Knowledge of Vitamin A Deficiency and Crop Adoption: Evidence from a Field Experiment in Mozambique*

Rute M. Caeiro† and Pedro C. Vicente‡

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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 production and 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 find considerable increases in nutrition-related knowledge, as well as knowledge about cooking and planting OFSP, which persist after more than a year. We also observe clear evidence of adoption of OFSP for production in the short- and medium-run, which spreads through social networks. However, we do not find clear signs of dietary improvements in our specific measures of consumption of vitamin A rich foods. Overall, our results support the view that training centered on nutrition-sensitive agricultural information can play a significant role in shaping farmers' knowledge and crop adoption decisions.

JEL Classification: O12, O13, Q16, I15.

Keywords: Vitamin A, Orange-fleshed Sweet Potato, Africa, Mozambique, Randomized Evaluation.

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† Nova School of Business and Economics, Universidade Nova de Lisboa and NOVAFRICA. Email: rute.m.caeiro@novasbe.pt.

‡Nova School of Business and Economics, Universidade Nova de Lisboa, NOVAFRICA and BREAD. Email: pedro.vicente@novasbe.pt.

1 Introduction

Malnutrition and food insecurity continue to be widespread in all of Sub-Saharan Africa. In that region, vitamin A deficiency has stood out as an underlying cause of severe illness, blindness, and premature death for children and women. In Mozambique, where this study was conducted, vitamin A deficiency affects 69 percent of children under five and 14 percent of pregnant women.[1] The leading approach to fighting vitamin A deficiency has been capsule supplementation, but the need for capsules to be administered regularly, poor road access, isolated rural communities, and underdeveloped health-provision systems make this solution unlikely to be effective or sustainable. In this context, biofortification of food crops[2] and promoting consumption of available vitamin-A rich foods have emerged as promising new trends.[3]

In this paper, we analyze the impact of a nutrition-related agricultural intervention designed to promote the uptake of a pro-nutrition crop. In particular, we evaluate how nutrition training combined with agronomic training can foster adoption and diffusion of orange-fleshed sweet potato (OFSP) varieties. OFSP is a biofortified crop, not only highly rich in pro-vitamin A,[4] but also an affordable crop, suitable for cultivation in all rural areas of Mozambique. We conducted a randomized evaluation of OFSP-related training to female farmers, which underlined nutrition information. This training was administered by VIDA,[5] an international 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. 49 of these women were subject to treatment. The treatment consisted of two stages. In the first stage, group-level training was provided, which focused on the nutritional needs of young children and 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 of this training. This was then followed by a second stage, in which the main points of the previous training were reviewed at the individual level.

[1] See WHO (2009).
[2] Biofortification refers to the process of increasing the nutritional value of food crops.
[3] See Allen and Gillespie (2001).
[4] Pro-vitamin A is a precursor, which the human body converts into vitamin A.
[5] For more detailed information see http://www.vida.org.pt/.

By exploiting our experimental design, we are able to measure the effects of the treatment on different outcomes of interest. These were collected through survey questions regarding knowledge measures, as well as planting and consumption patterns. Our results show a clear and immediate improvement in nutrition knowledge outcomes, as well as knowledge about farming and cooking OFSP, which persist more than one year after the treatment. Most notably, we find that farmers are able to recall key nutrition messages, such as who suffers most from vitamin A deficiency and how to prevent it. Alongside the increase in knowledge, we identify evidence of an increase in OFSP production right after the treatment, which remained significant in the medium-run. We also find that treated farmers exchange planting material with other farmers, contributing to the diffusion of OFSP adoption through their social networks. Despite these clear improvements in knowledge and consequent adoption, we do not find statistically significant effects in our specific survey measures of consumption of OFSP and other vitamin A rich foods, which are time-sensitive. Weather-related harvest losses close to surveying is a possible explanation for the absence of effects on consumption. In sum, our results point to nutrition-sensitive agricultural communication having the potential to be an effective tool in addressing nutritional deficiencies, through the adoption of improved crop varieties.

A large body of literature has documented the effectiveness of agricultural interventions aimed at improving nutrition and health outcomes (Masset et al., 2012; Ruel and Alderman, 2013). Agriculture is thought to affect nutrition through several possible direct and indirect channels, such as food production for the household's own consumption, income generation, and empowerment of women through increased control over resources (World Bank, 2007). Particularly in the presence of market imperfections, agricultural production may play a relevant role in food security and nutrition through food production for own consumption. In this context, promotion of nutrition-sensitive agricultural technologies, most notably biofortified crops, can be an effective strategy to address micronutrient malnutrition. However, for this strategy to be sustainable, it needs to foster broad adoption of the crops by farmers. Crops with nutrition benefits are not necessarily agronomically superior to conventional varieties, which can deter adoption. Therefore, a good understanding of technologies' nutritional benefits, in addition to their agronomic characteristics, might be crucial in increasing adoption (Gilligan, 2012). Still, evidence regarding the effects of nutritional communication on crop adoption is scarce and mixed. For example, while de Groote et al. (2016) contend that knowledge of nutrition benefits increases adoption in settings where farmers have a good understanding of the agronomic performance of the crops, de Brauw et al. (2018) find that nutritional training only marginally affects adoption of OFSP in Mozambique.

Our paper is closely related to the literature focusing on the promotion of OFSP as a means to reducing vitamin A deficiency. Previous studies in the public health literature have documented the effectiveness of OFSP in improving the vitamin-A status of women and children (Low et al., 2007; Hotz et al., 2012a; Hotz et al., 2012b). Focusing specifically on the dissemination of OFSP fortified varieties in Mozambique, Hotz et al. (2012a) conducted a randomized control trial of a large-scale, intensive program promoting the production and consumption of OFSP. The intervention was successful in promoting OFSP adoption, increasing vitamin A intakes, and reducing vitamin A deficiency. In addition, the authors tested two different models of intervention intensity and found no significant difference between more and less intensive interventions, potentially suggesting a relevant role for less intensive and short-lived intervention designs like the one in this paper. Additional analysis by Jones and de Brauw (2015), showed that the program led to a reduction in diarrhea prevalence and duration among children. A recent systematic review has highlighted the successes as well as the remaining challenges for OFSP interventions in Mozambique (Jenkins et al., 2015). The authors note that OFSP-interventions have resulted in increased production and consumption, leading to improvements in vitamin A status. Despite these successes, a number of agronomic constraints, such as availability of vines, poor soil fertility, and poor yields still hamper farmers' production capacity, thereby limiting the availability of OFSP for consumption. Our paper adds to this literature by analyzing the causal impacts of an intervention promoting OFSP, which emphasized education for nutrition. We are able to document effects on nutrition and farming knowledge over time, as well as on farmers' adoption decisions, diffusion of planting material, and household consumption.

