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Sustainability of impact
Dimensions of decline and persistence in adopting a biofortified crop in Uganda

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Sustainability of impact: dimensions of decline and persistence in adopting a biofortified crop in Uganda

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Summary

We examine the sustainability of the impact of a biofortification program that introduced provitamin A-rich orange sweet potatoes (OSP) to farming households in Uganda. The crop was introduced in a randomized controlled experiment to test the impact and cost-effectiveness of introducing OSP on crop adoption and dietary intakes of vitamin A. A previous impact evaluation of the two-year project using baseline and endline data found large impacts on both OSP adoption and vitamin A consumption in project households. Here, we study sustainability of the intervention by looking at the profile of OSP adoption during the project and over four seasons after the project's end. After achieving an adoption rate of 92 percent in the first season, a trajectory of declining adoption continued, and may have accelerated, after the project ended. Mean adoption rates fell to 37 percent four seasons after the project ended. However, there was substantial heterogeneity in the adoption patterns across districts and between primary beneficiaries and neighboring farming households. This is consistent with a pattern of experimentation among initial adopters followed by a period of learning about profitability and consumption preference for the crop. Non-beneficiaries display a similar pattern of learning. We explore the mechanisms that predict decline and persistence in adoption behavior among various types of farmers, and consider implications for the cost-effectiveness of the intervention.

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Abbreviations and acronyms

NGO	nongovernmental organization
OSP	orange sweet potato
RCT	randomized controlled trial
REU	Reaching End Users (biofortification project of HarvestPlus)
WYSP	white or yellow sweet potato

1. Introduction

Projects designed to spur agricultural development or promote adoption of health behaviors in developing countries are often implemented over a very limited time horizon of only a couple of years or less. The unstated justification for these short initiatives must be that a large, temporary push of investment and activity will be sufficient to induce lasting adoption of the technologies or behaviors being promoted. Other practical considerations also limit the lifespan of such development projects, including funding constraints, limited commitment of donors, and frequent turnover of project and donor staff. The growth of experimentation and evaluation in development, which has led to many valuable discoveries, has also contributed to the implementation of short duration projects designed as pilot studies or for the purpose of experimentation only. Very little is known about the sustainability of the impact of these short duration development projects. Do farmers who adopted agricultural technologies during the project abandon the technologies when the project is over? Do beneficiaries retain lessons learned about farming practices or healthy behaviors, and do these behaviors continue without the support of the project? Even when projects include rigorous impact evaluations, it is not usually known if the impacts quickly dissipate after the project and evaluation are completed, or how the size of measured impacts depends on the length of project duration or the timing of the evaluation endline surveys.

A number of factors affect the sustainability of projects that promote adoption of agricultural technologies or health behaviors, where sustainability is measured by the medium-term adoption rate or adherence to the health behaviors introduced. With many projects, initial adoption or adherence rates are high as participants willingly try out a new technology or behavior. Enthusiasm for the potential benefits from the project may induce high initial participation. During the project, participants experiment with the technology and learn about its profitability or effectiveness. For new crops, this may also include establishing preferences for consumption of the crop. Some of what is learned includes information about the input cost and labor time needed to use the technology and possible constraints in accessing complementary inputs like credit or water. Spillover effects in adoption can also be important, whereby participants rely on each other to share information about the crop, to provide access to the technology after idiosyncratic crop failure, or due to imitation effects. This process often leads to declining adoption or adherence profiles during the project, unless the project is unusually profitable or effective, such as with Green Revolution technologies. The end of a project may accelerate these declines if the project subsidized inputs, assisted learning, or facilitated technology diffusion. An important policy question is whether declining adoption or adherence profiles settle at an equilibrium adoption rate, and whether this adoption rate is sufficiently high that the original project investment is deemed cost-effective.

Rogers' (2003) classic, *Diffusion of innovations*, first published in 1962, describes the critical role of communication and social interaction in the time profile of the spread of new technologies. Successful innovations follow an S-shaped adoption curve with slow initial adoption followed by a period of take-off, leading eventually to near saturation of adoption if a critical mass of adopters is reached. This pattern of diffusion and sustained adoption characterizes the introduction of clearly superior, more profitable innovations. In agriculture, this pattern of diffusion of innovation is often limited by the appropriateness of the technology to the setting, including soil quality, access to water, and presence of pests. Recent evidence for projects promoting the adoption of productivity enhancing agricultural technologies supports the notion that adoption profiles for seemingly profitable technologies introduced through projects are likely to decline as farmers gain experience with the technology. In recent research, technologies such as hybrid maize seed and fertilizer turned out to be unprofitable for many farmers (Duflo *et al.* 2009; Suri 2011). Other evidence shows that adoption of agricultural technologies may be limited by poor farmers' present-biased preferences (Duflo *et al.* 2011), by risk in the face of missing insurance markets (Dercon and Christiaensen 2007), or by other market inefficiencies (see Jack 2011 for a review). Moser and Barrett (2003) report on a rice-intensification technology that faced widespread disadoption once training and support were removed, in part because the labor requirements made the technology unprofitable.

In health, Kremer and Miguel (2007) examine the sustainability of a deworming project in Kenya. The project was designed to promote private take-up of deworming medications, but deworming is a public good because the majority of the social benefits accrue to others through reduced disease transmission. Take-up rates of deworming were low in the absence of subsidies. The authors conclude that this one-time intervention could not sustainably overcome the free-riding behavior that characterizes private provision of public goods.

This paper examines the sustainability of impact of an agricultural intervention designed to promote the adoption and consumption of biofortified, vitamin A-rich orange sweet potato (OSP) in Uganda as a strategy to reduce vitamin A deficiency.[1] In 2007, HarvestPlus and local nongovernmental organizations (NGOs) distributed OSP planting material (vines) to 10,000 households in three districts by working with local farmer groups. Over the next two years, project staff conducted agricultural trainings of farmer group members on how to grow OSP and nutrition trainings on the benefits to children and women of consuming OSP and other sources of vitamin A. As part of this pilot study, researchers conducted a randomized controlled trial (RCT) to measure the impact of the two-year intervention on

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[1] An efficacy study from South Africa showed that daily consumption of OSP, which provided around 2.5 times the vitamin A recommended dietary allowance for 4-to-8-year-old children, improved liver vitamin A stores (van Jaarsveld *et al*. 2005). In a study of an OSP biofortification initiative in Mozambique, Low *et al*. (2007) found that children in treated communities growing OSP had higher vitamin A intakes than children in comparison communities (median 426 vs. 56 μg retinol activity equivalent) and higher serum retinol concentrations (by 0.075 μmol/L on average).

adoption of OSP by project beneficiaries, diffusion of the crop to other households, changes in dietary intake of vitamin A, and impacts on vitamin A status measured by serum retinol in blood samples. The experiment included random assignment of villages into a control group and two treatment arms that differed in intensity of training. The intensive treatment arm included distribution of OSP vines and two years of trainings; the less intensive arm included distribution of OSP vines and only one year of training, resulting in a savings of 20–30 percent of project cost relative to the intensive treatment. The two-year evaluation study found large impacts of the intervention including: a 61 percent adoption rate of OSP by project beneficiaries at the end of the two years of the project; a 76 percent increase in mean dietary intake of vitamin A by children under age 3; and a modest improvement in vitamin A status among children with low vitamin A status at baseline (Hotz *et al*. 2012).[2,3] Moreover, the biofortified OSP was adopted as intended, primarily as a substitute in production and consumption for the less nutrient-dense white or yellow sweet potato (WYSP) varieties (de Brauw *et al*. 2010). In 2011, we returned to the original evaluation study villages to learn about the sustainability of the OSP project that ended in August 2009.[4] At the end of that pilot study, households in farmer groups in the control villages received OSP planting material, but no additional training.

