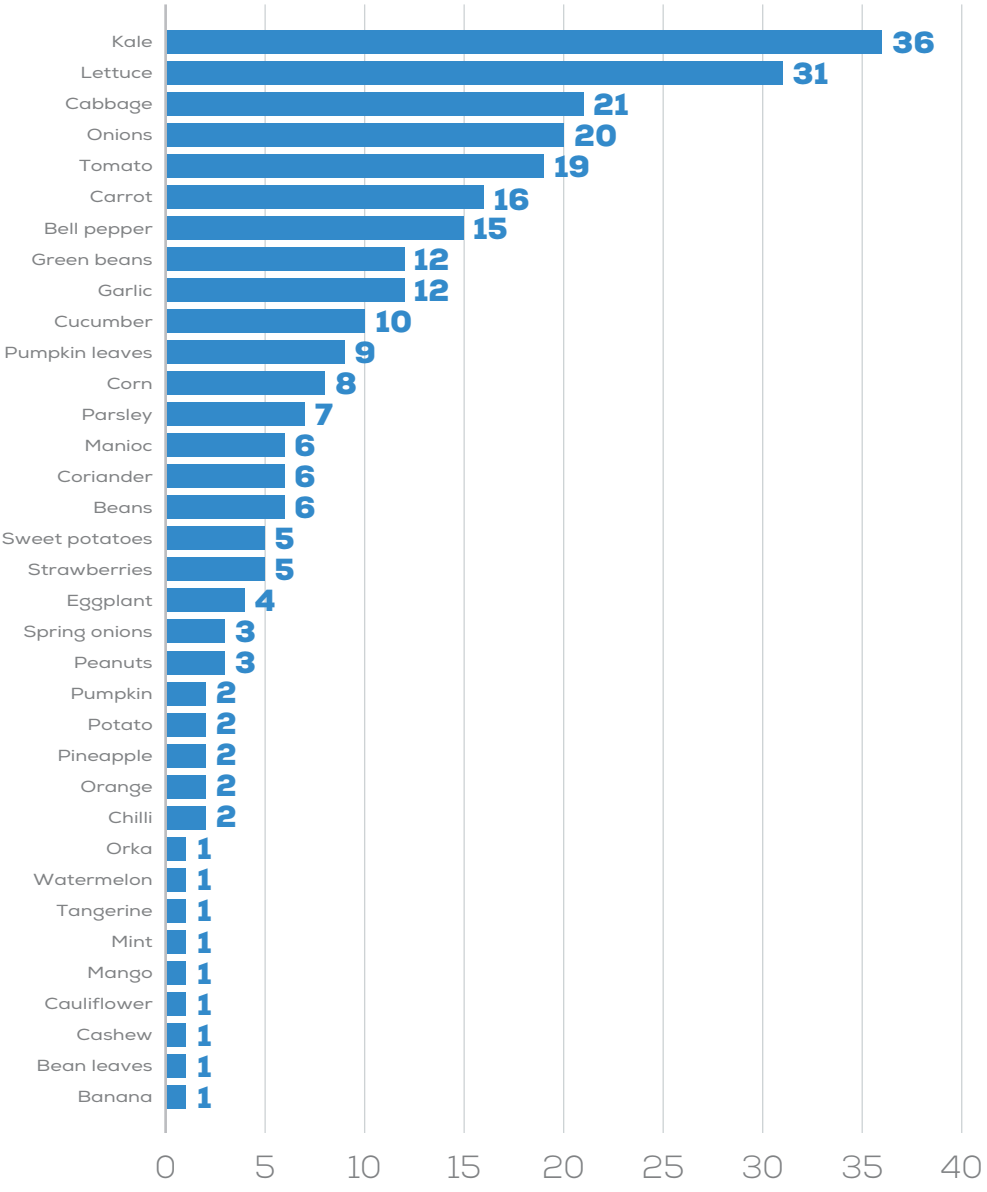


4. Crop benefits

To measure potential diversification of crops the greenhouses might have led to, farmers were asked to recall which crops they grew before they received the greenhouses. As shown in Graph 23, 82 percent of the farmers grew kale (36) and 70 percent grew lettuce (31). Other important crops were cabbage (48 percent), onions (45 percent), tomatoes (43 percent), carrots (36 percent) and bell peppers (34 percent). Most farmers interviewed relied on at least four different crops, which may have contributed to their food security.