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, informational outcomes, planting and consumption patterns. The discussion and limitations are presented in section 5 and 6, respectively. In Section 7 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 (68 percent) live in rural areas and depend primarily on subsistence agriculture (World Bank, 2013). Life expectancy at birth is 52 years old for men and 54 for women, the mortality rate under the age of 5 is of 90 per 1000 live births,[6] and 44 percent of children under 5 suffer from malnutrition.[7]

The fieldwork for the current study was carried out in the Matutuíne district, which is mainly rural and located in the Maputo province in the southern extreme of the country. With a population of around 37 thousand according to the INE (2007) Population Census, it is characterized by low literacy rates, poor road infrastructures, and underdeveloped health services. The district has the highest prevalence of food insecurity in the province, affecting 82 percent of households[8]. Southern Mozambique is characterized as a semi-arid and arid environment with one rainy season and two main agricultural seasons. The first and main agricultural season starts in October, with the beginning of the rainy season, while the harvest takes place between February and March. This is followed by the second agricultural season, starting in March with the harvest happening in July and August. Although there are two agricultural seasons, most cultivation work follows the rain calendar, while the second agricultural season depends heavily on farmers' irrigation capacity outside the rainy season. As such, in years of poor rain and for farmers without irrigation capacity, the second agricultural season commonly does not take place.

3 Experimental design

3.1 Treatment

[6] See the report 'World Health Statistics 2014', 2014, by WHO.
[7] See the report 'Child poverty and disparities in Mozambique 2010', 2011, by UNICEF.
[8] See the report 'Mozambique - Trend Analysis: Key Food Security & Nutrition Indicators', 2016, by WFP.

The main goal of the treatment was the diffusion and adoption of OFSP varieties as a means to reduce malnutrition and food insecurity. The treatment was administered to 49 female farmers distributed across nine villages in the Matutuíne district in collaboration with VIDA. It involved the provision of information about nutrition, farming and cooking training, all related to the OFSP varieties.

The first stage of the intervention consisted of a two-day group training in VIDA's facilities in Matutuíne district. The training took place in April of 2013, in the middle of the second agricultural season. 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 on the nutritional needs of young children: it stressed the importance of increasing the intakes of vitamin A-rich foods 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 stage was conducted at the individual level before the first post-training survey. Approximately 76 percent of the treatment group attended the training session, while 98 percent received the individual session.

Following the intervention, the NGO remained active in the region. Due to drought spells experienced in the 2013/2014 agricultural season, extra vines were made available to farmers that required them in December of 2013 and in April of 2014. Furthermore, throughout the 2013/2014 agricultural season, the NGO provided agricultural technical support when required by the farmers, which included at least two rounds of generalized visits.

Compared to other interventions in Mozambique involving OFSP (e.g., Low et al., 2007; Hotz et al., 2012a) our intervention similarly comprised vines distribution coupled with training. There are, however, two main differences between previous interventions and ours. First, our treatment focused on education for nutrition, which substituted an explicit market development component. Given that the majority of farmers in our sample are subsistence farmers and that the market system in the region is notably underdeveloped, an explicit market development intervention would have been difficult to adapt to our context. The second difference relates to the intensity of the interventions. Previous OFSP projects included a series of meetings with treated farmers, spread out over the course of several agricultural seasons, covering agricultural and nutritional topics. In contrast, the core of our intervention consisted of intensive group training in one agricultural season. However, at a later stage the main messages were reinforced once at the individual level, and on-demand technical assistance remained available for a year.

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 49 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 49 random individuals could participate in the first (the treatment group in our study). The remaining 51 (the control group) would be allowed to attend a future training-round, which was set to take place in the following year. In addition to the female farmers, we also followed a sample of children, composed of all the children up to five years old in 2013 whose primary caretakers were the farmers in our sample.

3.3 Measurement

We collected data in three rounds of household surveys. The baseline survey was conducted two weeks prior to the beginning of 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. Both these survey rounds happened in the middle of the second planting season of 2013. The final survey round was administered in August of 2014, approximately one year and four months after the initial training and in the end of the second harvest season. Our measurement is divided in three main categories: information measures, as well as planting and consumption patterns.

The first group of measures concerns the information variables, designed to assess subjects' knowledge about the topics addressed in 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 the online appendix to this paper (Table A1). 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, with one of them being the right one. All information measures were collected in the post-treatment and endline surveys.

We collected data concerning production patterns through survey questions at the baseline, post-treatment, and endline surveys. The baseline and endline surveys recorded all crops planted in the first agricultural season of 2012/2013 and the second agricultural season of 2013/2014, respectively. In between, the post-treatment survey recorded crops planted from the start date of the training session, during the second agricultural season of 2012/2013. These survey questions allowed us to measure the reported differences in production between the survey dates. We also 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. In addition, we make use of social network data collected at the endline survey to analyze how the treatment affected the sharing of vines among farmers. These data were collected using a 'within sample' approach, where we asked each individual if they had shared OFSP vines with each one of the other farmers within the corresponding village sample.