In this paper, we explore the sustainability of the OSP intervention two years after its completion. Using data from three survey rounds, we examine patterns in OSP cultivation in the eight agricultural seasons after the OSP vines were first distributed to project households.[5] The outcomes considered include the time profile of the prevalence of OSP cultivation, new OSP adoption, and OSP disadoption by members of project farmer groups and as spillovers to nonmember households in the same communities. We compare causal impacts of the interventions at the end of the project (season 4) and two years later (season 8). The rate of adoption among project beneficiaries declined to 66 percent on average in season 4 and 37 percent in season 8, but there is substantial heterogeneity in adoption profiles across districts, suggesting potentially sustainable adoption in some districts and near abandonment of the crop in others. Next, we consider the effect on OSP adoption decisions of the cessation of program-related activities, differences in the intensity of the flow of information in the two treatment arms, and timing of access to planting material in the control group. We also explore how these factors

[2] There was no significant difference in mean OSP adoption rates or dietary intake of vitamin A for children under age 3 across the two treatment arms, so we report the overall treatment effect on these outcomes. Serum retinol samples were collected only for the intensive treatment arm.
[3] On the basis of this evidence, HarvestPlus received funding in 2011 to scale up the OSP project in Uganda to reach 225,000 beneficiaries over the next five years. This is an ongoing project.
[4] The follow-up study round in 2011 did not include the dietary recall measures collected earlier due to the high cost of collecting those data. More limited measures of dietary intake of vitamin A-rich food sources were used, but preliminary analysis of these data indicated that they are not as reliable as the previous measures. Analysis of these measures is not included here.
[5] In the region of study, there are two agricultural seasons per year corresponding to two rainy seasons, a main season roughly from March to July, and a lesser season from August to November.

affect diffusion of the OSP technology. We present findings from models of determinants of OSP adoption decisions that capture the role of agronomic conditions, household characteristics, and farm characteristics, and control for unobservable household effects and lagged effects of prior adoption decisions. In explaining the pattern of adoption, we distinguish between the role of information, access to planting material, and imitation effects. We also explore how social and information networks mitigate these effects. In related research, we found large effects of information networks that were consistent with imitation effects and returns to agglomeration in sharing planting material (McNiven and Gilligan 2012). There are also interesting interview effects in the data that reflect the effect of participating in the baseline survey on adoption. These effects suggest the potential benefits of priming targeted households for technology promotion but also of suggest lessons about interpretation of effects from RCTs that include baseline surveys. Finally, we consider the implications of these findings for the cost-effectiveness of the OSP intervention. Short-term projects to promote technology adoption that have sustained impacts will be far more cost-effective. Moreover, persistence in the diffusion of the OSP technologies has important implications for the feasibility of biofortification as a strategy to address micronutrient deficiency. We consider the implications of our findings for biofortification programs.

This paper is organized as follows. Section 2 describes the HarvestPlus OSP intervention and the data. Section 3 presents the empirical strategy for identifying impacts of the intervention and for exploring determinants of adoption patterns. Section 4 presents the results, while Section 5 considers the implications for cost-effectiveness and Section 6 presents conclusions.

2. The OSP intervention and the data

2.1 The HarvestPlus OSP project

The HarvestPlus Reaching End Users (REU) project in Uganda introduced OSP through the distribution of OSP vines in August 2007. This was followed by up to two years support to farmers who received the planting material through periodic trainings on how to cultivate and maintain OSP, and on the health benefits of consuming OSP and other dietary sources of vitamin A. The project worked with farmer groups, selecting one farmer group in each community in which it operated to provide support and coordination in distribution of OSP planting material and in the conduct of the trainings.[6] Two local NGOs, Volunteer Efforts for Development Concerns and Farming for Food and Development,

[6] In order to participate in the project, farmer groups had to have at least 10 members, had to be operating for at least one year, must have at least 4 members with children under age 5, and could not be focused exclusively on promotion of a cash crop. If multiple farmer groups in a village met these criteria, one would be selected through consultation between the implementing NGO and village leadership.

managed project implementation including OSP vine distribution and trainings. Agriculture and health extension workers from each NGO trained one member of each farmer group as an agricultural promoter and another as a nutrition promoter. After being trained by the NGOs, these promoters conducted a series of trainings of farmer group members on how to grow the crop, and on the nutrition of vitamin A and child and maternal diets.[7] Farmer groups are a common village institution in Uganda that serves as a mechanism for information sharing and support for interested farmers, and also coordinates participation in projects promoting new agricultural technologies. Through these selected farmer groups, the project directly reached roughly 10,000 farm households in three districts: Kamuli, Mukono, and Bukedea. In Kamuli and Mukono districts, WYSP was a staple food crop with 98 percent of households reporting that they grew these crops in the year before baseline.[8] In Bukedea district, only 60 percent of households grew any sweet potato in the year prior to baseline. The share of planted area devoted to any sweet potato (16 percent in the main season at baseline) is consistent with sweet potato being a primary staple crop. Other staple crops in this area include cassava and maize, which account for 30 percent and 27 percent of planting area, respectively. Marketing practices for sweet potato varied by district. At baseline, the share of households that reported ever buying WYSP was only 5 percent in Kamuli, 20 percent in Mukono, and rose to 52 percent in Bukedea. Orange sweet potato was generally not grown in these areas prior to the initiation of the intervention; less than 1 percent of respondents grew OSP in the two seasons (one year) prior to the start of the intervention (Arimond *et al*. 2009).

As noted earlier, the original impact evaluation of the REU project included two intervention models that varied in length of trainings. Both models had four primary components:

(i) develop an OSP vine distribution system that provided free vines to households in selected farmer groups;
(ii) provide extension to men and women in project households on OSP production practices and marketing opportunities;
(iii) provide nutritional knowledge, in particular about vitamin A deficiency, to women in these same households; and
(iv) develop markets for OSP roots and processed products made from OSP roots.

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[7] The agriculture trainings addressed agronomic properties of OSP, field preparation and planting methods, disease and pest control, yield assessment, and vine conservation. The nutrition trainings provided lessons on food and its functions, the importance of consuming vitamin A and its sources, maternal nutrition, and infant and young child feeding practices. Limited additional trainings were held on marketing OSP and on preparation of OSP products. The agriculture trainings were held in coordination with the OSP production cycle. The nutrition and marketing trainings were held during the agricultural season.
[8] Yellow sweet potato has a mild yellow color but has very low density of beta carotene and so is not a rich dietary source of vitamin A. We treat white and yellow sweet potato as the same conventional sweet potato crop.

Component (i) was identical across the two intervention arms. Beneficiary households reported receiving 11 kilograms of vines on average from July to October 2007, and 70 percent of households received all of the vines in a one-time distribution. The remaining households received a second distribution of some OSP varieties they had not yet received. There was no difference in average quantity of vines received across the two treatment arms (de Brauw *et al*. 2010). Less than 8 percent of households reported receiving any OSP vines from the project in a subsequent season, and most of those were in season 2 of the project, at the start of 2008. Components (ii)–(iv) were provided for two years under the intensive treatment and for one year under the less intensive treatment, at a savings of 20–30 percent of total model costs. The OSP varieties provided shared many of the same characteristics of conventional sweet potato varieties (WYSP) being grown at baseline. On average, the OSP varieties were modestly higher yielding, but were also somewhat more susceptible to rot during dry periods (de Brauw *et al*. 2010). As part of the agricultural trainings, farmers were taught to plant the OSP vines grouped in mounds using techniques that were somewhat more labor intensive than the methods typically used for WYSP.

2.2 The study design and data

This study on impact sustainability built on the original RCT of the OSP project to measure the patterns of OSP adoption over the period 2007–2011 in several reference groups: farmer group member household beneficiaries of the original OSP project; control farmer group households in other communities; and neighboring households living near the original beneficiaries, which included households in the same communities and households living in other communities bordering the primary study villages. This spillover sample was included in the study in order to measure OSP crop diffusion. Figure 1 shows the role of these reference groups in the study and the nature of their exposure to treatment. Primary beneficiaries in the intensive treatment (T_1) received OSP planting material and two years of trainings, while primary beneficiaries in less intensive treatment (T_2) received OSP planting material and only one year of trainings. Neighbors of these farmer group member households living in the same communities or neighboring communities were indirectly exposed to the treatment and may have received planting material or some knowledge from the trainings over the same period. The control group (T_0) received access to OSP planting material in August–September of 2009, after the original evaluation study, but did not receive any trainings. There were no other project activities provided in the study areas after August 2009 until the survey round on sustainability of impact was conducted in July 2011.

Household panel data collection included a baseline survey for the original impact evaluation of the REU project conducted in June–August 2007, and an endline survey for that evaluation in June–August 2009, just as the project was ending. A follow-up survey of the same households was conducted in July–September 2011. The original evaluation study design included 84 farmer group or village (hereafter farmer group) clusters that were randomly assigned to the intensive biofortification treatment, the less intensive treatment, and a control group, with randomization stratified by district.[9] Randomization to the three treatment groups was imbalanced, with 36 farmer group clusters randomly assigned to the intensive treatment, 12 farmer group clusters assigned to the less intensive treatment, and 36 farmer group clusters assigned to the control group (Panel A, Table 1). This imbalanced design was necessary in order to have sufficient power in the intensive treatment and control group to identify impacts on vitamin A status in serum blood samples from children and adult women. Power calculations suggested that expected effect sizes on outcomes related to OSP adoption and diffusion and to dietary intake of vitamin A could be identified with 12 sample clusters in the less intensive intervention arm.