GRAPH 23. NUMBER OF FARMERS WHO USED TO GROW EACH TYPE OF CROP, BEFORE GREENHOUSES

n=44



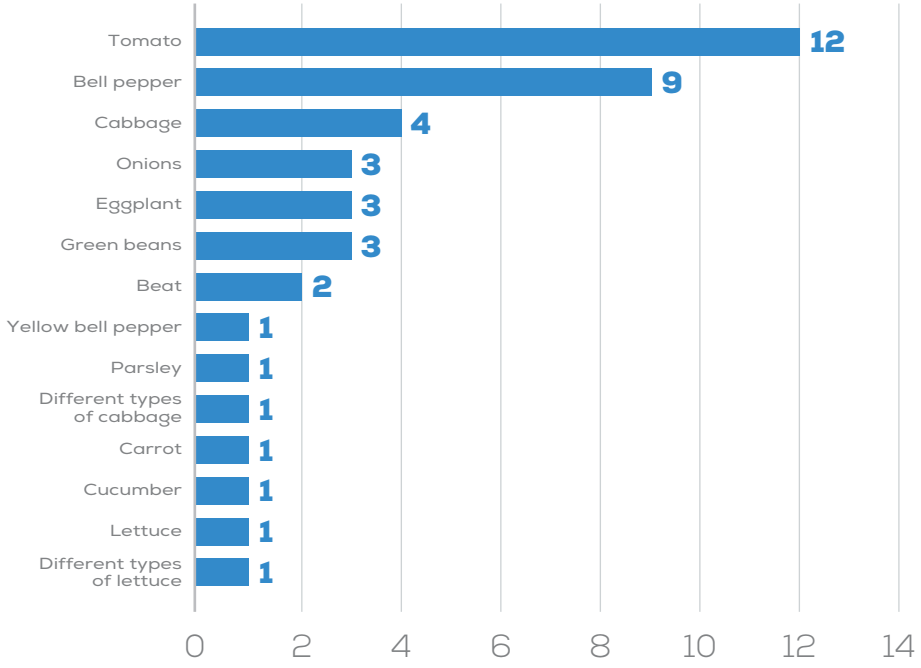
The arrival of the greenhouses allowed some farmers to grow crops they had not grown before. As shown in Graph 24, 19 farmers (44 percent) started growing something new. Most of those farmers started growing tomatoes and bell peppers after the greenhouses were built (see Graph 25). The farmers said those two crops are more sensitive to weather variations and pests, and the fact that the greenhouses were expected to provide benefits in those two areas made them confident enough to start growing them. Reportedly, tomatoes and bell peppers are also more valuable than other crops in the market. Other crops adopted by more than one farmer included cabbage, onions, eggplants, green beans, and beets.

GRAPH 24. NUMBER OF FARMERS WHO DIVERSIFIED CROPS AFTER RECEIVING THE GREENHOUSES

n=44

GRAPH 25. DIVERSIFICATION OF CROPS AFTER GREENHOUSES WERE BUILT

n=19



Measuring whether the greenhouses increased farmers' yields is difficult, especially considering that most of them transplanted seedlings from the greenhouses to open-air lands outside of the greenhouses. In those cases, the products of the greenhouses still were not ready for consumption or sale, so there is no sense in attempting to measure seedlings production in kilograms or bags.

Also, measuring and taking note of farming yields is not a common practice among farmers interviewed. To some extent, they could estimate what they recently produced in terms of kilograms, boxes, or "*canteiros*" – the smaller portions into which farmers divide their land, where they usually plant the same crop. The number and size of *canteiros* varied according to the farmers and the size of their land. Even though it was easier for farmers to recall how much they earned for each *canteiro*, it is a very imprecise way of measuring their produce, because there is not a universal *canteiro* measurement.