The data on consumption patterns concern questions on consumption of OFSP and other vitamin A rich foods incorporated in the endline survey only. With respect to OFSP, respondents were asked to report whether or not they had consumed OFSP in the past week, and, if so, the corresponding quantities. As for the consumption of other vitamin A rich foods, the questions focused only on the consumption of the different food items in the past week, namely consumption of vitamin A rich foods from animal source (milk and eggs), from vegetable source (orange vegetables and dark green leaves), and vitamin A rich fruits. These are questions focusing on short periods of time at a specific point in the year, giving an indication of whether experimental subjects consumed OFSP and other vitamin A rich foods after the intervention took place.[9]

3.4 Estimation strategy

We employ two main strategies to obtain estimates of the treatment effects for the different outcomes. The first one involved the use of the specification:

$$Y_{i,l} = \alpha + \beta T_i + \varepsilon_{i,l}, \tag{1}$$

where *Y* represents the outcome 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:

$$Y_{i,l} = \alpha + \beta T_i + \gamma Z_{i,l} + \theta X_i + \varepsilon_{i,l}, \tag{2}$$

[9] We also collected data on consumption of OFSP in the past month and anthropometric measures of children.

where Z is a vector of village dummies and X is a vector of individual-specific characteristics.

The second approach followed was a difference-in-differences specification, which was only used to estimate the treatment effects on the planting patterns (in parallel with the first specifications), due to the structure of the 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:

$$Y_{i,l,t} = \alpha + \beta T_i + \mu t + \delta(t * T_i) + \varepsilon_{i,l,t}, \quad (3)$$

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 time and treatment dummies. Once again, the model was expanded to include village dummies and individual-specific control variables:

$$Y_{i,l,t} = \alpha + \beta T_i + \mu t + \delta(t * T_i) + \gamma Z_{i,l} + \theta X_i + \varepsilon_{i,l,t}, \quad (4)$$

All the aforementioned estimations employ OLS and we use robust standard errors to account for heteroskedasticity. To address concerns related to multiple hypotheses testing we perform two robustness checks. First, while employing the algorithm described in Romano and Wolf (2016), we compute, for each null hypothesis under study, a corresponding p-value adjusted for the stepwise multiple hypothesis testing method proposed in Romano and Wolf (2005a, 2005b). This method is stepdown like other improvements over Bonferroni (e.g., Holm, 1979), and resampling-based, accounting for dependence between hypotheses which allows increasing the power of the testing over other previous methods. Second, following Kling et al. (2007), for the knowledge variables, we test for joint significance within the same family of outcomes, using a summary index[10] of the average standardized effects for each family of outcomes.

[10] The summary index is computed by first standardizing each outcome variable independently, i.e., subtracting the mean and dividing by the standard deviation of the control group. Second, we take the average across the standardized measures within the same class of outcomes.

Finally, we make use of a dyadic regression framework to analyze how the treatment affected the sharing of vines, and who shared vines with whom. We consider that individual i shared vines with individual j if either i mentioned giving vines to j, or j mentioned receiving vines from i. Each individual is regarded as a node and the dyad is taken as the unit of observation. We use directed dyadic regression since the transfer of vines is directional, i.e., one of the farmers is the giver, while the other is the receiver. We estimate the following regression:

$$Y_{ij} = \alpha + \beta_i T_i + \beta_j T_j + \gamma_2 (z_i - z_j) + \gamma_2 (z_i + z_j) + \lambda_v + \varepsilon_{ij} \qquad (5)$$

In the above specification, Y_{ij} is a binary variable which takes the value of 1 if the individual i shared vines with individual j as defined above. T_i and T_j are binary variables capturing the treatment status of the giver (i) and of the receiver (j), respectively, taking value 1 if the individual was assigned to the treatment group and 0 otherwise. z_i and z_j are vectors of individual-specific characteristics for the giver and receiver, respectively. Following Fafchamps and Gubert (2007) controls are included in differences and in sums, so as to account for the effect of the differences in characteristics of the nodes and the combined effect of the characteristics on the outcome of interest. Finally, the specification also includes village fixed effects λ_v.

We have also expanded the above specification to exploit the treatment statuses of who gave vines to whom:

$$Y_{ij} = \alpha + \beta_1 T_i T_j + \beta_2 T_i C_j + \beta_3 C_i T_j + \gamma_2 (z_i - z_j) + \gamma_2 (z_i + z_j) + \lambda_v + \varepsilon_{ij} \qquad (6)$$

where the variables of interest are $T_i T_j$, $T_i C_j$, and $C_i T_j$ which refer to the combined treatment status of the giver and of the receiver. $T_i T_j$ takes the value of 1 if both the giver and receiver are treated individuals, and zero otherwise. $T_i C_j$ takes the value of 1 if the giver belongs to the treatment and the receiver belongs to the control, and zero otherwise. Finally, $C_i T_j$ takes the value of 1 if the giver belongs to the control group and the receiver belongs to the treatment group, and zero otherwise. This means the hidden category is when both giver and receiver belong to the control group. All estimations employ OLS.

We follow Cameron, Gelbach, and Miller (2011) in using two-way cluster-robust standard errors, clustered at both i and j.

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 the online appendix to this paper (Tables A3). We report differences between the control and treatment groups, along with the control-group means. 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.[11]

As expected, given our assignment rule, we do not find any statistically significant difference in village characteristics between the two groups. Likewise, there are no significant differences in individual-level results on basic demographics, religion and ethnicity and occupation, and for agriculture. 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. 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.[12] All the corresponding differences between groups were found to be insignificant, except for two.

Overall, 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.

[11] Two individuals from the control group and five from the treatment group were not surveyed at the endline data collection.
[12] These are available upon request to the authors.

It is also worth noting that, in the baseline sample, on average, control group individuals are 36-years old and have three years of education. The majority (76 percent) belongs to the Chironga ethnic group. 94 percent own a farming plot, and the average plot size is 1.4 hectares. In terms of production practices in the previous agricultural season, control farmers cultivated on average 3.47 distinct crops, 67 percent practiced crop rotation, 21 percent used extension services, 43 percent purchased seeds, and 31 percent planted OFSP.