Within each cluster, the baseline sample included 14 households with at least one child aged 3–5 that had a member in the selected farmer group for that cluster, resulting in a primary targeted sample of 1,176 households. Attrition was moderate in this sample at 11.5 percent over the four years of data collection. This resulted in a three-round panel of 593 farmer group member households in the 48 treated farmer groups and 445 farmer group member households in the 36 control farmer groups (Panel A, Table 1).

We also study within-community diffusion of OSP to households that were not members of the selected farmer group but were located in the farmer group's village.[10] These nonmember households were surveyed at baseline, endline, and follow-up. Five nonmember households with at least one child aged 3–5 at baseline were targeted in the community of each farmer group, leading to a baseline local diffusion sample of 420 households. Attrition was higher in this sample, at 21.4 percent by 2011. This yielded a three-survey panel of 187 nonmember households in the 48 treated farmer groups and 143 households in the 36 control farmer groups (Panel A, Table 1). In order to increase the power of the study to measure local diffusion and to test for the presence of baseline interview effects, six additional nonmember households with at least one child aged 3–5 years at follow-up were interviewed in the follow-up survey in the 36 control communities, and 34 of the treated communities (409 households in total). In the remaining 14 treated communities, all households in the main village of the farmer group were interviewed, regardless of the presence of children in the household, in order to study the role of social networks in decisions concerning OSP adoption, consumption, and knowledge, resulting in 923 additional interviews in the follow-up survey.

[9] The sample was designed so that each farmer group and the village in which the majority of its members lived were sampled together. Within villages, the household sample was stratified on membership in the selected farmer group, and households were sampled from among these farmer group members and among nonmember households.

[10] Some of the diffusion sample households may have been members of other farmer groups in the community, but most of the diffusion sample households did not belong to any farmer group.

Finally, to study cross-community diffusion, data were collected from households in farmer groups in parishes (groupings of three to seven villages) outside of the area directly reached by the intervention. Specifically, data were collected from parishes in which all farmers' groups did not participate in the intervention and that were adjacent to parishes with farmer groups that did participate. First, nine parishes adjacent to each district were randomly selected from among all such parishes. Then, in each of these 36 parishes, four farmer groups were chosen at random from among all farmer groups in these parishes. Finally, households were selected from the 102 chosen diffusion farmer groups, as follows. Before selecting households, the farmer groups were divided into three strata, one with the groups that had at least one member cultivating OSP at follow-up (cultivating groups), another with the groups in which at least one member had disadopted OSP and no members were cultivating OSP at follow-up (disadopting groups), and a third consisting of the groups without any members who had ever cultivated OSP (never-adopting groups). Households of types corresponding to the group types were selected from the diffusion farmer groups. First, in all farmer groups, three households that had never grown OSP were selected at random from among never-adopting households with a child aged 3 to 5 years. Second, in disadopting and cultivating groups, an additional three households that had disadopted OSP were selected at random from among disadopting households with a child aged 3 to 5 years. Third, in adopting groups, three households cultivating OSP were selected at random from among cultivating households with a child aged 3 to 5 years.[11] This resulted in a cross-community diffusion sample of 534 households (Panel B, Table 1).

Each household survey round collected detailed information on household access to land, farming practices and agricultural production, food and nonfood consumption, and knowledge about nutrition. A separate 24-hour dietary recall survey was conducted in the same households at baseline and endline to measure dietary intakes of vitamin A and other nutrients in children and adult women. The 2007 baseline survey gathered detailed information on these topics to serve as contextual and control variables in the evaluation. This included the household's experience with growing WYSP varieties, which were common in the diet of these districts at the time, but are much less dense sources of vitamin A than the OSP varieties distributed through the project later that year. Estimates show that baseline values of key outcome and control variables, including share of households growing WYSP, land area, and dietary intakes of vitamin A were balanced across the three treatment arms (Arimond *et al*. 2009). The 2009 endline survey covered

[11] If the sample targets for never-adopting, disadopting, or cultivating households could not be met with households with a child aged 3 to 5 years, the remaining sampled households of each type were chosen at random from among all households of the type. In many cases, the target number of a type of household could still not be met, either because households could not be interviewed or because there were not enough households of each type in the farmers' group. When there were not enough cultivating households in a diffusion farmer group, additional disadopting households were selected from the group. Likewise, when there were not enough disadopting households in a diffusion farmer group, additional never-adopting households were selected from the group.

the same topics, including detailed retrospective information on farm area planted, crops grown, inputs used, and crop production and sales over the four agricultural seasons since the start of the project. The follow-up survey in 2011 covered the same topics in the original farmer group sample and the local diffusion sample, including detailed agricultural production data for the four agricultural seasons since the end of the project in August 2009. The survey instrument for the cross-community diffusion sample in 2011 was much shorter, but captured WYSP and OSP projection practices over the eight seasons since the beginning of the project. The 2009 and 2011 survey rounds also included detailed information on households' social and information networks, including a series of questions about interaction and communication with a randomly selected sample of households from our sample, in order to learn about the role of networks in information and crop technology diffusion.

3. Empirical strategy

The empirical models used include treatment effect models that rely on the original RCT design to estimate causal impact of the OSP interventions on adoption and diffusion over the eight seasons following the interventions, as well as a series of determinants models to capture factors shaping adoption and disadoption over time. Using the RCT design, we test for differences in OSP adoption patterns between the intensive and less intensive treatment arms in order to determine whether there is a persistent effect of the knowledge obtained through additional trainings provided under the second year of the project in the intensive treatment arm. Differences in impact of these two models are well identified by the random assignment of farmer groups to treatment. We estimate OSP adoption rates, OSP area cultivated, and OSP disadoption rates to describe the impact of the project on OSP cultivation outcomes for treated farmer group members at the end of the project (season 4) and two years later (season 8). Because so few households (0.5 percent) were cultivating OSP at baseline, we do not estimate the change in OSP cultivation relative to baseline. We compare OSP adoption profiles in the two treatments to OSP adoption in control communities. These treatment effects are underestimated in season 4 because OSP adoption in control communities during the project was mostly due to control group contamination or measurement error. When we compare adoption profiles to the control group in season 8, we must account for the fact that control group households received OSP vines in season 5 of the project.

We also explore determinants of OSP adoption over time using an implied model of economic decision-making that OSP will be cultivated each season if the benefits of doing so exceed the costs. These models include a variety of household and farm characteristics that affect the costs and benefits of adoption, including land area available, available household labor, and presence of children in the household, which would increase the perceived benefits of adoption. In addition, we control for nutrition knowledge of the primary caregiver in the household, a measure that shifts perceived benefits of adoption. We also include district fixed effects to control for unobserved differences across districts.

In our econometric specification of OSP adoption, the dependent variable, y_{isc}, is an indicator equal to 1 if household i cultivated OSP in season s in community c, and equal to 0 otherwise. This model can be expressed as:

$$y_{isc} = X_{ic}\beta + \eta_s + \eta_F + \epsilon_{isc} \quad (1)$$

where X_{ic} is a vector of time-invariant household characteristics and η_s is a vector of season fixed effects. η_F is a vector of district or community fixed effects, where $F \in \{d, c\}$, depending on the specification. ϵ_{isc} is an error term.

An alternative model can be expressed as:

$$y_{isc} = X_{ic}\beta + \eta_s + (s * X_{ic})\gamma + \eta_F + \epsilon_{isc} \quad (2)$$

where $s * X_{ic}$ is the interaction of season with a vector of household characteristics, which can control for the differential effect of household characteristics in response to season-specific shocks.

A third model estimates the determinants of the duration of OSP cultivation, which is accomplished with a proportional hazards model. The hazard function relates to the duration of OSP adoption, or the number of seasons that a farmer cultivates after the start of the program, for households that adopted OSP in season 1 of the project. This difference in sample from the other determinants models should not lead to large differences in estimated determinants of OSP adoption because 92 percent of households in the project planted the OSP vines they received at the start of the project. This duration is denoted as T. We denote the probability that the duration is less than t by $F(t) = \Pr[T \leq t]$. The hazard function, $\lambda(t)$, is the change in the probability of failure at time t, conditional on the agent having survived to t. We estimate the conditional hazard function, $\lambda(t|X, \beta)$, using the Cox proportional hazards model to learn about the influence of household characteristics on the duration of OSP cultivation. This model assumes that households still cultivating OSP in season 8 will eventually disadopt OSP, but that data on the household were censored before it disadopted. As we do expect that some households will continue cultivating OSP into the future, the assumptions of the model differ somewhat from our beliefs about the true data generating process.