Of the 47 farmers interviewed, only nine could precisely state production yields from the greenhouses. Their reported values are presented in Table 3. It is important to note that these were the values farmers kept track of, recalled, or estimated, so the numbers might be imprecise.

TABLE 3. PRODUCTION FROM THE GREENHOUSES, PER SEASON OR MONTH

Farmer	Amount	Unit	Crop	S/M
1	700	kg	Tomato + cucumber	Season
2	100	kg	Tomato	Season
2	600	kg	Green beans	Season
3	50	kg	Tomato	Season
4	100	boxes	Tomato	Month
4	350	kg	Bell peppers	Month
5	100	kg	Tomato	Season
5	20	kg	Bell peppers	Season
5	50	kg	Eggplant	Season
6	50	kg	Carrot	Season
6	200	kg	Cabbage	Season
7	1,400	kg	Cabbage	Season
8	4,000	kg	Cabbage	Season
9	400	units	Lettuce (hydroponic)	Month

In one group interview, farmers said they had not managed to produce anything from the greenhouses. Two farmers said the greenhouses increased production yields. Three farmers declared that their yields were not influenced by the greenhouses, because they produced seedlings to sell rather than harvested crops. Each tray had between 200 and 250 holes for seedlings, and greenhouses usually had between 40 and 100 trays. Therefore, seedling production capacity varied from 8,000 to 25,000 seedlings.

In addition, some of the farmers interviewed were not directly engaged in producing in the greenhouses, but rather purchased seedlings from greenhouse owners. For example, one farmer purchased four trays of tomato seedlings (800 plants total) and 12 trays of cabbage seedlings in September 2017, and then purchased four trays of tomato seedlings in 2018.

5. Income benefits

As with yields, the farmers did not keep close track of how much they earned and spent. The information obtained mainly was based on what farmers could recall about what they had sold recently or up to one year before. The easiest way to get the information was to ask how much they would earn for selling one *canteiro* or one kilogram of each crop, and from there calculate the amount produced. However, in some cases, farmers would state the total amount they earned in a month or a season.

Prices per *canteiro* differed depending on the season. During the summer, fewer farmers are able to produce food, owing to the extreme heat and reduced water availability. Summer prices are higher, because less produce is offered. Values can range from 50 to 700 meticais per *canteiro*, depending on the crop, its condition/quality, and the season. Researchers calculated per-*canteiro* prices using average price and average yield data provided by each farmer.

Seedling prices ranged from 1 to 2.5 meticais per plant. Farmers also would discount prices for a whole tray (244 seedlings), ranging from 250 to 484 meticais per tray. For farmers who dedicated themselves to selling seedlings, whether inside or outside of the association they belonged to, all of the income generated by this activity usually was considered their financial benefit from the greenhouses.

The range of stated income is broad because the farmers referred to either monthly or seasonal income. The smallest stated income was as little as 500 meticais, while the largest was over 800,000 meticais. During the fieldwork for this report, it was not possible to capture how many months constitutes a season. Since a conversion of income on a common basis is not feasible, the income values in this section are presented on a monthly and seasonal basis, with no distinction.

Because the greenhouses represent a different way of growing crops for most of the farmers, it was often easier to measure how much income they earned solely from the greenhouse (selling seedlings) and solely from their *machambas* (selling produce), instead of calculating income based on past and present. There were also cases where farmers did not directly sell seedlings from the greenhouses but replanted them outside and sold the produce later. In those cases, income variations might not be due only to the existence of the greenhouses, but also to the farmers' own productivity, price variations, and varying weather conditions. Researchers observed that negotiating prices directly with buyers was a common practice.

To assess income benefits from the greenhouses, farmers were asked to recall how much income they earned before the greenhouses were built (two to four years earlier). This was no easy task for them, since they already had a hard time knowing how much they were earning at present. Out of 47 interviews,

33 farmers were able to determine their current income, while only 22 shared their past income. Therefore, the income benefit from the greenhouses can be inconclusive or misleading. As shown in Graph 26, the average, median, and minimum past income was higher than in the present. Nevertheless, four farmers believed their income had increased, even if they had not monitored their earnings. Income changes for each farmer individually tells a different story. As shown in Table 4, 14 of the 22 total farmers responding saw their incomes increase after the greenhouses (64 percent), one earned less (5 percent), and seven experienced no change (32 percent).

