Vitamin A Deficiency and Training to Farmers: Evidence from a Field Experiment in Mozambique*

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Abstract

Vitamin A deficiency is a widespread public health problem in Sub-Saharan Africa. This paper analyzes the impact of an intervention fighting vitamin A deficiency through the promotion of the consumption of orange-fleshed sweet potato (OFSP). We conducted a randomized evaluation of OFSP-related training to female farmers in Mozambique, who were also the primary caretakers of pre-school children. The treatment consisted of group and individual-level training where basic knowledge about nutrition was taught, and planting and cooking skills related specifically to OFSP were developed. We found encouraging evidence of adoption of OFSP for production in the short and medium-run, but only marginally significant improvements in our measures of consumption of OFSP. The treatment led to gains in child nutrition status less than one year and a half after the treatment was administered, identified by improvements in weight-for-age and height-for-age Z-score. Lastly, we also found considerable increases in nutrition-related knowledge, as well as knowledge about cooking and planting OFSP.

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1 Introduction

Malnutrition and food insecurity continue to be widespread in all of Sub-Saharan Africa. In this context, vitamin A deficiency has stood out as an underlying cause of severe illness, blindness and premature death for children and women in the region. In Mozambique, where this study was conducted, vitamin A deficiency affects 69 percent of children under five and 11 percent of pregnant women according to a 2009 World Health Organization report. The leading approach to fighting vitamin A deficiency has been capsule supplementation, which has proven effective. Still, the need for capsules to be administered every six months, poor road access, isolated rural communities, and underdeveloped health systems make this solution unlikely to be sustainable in the long-term. In this context, food fortification[1] and promoting consumption of available nutritive foods have emerged as promising new trends, as documented by Allen et al. (2001).

In this paper we analyze the impact of the dissemination of orange-fleshed sweet potato (OFSP) as a food-based approach to fight vitamin A deficiency. OFSP has been shown by Van Jaarsveld et al. (2005) and Low et al. (2007) to be effective in increasing vitamin A status. Not only is it highly rich in pro-vitamin A,[2] it is also a resilient and affordable crop, suitable for cultivation in all rural areas of Mozambique. We conducted a randomized evaluation of OFSP-related training to female farmers. This training was administered by VIDA,[3] a Portuguese NGO which has operated in Mozambique for two decades providing support to local communities. Our sample comprised 100 female farmers who were also the primary caretakers of pre-school children, 50 of which were subject to treatment. The treatment consisted of two stages. In the first stage group-level training was provided, which focused on the nutritional benefits of OFSP, along with the theory and practical aspects (including demonstrations) of planting and cooking OFSP. Some OFSP vines were also distributed at the end. This was then followed by a second stage, in which the main points of the previous training were revised at the individual level.

By exploiting this experimental design, we are able to measure the effects of the treatment on different outcomes of interest. These were collected through survey questions regarding planting patterns, consumption patterns, children anthropometric indicators, and information measures. Our results show an increase in OFSP production right after the treatment, which remained significant more than one year after the treatment. However, we only find marginally significant effects on our specific survey measures of OFSP consumption. Still, we observe that the treatment led to gains in key nutritional indicators for children, namely weight-for-age and

[1] Food fortification refers to the process of adding micronutrients to food.
[2] Pro-vitamin A is a precursor, which the human body converts into vitamin A.
[3] For more detailed information see http://www.vida.org.pt/.

height-for-age Z-scores. Consistently with these gains, the treatment translated into clear improvements in knowledge about nutrition, and about farming and cooking OFSP.

This paper relates to the existing literatures on the adoption and diffusion of agricultural technologies, and on the effects of malnutrition (and its corresponding mitigation strategies) on human capital.

On adoption and diffusion of agricultural technologies, it is worth mentioning the vast literature on the Green Revolution. Foster and Rosenzweig (1995), for instance, focus on the Indian experience to investigate the adoption of new varieties of seeds. They found that inexperienced farmers were less likely to adopt new varieties, and more likely to have negative profits in the first year of adoption. Duo et al. (2007), in a contribution related to fertilizer adoption in Kenya, observed that farmers who participated in demonstration plots were more likely to adopt the new technology. Specifically in Mozambique, Bandiera and Rasul (2006) concluded that farmers were more likely to adopt a new technology when other farmers within their network adopted the technology as well.

Regarding malnutrition and human capital, Dasgupta and Ray (1986) formally linked the incidence of undernourishment to productivity, and therefore to unemployment and the distribution of income. On the empirical side, Strauss (1986) found evidence of a nutrition-productivity link in self-employed farmers from Sierra Leone, concluding that, for low baseline calorie levels, a 10 percent increase in calorie intake would lead to a 4 percent increase in worker productivity.

Recent studies have involved experimental work focusing on child-nutrition interventions. Bobonis et al. (2006), for instance, showed that delivering iron supplementation, vitamin A capsules, and deworming drugs to pre-school children substantially increased child weight and decreased school absenteeism for the treated students. Field et al. (2009), taking a different approach, provided iodine supplements to mothers while pregnant and found a positive effect on school attendance in children born from mothers who received the treatment. Luo et al. (2012), however, showed that delivering multivitamins to students in rural China had no significant impact on test scores, despite decreasing iron deficiency levels. In an approach analogous to ours, Shi et al. (2012) addressed the issue of iron deficiency and anemia through health training to parents. This led to significant decreases in anemia rates among female children of treated parents. Most closely to our study is Low et al. (2007), who focus on OFSP to address vitamin A deficiency. Low et al. (2007) follow a large-scale information campaign on agricultural and nutrition topics targeting groups of farmers. The intervention revealed that treated farmers were more likely to cultivate OFSP two years after, and that children of treated parents had higher intakes of vitamin A than the control group. Our study tests whether these conclusions hold in a distinct setting, with a different smaller-scale and potentially more cost-effective intervention.