In another model, we test whether some variables are associated with a pattern of OSP adoption and subsequent OSP disadoption while others are associated with a pattern of sustained OSP cultivation, using an ordered logit functional form. We assume that each household has an underlying long-run net benefit from OSP cultivation that is determined by observed household and farm characteristics. Households that never cultivate OSP are assumed to have low net benefits of OSP cultivation, those that adopt and subsequently disadopt are assumed to have moderate net benefits, and those that are still cultivating OSP in season 8 have high net benefits. We then estimate the marginal effect of each characteristic on the likelihood that the household is a never-adopter, disadopter, or sustained adopter of OSP.

In order to study OSP diffusion, we estimate OSP adoption models (1) and (2) on the two diffusion samples: local nonmember neighbors of the project participants, and farmer group members in communities adjacent to the original study communities, the cross-community diffusion sample.

Our estimates address several important measurement issues. Estimates of OSP adoption behavior for nonmember households may suffer from an interview bias. This bias has two components. One arises from the fact that, during the baseline survey interview, respondents were asked many questions about OSP, including about its benefits for consumption. That may have directly created interest in the crop and suggested to respondents that it is a healthy crop to consume. There may also be more traditional Hawthorne effects at work—knowing they are being studied, subjects may alter their behavior. For example, households interviewed at baseline may have been more attentive to doing well during the study period because they knew they were being studied. This may have caused them to pay closer attention to what was going on around them, which could lead them to learn that some of their neighbors had just started growing OSP. Both these factors serve as a form of encouragement to non-member respondents to more actively seek OSP or cultivate it. It is not possible to disentangle these two effects. Nonetheless, it is possible to estimate the extent of the aggregate interview bias in our data using the supplemental sample from the follow-up survey of randomly selected nonmember households living in the same communities as treated farmer groups. We asked respondents in these households the same questions about their OSP cultivation behavior over seasons 4–8 as we asked nonmember households originally sampled at baseline. This allows us to measure the extent of interview bias by directly comparing households across the two nonmember samples. To make these comparisons as accurate as possible, we adjust the analysis for covariates related to household composition, because nonmember households first interviewed at baseline were sampled from among households with at least one child aged 3–5 years, whereas this restriction was not placed on the sampling of nonmember households conducted for the follow-up survey.

Next, we also account for potential recall bias in the form of telescoping of recall regarding seasons in which farmer group member or nonmember households cultivated OSP. Our adoption data for seasons 1–4 are retrospective from the 2009 endline survey, for which season 4 was the most recent season. Adoption data for seasons 5–9 are taken from the 2011 follow-up survey, for which season 8 was the most recent season. Measurement error in recall likely increases with the length of the recall period, so the data for seasons 4 and 8 are likely the most accurate. The follow-up survey interview also asked about OSP cultivation in season 4 of the project, which coincides with the latest season recorded in the 2009 endline survey. We compare responses on the same variable from these two data sources to explore the extent of recall bias in the estimates. We generate an adjusted series of data to reduce bias from recall and compare trends in OSP adoption using this adjusted series.

Trends in OSP cultivation can also suggest whether the cessation of the program affected decisions concerning OSP cultivation. Treated farmers' group members received trainings and backstopping from agricultural extension agents for the program's four seasons. In addition, each farmers' group had two members who were recruited to promote OSP adoption and to train farmer group members on its health benefits. These activities were no longer supported by the project after the fourth season. Members and perhaps nonmembers might disadopt OSP or otherwise change their behavior after the fourth season. We informally test for evidence of such a cessation effect by examining whether the trends in OSP cultivation and disadoption change between the fourth and fifth seasons.

4. Results

4.1 Patterns of OSP adoption by district

We first present the pattern of adoption behavior by district over the eight seasons under study for project farmer group households (both treatments aggregated) and for nonmember neighbors of these households in the same communities, as shown in Figure 2. Project participants adopted OSP at a very high rate at the beginning of the project, with 92 percent planting OSP in the first season. This demonstrates their willing participation and interest in learning about the production and consumption characteristics of the crop. In subsequent seasons, average adoption rates decline, as might be expected from such high rates of initial adoption, but there is substantial heterogeneity in the adoption patterns across districts. In Kamuli and Mukono, adoption rates increase in the second season, which likely reflects the project's small delay in providing some households with planting material. Adoption rates then decline in these districts but remain near 80 percent in season 4, the last season of the project. In Bukedea district, on the other hand, OSP adoption rates plunge after the first season, steadily declining to less than 40 percent by the end of the project in season 4. After the end of the project, adoption rates appear to stabilize in Kamuli and Mukono for season 5, but this likely reflects recall bias in these retrospective data. In the next three seasons, adoption steadily declines in all three districts. Rates of adoption among project households are still at or above 50 percent in Kamuli and Mukono in season 8, but the trend suggests that the pattern of disadoption may continue. In Bukedea district, most project households had abandoned the crop for production by season 8.

The pattern of OSP adoption among the local diffusion sample of farmer group nonmembers in the same communities shows even more heterogeneity in behavior by district, with a pattern of disadoption over time, but potential for sustained adoption among this diffusion sample in Mukono. The relatively high adoption rate of OSP among these secondary beneficiaries in season 1 (50 percent or more in all three districts) demonstrates the ease with which planting material is shared within communities. Indeed, these data indicate that many households in project farmer groups gave OSP vines to their neighbors at the moment of receiving vines from the project. This encouraging initial diffusion rate is likely due to the relatively large quantity of planting material received by project participants. Over time, the trend is toward disadoption of the crop in these spillover households in Kamuli and Bukedea districts. Among secondary beneficiaries in Mukono, the adoption rate is stable during the project. It declines after the project but at a low rate, with the season 8 adoption rate remaining above 50 percent. We now explore in more detail the determinants of these adoption patterns.

4.2 OSP adoption behavior in project communities

We begin by summarizing key characteristics of sample subgroups in the project communities, including members and local nonmembers of selected farmer groups, and comparing characteristics between treatment and control communities. Mean household and farm characteristics of these sample subgroups in project communities are presented in Table 2. The first three columns present means of baseline characteristics of farmer group member households by treatment group status and tests of equality of means between treatment and control; the second three columns present means of baseline data for nonmember households interviewed at baseline (originally sampled nonmembers) by treatment group status and similar tests of equality of means across treatment and control communities. Columns 3 and 6 show that the treatment and control samples are balanced on most characteristics. Column 7 tests for differences in means between farmer group members and originally sampled nonmembers in treated communities. These tests are intended to characterize the differences between farmer group members and nonmembers at baseline rather than assess balance in the samples. Farmer group members may be systematically different from nonmembers in terms of their interest in or experience in farming, their willingness to learn from their peers, or other factors that could affect the probability of OSP adoption and sustained cultivation. Farmer group members are more likely to have cultivated WYSP. They may also have more land and educated household heads, although differences in these variables are weakly significant. Farmer group member households also have more children aged 3–5 years and fewer children aged 0–2 years, which is a function of the criteria used to select farmer group members into the sample. Reasonably, farmer group members also reside closer to the farmer group meeting place than do nonmembers.

Table 3 presents estimates of OSP cultivation and OSP purchasing behavior among treated farmer group members at the end of the OSP project in season 4 and two years later in season 8. Panel A shows the proportion of farmer group members cultivating OSP, Panel B shows the mean acres of OSP under cultivation among members cultivating OSP, and Panel C shows the proportion of members purchasing OSP for home consumption. Seasons 4 and 8 were chosen to reduce concerns about recall bias and to estimate the change in impact of the project in the two-year period after it ended.

After the four seasons of the project, 66 percent of treated farmer group members were cultivating OSP (Panel A). As shown in Figure 2, the rates of cultivation are much higher in Kamuli and Mukono districts than in Bukedea district. While 84 and 81 percent of farmer group members were cultivating OSP in Kamuli and Mukono, respectively, only 38 percent were cultivating OSP in Bukedea. In season 8, 37 percent of farmer group members were cultivating OSP: 49 percent in Kamuli, 59 percent in Mukono, and only 8 percent in Bukedea.

Over this period, average land area devoted to OSP declined as well, as shown in Panel B of Table 3. In season 4, farmer group members cultivating OSP planted 0.24 acres on average, but by season 8, the average area planted had fallen by half. Orange sweet potato acres declined more in Bukedea than in the other two districts, albeit from a higher initial level, which reflects the drier climate and larger farms in Bukedea than in the other districts.