Reportedly, farmers believed the income benefit from the greenhouses lay in reducing expensive agricultural inputs, such as seeds and pesticides. Some farmers stated that, since the crops from the greenhouse were of better quality, it was easier to sell them. The knowledge they gained from using the greenhouses also is considered a contributing factor to their income. Farmers who buy seedlings from the greenhouses see the good price they pay for a high-quality product as an advantage.

GRAPH 26. PAST AND PRESENT INCOME, BEFORE AND AFTER GREENHOUSES

n=41

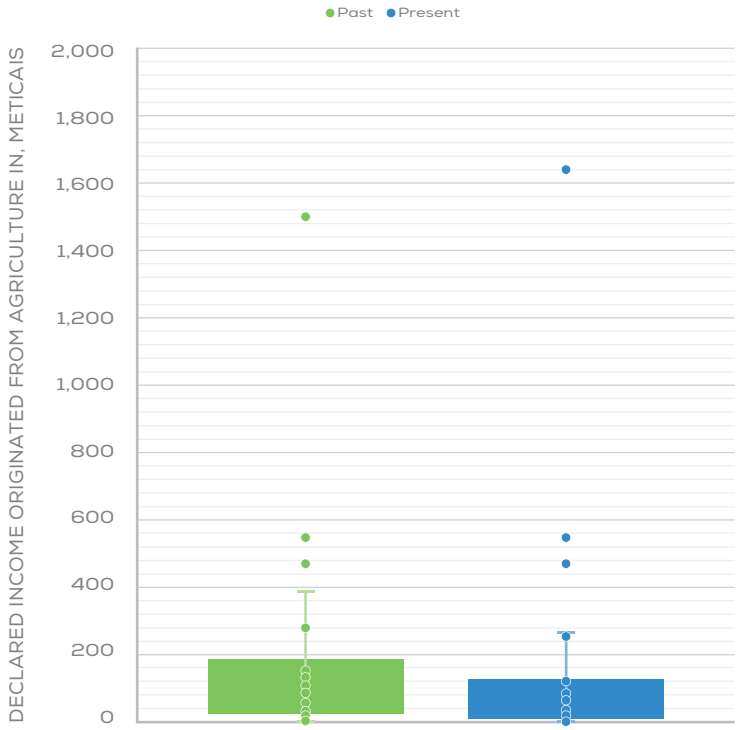


TABLE 4. CHANGE IN INDIVIDUAL FARMER INCOME WITH GREENHOUSE USE

Income change	Number of farmers	% of farmers
Positive	14	64%
Negative	1	5%
No change	7	31%
Total	22	100%

6. Difficulties with innovation usage

When asked about difficulties and problems that arose from using the greenhouses, 22 percent of the farmers (10) declared that they had experienced no problems, as shown in Table 5. The problems farmers did identify represented both producer and customer viewpoints.

Some of the problems with the design and materials of the greenhouses had already been identified by World Hope at the beginning of the project, and those problems were fixed at a later stage. Those issues included dealing the plastic material covering the wooden structure, which kept the inside too warm and the crops. World Hope improved the design. Updated greenhouses had a higher ceiling and used netting instead of plastic, which allowed air to circulate and ventilate the crops. The quality of the wood was questioned as well. It was later replaced with better, stronger wood, making the greenhouses more resistant to wind and rain.