The remainder of the paper is organized as follows. In section 2 we provide details about our Mozambican context. Section 3 presents the experimental design, where we describe the treatment, sampling and assignment to treatment, measures employed, and the estimation strategy. The econometric results are displayed in section 4, where we analyze balance, consumption and planting patterns, anthropometric outcomes, and possible mediator including information. In Section 5 we conclude.

2 Context

Mozambique is a Portuguese-speaking country, located in Sub-Saharan Africa. While it is richly endowed with natural resources and has experienced impressive GDP growth in recent years, it is still considered one of the poorest countries in the world. It has a population of around 23 million, of which the vast majority (69 percent) lives in rural areas and depends primarily on subsistence agriculture. Life expectancy at birth is 52 years old for men and 53 for women, and the mortality rate under the age of 5 is of 103 per 1000 live births, according to the World Health Organization.[4] As of 2008, 44 percent of children under 5 have been reported by the United Nations Development Program to suffer from malnutrition.

The fieldwork for the current study was carried out in the Matutuíne district, which is mainly rural and located in the southern extreme of the country. With a population of around 37 thousand, it is characterized by low literacy rates, poor road infrastructures and underdeveloped health systems.

3 Experimental design

3.1 Treatment

The main goal of the treatment was the diffusion and adoption of the OFSP variety as a means to reduce malnutrition and food insecurity. The treatment was administered to 50 female

[4] Source: http://www.who.int/countries/moz/en/

farmers distributed across nine villages in the Matutuíne district in joint collaboration with VIDA. It involved the provision of information about nutrition, farming and cooking training, all related to the OFSP variety.

The first stage of the intervention consisted of a two-day group training in VIDA's facilities in Matutuíne district. All individuals assigned to the treatment group received an invitation to attend the training and transportation to the facilities was provided. A nutrition worker from a local health center administered the first session, which covered basic concepts of nutrition. Topics covered included diversified diets, the consequences of malnutrition, and the role of vitamin A. At this point, OFSP was introduced as a food-based approach to fighting vitamin A deficiency. This session had a particular focus in young children nutritional needs: it stressed the importance of increasing vitamin A-rich foods intakes through the inclusion of OFSP in their diet. An expert in agronomy delivered the second session. This session offered a theoretical exposition about OFSP-cultivation techniques. It then included a practical exercise in which the participants planted a small field of OFSP themselves. The final stage of the training consisted of a cooking-demonstration of potential uses of OFSP in daily meals, also complemented with a practical exercise. Finally, each individual in the treatment group received eight kilograms of vines of five different OFSP-varieties, together with a manual summarizing the training session for future reference.

The second stage of the treatment revised the key topics covered in the first stage. This was conducted at the individual level before the post-training survey.

3.2 Sampling and assignment to treatment

The sample of individuals in our study was taken from nine villages in the Matutuíne district, selected on the basis of the NGO having done prior work there. In each village we gathered a group of female farmers who showed interest in participating in the study and receiving the corresponding training, conditional on them being the primary caretakers of children at pre-school age. In total, 100 people were selected. We then randomly selected 50 of these individuals to receive the treatment. The remaining individuals compose the control group. Note that our randomization procedure formed blocks at the level of each village, allowing for the allocation of approximately the same number of individuals to treatment and control within each village. The 100 female farmers were informed that two rounds of training would take place in the VIDA facilities, and that only 50 random individuals could participate in the first (the treatment group in our study). The remaining 50 (the control group in our study) would be allowed to attend the second training-round, which was set to take place in the following year. Furthermore, all the pre-school children whose primary caretakers were the farmers in our sample represent our sample of children. This corresponds to 134 children, 68 belonging to the control and 66 to the treatment group.

3.3 Measurement

We collected data in three rounds of household surveys. The baseline survey was conducted two weeks prior to the treatment. A post-treatment survey was conducted one week and a half after the training in order to assess the short-run effects of the treatment. The final survey round was administered approximately one year and four months after the training. Our measurement is divided in three main categories: planting and consumption patterns, anthropometric measures and information.

The first group of measures concerns production and consumption patterns. The data concerning production were collected through survey-questions at the baseline, post-treatment, and enline surveys. We recorded all crops planted in the previous agricultural season for the baseline and endline surveys, while at the post-treatment survey we recorded all crops planted since the date of the training session. This question allowed us to measure the reported differences in production between the survey-dates. In addition to the above, we included a subsection of production-related questions, only present in the endline survey, in which we recorded the number of harvested crops in the previous agricultural season. The data on consumption patterns concern questions on consumption of OFSP present in the endline survey only, in which respondents were asked to report whether or not they had consumed OFSP in the past month and in the past week, and, if so, the corresponding quantities. These are specific questions giving an indication of whether experimental subjects consumed OFSP after the intervention took place, which can be subject to measurement error.

The anthropometric measures were collected during the baseline and endline surveys. Specifically, we measured and weighted all the pre-school children of mothers in our sample that we were able to locate at the time of the surveys. These measurements were then processed using the weight-for-age, height-for-age and weight-for-height Z-score classification system[5], where Z-scores reflect the standard deviation from the median of reference healthy and well-nourished U.S. children of the same age and gender. Z-scores below -2, meaning 2 standard deviations below the median in the reference population, are the most common criterion for

[5] Biologically implausible values were excluded from the analyses, as recommended by the World Health Organization.

malnutrition. In particular, children with weight-for-age falling below the -2 cut-off are considered to be underweight and undernourished. As for the height-for-age Z-score and weight-for-height, when the Z-score falls below the cut-off, children are considered to be stunted and wasted, respectively. A more detailed malnutrition classification distinguishes between mild (Z-score ≤1), moderate (Z-score ≤2), and severe malnutrition (Z-score ≤3). These measures allow us to assess children's development patterns, which proxy for the nutritional and health situation of the children in our sample.