Orange sweet potato for consumption may be acquired either through home production or through purchase. Purchases indicate developing preferences for OSP for consumption that are not being met by growing the crop at home. An increase in OSP purchases might also indicate a growing market for OSP roots for consumption. Panel C of Table 3 shows that purchases are rare in both seasons 4 and 8. Overall, 7 and 8 percent of farmer group member households purchased any OSP in seasons 4 and 8, respectively. These figures are higher for Bukedea than for the other districts. In fact, the share of households in Bukedea purchasing OSP for consumption in season 8 is higher than the share growing it, suggesting that some households that grew OSP liked it for consumption but preferred not to grow the crop themselves. Nonetheless, the data on OSP purchases suggest that only a small market for OSP for consumption has developed.

These patterns of gradual disadoption among project participants are also reflected in the time pattern of local diffusion rates. Table 4 summarizes OSP adoption, area planted, and consumption in seasons 4 and 8 for nonmember households living in the same communities as treated farmer group members. In season 4, 39 percent of nonmember households living in communities with treated farmers' groups were cultivating OSP (Panel A of Table 4). This indicates that there was significant local OSP diffusion. By season 8, only 25 percent of these secondary beneficiary households were still cultivating OSP, a 14 percentage point decline. Differences between districts in adoption behavior or project farmer group members are also reflected in their nonmember neighbors. By season 8, only 18 and 8 percent of nonmembers were cultivating OSP in Kamuli and Bukedea districts, respectively, while 53 percent of nonmembers were cultivating OSP in Mukono district. Just as did farmer group members, most nonmembers decreased the acres they cultivated with OSP between seasons 4 and 8, as shown in Panel B. On average, area cultivated with OSP was reduced by half, to 0.12 acres. Mean area planted with OSP by nonmembers increased in Bukedea, but this is based on a small sample of only 20 households. Only 7 percent of nonmembers reported purchasing OSP in season

8, a weakly significant decrease of 8 percentage points from season 4. This decrease suggests that demand for OSP among nonmembers not cultivating OSP is not increasing. We examine possible explanations for these differences in patterns of adoption by district in section 4.4 in the section below.

The average adoption rates over time presented so far capture a variety of adoption behaviors, including substantial disadoption by households that had grown the crop for several seasons, as well as new adoption by households that previously had no experience growing the crop. We disaggregate these trends in adoption behavior in Table 5. Panels A, B, and C of Table 5 present aggregate and district-specific OSP cultivation rates, new OSP adoption, and disadoption rates over time, respectively. We define a season’s cultivation rate as the proportion of households cultivating OSP in the season. The rate of new adoptions is the proportion of households cultivating OSP in that season among those that were not cultivating OSP in the previous season. The disadoption rate is the proportion of households not cultivating OSP in the season among those that were cultivating OSP in the previous season. In each panel, the first four columns report figures for farmer group members and the second four columns report figures for nonmembers in project communities.

An estimated 92 percent of treated farmer group members cultivated OSP in the program’s first season. In season 2, 30 percent of treated farmer group members in Bukedea had disadopted OSP, while the disadoption rates in Kamuli and Mukono were 2 and 4 percent, respectively. Farmers in Bukedea also had a lower adoption rate in the second season than those in the other districts. Thus, after only one season of cultivation, the differences across districts in the long-term trends become apparent.

The cultivation rate declined year over year for members of project farmer groups, with the exception of second season 2009. At that time, the cultivation rate increased from 66 percent in the fourth season to 70 percent in the fifth season, and then declined to 60 percent in the sixth season. With the exception of second season 2009, the rate of new adoption declined. This is not surprising: once a farmer has tried and disadopted OSP, they are unlikely to adopt OSP a second time unless some constraint on OSP production has been relieved. Thus, a household might adopt a second time if it experienced changes in its labor supply, in the farm gate price of OSP, in the health status of household members, in the amount of information about OSP cultivation, or in its expectations of future rainfall. The new adoption rate in Bukedea declined from 90 percent in the first season to 26 percent in the fourth season. Once the program ceased its activities, the new adoption rate declined to only 5 percent. Although we cannot attribute this collapse in new adoptions in Bukedea to the cessation of project activities, it is clear that the rate of new adoptions did not flatten out after the project, but continued to decline. Kamuli experienced a similar, albeit less pronounced decline in the rate of new adoptions between the fourth and fifth seasons. In contrast, Mukono’s adoption rate decline appears to have occurred between the fifth and sixth seasons.

The rate of disadoption increased during seasons 2–4 in the project and then flattened out in the two seasons immediately after the project ended, only to increase again over time. The disadoption rate is high in Bukedea, of course. In Kamuli and Mukono, the disadoption rates in seasons 2–4 increase from 2 to 11 percent and 4 to 13 percent, respectively. Both then see a slight decline in seasons 5 and 6, before again experiencing a rise in seasons 7 and 8. In Kamuli and Mukono, 29 and 23 percent, respectively, of treated farmer group members who were cultivating OSP in season 7 reported not cultivating OSP in season 8. That the rate of disadoption increased from season 6 to season 8 while the rate of new adoptions stagnated suggests that the share of project households growing OSP is likely to continue to decline into the future, with the possible exception of those in Mukono district.

The aggregate trends in OSP cultivation, adoption, and disadoption among nonmembers sampled at baseline in treated communities are similar to those among treated farmer group members, although the rates of cultivation are lower. As with treated farmers' group members, nonmembers in treated communities adopt OSP at fairly high rates early in the project; then the average shares of nonmembers growing the crop decline as households learn about their profitability and preference for the crop. These results are presented in the last four columns of Table 5. In the first season after the intervention's start, 57 percent of nonmembers cultivated OSP. This indicates that there was significant interest among nonmembers and that constraints on the availability of OSP vines to nonmembers were not severe. The adoption pattern among these secondary beneficiaries varies widely by district over the next seven seasons. Adoption gradually declines in Kamuli until after the end of the project, then falls off steeply in season 8. In Bukedea, there is rapid disadoption after the first season of experimentation, while in Mukono the OSP adoption rate by nonmember neighbors is roughly 70 percent through season 5 and remains above 50 percent in subsequent seasons. In fact, in season 8, the adoption rate in the nonmember sample of 53 percent is very close to that in the farmer group member sample of 59 percent in treated communities. This suggests potential for sustainably high adoption of OSP in Mukono after the end of the project.

Overall, the patterns of adoption observed reflect experimentation on the part of households participating in the project and their neighbors exposed to the new OSP crop and messages about its potential health benefits. Adoption of the crop by farmer group members in the project is very high in the early seasons of the project, making it inevitable that adoption rates would decline as households learned about the crop, its production characteristics, and their preferences for consuming it. This behavior yields an adoption profile among project beneficiary households of declining average adoption that reflects learning about the technology. Figure 3 shows the share of households ever adopting OSP and the share of households currently adopting OSP by season for farmer group member households in treated communities and for their nonmember neighbors. Among treated farmer group members, the share of households ever adopting the crop starts above 90 percent and approaches complete saturation as nearly all households try to grow OSP in at least one season. However, the process of learning about the technology is apparent in the adoption behavior in this sample, as average adoption rates decline steadily over the eight seasons. The evidence presented earlier shows that there is substantial heterogeneity in these adoption patterns across districts for treated households. Adoption behavior in the spillover sample of nonmember neighbors shows traces of a more classical diffusion story. The share of households adopting OSP among nonmembers has the classic S-shape that characterizes the diffusion of most innovations (Rogers 2003). In this context, diffusion starts at a high initial rate of adoption because of easy access to the technology. Diffusion then accelerates before flattening out. The pattern of this acceleration is likely affected by recall bias around seasons 5 and 6, but the S-shape pattern would likely be retained without this bias. In this spillover sample, there is also evidence of learning as average adoption rates decline. Nonetheless, adoption remains high in Mukono district and moderate in Kamuli.

4.3 Patterns of OSP adoption by treatment arm

We can learn about the role of agricultural extension services and nutrition information in promoting and sustaining OSP adoption by comparing adoption rates across the three treatments arms from the RCT design. Recall that the intensive treatment arm provided two full years of trainings on how to grow OSP and on nutrition, while the less intensive arm provided only one year of trainings. Also, farmer group member households in control group communities were provided OSP planting material at the end of the project, just prior to season 5. Figure 4 shows the adoption profiles for households in communities assigned to the three treatment arms during the eight seasons after the start of the OSP project. The upper panel presents adoption rates for farmer group member households in these communities, and the lower panel presents adoption rates for the spillover sample of nonmember households in the same communities.