TABLE 5. DIFFICULTIES WITH THE GREENHOUSE REPORTED BY FARMERS

Problems and difficulties with the greenhouses	# of farmers	% of farmers (N = 46)
None	10	22%
Too warm inside	9	20%
Not enough inputs	9	20%
Too small	6	13%
Pests and diseases	5	11%
Inability to fix damages	4	9%
Low-quality wood	3	7%
Not enough seedlings available for purchase	3	7%
Damaged by windstorms	3	7%
Access to markets	3	7%
Lack of farming knowledge	2	4%
Expensive seedlings	2	4%
Old material	2	4%
Not well accepted by some association members	1	2%
Lack of information from the association	1	2%
Ceiling height too low	1	2%
No ventilation	1	2%
Not enough water	1	2%
Management of the greenhouse	1	2%
Lack of continuity of the project	1	2%

Twenty percent of the farmers (9) complained about not having enough inputs to grow inside the greenhouses. This usually was due to their lack of money to purchase seeds and inability to prepare substrate for growing seedlings in trays. At first, ACDI/VOCA gave the substrate to farmers. Some managed to start producing their own substrate. However, it seems as though this skill was not taught to all farmers, because some of them specifically stated they were not working at the greenhouses anymore due to their inability to prepare substrate.

Six farmers complained that the greenhouses were too small, because they could not produce as much as they wanted to. This related to three customers complaining that there were not enough seedlings available for purchase at the closest greenhouse. Twelve farmers suggested that the greenhouses could be bigger (Graph 27), even though only six initially complained about its size.

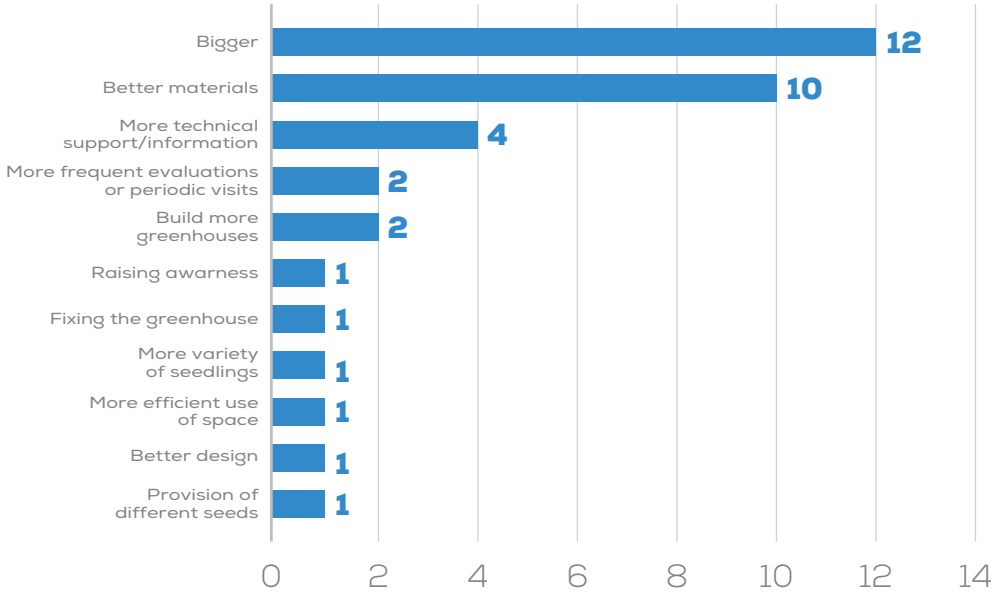
Because the greenhouses allowed such diversification of crops, five farmers (Table 5) faced pests and diseases (mainly in tomato crops) that they were not used to seeing, and they did not know how to deal with them. Four farmers were bothered by their inability to fix damaged greenhouses. This is particularly important to ensure longevity of the project. If the innovation breaks down and farmers cannot use it anymore, then it is only a matter of time until all greenhouses are broken and the project is over. Building sturdy greenhouses and teaching farmers how to fix them can be an effective strategy for extending the duration of the project.

Even though many farmers were successful in selling seedlings, three farmers encountered barriers. Their potential customers did not see the value of the seedlings and found them too expensive, or they did not have enough money to purchase them. One of the farmers complained that he had to rely on intermediaries to sell the products to hotels and restaurants, and he would prefer to sell them directly.