Finally, our information measures were designed to assess subjects' knowledge about the topics addressed by the training. These measures are divided between nutrition knowledge, knowledge about cooking OFSP, and knowledge about planting OFSP. The specific questions employed are shown in Table 1. The nutrition questions were related to awareness of vitamin A and its importance, as well as to the prevention and consequences of vitamin A deficiency. The cooking questions asked the respondents to report all the dishes they were aware of which included OFSP as an ingredient. Finally, the questions about planting OFSP focused on knowledge concerning how to choose, prepare, irrigate and harvest a field of OFSP. Each question presented a story about someone facing problems during the cultivation process of OFSP. These questions asked the respondent to pick one out of two potential solutions for the problem, one right and one wrong. All information measures were collected in the post-treatment and endline surveys.

< Table 1 around here >

3.4 Estimation strategy

Two main strategies were used in order to obtain estimates of the treatment effects for the different outcomes. The first one involved the use of the specification:

$$outcomes_{i,l} = a + bT_i + \varepsilon_{i,l}, \tag{1}$$

where *outcomes* are the variables of interest based on information collected in the surveys, and *T* is a binary variable which takes the value of 1 if the individual was assigned to the treatment group and 0 otherwise. i and l are individual and location subscripts, respectively. The above specification was also expanded to include location dummies and individual control variables:

$$outcomes_{i,l} = a + bT_i + cY_{i,l} + dX_i + \varepsilon_{i,l}, \tag{2}$$

where Y is a vector of location dummies and X is a vector of individual-specific characteristics.

The second approach followed was a difference-in-difference specification, which was only used to estimate the treatment effects on the planting patterns and anthropometric outcomes (in parallel with the first specifications), due to the structure of our available data. Note that difference-in-differences, like controls, can help us in face of limited statistical power in our experiment. The equation is as follows:

$$outcomes_{i,l,t} = a + bT_i + et + f(t * T_i) + \varepsilon_{i,l,t}, \tag{3}$$

where t is a dummy for time taking the value of 0 before the treatment and 1 after, and $t*T$ is an interaction between the time and treatment dummies. Once again, the model was expanded to include location dummies and individual-specific control variables:

$$outcomes_{i,l,t} = a + bT_i + et + f(t * T_i) + cY_{i,l} + dX_i + \varepsilon_{i,l,t}, \tag{4}$$

All the estimations in our paper employ OLS. We clustered standard errors, allowing for correlation in the error term, at the village level except for the estimations of the anthropometric measures, which were clustered at the household level.

4 Econometric results

4.1 Balance

We begin the analysis by assessing the comparability of the treatment and control groups. We run village and individual-level balance tests on a wide range of variables from the baseline survey, the results of which are reported in Tables 2a and 2b, respectively. The aforementioned tests are conducted for both the baseline and the endline samples. Note that we faced some attrition, as we resurveyed 93 of the 100 individuals in the original baseline sample. Both tables report differences between the control and treatment groups, along with the control-group means.

< Tables 2 around here >

In Table 2a we focus on the existence of infrastructures, market vendors, electricity, and piped-water supply at the village level. As expected given our assignment rule, we do not find any statistically significant difference between the two groups in either sample. Table 2b displays the individual-level results for basic demographics, religion and ethnicity, occupation, assets and expenditures, and basic demographics and anthropometrics for children. Concerning basic demographics, none of the differences between groups is found to be statistically significant. Regarding religion and ethnicity, only one variable turns out to be significantly different across comparison groups: belonging to the Bitonga ethnic group is more likely in the treatment group. In the occupation category, none of the differences between control and treatments groups are statistically significant at conventional levels. With respect to assets and expenditures, we only find significant differences in ownership of ducks, which are less likely to exist in the treatment group. Finally, at the bottom of Table 2b, we report the results of the balance tests for basic demographics and anthropometrics for the pre-school children in our sample. From the baseline to the endline group 99 children remained in the sample. This difference was due to the timing of the final data collection effort, which was contemporaneous to school holidays. For that reason, some children were away from their home village visiting relatives. Looking at the table, we do not see any statistically significant difference between treatment and control groups for both survey samples. In addition to those already discussed, we performed tests for fifty-four other baseline variables, the results of which are omitted to avoid excessive length. All the corresponding differences between groups were found to be insignificant, except for two.

To conclude, even though a few differences between the treatment and control groups have been detected, we are confident that such differences are due to chance, and that the randomization procedure that we employed was effective at identifying comparable groups in our study.

4.2 Planting patterns

This section focuses on the outcomes relating to planting patterns. Tables 3a, 3b and 3c display the corresponding econometric results. For each outcome of interest we present estimates of the treatment effects employing three different specifications: including no controls, including location dummies only, and including both location dummies and individual demographic controls. Estimates of the mean for the dependent variable in the control group are displayed as well. The first three regressions of Tables 3a and 3b and the all the regressions of Table 3c employ versions of specifications (1) and (2). The remaining regressions use a difference-in-difference estimation strategy, based on specifications (3) and (4).

< Tables 3 around here >

Table 3a displays the short-run results of OFSP planting patterns (based on data collected just after the intervention), while Tables 3b and 3c focus on the longer-run results (based on data collected in the final survey). As we can see from the difference-in-difference estimates in Table 3a, the treatment effect on the cultivation of OFSP translated to an increase in 71-73 percentage points right after the treatment was administered, statistically significant at the 1 percent level. However, at the endline survey, the effect of the treatment is smaller: it yields a 25-28 percentage-point increase. Moreover, these results are supported by the estimates not employing baseline data, in which the relevant coefficients decrease slightly but remain statistically significant. It is also worth noting that reported OFSP cultivation in the control group increased substantially between the baseline and the endline survey dates: specifically, by 36 percentage points, significant at 5 percent level, which points towards significant contamination of the treatment to control individuals.