Among farmer group members, there is little difference in adoption profiles over this period. Interestingly, a slightly higher proportion of households in the intensive treatment arm (5 percent) adopt OSP than in the less intensive treatment arm in season 4, the last season of the evaluation. However, this advantage to the intensive model disappears by season 5, and there is no persistence in this advantage afterward. This suggests no benefit in adoption probabilities from the additional year of trainings among project households. Farmer group member households in the control group communities have no access to OSP except through a small amount of contamination until season 5 at the end of the project. Sixty percent of control farmer group members planted OSP that season. Two interesting trends emerge. First, the pattern of disadoption in the control group follows that of the two intervention groups over the next four seasons, declining at the same rate. However, the share of households adopting OSP is 10–14 percent lower in the control group in season 8 than in the two intervention groups, and these differences between the two treatment arms and the control group are significant. Unfortunately, we cannot disentangle the source of this second effect. Households in control farmer groups received a smaller quantity of OSP vines than their treated counterparts had received four seasons earlier, but they also received no agriculture or nutrition trainings related to the project. Therefore, we cannot conclude whether this difference in adoption probabilities was due to access to the technology or to the benefits of information provided through trainings.

In the spillover samples of neighboring households in the same communities (lower panel of Figure 4), the share of households adopting OSP is roughly the same between the communities assigned to the intensive treatment and the less intensive treatment until season 5, when the adoption rate jumped for nonmember households living in communities assigned to the less intensive treatment. However, over subsequent seasons, the adoption rate falls faster in the less intensive communities, so that the rate of diffusion is somewhat higher (7.3 percent) by season 8 in the intensive treatment arm than in the less intensive treatment arm. This suggests some lagged information effects or simply persistent effects of more intensive project activity in these communities. In control communities, nonmember households adopted OSP at nearly the same rate in season 5 as those in communities assigned to the intensive treatment. Over time, the diffusion rate in control communities falls, so that by season 8 it is lower by 12 percent in the intensive communities and by 5.5 percent in the less intensive communities. The difference in OSP adoption rates in season 8 in the local spillover sample is significant at the 5 percent level between the intensive treatment and the control group, but is not significant between the less intensive treatment and the control group or between the two models with differing treatment intensity.

4.4 Determinants of OSP adoption in project communities

In order to better understand these adoption patterns, we estimate models of determinants of OSP adoption among farmer group member beneficiary households and their nonmember neighbors as a function of baseline individual, household, and farmer group characteristics. Table 6 presents estimates from a linear probability model of the determinants of treated farmer group member OSP cultivation. Column 1 presents estimates conditional on district and season fixed effects. Households that were cultivating WYSP at baseline are more likely to cultivate OSP. Households that were recruited to join the farmer group for the OSP project are 5.6 percent less likely to be growing OSP, which may reflect their lower commitment to the activities of the farmer group or other selection effects that makes them less like other farmer group members. When community fixed effects are added in column 2, no characteristics had a statistically significant association with the probability of cultivating OSP. This suggests that factors that influence OSP cultivation are highly correlated within communities. Columns 3a and 3b present a single specification in two columns. The coefficients on farm and household characteristics are shown in column 3a, while the coefficients on the interaction of season with these characteristics are shown in column 3b. This model shows that the effect of having experience with growing WYSP at baseline has a larger effect on the probability of growing OSP in later seasons. The effect of having access to a lowland parcel for storing vines between seasons is positive in early seasons but declines over time. Also, the effect of education on OSP adoption is greater in later seasons, perhaps because maintaining planting material gets harder with time.

Table 7 presents results from an ordered logit model in columns 1a–1c and three separate Cox proportional hazards models in columns 2–4. As fixed effects are not consistent under the ordered logit model, only district indicators and an indicator of model status are included. Average marginal effects are reported in columns 1a–1c. Having any irrigated land at baseline is associated with an increased probability of disadopting OSP and a decreased probability of still cultivating OSP, which suggests competition for this land from other crops. Households with a member with at least a secondary school education are less likely to disadopt OSP and more likely to still cultivate OSP.[12] Household expenditure is negatively associated with the likelihood of disadopting OSP and positively associated with the likelihood of still cultivating OSP.

Columns 2–4 present three separate Cox proportional hazards models. Hazard ratios associated with household characteristics are reported. A coefficient less than 1 means that households with a high value of the characteristic disadopt OSP later than do those with a low value of the characteristic. Likewise, a coefficient greater than 1 means that households with a high value of the characteristic disadopt OSP earlier than do those with a low value of the characteristic. Column 2 presents the results of a model that includes only farm and household characteristics. Column 3 adds district indicator variables and an indicator equal to 1 if the household is in an intensive treatment community and equal to 0 if the household is in a less intensive treatment community, which allows the hazard to differ across districts and treatment arms. Column 4 adds district strata to the model in column 2, which allows the base hazard to differ across districts.

In the first two models, previous sweet potato cultivation is associated with increased duration of OSP cultivation, though the effect is only statistically significant at conventional levels in the specification without district effects. This variable helps to explain why OSP adoption rates fell so sharply in Bukedea district. Unlike Kamuli and Mukono, where WYSP is a major staple food crop and is commonly grown, sweet potato is a less important crop in both production and consumption in Bukedea. On average, only 4.6 percent of cultivated area was devoted to sweet potato in Bukedea in the season before the start of the project. Cassava was a more dominant crop in Bukedea than in the other two districts, accounting for 41.8 percent of planted area in first season 2007. This likely

[12] In related research (Gilligan *et al*. 2014), we examine the role of gender in the household decision to adopt OSP, considering whether the leading role of women in the sample in shaping the diets and nutrition of children gives them a unique role in the decision to adopt OSP. The results indicate that OSP is least likely to be grown on land plots controlled exclusively by men, but plots controlled exclusively by women do not have the highest rates of adoption. Rather, plots under joint control, but on which women play the leading role, are significantly more likely to contain OSP.

reflects a combination of comparative advantage in production and taste factors. Bukedea is drier than the other two districts, making it more difficult to maintain sweet potato vines between seasons. Also, the dietary recall surveys showed much less frequent consumption of any sweet potato in Bukedea than in the other districts.

For other characteristics, the logarithm of per capita household expenditures and being in the lowest tertile of cultivated land with good soil are associated with a longer duration of OSP cultivation. The logarithm of total cultivated area and having any irrigated land are associated with a shorter duration of OSP cultivation.

In summary, we find that the logarithm of per capita household expenditures and previous sweet potato experience are consistently positively associated with OSP cultivation. Other determinants are associated with OSP cultivating in some specifications. Household education is positively associated with OSP cultivation while having any irrigated land, and the amount of land with good soil are both negatively associated with OSP cultivation. However, the influence of these characteristics is difficult to disentangle from unobservable characteristics that vary at the community level: in specifications that are robust to various forms of unobserved variation at the district or community level, the statistical significance of determinants tends to fade. The only determinant that is robust to geographical unobservables associated with district or community is the logarithm of per capita household expenditures.

We now examine the determinants of OSP cultivation among nonmember households in the local spillover sample. The determinants of nonmember OSP cultivation may be different from the determinants of farmer group members' OSP cultivation because nonmembers, on average, faced additional constraints to adopting OSP. Specifically, nonmembers were not offered OSP vines or trainings concerning OSP. Alternatively, the difference may be due to different observed or unobserved farm and household characteristics. Results are first presented for originally sampled nonmembers as a function of baseline characteristics. We also estimate the model on similar specifications for the pooled sample of originally and newly sampled nonmembers. These latter specifications use OSP cultivation in seasons 5–8 as the outcome and household and farm determinants measured at follow-up (variously for seasons 5 or 8) because adoption was not captured for seasons 1–4 in the newly sampled nonmember households in the follow-up survey. We use the same four models as we used for farmers' group member households.

Table 8 presents linear probability models of the determinants of OSP cultivation for treated originally sampled nonmember households. No statistically significant associations were detected. Table 9 presents similar models using the pooled sample of originally and newly sampled nonmembers. In columns 1 and 2, the models without variables that interact season with characteristics, growing WYSP in season 5, the logarithm of total cultivated acres, an indicator for the presence of a lowland parcel, and the number of household members aged 6–17 are positively associated with OSP cultivation. In addition, when community and season fixed effects are added in column 2, the coefficient on the logarithm of the distance in kilometers to the farmers' group meeting place is positively associated with OSP cultivation and statistically significant. Interpreting the magnitude of the statistically significant coefficients in column 2, we see that treated nonmembers who grew WYSP in season 5 were 17 percentage points more likely to cultivate OSP than those who did not; doubling the cultivated area in season 5 implies a 4 percentage point increase in the likelihood of cultivating OSP; nonmembers with a parcel in the lowlands in seasons 7 or 8 were 9 percentage points more likely to cultivate OSP than those without; each additional household member between the ages of 6 and 17 is associated with a 3 percentage point increase in the likelihood of cultivating OSP; and doubling the distance to the nearest farmers' group implies a 7 percentage point decrease in the likelihood of cultivating OSP. In specifications in which season is interacted with characteristics (shown in column 3b), only two characteristics were observed to have a positive association with the likelihood of cultivating OSP: having cultivated WYSP in season 5 and the logarithm of total cultivated area. No interacted variables differed statistically from 0.