4.2 Information

We now turn to our analysis of information measures. Information outcomes are divided into 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.[13] The survey measures were normalized (z-scores) by subtracting the mean and dividing by the standard deviation of the control group.[14] Therefore, each variable has mean 0 and standard deviation 1 for the control group. We present estimates of the treatment effects employing three different specifications: including no controls, including village dummies only, and including both village dummies and individual demographic controls. All regressions employ versions of the one-difference estimation strategies, specifications (1) and (2). Tables 1a, 1b, 1c, and 1d display results for the various measures of nutrition information, information about cooking OFSP, and information about planting OFSP. In the first three columns of the aforementioned tables we focus on short-term treatment effects, using post-treatment data. The remaining columns focus on the medium-run effects employing endline data. We report stepdown p-values adjusting for multiple testing in groups. Therefore, in Tables 1a and 1b, the p-values are adjusted for testing the 18 knowledge outcomes reported (nine variables over two periods). In Tables 1c and 1d, the adjusted p-values account for two and 12 outcomes tested, respectively. At the bottom of Tables 1b and 1d, we display the results for the overall effect of the treatment on nutrition information

[13] The corresponding survey-questions are presented in the online appendix to this paper (Tables A1).

[14] In Tables A2 of the online appendix we display the average and corresponding standard errors for each variable in the original scale.

and information about planting OFSP, respectively. These results are based on the analysis of summary indexes, which aggregate knowledge indicators at each point in time.

< Tables 1 around here >

Tables 1a and 1b present the results regarding nutrition information outcomes, which refer to knowledge and awareness of the importance of vitamin A and OFSP. These are expressed in standard deviation units. There are clear significant effects on the nutrition-knowledge outcomes in both time periods. As expected, the increases in nutrition knowledge were strongest right after the treatment but decreased as time passed. Looking at the post-treatment outcomes in Table 1a, we can see that there was an immediate improvement in vitamin-A-related nutrition knowledge outcomes across the board, ranging from 0.34 to 1.83 standard deviation units. 'Heard about vitamin A' was found to increase by 0.34-0.39, statistically significant at the 5 percent level, although significance is lost after adjusting for multiple-hypothesis testing. 'Knowledge about importance of vitamin A' and 'considers vitamin A deficiency a problem' experienced more pronounced improvements, of a similar order of magnitude, increasing by 0.81-0.88 and 0.70-0.73, respectively. Both of those effects are statistically significant at the 1 percent level (confirmed by Romano-Wolf p-values). However, despite these short-term improvements, knowledge gains seem to have faded away with time, as indicated by the endline results, where the coefficients are considerably smaller and no longer significant. Similarly to the aforementioned outcomes, we found marked and statistically significant improvements in 'knowledge of who suffers most from vitamin A deficiency' and 'knowledge about preventing vitamin A deficiency' right after the treatment, which increased by 0.66-0.71 and 0.58-0.61, respectively. Moreover, the effect of the treatment on those outcomes remained significant and similar in magnitude at the endline, indicating that individuals were able to retain most of the information even after significant time had passed. The largest post-treatment gain in vitamin-A-related information was observed in 'knowledge about food items containing vitamin A', which rose by 1.78-1.83 standard deviations. Although smaller in magnitude, this result remained statistically significant at conventional levels for the endline. However, the adjusted p-value exceeded 10 percent. The three outcome variables in Table 1b show results for knowledge related to OFSP nutrition. Again, immediately after the treatment, there were considerable increases in 'awareness of OFSP', 'knowledge about importance of OFSP' and 'knowledge about who should consume OFSP'. These were improvements of more than 1 standard deviation in each variable. The impact of the treatment on those variables remained positive and statistically significant at conventional levels for the endline, although smaller in magnitude. Yet, as before, when we adjust the p-values the results are no longer significant. Finally, at the bottom of Table 1b we estimate the impact of the treatment on the nutrition knowledge summary index. The index represents the standardized effect for the average across the various knowledge measures. We display the effects for the post-treatment and endline. Consistent with the results found above, the treatment led to an immediate increase in overall nutrition knowledge of 0.99-1.00 standard deviations, statistically significant at the 1 percent level. This result remained positive and highly significant more than one year after the treatment, although with smaller point estimates, of 0.39-0.40.

The estimation results regarding knowledge about cooking using OFSP as an ingredient in the post-treatment and endline surveys are reported in Table 1c. The table shows that the treatment increased knowledge of OFSP-based dishes by 1.84-1.93 standard deviation units right after the treatment was administered and by 1.02-1.08 at the endline. These results are all statistically significant at the 1 percent level (including when Romano-Wolf testing is performed).

Table 1d shows the outcomes relating to knowledge about farming OFSP. As expected, there was a significant improvement in farming-related knowledge right after the treatment, which was still present more than a year after the treatment. Looking at the table, with the exception of 'knowledge of how to plant OFSP' and 'knowledge of how to prepare the field after harvesting', all results that were statistically significant at the post-treatment survey remained so at the endline survey, and all but one remained similar in magnitude. However, we lose some significance after adjusting for multiple-hypothesis testing. We begin with the variables for which the treatment effect was found to be significant at conventional significance levels both in the short and in the longer run. In terms of standard deviation units, 'knowledge of how to prepare the field to plant OFSP' increased by 0.68-0.70 standard deviations at the post-treatment, falling to 0.40-0.41 at endline. All of those coefficients are statistically significant at conventional significance levels, except for the endline effect when looking at the Romano-Wolf p-value. 'Knowledge of when to harvest OFSP' rose by 0.35-0.38 in both time periods, but the corresponding adjusted p-values are above 10 percent. 'Knowledge of how to harvest OFSP' was found to be higher in the treatment group by 0.56-0.64 in the short and medium run, statistically significant even after controlling for multiple-hypothesis testing. It is interesting to note that treated farmers also seemed to gain knowledge with experience, as we found no significant results in 'knowledge of how to irrigate OFSP' right after the treatment, but that rose by a significant 0.52-0.56 standard deviations at the endline survey (Romano-Wolf p-values statistically significant at 5 percent level). The treatment effects on 'knowledge of how to plant OFSP' and 'knowledge of how to prepare the field after harvesting' were found to be significant in the post-treatment survey, yielding between 0.53-0.56 and 0.59-0.62 respectively, but insignificant and considerably smaller in magnitude in the endline survey. Finally, the treatment effect on average farming knowledge is displayed at the bottom of Table 1d. The results show a clear increase in both time periods, representing improvements of 0.49-0.50 and 0.29-0.31 in the short and longer time horizons, respectively, statistically significant at the 1 percent level.