In Table 3c we display the estimates computed for the number of OFSP harvested crops reported in the endline survey. We observe that individuals in the control group have on average 0.5 harvested crops, while treated individuals report having on average 0.39-0.41 more harvested crops, significant at 10 and 5 percent level depending on whether demographic controls are included. These results appears to provide evidence that not only the treatment group went on to cultivate OFSP even when significant time after the training had passed, but also that they had on average more OFSP production than the control group.

4.3 Consumption patterns

In Tables 4 we estimate the treatment effects on consumption of OFSP, using specifications (1) and (2). Using endline reports of OFSP consumption, we analyze the consumption patterns of OFSP for the previous week (Table 4a) and the previous month (Table 4b). In each table, we show results for whether OFSP was consumed and the corresponding quantities consumed. Once again results shown correspond to specifications without controls, with location dummies, and with location dummies and individual demographic controls at the same time.

< Tables 4 around here >

When controlling for location dummies and individual characteristics, OFSP consumption in the previous week is found to increase by 11 percentage points in the treatment group. This effect is statistically significant at the 10 percent level. We fail to uncover statistically significant results for the remaining specifications, even though all of them yield positive point estimates close to 8 percentage points in magnitude. Furthermore, we see no significant results on the quantities consumed during the same period, even though point estimates are positive. When the time period is expanded to include the full previous month, similar results arise, with all the coefficients from the different estimation strategies being positive. However, the treatment effect is only significant when controlling for location and individual characteristics. This effect of the treatment on consumption is a 9.7 percentage-point increase, which is significant at the 5 percent level. The quantities consumed in the same period do not yield significant results. In conclusion, we appear to have some evidence in favor of improvements in consumption patterns. However, these are not robustly significant across specifications, possibly because of limited statistical power in our experiment.

4.4 Anthropometric outcomes

We now turn our attention to the anthropometric measures: weight-for-age, height-for-age and weight-for-height Z-scores. These were calculated from data collected on the weight and height of the children in our sample during the baseline and endline surveys. Tables 5a, 5b, and 5c report the results for these anthropometric outcomes, employing both one-difference and difference-in-difference estimation strategies, i.e., versions of specifications (1), (2), (3) and (4).

< Tables 5 around here >

As we can see from the difference-in-difference estimates in Table 5a, the treatment led to gains in the weight-for-age Z-scores of 0.67-0.83, statistically significant at the 10 and 5 percent levels for the specifications without and with individual control variables (respectively). For the one-difference specifications, the results are only statistically significant when including location dummies and individual controls. In this case the treatment led to a Z-score improvement of 0.77, significant at 10 percent level, which is in line with the difference-in-difference results.

Looking at the treatment effects on height-for-age Z-scores (Table 5b), we observe that the treatment led to similar gains. In the one-difference regressions, we find improvements of 0.52-0.79, which are significant at 10 or 5 percent level. In the difference-in-difference regressions, all the coefficients from the different estimation strategies are positive and in line with the one-difference estimation, but the results are only significant when controlling for location dummies and individual characteristics. This corresponds to an improvement of 0.95 in the height-for-age Z-score, significant at 5 percent level.

Finally, we find no statistically significant improvements in child weight-for-height Z-scores, as reported in Table 5c, even though all point estimates are positive. All in all, we see significant impacts of the treatment in child nutritional status one year and four months after the treatment was administered.

4.5 Information

The information measures are divided in three groups: nutrition information, information about cooking OFSP, and information about planting OFSP. All information measures were collected in the post-treatment and endline surveys. The corresponding survey-questions are presented in Table 1. The estimations in this section were conducted using specifications (1) and (2). These results are shown in Tables 6.

< Tables 6 around here >

Table 6a presents the results regarding nutrition information outcomes, which refer to knowledge and awareness about the importance of vitamin A. With the exception of ‘heard about vitamin A’, which is binary, ‘knowledge about food containing vitamin A,’ which ranged from 0 to 3, and ‘considers vitamin A deficiency a problem,’ scaled from 1 to 5, all the remaining dependent variables are ranked from 1 to 3, with 1 corresponding to not knowing the answer, 2 to providing a correct but incomplete answer, and 3 to providing a correct and complete answer. As we can see there are clear significant effects on the nutrition-knowledge outcomes in both time periods. As expected the increases in nutrition knowledge are stronger right after the treatment and decreased slightly as time passed. More specifically, looking at the endline outcomes of Table 6a, ‘knowledge of who suffers most from vitamin A deficiency’ increased by 0.31-0.39 points (in the scale of 1 to 3), ‘knowledge on preventing vitamin A deficiency’ rose by 0.42 points, ‘knowledge about food containing vitamin A’ improved by points 0.39-0.42, and, finally, ‘awareness of OFSP’ and ‘knowledge about importance of OFSP’, increased by 0.29-0.34 points and 0.23-0.27 points, respectively. All of the previous effects are significant at standard significance levels. As for the remaining nutrition-knowledge outcomes we found no statistically significant differences between the treatment and control group more than one year after the training.

The estimation results regarding knowledge about cooking using OFSP as an ingredient in the post-treatment and endline surveys are reported in Table 6b. That table shows that the treatment increased knowledge of OFSP-based dishes by 2.7 dishes right after the treatment was administered and by 0.88-0.95 dishes at the endline. These results are all statistically significant at 1 the percent level.