Estimates of associations between farm and household characteristics and the likelihood that the nonmember has never adopted OSP, has disadopted OSP, and is still cultivating OSP are presented in Table 10 using ordered probit regression models. Nonmembers who grew WYSP in season 5, who have larger cultivated land areas, who have more good soil, and who have more household members aged 6 to 17 are more likely to still be cultivating OSP and less likely to have never adopted OSP.

Associations between farm and household characteristics and the duration of OSP cultivation are presented in Table 11. Columns 1–3 present estimates of these associations for all originally sampled nonmembers. Because many nonmembers adopted OSP in seasons apart from the first, a proportional hazards regression may not model the data generating process for treated nonmembers as well as it did for treated farmers' group members. Thus, estimates for originally sampled treated nonmembers that adopted OSP in season 1 are presented in columns 4–6. While this sample of treated nonmembers is selective, and thus it may be difficult to generalize the estimate in the last three columns, the data generating process of OSP cultivation decisions for originally sampled treated nonmembers that adopted OSP in season 1 may more closely match the assumptions of a proportional hazards model than does that of all treated nonmembers. Data on newly sampled treated nonmembers are not used because data on OSP cultivation in seasons 1–3 were not collected from them. Columns 1 and 4 present results of a model that includes only farm and household characteristics. Columns 2 and 5 add district indicator variables and an indicator equal to 1 if the household is in a Model 1 community and equal to 0 if the household is in a Model 2 community, which allows the hazard to differ across districts. Columns 3 and 6 add district strata to the model in columns 1 and 4, respectively. This addition allows the base hazard to differ across districts. These estimates are largely in keeping with the previous models, except there is a larger effect for having a large farm with good soils on the probability of adopting OSP for a longer duration. Otherwise, education, past experience with WYSP, and cultivated area at baseline all extend the duration of the period of growing OSP in this sample.

4.5 Across-community OSP diffusion to farmers' groups outside the original study area

We've shown that OSP diffused from the farmers' group member households that were offered OSP by the REU program to other households in the members' communities that were not offered OSP by the program. Could OSP have spread outside of these communities? If so, how far? How many households outside of these communities are still cultivating OSP?

We focus on households in farmer groups that were adjacent to the REU study area; we refer to these as diffusion households. We are interested in how many diffusion households are cultivating OSP and how many diffusion household have disadopted OSP. As described previously, diffusion households were sampled according to three strata based on their OSP cultivation histories: one stratum consisting of cultivating households, a second consisting of disadopting households, and a third consisting of households that have never adopted OSP.

Three households were sampled from each stratum present in a diffusion farmer group. Households were sampled based on their reports of their OSP cultivation status (cultivating, disadopted, or never adopted) on the day of the interview. However, two months prior to the follow-up survey's start, a tracking exercise had generated the list of farmers' group members from which households were sampled to be interviewed in the follow-up survey. The list was generated by interviewing the chairperson of the farmers' group. At that time, a preliminary measurement of each farmers' group member's OSP cultivation status was also obtained from chairpersons, in order to facilitate targeting households within strata. Unfortunately, the chairpersons' reports concerning the OSP cultivation status of members was frequently inaccurate. For example, a chairperson might report that all member households had disadopted OSP while some member households reported cultivating OSP. When the reports of the chairperson and the household's respondent differed, the report of the respondent was used in constructing the sample. However, as a consequence, the total number of member households within strata in a farmers' group is not always known. Thus, we present three candidate sets of sampled weights. All three employ the chairperson's report of overall group size to calculate the weights.

The first weight assumes that a simple random sample was drawn. It is likely to dramatically overestimate the proportion of diffusion households cultivating OSP. The second weight assumes that all of the group's cultivating and disadopting households were sampled by setting their weights equal to 1. The never-adopting households are assumed to comprise the remainder of the farmers' group's population. It is likely to dramatically underestimate the proportions of diffusion households that were cultivating OSP and that disadopted OSP. In the third weight, when the sample target for cultivating or disadopting households could not be met (and the group's household population meets or exceeds the number of targeted households), then that household type's weight is set to 1, as per the second weight. Thus, weight equal to the population of the farmers' group minus the number of households with weight equal to 1 has yet to be assigned. This remaining weight is divided equally among the households that have not yet been assigned weight.[13]

Table 12 presents OSP cultivation, adoption, and disadoption rates in seasons 5–8 from the agricultural production data series, as estimated using the three sets of weights. We examine first whether a diffusion household has ever cultivated OSP. The first, second, and third sets of weights estimate the proportion of diffusions households that have ever cultivated OSP to be 0.25, 0.10, and 0.20, respectively. As expected, weight 1 yields the highest estimate and weight 2 yields the lowest. In the following analysis, we will report only weight 3, as we believe it most closely reflects the true sample design. We see very little OSP adoption and significant OSP disadoption, suggesting that the long-run OSP cultivation rate among diffusion households is lower than the 7 percent reported in season 8.

4.6 Sustained learning and the role of nutrition knowledge in OSP adoption

Another dimension of sustainability of impact in this project is the nutrition behavior change trainings provided. These sessions covered many topics, but important ones for the OSP project are the number of vitamin A messages the mother can learn and the number of child feeding practices. These sessions were designed to teach mothers about good dietary sources of vitamin A, including OSP, and how to prepare them, and also about child feeding practices. Table 13 summarizes the average number of messages recalled by mothers on these two topics in seasons 1, 4, and 8 of the project. Results show clearly that mothers learned more nutrition messages between the baseline survey and the end of the project, but that there was some retention of these lessons even two years after the project ended. These impacts of the project on knowledge about the health benefits of consuming OSP may have helped to boost the impact of the project on adoption and diffusion rates as well.

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[13] For example, suppose three households of each type were targeted in a farmers' group with 14 members but only two cultivating households were interviewed. The two cultivating households both receive a weight of 1, for an implied cultivating population of 2. The three sampled disadopting and three sampled never-adopting member households each receive a weight of 2, so that the implied disadopting and never-adopting populations are both 6. Thus, the total implied population is equal to 14, the number of farmers' group members.

4.7 Interview effects

Recently, economists have given increased attention to the concern that the researcher's observations of subjects in an experiment may affect their behavior, the so-called Hawthorne effect. Henry Landsberger (1958) observed such an effect in experiments conducted at the Hawthorne Works factory near Chicago from 1924–1932, which commissioned research on ways to improve productivity at the factory. Landsberger concluded that any treatment (for example, cleaning floors or altering lighting) improved productivity; he hypothesized that factory workers put forth more effort as a result of knowing that they were being observed. However, later studies of the same data (Jones 1992; Levitt and List 2011) have shown that the increases in productivity can largely be attributed to other factors. Nonetheless, effects of being interviewed have been observed recently in studies of health (Zwane *et al*. 2011), although no effects were observed in the context of microfinance programs.

To test for such interview effects, in addition to resurveying nonmember households that were interviewed in the baseline and endline surveys (originally sampled nonmembers), additional nonmembers were randomly sampled and first interviewed in the follow-up survey (newly sampled nonmembers). Newly sampled nonmembers consist of two subsamples, drawn differently depending on whether or not detailed data on social networks were collected from households in the nonmember's community. We'll only briefly discuss the difference in the samples. Social networks data were collected from all households in 15 of the 24 communities of Model 1 farmers' groups. The 15 selected communities were those with the smallest nonmember populations, so data could be collected on the greatest number of community networks at the least cost. All nonmembers in networks communities were interviewed at follow-up. In contrast, in non-networks communities, only six nonmembers were sampled from among all nonmembers with at least one child aged 3 to 5 years.