In sum, for the information related to vitamin A deficiency we have found clear improvements in knowledge right after the treatment, not only in terms of awareness and importance of the problem but also on how to tackle it. More than one year after the treatment the evidence becomes a little patchier: we no longer see the same results on knowledge related to awareness and importance of vitamin A and OFSP, although farmers did seem to retain most of the information on who tends to suffer from vitamin A deficiency, and how to prevent it. Besides nutrition knowledge, treated individuals retained knowledge on how to integrate OFSP in their daily meals, as evidenced by the cooking knowledge outcomes. It also appears that some of the farming knowledge gained right after the treatment persisted over time. These results indicate that simple nutrient-sensitive agriculture interventions can have long lasting effects in farmers' knowledge, with the potential to contribute not only to the adoption of crop varieties, but also to improvements in dietary intakes.

4.3 Planting patterns

This section focuses on the outcomes related to planting patterns. Tables 2 show the corresponding econometric results. Tables 2a, 2b, and 2c use individual level data. The first three regressions of Tables 2a, 2b and 2c employ versions of specifications (1) and (2), and the reported p-values account for the three hypotheses tested. The remaining regressions of Tables 2a and 2b use a difference-in-difference estimation strategy, based on specifications (3) and (4). Table 2a makes use of post-treatment and baseline data, while Table 2b employs endline and baseline data. Table 2c only uses endline data. The corresponding p-values are adjusted for testing the two outcomes reported. In the first three columns of Tables 2a, 2b, and 2c, we report the control group mean for the dependent variable, corresponding to post-treatment in Table 2a, and to the endline in Tables 2b and 2c. In the remaining columns we present the control group mean for the dependent variable at baseline. Finally, Table 2d employs dyadic-level analysis using specification (5) in the first three columns and specification (6) in the remaining columns. As before we display the estimations without controls, including village dummies only, and including both village dummies and individual demographic controls.

< Tables 2 around here >

Table 2a displays the short-run results of OFSP planting patterns (based on data collected just after the intervention), while Tables 2b and 2c focus on the longer-run results (based on data collected in the final survey). As we can see from the difference-in-differences estimates in Table 2a, the treatment effect on the probability of cultivating OFSP translated to an increase in 72 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 an increase in approximately 26 percentage points. These results are supported by the estimates not employing baseline data, in which the relevant coefficients decrease slightly but remain statistically significant. In addition, when we apply the adjusted p-values these effects remain statistically significant for all specifications except one. 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. Given that OFSP can be propagated through vines, rather than through seeds, it is possible that treated farmers exchanged planting material with other farmers, which might help to explain the increase in control-group farmers planting OFSP. We expand on this hypothesis below.

In Table 2c we show the estimates computed for the number of OFSP harvested crops in the last 12 months 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 0.34-0.41 more harvested crops. This result is statistically significant at the 10 percent level for all specifications except one, where the coefficient is similar in magnitude but no longer significant.[15]

Finally, in Table 2d we analyze how the treatment affected the exchange of planting material among farmers. Looking at the first three columns, results show that the treatment status of the potential giver in the dyad is positive and statistically significant, indicating that treated individuals shared vines with other farmers. This represents a 12-13 percentage point increase over dyads composed of control individuals, statistically significant at the 1 percent level. In addition, dyads where the receiver was treated are more likely to share vines as well, but this result is not robust to the different estimation strategies. In the last three columns of Table 2d, we explore the patterns of vine sharing by further detailing the treatment status of the potential giver and receiver of vines. As we can see from the results, treated individuals are more likely to share vines with both treatment and control farmers, when compared to control individuals sharing with control individuals. This represents an 18-19 percentage-point increase in vine sharing from treated to other treated farmers, and 14-15 percentage-point increase in sharing from treated to control farmers. Both results are statistically significant at the 1 percent level. In addition, it is worth noting that we also find a positive and statistically significant effect for sharing from control to treatment farmers, although much smaller in magnitude (again, when comparing to sharing between control individuals).

The results appear to provide evidence that not only farmers in 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. In addition, we find evidence that the treatment farmers shared planting material with both treated and control farmers, which is consistent with the increased OFSP production by control farmers at the endline.

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[15] These results are also corroborated by our analysis of the treatment effect for the overall planting outcomes in Table A4 of the online appendix to this paper.

4.4 Consumption patterns

In Tables 3 we estimate the treatment effects on consumption of OFSP and other vitamin A rich foods, using endline reports of consumption while employing specifications (1) and (2). The p-values reported are adjusted for testing all the consumption outcomes in Tables 3. Once again results shown correspond to specifications without controls, with village dummies, and with village dummies and individual demographic controls at the same time.

Table 3a shows treatment effects on the consumption patterns of OFSP for the previous week, namely whether OFSP was consumed and the corresponding quantities consumed.

< Tables 3 around here >

We do not find statistically significant results on the probability of OFSP consumption in the previous week or on the quantities consumed during the same period, even though point estimates are positive.[16]

It is worth noting that, despite being widely grown, only a small proportion of farmers consumed OFSP at the endline – 12 and 17 percent in the previous week and the previous month, respectively. Recall that the final data collection took place at the end of the second growing season of the 2013/2014 agricultural season and so OFSP should have been available for consumption. Two plausible hypotheses could account for the low OFSP consumption. The first is that farmers may have chosen to sell their OFSP produce, instead of consuming it. The second is harvest loss. There is little evidence for the production-for-sale conjecture given that in the endline survey only three individuals reported selling OFSP. We do find support for the second hypothesis as farmers reported substantial harvest losses: 45 percent lost their entire harvest in both 2013/2014 planting seasons. Of those farmers that did not, the vast majority (66 percent) were not able to harvest in the second planting season, which was characterized by abnormal rainfall

[16] Consumption of OFSP in the previous months shows similar results. These results are displayed in Table A5a of the online appendix.

patterns. Specifically, the beginning of the planting season saw unusually heavy rainfall as a result of a tropical cyclone off the coast of Mozambique, followed by below average precipitation in the remaining months (FEWS NET, 2014). Consistent with that, in the endline survey farmers reported significant loss of crops due to either erratic weather, animal destruction, or both. In addition, it is unlikely that farmers still had OFSP from the previous planting season, as only three individuals reported storing OFSP crop.