Finally, Table 6c displays the outcomes relating to knowledge about farming OFSP. All dependent variables are binary, taking the value of 1 for correct answers and 0 otherwise. Looking at the table, with the exception of 'knowledge of how to prepare the field after harvesting', all results that were statistically significant at the post-treatment survey remained significant at the endline survey, although smaller in magnitude. We begin with the variables for which the treatment effect was found to remain significant in the short and longer-run at the standard significance levels. Among these, 'knowledge of how to prepare the field to plant OFSP' increased by 17 percentage points, 'knowledge of how to irrigate OFSP' increased by 25-33 percentage points, 'knowledge of when to harvest OFSP' improved by 12 percentage points, 'knowledge of how to harvest OFSP' was found to be higher in the treatment group by 30-31 percentage points. In turn, we found no significant results in 'knowledge of how to plant OFSP' in both survey rounds. Finally, the treatment effect on 'knowledge of how to prepare the field after harvesting' was found to be significant in the post-treatment survey, yielding between 48-55 percentage points, but found to be insignificant in the endline survey.

5 Concluding remarks

In this paper we have analyzed the short and medium-run impacts of a randomized evaluation of OFSP-related training as a food-based approach to fight vitamin A deficiency. Towards that end group and individual-level training was provided by an NGO to female farmers in Mozambique. In that context, farmers were taught basic concepts of nutrition, how to plant OFSP, and how to introduce OFSP in household meals. We found evidence of adoption of OFSP planting at right after treatment and a year and four months after the treatment. However, we have weaker evidence of impacts of the intervention on OFSP consumption at the endline survey. The treatment led to relevant gains in the anthropometric indicators of the pre-school children of mothers in our sample. Finally, we found considerable increases in knowledge associated with vitamin A, as well as with cooking and planting OFSP.

We believe that the results from this project provide relevant insights into the process of agricultural-technology adoption and, more importantly, to the efficacy of nutrition-related interventions. More can be done to find sustainable approaches to overcome nutrition deficiencies in Africa. We believe our work may show that providing information and skills to targeted individuals can be part of such an approach.

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Table 1: Information survey measures

	variables	phrasing of the question	original scale
Nutrition knowledge	heard about vitamin A	Have you heard about vitamin A? (no/yes)	0 to 1
	knowledge of who suffers most from vitamin A deficiency	Who suffers most from vitamin A deficiency? (Answers ranged from not knowing to mentioning pregnant women and children)	1 to 3
	knowledge about importance of vitamin A	How is vitamin A important for people? (Answers ranged from not knowing to mentioning it being important for growth and development of the body/protecting the eyes/protecting against infections)	1 to 3
	knowledge about preventing vitamin A deficiency	What can you do to prevent vitamin A deficiency? (Answers ranged from not knowing to mentioning eating vitamin A rich foods)	1 to 3
	knowledge about food containing vitamin A	Please name three food items that contain vitamin A.	0 to 3
	considers vitamin A deficiency a problem	Do you consider vitamin A deficiency a problem? (Answers ranged from not serious problem to very serious problem)	1 to 5
	awareness of OFSP	What is na OFSP? (Answers ranged from not knowing to mentioning that it is na food item important for health)	1 to 3
	knowledege about importance of OFSP	Why do you think that eating OFSP is important? (Answers ranged from not knowing to mentioning that it is important for growth and development/that it protects against diseases)	1 to 3
	knowledege about who should consume OFSP	In your view who would benefit the most from eating OSFP? (Answers ranged from not knowing to mentioning pregnant women and children)	1 to 3
Cooking knowledge	number of dishes with OFSP	Please name dishes you can cook using OFSP as an ingredient.	0 to 10
Farming knowledge	knowledge of how to prepare the field to plant OFSP	Mrs. Alzira wants to plant OFSP and she has two farms. One where she has always planted OFSP and another where she has not planted OFSP in the past two years. Where do you think she should plant? (wrong answer or not knowing/correct answer)	0 to 1
	knowlede of how to plant OFSP	Mr. José wants to plant OFSP, but he does not know if he should plant in mounds or just bury the vine. What do you think he should do? (wrong answer or not knowing/correct answer)	0 to 1
	knowledge of how to irrigate OFSP	Mr. Vítorino has planted OFSP in the past week but he does not how many times he should irrigate the vine. What do you think he should do? (wrong answer or not knowing/correct answer)	0 to 1
	knowledege of when to harvest OFSP	Mrs. Maria planted OFSP, but she does not know when to harvest. When do you think she should harvest? (wrong answer or not knowing/correct answer)	0 to 1
	knowledge of how to harvest OFSP	Mrs. Idalina planted OFSP and it is ready to be harvested. However, she does not know if she should leave the potatoes in the field or store them in a hole. What do you think she should do? (wrong answer or not knowing/correct answer)	0 to 1
	knowledge of how to prepare the field after harvesting	Mr. António harvested the OFSP and he wants to plant another crop. However, he does not know if he should leave the stover in the field or if he should clean the field. What do you think he should do? (wrong answer or not knowing/correct answer)	0 to 1

Table 2a: Location characteristics - differences across treatments and control; for both baseline and endline samples

	baseline sample		endline sample	
	control	treatment	control	treatment
complete primary school	0.784	-0.009 (0.026)	0.796	0.000 (0.016)
police	0.216	-0.012 (0.016)	0.204	0.000 (0.016)
health center	0.647	-0.014 (0.024)	0.653	-0.017 (0.020)
market vendors	0.333	-0.027 (0.019)	0.327	-0.008 (0.019)
electricity	0.412	-0.004 (0.025)	0.408	0.001 (0.021)
piped water	0.216	-0.012 (0.016)	0.204	0.000 (0.016)
paved road	0.098	0.004 (0.006)	0.102	0.012 (0.011)
land road	0.431	0.018 (0.024)	0.449	0.028 (0.020)
river	0.765	0.011 (0.016)	0.755	0.018 (0.026)