Two farmers recognized that lack of farming knowledge was a barrier to better taking fuller advantage of the greenhouses (Table 5), while four farmers suggested that more technical support and information would have been beneficial (Graph 27). Two farmers said they would appreciate more visits by World Hope or ACDI/VOCA, or even more frequent evaluations such as this one. Other suggestions made by farmers are presented in Graph 27.

GRAPH 27. FARMERS' SUGGESTIONS FOR IMPROVING THE GREENHOUSE PROJECT BY WORLD HOPE

n=36



IV. DISCUSSION

This reports sheds light on a number of challenges encountered in obtaining information for World Hope's GRO innovation assessment. For example, the evaluation relied a great deal on comparing past and present yields, income, and water consumption. However, with this innovation, comparisons are difficult, because the greenhouses do not replace the use of land, but rather complement it. The report also identifies challenges the farmers had with the GRO system itself. The small size of the greenhouses makes it impossible for many of the farmers to abandon the land they farm. Some of the issues farmers faced related to the design and building materials were identified in the beginning of the project and fixed by World Hope. Farmers' other issues included not having the means to buy or the knowledge to produce inputs (e.g., substrate), a lack of knowledge about controlling pests, and an inability to fix damages.

Besides receiving more and bigger greenhouses that use better materials, farmers would be happy to receive more agricultural advice and periodical visits by the involved organizations. However, local contacts informed the research team that World Hope and ACDI/VOCA were either leaving Mozambique or already had left. This represents a loss of local knowledge about the project (who the farmers are, where they are located, how to reach them, etc.) that could make it difficult to conduct future impact assessments of this innovation. This also could impact future use of the greenhouses; consistent follow-ups by the organizations, if they were in the area, could encourage farmers to continue using the greenhouses and learning new techniques.

In spite of these challenges, the farmers' overall attitudes toward the greenhouses were very positive. Even if some farmers were not using a greenhouse anymore (e.g., because it was damaged), they

acknowledged the potential benefits of using the greenhouse. It was easier to collect qualitative than quantitative data. For example, most farmers did not register yields, earnings, or water consumption, but it was clear to them that the greenhouse saved water. For that reason, it was easier to get perceptions and answers on qualitative benefits and issues related to the greenhouses than it was to document quantitative trends.

1. Use, availability, and uptake

The most evident barrier to continuing use of the greenhouses was if they became damaged or destroyed. Eleven of the 44 greenhouses had been destroyed or abandoned, while a few others were damaged but their owners planned to get them fixed.

It was hard to assess which farmers were still making use of the greenhouses, because many of the units were empty at the time of the visit. This could be just a coincidence, but it also could be that the farmers would prefer not to admit they had not been using this asset, fearing that they could lose it. In some cases, farmers acknowledged they had not been using the greenhouses since the year before, only because they lacked substrate or other inputs.

The real number of people benefitting from the greenhouses also is unknown. In many associations, only one member is responsible for buying inputs and growing seedlings, while other members are welcome to purchase seedlings if they want. Therefore, the number of members in each association does not represent the number of people who have benefited from the greenhouse. It was not in the scope of this study to extensively study and identify all users of the innovation.
An advantage of the greenhouses as an innovation is its flexibility. There were different ways to use the greenhouses, and this allowed farmers to use them according to their needs, expertise, and desire. Although this is considered a good thing, it was not clear why only selected farmers received trays and other inputs to grow seedlings, and why two received hydroponics equipment, while others received only the greenhouse and had to plant directly in the soil.

The most successful arrangement seemed to be the greenhouses where growing seedlings with trays was accompanied by specific training. The seedlings were of high quality, and farmers who managed to produce them in large quantities had a more reliable source of income, because they could sell to different clients. The hydroponics systems also seemed to have great potential. Farmers who produced lettuce using hydroponics had more lucrative clients (e.g., hotels and restaurants), although neither of the two greenhouses contained lettuce plants at the time of the visits.

General support of the project was felt. Farmers' were eager to share their greenhouse experiences with others. Also, some farmers wanted to have their own greenhouses or wished their greenhouse was bigger. One farmer who buys seedlings said he is buying material to build his own greenhouse. Farmers at associations said they believed if the greenhouses were bigger, more people could work on them, instead of just one per greenhouse. Some associations even had their own larger greenhouses, as shown in Photo 9.