In Table 3b we analyze the consumption patterns of other vitamin A rich foods in the previous week, namely the consumption of milk and eggs, orange vegetables and dark green leaves, and vitamin A rich fruits. As we can observe, there is no statistically significant effects of the treatment on the consumption of milk and eggs, or on orange vegetables and dark green leaves. However, when we turn our attention to vitamin A rich fruits, consumption in the previous week is found to increase by 18-19 percentage points in the treatment group. This effect is statistically significant at conventional levels, but after adjusting for multiple-hypothesis testing this result is no longer significant.[17]

Although we do not find statistically detectable impacts in our consumption measures at the time of the endline data collection, we cannot rule out that consumption might have happened at earlier points in time. In addition, it is possible that, at least to some extent, our results also reflect the inherent difficulties in accurately measuring consumption through surveys.[18]

5 Discussion

There are two main channels by which the intervention could affect nutrition outcomes. First, the most direct potential channel is food production for household consumption. If the intervention resulted in increased OFSP production it could directly increase the availability of OFSP for household consumption, thus providing greater access to a vitamin A rich food. Improvements in vitamin A status are associated with reductions in child morbidity (Mayo-Wilson et al., 2011), and improvements in child nutrition status

[17] These results are in line with our analysis of the treatment effect on average consumption measures displayed in Table A5b of the online appendix.

[18] Further challenges in capturing results in our consumption survey measures arise from the fact that baseline data on consumption are not available.

and growth. In particular, vitamin A has been shown to affect growth among children with severe vitamin A deficiency. However, given that vitamin A deficiency commonly occurs together with other forms of micronutrient deficiency that also limit growth, improvements in child growth may not occur if other nutrient deficiencies are more severe (Rivera et al., 2003). Second, since the intervention conveyed information on children's nutritional needs, and promoted healthy diets for the targeted households, it could have contributed to improve nutrition outcomes indirectly by raising farmers' awareness of such issues, potentially leading to an increase in consumption of nutritionally rich foods other than OFSP.[19]

6 Limitations

In context of impacts on nutrition, our study faces some limitations. First, as described in section 4.4, we do not find clear improvements in dietary intakes in our specific consumption measures. While useful as a proxy for vitamin A availability and absorption, household dietary information can nevertheless suffer from a few limitations. There may inherently be some degree of measurement error when recalling dietary data. Further problems can arise from difficulties in accounting for absorption efficient as a result of differences in bioavailability, in processing and storage losses, and in absorption capacity due to infection diseases or low-fat intakes[20] (Jenkins et al., 2015). Second, we do not find strong evidence of impact on children nutrition status. Detailed results are reported in the online appendix to this paper (Table A6) where we show the treatment effects on child anthropometric outcomes, which proxy for child nutrition status. These results are in line with those of Low et al. (2007) and de Brauw et at. (2015), who failed to find a significant impact of OFSP interventions in Mozambique on broad nutrition indicators such as child growth, which is consistent with vitamin A deficiency not being the only nutrient deficiency limiting growth (Rivera et al., 2003). In addition, infection diseases, which are prevalent in rural Mozambique (WHO, 2015), can contribute to decrease nutrient intakes and to increase nutrient losses. As such, in these settings, improvements

[19] A third channel could be theoretically possible, as the intervention could also increase household income, via the use of produced OFSP for sale rather than for own consumption. The resulting higher income could translate into an improvement in nutrition outcomes as farmers could use the additional income to increase the quantity and/or improve the nutritional quality of their food purchases. However, this is unlikely to have been a significant channel in our case since only three individuals in the sample reported selling OFSP, with average annual sales of 13 Kgs (14 USD) per individual.

[20] Vitamin A is a fat-soluble micronutrient.

in dietary intakes might not be sufficient to promote child growth (Bhan et al., 2001). However, previous studies have reported positive effects on narrower measures of nutrition, such as the prevalence of morbidity as a proxy for nutrition status (Jones and de Brauw, 2015), vitamin A intakes measured using dietary intake data (Low et al., 2007; de Brauw et al., 2018; de Brauw et al., 2015; Hotz et al., 2012a), and, most notably, serum retinol concentrations, which reflect vitamin A status, in blood sample collections (Low et al., 2007; Hotz et al., 2012b and de Brauw et al., 2018). Future research on nutrition-sensitive interventions should include more tailored measures of nutrition status, whenever possible.

7 Concluding remarks

In this paper we have analyzed the short and medium run impacts of a randomized evaluation of OFSP-related training, which underlined the crop's nutritional benefits. 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. Our results show that the treatment led to considerable improvements in knowledge associated with vitamin A, as well as with cooking and planting OFSP in the short and medium-run. These results indicate that farmers were able to retain most of the information even after significant time had passed. We also found evidence of increased OFSP planting right after and a year and four months after the treatment. In addition, we show that treated individuals contributed to increase OFSP-adoption by peer farmers. However, there was no measurable impact on our measures of OFSP consumption at the endline survey, and we only found limited evidence of increased consumption of other vitamin A rich foods.

A final point that deserves discussion is the pattern of knowledge retention by farmers. While nutrition knowledge improved considerably right after the treatment, only some key messages seemed to persist with farmers. Most notably, over time farmers tended to forget more abstract information related to the underlying nutritional principles, such as knowledge related to awareness and importance of vitamin A. They were better able to recall information focusing on specific actions and recommendations, such as identifying who suffers most from vitamin A deficiency and how to prevent it. These results suggest that, although the nutrition principles might be important in a first stage to create awareness about the relevant problems, the specific actions that farmers need to take are easiest to remember.