Note: Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2b: Individual characteristics - differences across treatment and control groups; for both baseline and endline samples

		baseline sample		endline sample	
		control	treatment	control	treatment
basic demographics	age	35.784	-0.784 (3.121)	36.449	-0.868 (3.406)
	years of education	3.196	0.212 (0.408)	2.980	0.407 (0.402)
	married	0.588	-0.017 (0.084)	0.571	-0.026 (0.096)
	separated	0.039	0.042 (0.050)	0.041	0.027 (0.052)
	single	0.333	-0.048 (0.128)	0.347	-0.029 (0.137)
	widowed	0.039	0.022 (0.056)	0.041	0.027 (0.062)
	father's education	1.627	-0.464 (0.399)	1.510	-0.556 (0.399)
	mother's education	1.039	-0.468 (0.259)	1.041	-0.473 (0.271)
religion and ethnicity	no religion	0.040	-0.018 (0.018)	0.042	-0.017 (0.017)
	zion	0.280	0.024 (0.067)	0.292	0.025 (0.069)
	other christian	0.065	-0.022 (0.096)	0.500	-0.037 (0.091)
	changana	0.137	-0.035 (0.032)	0.143	-0.052 (0.049)
	bitonga	0.000	0.061* (0.030)	0.000	0.068* (0.033)
	chironga	0.765	-0.112 (0.074)	0.796	-0.137 (0.081)
	chonga	0.020	-0.020 (0.020)	0.020	-0.020 (0.021)
	chopi	0.059	-0.018 (0.054)	0.041	-0.018 (0.049)
	zulu	0.020	0.021 (0.020)	0.045	0.045 (0.031)
occupation	farmer	0.784	0.012 (0.070)	0.796	0.000 (0.075)
	stays at home	0.000	0.020 (0.020)	0.000	0.023 (0.023)
	vendor	0.000	0.020 (0.020)	0.000	0.023 (0.023)
	has no job	0.020	-0.020 (0.020)	0.020	-0.020 (0.021)

Note: Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2b: Individual characteristics - differences across treatment and control groups; for both baseline and post-treatment samples (continued)

		baseline sample		endline sample	
		control	treatment	control	treatment
assets and expenditures	machamba	0.941	-0.043 (0.039)	0.959	-0.050 (0.041)
	expenditures	2,407.347	2130.457 (1737.045)	2445.957	2339.757 (1981.540)
	income	3,357.250	-1384.015 (839.067)	3420.000	-1337.667 (917.863)
	pigs	0.471	-0.042 (0.068)	0.490	-0.013 (0.052)
	cows	1.647	-0.994 (0.712)	1.694	-1.080 (0.765)
	donkey	0.333	-0.333 (0.235)	0.347	-0.347 (0.249)
	chicken	7.255	0.888 (1.918)	6.918	1.332 (1.759)
	ducks	1.549	-0.855* (0.441)	1.612	-1.021* (0.525)
	phone	1.451	-0.002 (0.131)	1.388	-0.001 (0.118)
	tables	0.980	0.122 (0.165)	1.000	0.114 (0.188)
	chairs	3.549	-0.120 (0.456)	3.490	-0.240 (0.417)
	bed	1.294	-0.253 (0.155)	1.327	-0.349 (0.139)
	radio	0.510	-0.061 (0.145)	0.531	-0.076 (0.149)
	tv	0.333	-0.007 (0.120)	0.347	-0.029 (0.114)
	bike	0.235	0.010 (0.082)	0.245	0.028 (0.085)
	clock	0.235	0.193 (0.212)	0.245	0.187 (0.223)
	solar panel	0.314	-0.110 (0.088)	0.286	-0.104 (0.102)
children basic demographics and anthropometric	age	2.686	0.252 (0.171)	2.208	0.086 (0.293)
	gender	1.606	-0.146 (0.122)	1.548	-0.048 (0.102)
	weight-for-age Z-score	-0.709	-0.170 (0.345)	-0.716	-0.131 (0.363)
	height-for-age Z-score	-1.320	-0.040 (0.429)	-1.250	0.016 (0.478)
	weight-for-height Z-score	0.336	-0.286 (0.336)	0.310	-0.243 (0.368)

Note: Standard errors reported in parenthesis, these are corrected by clustering at the village level.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3a: Planting patterns post-treatment

dependent variable ------>		planted OFSP					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.628***	0.625***	0.605***	-0.089	-0.088	-0.124
	standard error	(0.068)	(0.070)	(0.084)	(0.109)	(0.108)	(0.134)
time	coefficient				-0.254**	-0.256**	-0.261**
	standard error				(0.095)	(0.096)	(0.101)
time*treatment	coefficient				0.717***	0.722***	0.737***
	standard error				(0.110)	(0.113)	(0.122)
mean dep. variable (control)		0.060	0.060	0.060	0.314	0.314	0.314
r-squared adjusted		0.417	0.401	0.365	0.228	0.245	0.225
number of observations		98	98	94	198	198	190
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. The dependent variable is binary. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3b: Planting patterns endline

dependent variable ------>		planted OFSP					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.167**	0.170**	0.193**	-0.089	-0.085	-0.112
	standard error	(0.063)	(0.068)	(0.075)	(0.109)	(0.109)	(0.123)
time	coefficient				0.360**	0.361**	0.342**
	standard error				(0.115)	(0.117)	(0.121)
time*treatment	coefficient				0.257*	0.255*	0.288*
	standard error				(0.127)	(0.129)	(0.141)
mean dep. variable (control)		0.673	0.673	0.673	0.314	0.314	0.314
r-squared adjusted		0.027	0.054	-0.004	0.238	0.262	0.252
number of observations		93	93	89	193	193	185
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. The dependent variable is binary. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3c: Planting patterns

dependent variable ------>		OFSP harvested crop		
		(1)	(2)	(3)
treatment	coefficient	0.409*	0.392*	0.414**
	standard error	(0.221)	(0.225)	(0.186)
mean dep. variable (control)		0.500	0.500	0.500
r-squared adjusted		0.025	0.042	0.131
number of observations		92	92	88
location dummies		no	yes	yes
demographic controls		no	no	yes