However, a possible uptake of the project should be considering that some of the greenhouses are not being used to their full capacity. Identifying the reasons for this could ensure that further investments will have potential for creating real value. Farmers value training and knowledge, even if it reveals some of their limitations, so future uptakes of the project should consider reviewing the technical knowledge that accompanies construction of the greenhouses. Potential areas of improvement for farmers might include learning how to make substrate, how to fix the greenhouses, and how to control certain pests.

PHOTO 9. Large greenhouse owned by Associação 44ha; not provided by World Hope.

2. Crop yields and survival

It was not possible to measure whether the greenhouses influenced crop yields, but they contributed to an increase in crop survival. The walls and ceilings of the greenhouses protected crops from weather variations and pests. The humidity was kept high inside the greenhouses, so less water was needed.

Growing seedlings in trays proved to be a more efficient use of seeds. Transplanting seedlings to outside fields was more effective and less harmful to their roots than when plants were grown from seed outside. Hence, crops that started to grow inside the greenhouse were more likely to survive even if they were transplanted outside at some point.

Another benefit some farmers experienced was crop diversification. The ability to save seeds and pesticides made farmers feel more confident about what they were planting. This encouraged them to plant more sensitive crops, such as tomatoes and bell peppers, and take a chance on more expensive seeds, such as cabbage. Eggplant is another crop that was planted more often after the greenhouses were built.

3. Changes in income

Income famers earned from agricultural activities has increased for 64 percent of them. For one farmer, income decreased: Agriculture is not her main source of income, and now that she has retired, the money she earns from agriculture is much higher. Thirty-two percent of farmers experienced no change in income, but they recognized the skills they learned, the quality of the product, and the savings provided by the greenhouses.

Using the greenhouses saved time for 89 percent of the farmers. It also contributed to saving scarce resources, such as water, and reducing expensive inputs, such as seeds and pesticides. The possibility of growing crops throughout the year also represented an opportunity for farmers to increase their income or, at least, their food sources. This is particularly beneficial, considering that food production decreases in summer and prices are higher.

Agriculture does not have an assured market, which makes it difficult for farmers to earn a fixed income. Buyers come to *machambas* and buy one *canteiro* of crops on one day, but farmers never know when they might sell something again. The greenhouses represented a more secure source of income, since the high quality of the seedlings contributed to selling them in most cases. It is arguable that the greenhouses made farmers more resilient to economic and climatic changes.

4. Gender differences

During the field visits, it was observed that many women are involved in agriculture. Entire associations were composed of women and some had women presidents. Six of the associations interviewed had more women members than men. Women seemed to run their own businesses independently, instead of staying at home and taking care of children. Female farmers were more willing to be interviewed than male farmers, who would state that they were too busy to talk.
The collected data showed there are gender differences related to amount of land owned. Most women had plots of land smaller than one-tenth of a hectare, while most men had more than that.

5. Impact on poverty

The questionnaire used to collect data for this assessment did not have any poverty indicators or measurements. Therefore, the discussion about impact on poverty is based on observations. The majority of users depended on agriculture as their only a source of income. It was remarkable how low their income was and how high the prices were that they had to pay for certain inputs, such as seeds and medicine.

Only one farmer was clearly a large producer. He owned seven and a half hectares of land and had an income of 2 million to 2.5 million meticais per season. He had a pump to extract water from a river close by and 15 employees working the land for him. He said he would even buy seeds in South Africa and he won a prize for best national producer in 2014. He and his wife had two greenhouses, and neither were in use. This made the researchers wonder whether giving the greenhouses to large producers makes sense, since they already have an assured source of income and might not value the incremental income the greenhouses offer.

The research team was not informed about how World Hope selected farmers for the project. In the beginning, in Gaza, some of the people who received greenhouses did not have agriculture as their primary occupation. Even a local employee of World Hope had received a greenhouse, and he had never worked in agriculture before. At the time of the interview, he was not growing crops, but he planned to do it at that time because he was unemployed. For those users, it seemed as though agriculture was a hobby, while the greenhouses given by ACDI/VOCA seemed to contribute more to poverty alleviation. Two farmers stated clearly that the greenhouses were helping them overcome poverty.