We believe that the results from this project provide relevant insights into the process of adoption of agricultural technologies and, more importantly, to the efficacy of agricultural interventions emphasizing education for nutrition. 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 1a: Nutrition knowledge outcomes

dependent variable		post-treatment			endline		
		one-difference			one-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
heard about vitamin A	coefficient	0.39**	0.38**	0.34**	0.21	0.19	0.17
	standard error	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.15)
	adjusted p-value	[0.14]	[0.14]	[0.28]	[0.14]	[0.14]	[0.28]
knowledge about importance of vitamin A	coefficient	0.86***	0.88***	0.81***	0.21	0.22	0.25
	standard error	(0.18)	(0.18)	(0.18)	(0.21)	(0.21)	(0.21)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.52]	[0.55]	[0.54]
considers vitamin A deficiency a problem	coefficient	0.73***	0.72***	0.70***	0.08	0.11	0.12
	standard error	(0.15)	(0.15)	(0.16)	(0.22)	(0.21)	(0.22)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.69]	[0.55]	[0.54]
knowledge of who suffers most from vitamin A deficiency	coefficient	0.67***	0.66***	0.71***	0.58**	0.58**	0.61**
	standard error	(0.21)	(0.22)	(0.20)	(0.23)	(0.24)	(0.25)
	adjusted p-value	[0.02]	[0.03]	[0.01]	[0.10]	[0.13]	[0.10]
knowledge about preventing vitamin A deficiency	coefficient	0.61***	0.59***	0.58***	0.56***	0.57***	0.54***
	standard error	(0.16)	(0.16)	(0.18)	(0.21)	(0.20)	(0.21)
	adjusted p-value	[0.00]	[0.00]	[0.01]	[0.05]	[0.05]	[0.09]
knowledge about food items containing vitamin A	coefficient	1.78***	1.80***	1.83***	0.45**	0.46**	0.47**
	standard error	(0.26)	(0.25)	(0.25)	(0.22)	(0.22)	(0.22)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.19]	[0.18]	[0.28]
village dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: The table reports estimates of treatment effects. All regressions are OLS. All dependent variables are z-scores. Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 1b: Nutrition knowledge outcomes (continued)

dependent variable		post-treatment			endline		
		one-difference			one-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
awareness of OFSP	coefficient	1.00***	0.97***	1.04***	0.61**	0.62**	0.58**
	standard error	(0.20)	(0.20)	(0.20)	(0.24)	(0.24)	(0.26)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.09]	[0.11]	[0.19]
knowledge about importance of OFSP	coefficient	1.18***	1.17***	1.14***	0.43**	0.45**	0.38*
	standard error	(0.19)	(0.19)	(0.19)	(0.20)	(0.21)	(0.21)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.20]	[0.17]	[0.33]
knowledge about who should consume OFSP	coefficient	1.65***	1.63***	1.69***	0.39*	0.35*	0.37*
	standard error	(0.22)	(0.20)	(0.21)	(0.23)	(0.21)	(0.21)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.31]	[0.37]	[0.33]
nutrition knowledge index	coefficient	0.99***	0.99***	1.00***	0.40***	0.40***	0.39***
	standard error	(0.11)	(0.10)	(0.11)	(0.12)	(0.12)	(0.12)
village dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: The table reports estimates of treatment effects. All regressions are OLS. All dependent variables are z-scores. Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 1c: Cooking knowledge outcomes

dependent variable		post-treatment			endline		
		one-difference			one-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
	coefficient	1.93***	1.90***	1.84***	1.08***	1.08***	1.02***
number of dishes with OFSP	standard error	(0.21)	(0.21)	(0.20)	(0.19)	(0.20)	(0.20)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
village dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: The table reports estimates of treatment effects. All regressions are OLS. All dependent variables are z-scores. Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 1d: Farming knowledge outcomes

dependent variable		post-treatment			endline		
		one-difference			one-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
knowledge of how to prepare the field to plant OFSP	coefficient	0.68***	0.68***	0.70***	0.41**	0.41**	0.40**
	standard error	(0.16)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)
	adjusted p-value	[0.00]	[0.00]	[0.00]	[0.10]	[0.07]	[0.13]
knowledge of how to plant OFSP	coefficient	0.56***	0.52***	0.53***	-0.24	-0.24	-0.27
	standard error	(0.17)	(0.17)	(0.18)	(0.26)	(0.27)	(0.29)
	adjusted p-value	[0.01]	[0.03]	[0.02]	[0.67]	[0.73]	[0.71]
knowledge of how to irrigate OFSP	coefficient	0.18	0.17	0.17	0.52***	0.53***	0.56***
	standard error	(0.20)	(0.21)	(0.21)	(0.17)	(0.17)	(0.18)
	adjusted p-value	[0.67]	[0.73]	[0.71]	[0.04]	[0.02]	[0.01]
knowledge of when to harvest OFSP	coefficient	0.37**	0.37**	0.38**	0.35**	0.36**	0.37**
	standard error	(0.18)	(0.19)	(0.18)	(0.16)	(0.16)	(0.16)
	adjusted p-value	[0.17]	[0.19]	[0.13]	[0.14]	[0.15]	[0.13]
knowledge of how to harvest OFSP	coefficient	0.60***	0.61***	0.56**	0.63***	0.63***	0.64***
	standard error	(0.20)	(0.21)	(0.22)	(0.18)	(0.18)	(0.19)
	adjusted p-value	[0.04]	[0.03]	[0.08]	[0.01]	[0.01]	[0.01]
knowledge of how to prepare the field after harvesting	coefficient	0.59***	0.61***	0.62***	0.09	0.08	0.13
	standard error	(0.16)	(0.16)	(0.18)	(0.20)	(0.20)	(0.20)
	adjusted p-value	[0.01]	[0.00]	[0.01]	[0.67]	[0.73]	[0.71]
farming knowledge index	coefficient	0.50***	0.49***	0.49***	0.29***	0.30***	0.31***
	standard error	(0.12)	(0.12)	(0.12)	(0.08)	(0.08)	(0.09)
village dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: The table reports estimates of treatment effects. All regressions are OLS. All dependent variables are z-scores. Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2a: Planting patterns post-treatment