Note: All regressions are OLS. The dependent variable ranges from 0 (no harvested crop) to 4 (4 or more harvested crop). Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4a: Consumption patterns

dependent variable ------>		has consumed OFSP in the past week (0-1)			quantity of OFSP consumed in the past week		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.079	0.076	0.108*	0.061	0.056	0.189
	standard error	(0.072)	(0.074)	(0.057)	(0.276)	(0.278)	(0.205)
mean dep. variable (control)		0.083	0.083	0.083	0.323	0.323	0.323
r-squared adjusted		0.004	0.002	0.051	-0.011	-0.022	0.196
number of observations		91	91	87	91	91	87
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. The dependent variables quantity of OFSP consumed are expressed in Kg. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4b: Consumption patterns

dependent variable ------>		has consumed OFSP in the past month (0-1)			quantity of OFSP consumed in the past month		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.062	0.059	0.097**	1.097	1.069	1.308
	standard error	(0.061)	(0.061)	(0.038)	(1.104)	(1.102)	(0.973)
mean dep. variable (control)		0.143	0.143	0.143	0.551	0.551	0.551
r-squared adjusted		-0.004	0.004	-0.001	0.004	0.003	-0.105
number of observations		93	93	89	93	93	89
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. The dependent variables quantity of OFSP consumed are expressed in Kg. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5a: Anthropometric outcomes

dependent variable ------>		weight-for-age Z-score					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.554	0.443	0.770*	-0.170	-0.208	-0.187
	standard error	(0.362)	(0.333)	(0.429)	(0.310)	(0.296)	(0.291)
time	coefficient				0.901***	0.946***	0.901***
	standard error				(0.294)	(0.299)	(0.318)
time*treatment	coefficient				0.725*	0.673*	0.835**
	standard error				(0.371)	(0.376)	(0.397)
mean dep. variable (control)		0.192	0.192	0.192	-0.709	-0.709	-0.709
r-squared adjusted		0.017	0.069	0.036	0.131	0.173	0.195
number of observations		91	91	88	219	219	212
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. All dependent variable are Z-scores. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the respondent level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5b: Anthropometric outcomes

dependent variable ------>		height-for-age Z-score					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.608*	0.521*	0.790**	-0.040	-0.070	-0.212
	standard error	(0.331)	(0.288)	(0.388)	(0.398)	(0.383)	(0.341)
time	coefficient				-0.011	0.065	-0.091
	standard error				(0.357)	(0.350)	(0.348)
time*treatment	coefficient				0.648	0.610	0.955**
	standard error				(0.442)	(0.436)	(0.411)
mean dep. variable (control)		-1.332	-1.332	-1.332	-1.320	-1.320	-1.320
r-squared adjusted		0.027	0.109	0.063	0.002	0.058	0.094
number of observations		88	88	86	208	208	203
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. All dependent variable are Z-scores. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the respondent level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5c: Anthropometric outcomes

dependent variable ------>		weight-for-height Z-score					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.111	0.076	0.257	-0.286	-0.283	-0.251
	standard error	(0.348)	(0.354)	(0.378)	(0.347)	(0.354)	(0.347)
time	coefficient				1.073***	1.073***	1.047***
	standard error				(0.301)	(0.309)	(0.327)
time*treatment	coefficient				0.397	0.381	0.539
	standard error				(0.408)	(0.417)	(0.427)
mean dep. variable (control)		1.409	1.409	1.409	0.336	0.336	0.336
r-squared adjusted		-0.010	-0.025	0.069	0.119	0.108	0.133
number of observations		93	93	90	216	216	210
location dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. All dependent variable are Z-scores. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the respondent level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6a: Nutrition knowledge outcomes

dependent variable		post-treatment		endline	
heard about vitamin A (0-1)	coefficient	0.158*	0.133*	0.059	0.017
	standard error	(0.070)	(0.062)	(0.043)	(0.034)
knowledge of who suffers most from vitamin A deficiency (1-3)	coefficient	0.479***	0.501***	0.311*	0.392**
	standard error	(0.119)	(0.140)	(0.142)	(0.161)
knowledge about importance of vitamin A (1-3)	coefficient	0.779***	0.722***	0.173	0.191
	standard error	(0.128)	(0.141)	(0.095)	(0.137)
knowledge about preventing vitamin A deficiency (1-3)	coefficient	0.823***	0.839***	0.416**	0.422**
	standard error	(0.185)	(0.189)	(0.126)	(0.174)
knowledge about food items containing vitamin A (0-3)	coefficient	1.398***	1.485***	0.390**	0.422*
	standard error	(0.190)	(0.203)	(0.125)	(0.215)
considers vitamin A deficiency a problem (1-5)	coefficient	1.461***	1.372***	0.098	0.299
	standard error	(0.341)	(0.364)	(0.242)	(0.277)
awareness of OFSP (1-3)	coefficient	0.736***	0.783***	0.298***	0.342***
	standard error	(0.145)	(0.151)	(0.086)	(0.085)
knowledge about importance of OFSP (1-3)	coefficient	0.842***	0.870***	0.233*	0.278*
	standard error	(0.107)	(0.092)	(0.101)	(0.141)
knowledge about who should consume OFSP (1-3)	coefficient	0.869***	0.931***	0.191	0.175
	standard error	(0.097)	(0.110)	(0.120)	(0.141)
location dummies		no	yes	no	yes
demographic controls		no	yes	no	yes