One farmer worked as an employee for the owner of the land. This was observed to be a common practice for people who do not own any land. He earns 2,500 meticais per month and complained about it being too little for the extensive amount of work he performed. He lives at the association near his work, away from his wife.

Other observations from the field related to poverty had to do with level of education and employment. Farmers located in more remote areas (farther away from Mozambique's capital, Maputo) were not as fluent in Portuguese as those who lived in less remote areas. Even though the country has other local languages, Portuguese is the only official one, and not being able to communicate in this language might be a barrier to social mobility.

6. Benefits of innovation for communities

The impact and benefits of World Hope's innovation can be noted more confidently for the farmers' associations than for individual users. Although this was not specifically measured, it can be argued that the greenhouses contributed to community cohesion. The flexibility provided by the greenhouses allowed associations to decide on varying labor division arrangements that suited them best. For instance, one association designated a specific day of the week during which farmers would gather at the greenhouse to work on it together.

In most cases, an active member of the association was rewarded with the task of learning about and growing seedlings in the greenhouse. That member usually was not the president, but someone with a degree of leadership and interest in learning new techniques. Then, all members of the association benefited from having high quality seedlings, but they paid for them so the greenhouse manager's work was compensated. This was an unexpected arrangement, but it seemed to work, as no farmer complained of having not been awarded the greenhouse management role.

In Associação Massacre de Mbusine KaMavota, the greenhouse was perceived as a technology that could be attractive to younger generations. Reportedly, young farmers are not that interested in working at the *machambas*, but they are interested in working with hydroponics in the greenhouse. As a result, this association is using the greenhouse from World Hope and other larger greenhouses it owns as a tool for engaging young farmers who want to learn more complex techniques. One of the advantages mentioned by a young farmer was that he could work at the greenhouse without getting dirty (Photo 10).

PHOTO 10. Young farmer who engaged in agriculture more through the greenhouse.

In a more abstract sense, some farmers said that getting the greenhouses was beneficial for their associations, because it showed members they had access to assets that otherwise would be difficult to get if they were not involved an association. The greenhouse gave farmers the feeling that they were had not been abandoned in a country where, apparently, the government offers few farming incentives. The greenhouses may have contributed to assuring farmers that belonging to an association is worthwhile.

IV. CONCLUSION

This report evaluated the impact of low-cost greenhouses built by World Hope International with the support of SWFF. Forty-four greenhouses have been installed since 2015, and 33 were still operational by the time of the field visits in June 2018. Forty-seven interviews were conducted with farmers who use the greenhouse in some way. Farmers are positively affected by directly growing crops in the greenhouse, buying seedlings from the greenhouse, or learning a new farming technique.

Farmers had an overall positive attitude towards the greenhouses. Eighty-seven percent of farmers interviewed plan on continuing to use the innovation. The most crucial benefits are the provision of an environment where crops can grow faster and be protected from weather variations and pests, with higher survival rates and better quality. These features allow farmers to grow crops throughout the entire year and save water. Eighty-nine percent of the farmers believe they saved time with the greenhouses, for various reasons. An income increase was observed for 14 farmers, and 10 said they had no problems when they used the greenhouse.

Farmers' willingness to share information and knowledge about the greenhouses shows that uptake of the project is possible. Ninety-two percent of farmers shared information or replicated their knowledge somehow. Farmers showed interest in having more and bigger greenhouses, as well as in receiving more agricultural advice and training.

There is no question that the World Hope GRO system with its greenhouses is an excellent asset to give farmers. Nonetheless, any future expansion or replication of the project would require giving more attention to user selection criteria, type of capacity building required for farmers to get the most out of the greenhouses, and frequent monitoring to ensure the project's aims are being achieved. A further suggestion is to require that farmers receive the greenhouses only after making a commitment to use it and fulfill certain goals. This could be a way of keeping farmers motivated and interested in using the greenhouses.

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