dependent variable ------>		planted OFSP					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.63***	0.63***	0.62***	-0.09	-0.09	-0.11
	standard error	(0.08)	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)
	adjusted p-value	[0.00]	[0.00]	[0.00]			
time	coefficient				-0.25***	-0.26***	-0.26***
	standard error				(0.07)	(0.07)	(0.07)
time*treatment	coefficient				0.72***	0.72***	0.72***
	standard error				(0.12)	(0.12)	(0.12)
	adjusted p-value				[0.00]	[0.00]	[0.00]
mean dep. variable (control)		0.06	0.06	0.06	0.31	0.31	0.31
r-squared adjusted		0.42	0.39	0.38	0.23	0.25	0.25
number of observations		98	98	98	198	198	198
village 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 village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2b: Planting patterns endline

dependent variable ------>		planted OFSP					
		one-difference			difference-in-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
treatment	coefficient	0.17*	0.17*	0.16*	-0.09	-0.09	-0.11
	standard error	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)
	adjusted p-value	[0.09]	[0.09]	[0.11]			
time	coefficient				0.36***	0.36***	0.36***
	standard error				(0.09)	(0.09)	(0.09)
time*treatment	coefficient				0.26**	0.25**	0.26**
	standard error				(0.13)	(0.12)	(0.12)
	adjusted p-value				[0.05]	[0.07]	[0.07]
mean dep. variable (control)		0.67	0.67	0.67	0.31	0.31	0.31
r-squared adjusted		0.03	0.05	0.03	0.24	0.29	0.29
number of observations		93	93	93	193	193	193
village 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 village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2c: Planting patterns endline

dependent variable ------>		OFSP harvested crop		
		one-difference		
		(1)	(2)	(3)
treatment	coefficient	0.41*	0.38*	0.34
	standard error	(0.23)	(0.22)	(0.22)
	adjusted p-value	[0.09]	[0.09]	[0.11]
mean dep. variable (control)		0.50	0.50	0.50
r-squared adjusted		0.03	0.05	0.15
number of observations		92	92	92
village 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 crops). Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2d: Planting patterns endline

dependent variable ------>		shared vines					
		(1)	(2)	(3)	(4)	(5)	(6)
treatment giver	coefficient	0.12***	0.12***	0.13***			
	standard error	(0.04)	(0.04)	(0.03)			
treatment receiver	coefficient	0.06	0.06	0.06*			
	standard error	(0.04)	(0.04)	(0.03)			
treatment to treatment	coefficient				0.18***	0.18***	0.19***
	standard error				(0.05)	(0.05)	(0.04)
treatment to control	coefficient				0.14***	0.14***	0.15***
	standard error				(0.04)	(0.04)	(0.04)
control to treatment	coefficient				0.08*	0.08*	0.08**
	standard error				(0.04)	(0.04)	(0.04)
mean dep. variable (control)		0.079	0.079	0.079	0.079	0.079	0.079
r-squared adjusted		0.038	0.055	0.120	0.113	0.056	0.121
number of observations		1 024	1 024	1 024	1 024	1 024	1 024
village dummies		no	yes	yes	yes	yes	yes
controls		no	no	yes	yes	no	yes

Note: All regressions are OLS. The unit of observation is the directed dyad. The dependent variable is binary. Controls are village dummies and node demographic characteristics, which include age, years of education, marital status, occupation and farmers' association membership. Two-way cluster-robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3a: Consumption patterns endline

dependent variable ------>		has consumed OFSP in the past week (0-1)			quantity of OFSP consumed in the past week		
		one-difference			one-difference		
		(1)	(2)	(3)	(4)	(5)	(6)
	coefficient	0.08	0.07	0.07	0.06	0.05	0.05
treatment	standard error	(0.07)	(0.07)	(0.07)	(0.25)	(0.24)	(0.25)
	adjusted p-value	[0.70]	[0.74]	[0.74]	[0.89]	[0.87]	[0.89]
mean dep. variable (control)		0.08	0.08	0.08	0.32	0.32	0.32
r-squared adjusted		0.00	0.05	0.03	-0.01	0.00	-0.04
number of observations		91	91	91	91	91	91
village dummies		no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes

Note: All regressions are OLS. The dependent variable has consumed OFSP is binary. The dependent variables quantity of OFSP consumed are expressed in Kg. Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3b: Consumption patterns endline

dependent variable ------>		has consumed milk and eggs in the past week (0-1)			has consumed orange vegetables and dark green leaves in the past week (0-1)			has consumed vitamin A rich fruits in the past week (0-1)		
		one-difference			one-difference			one-difference		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	coefficient	-0.06	-0.06	-0.10	-0.06	-0.07	-0.06	0.19*	0.18**	0.19**
treatment	standard error	(0.10)	(0.11)	(0.11)	(0.08)	(0.08)	(0.08)	(0.10)	(0.09)	(0.09)
	adjusted p-value	[0.89]	[0.87]	[0.76]	[0.89]	[0.87]	[0.77]	[0.27]	[0.22]	[0.14]
mean dep. variable (control)		0.45	0.45	0.45	0.84	0.84	0.84	0.24	0.24	0.24
r-squared adjusted		-0.01	-0.05	-0.03	-0.00	0.04	0.02	0.03	0.17	0.19
number of observations		93	93	93	93	93	93	93	93	93
village dummies		no	yes	yes	no	yes	yes	no	yes	yes
demographic controls		no	no	yes	no	no	yes	no	no	yes

Note: All regressions are OLS. The dependent variables are binary. Controls are village dummies and demographic characteristics, which include age, years of education, marital status dummies, occupation and farmers' association membership. Robust standard errors reported in parenthesis. Romano-Wolf p-values are presented in square brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.