Note: All regressions are OLS. Heard about vitamin A is a binary variable. Knowledge about food items containing vitamin A ranges from 0 (0 food items) to 3 (3 food items). Considers vitamin A deficiency a problem ranges from 1 to 5 (1: not serious at all; 2: not serious; 3: somewhat serious; 4: serious; 5: very serious). All remaining dependent variables range from 1 to 3 (1: does not know the answer; 2: correct but incomplete answer; 3: correct and complete answer). Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6b: Cooking knowledge outcomes

dependent variable		post-treatment		endline	
number of dishes with OFSP	coefficient	2.715***	2.699***	0.958***	0.881***
	standard error	(0.419)	(0.247)	(0.219)	(0.141)
location dummies		no	yes	no	yes
demographic controls		no	yes	no	yes

Note: All regressions are OLS. The dependent variable is number of dishes. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6c: Farming knowledge outcomes

dependent variable		post-treatment		endline	
knowledge of how to prepare the field to plant OFSP	coefficient	0.494***	0.573***	0.177**	0.175**
	standard error	(0.133)	(0.108)	(0.077)	(0.069)
knowledge of how to plant OFSP	coefficient	0.083	0.121	-0.049	-0.028
	standard error	(0.105)	(0.104)	(0.065)	(0.058)
knowledge of how to irrigate OFSP	coefficient	0.518**	0.566**	0.254***	0.336***
	standard error	(0.187)	(0.202)	(0.075)	(0.100)
knowledge of when to harvest OFSP	coefficient	0.351*	0.424**	0.123*	0.122*
	standard error	(0.173)	(0.161)	(0.056)	(0.057)
knowledge of how to harvest OFSP	coefficient	0.366*	0.350**	0.316**	0.309*
	standard error	(0.173)	(0.143)	(0.130)	(0.136)
knowledge of how to prepare the field after harvesting	coefficient	0.467***	0.553***	0.040	0.058
	standard error	(0.137)	(0.176)	(0.091)	(0.087)
location dummies		no	yes	no	yes
demographic controls		no	yes	no	yes

Note: All regressions are OLS. All dependent variable are binary, which take the value of 1 for a correct answer and 0 otherwise. Controls are location dummies and demographic characteristics, which include age, years of education, mother's education, marital status dummies, occupation dummies, property and farmers' association membership. Standard errors reported in parenthesis, these are corrected by clustering at the village level. * significant at 10%; ** significant at 5%; *** significant at 1%.

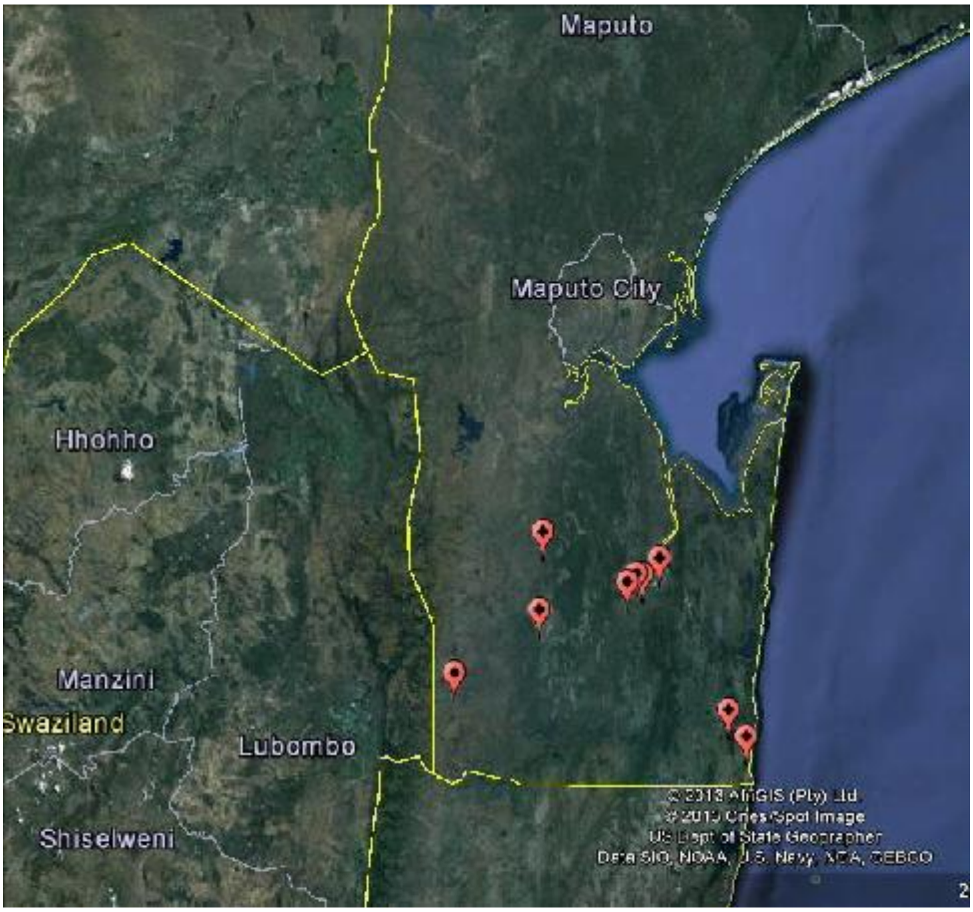

Figure 1: Map of experiment villages.