Using these samples, we now test for interview effects among nonmember households. Several separate effects may be present. Interviewed nonmembers were alerted to the existence of OSP during the baseline in the course of the interview, but other nonmembers may not have been alerted. Thus, the interview may have, for example, a causal effect on the proportion of nonmembers who have ever adopted OSP. Of course, nonmembers who were not interviewed at baseline may eventually learn of the existence of OSP. In this case, the interview's effect may only be on the time at which the nonmember learned about OSP. Thus, we might observe an interview effect on the timing of adoption. Even if the interview does increase the proportion of nonmembers cultivating OSP or affect the timing of first adoption of OSP, the interview may or may not affect the degree to which OSP cultivation is sustained over time. Whether or not an interview effect is long-lasting is clearly important in an assessment of what techniques could be used to promote a crop. Alternatively, the interview might instead affect the extent of reporting bias (specifically, recall bias) concerning OSP cultivation. We test in turn for these four effects – the likelihood that a nonmember ever cultivated OSP, the timing of first adoption, the likelihood of sustained cultivation, and reporting bias.

Table 14 tests for differences between originally and newly sampled nonmembers in terms of the proportion of nonmembers who have ever cultivated OSP and, among nonmember households that have ever acquired OSP vines, the proportion first acquiring OSP in each season. As the unconditional differences in means in column 3 and their counterparts that are conditional on household characteristics in column 4 are very similar, only the unconditional differences are cited in our discussion. Seventy-one percent of originally sampled nonmembers have ever cultivated OSP, 31 percentage points more than their newly sampled counterparts. This large difference suggests a strong effect of the baseline interview. Twenty-nine percent of originally sampled nonmembers who ever acquired OSP vines reported having first acquired vines in season 1. In contrast, only 16 percent of newly sampled nonmembers first acquired vines in season 1. The difference is statistically significant at the 0.01 level and quite large – 80 percent more ever-acquiring originally sampled nonmembers first acquired OSP in season 1 than did ever-acquiring newly sampled nonmembers. There is no statistically detectable difference in first vine acquisition in seasons 2–5, but in seasons 6–8, ever-acquiring newly sampled nonmembers first acquired significantly more OSP vines than originally sampled nonmembers. Thus, the impacts of the baseline interview on decisions concerning OSP cultivation include an increase in the proportion of nonmembers ever cultivating OSP and earlier first acquisition of OSP vines among those who ever acquire vines. Eighty-seven percent of ever-acquiring newly sampled nonmembers report having ever cultivated OSP, thus the interview’s effect on the timing of first vine acquisition is likely to be similar to the interview’s impact on the timing of first OSP adoption.

Table 15 presents data on OSP cultivation rates in seasons 4–8, using the reports of nonmember households. Data on OSP cultivation were collected at two points in the interview, once during a module on agricultural production, covering seasons 5–8, and a second time during a module on OSP conservation practices, covering seasons 5–7. We test for differences in the mean seasonal OSP cultivation rates in both series. Because the two nonmember samples are unbalanced in terms of household characteristics, after estimating the unconditional differences, the differences conditional on household characteristics are estimated. In both series, the originally sampled nonmembers report higher rates of OSP cultivation in all seasons. The unconditional differences are statistically significant at the 0.05 level in seasons 5 and 6 of both series and statistically significant at the 0.1 level in seasons 4–7 from both series, where data exist. The difference in season 8 in the agricultural production series is not statistically significant. The conditional tests of the difference in means by season reveal statistically significant differences in both seasons in season 5 but not in other seasons. That the differences are larger in past seasons but insignificant in season 8 suggests that either the baseline interview affects recall of OSP cultivation decisions or that the baseline interview affects OSP cultivation decisions in the shorter run (that is, up to season 7) but less over time, as evidenced by the similar rates of OSP cultivation in season 8.

We find several effects of the baseline interview on nonmember OSP cultivation and bias in nonmember reporting of OSP cultivation. Being interviewed at baseline causes nonmembers to be more likely to ever adopt OSP, to subsequently disadopt OSP, and to recall having cultivated OSP in a given season when they really did not. However, being interviewed at baseline does not change the likelihood of cultivating OSP after two years: while the baseline interview certainly alters nonmember behavior, it does so only in the short run.

Many nonmembers who were interviewed at baseline had adopted OSP in seasons soon after the program's start, yet the proportion of originally sampled nonmembers cultivating OSP in season 8 is the same as that of newly sampled nonmembers. Why? As OSP-adopting nonmembers experimented with the crop on their own fields, nonmembers that had not adopted OSP could have been observing the trials of adopters and talking with adopters about the benefits and costs of OSP. Thus, over time, a farm household could learn whether OSP is profitable given its unique configuration of farm and household characteristics even though the household is not cultivating OSP. Regarding the cultivation of OSP in context of the REU program, McNiven and Gilligan (2012) found that among nonmembers in the treated community, those that talked with many farmers' group members before the intervention were more likely to cultivate OSP than were those who talked to only a few. Similar results have been demonstrated in other contexts. For example, Foster and Rosenzweig (1995) observed learning from others in India, Conley and Udry (2010) observe this effect in Ghana, and Bandiera and Rasul (2006) discuss a similar effect in Mozambique.

5. Implications for cost-effectiveness of the interventions and for robustness of evaluation results to timing of evaluation surveys

Cost-effectiveness studies from evaluations of short-term projects typically estimate the average cost per beneficiary, including all direct and indirect beneficiaries reached during the intervention period. However, for many interventions, the stream of benefits continues to accrue to project participants after the project has ended. Moreover, continued diffusion of the technologies or knowledge of healthy behaviors from the project means that the benefits of the project could also expand after project completion. Cost-effectiveness estimates are sometimes modified to include relatively poorly informed extrapolations to estimate the number of additional beneficiaries that will ultimately benefit from the project's investments in future periods. Our results serve as a reminder that the benefits of an intervention can persist among households exposed to the intervention during the project period and may continue to expand in some subgroups. However, our results also suggest that such extrapolations may not be very reliable. We find substantial heterogeneity of sustainability of impact of the OSP interventions two years after the project was completed. The trend of disadoption that was apparent in Bukedea district by the end of the project continued during the four seasons after the project ended, among direct and indirect beneficiaries. In Kamuli and Mukono districts, adoption rates among direct and indirect beneficiaries at the end of the project were encouraging and suggested that relatively high adoption rates may persist. However, our data from two years after the end of the project show that adoption rates among primary beneficiaries continued to fall, from above 80 percent at the end of the project to just above 50 percent two years later. Moreover, rates of diffusion of the technology to secondary beneficiaries varied widely between these two districts over the two years after the project, with adoption rates in the diffusion sample falling below 20 percent in Kamuli but remaining above 50 percent in Mukono. We have been unable to find an explanation for this large difference in sustainability of spillover effects in adoption rates between these two districts. These are still healthy adoption rates, but they suggest caution about whether impacts can be sustained, particularly if projects do not embed some of their benefits into existing public service provision, such as encouraging government extensionists to promote and support OSP adoption when the project closes.

Cost-effectiveness estimates made at the end of the REU project suggested that the project cost $77–$107 per primary or secondary beneficiary over the two years of the project (de Brauw *et al*. 2010). After accounting for the new beneficiaries that received the technology after the project, estimated cost per beneficiary will have fallen further. Conservative estimates suggest that costs of the original OSP project may have fallen to $62–$86 per beneficiary, possibly lower, and these benefits will continue to spread over time.

Our results also show that estimates of the impact of a project may be sensitive to the timing of the endline data collection. We found a modest premium in impact on OSP adoption from the intensive model relative to the less intensive model in season 4 of the project. However, this difference in impact disappeared immediately in the next season and did not return over the next two years. Similarly, we saw trends in adoption and disadoption in the control group after the intervention ended that shadowed the patterns in the intervention groups. It is unlikely that such a parallel effect would have been predicted.

6. Conclusions

Little is known about the sustainability of impact of short duration projects that promote agricultural technology adoption and healthy behaviors. We find that the trends toward disadoption of the crop that were observed at the end of the two-year project continued in the following two years in many areas. However, there is also evidence that rates of OSP adoption stabilized at near 50 percent in Mukono district. In Bukedea, the crop had mostly disappeared from farmers' fields, though 18 percent of households continued to purchase the crop for consumption. In Kamuli, adoption continued to decline in the two years after the project from very high levels, but the adoption rate remained at 50 percent among project beneficiaries. The evidence is mixed on whether higher rates of adoption could have been sustained if funding had been available for the project to continue in a lower-cost maintenance phase. Comparing adoption profiles between the intensive and less intensive intervention (which ended one year earlier) in the original experiment shows no difference in adoption rates between beneficiaries in these treatment arms in season 8, two years, and three years, respectively, after the end of the projects. However, adoption rates were higher in the spillover sample of neighboring nonmember households in the communities in the more intensive two-year treatment. This suggests that higher aggregate adoption rates after eight seasons could have been achieved by a continuation of the project under limited additional funding.

Disentangling the impact pathways during an extended period of study like this can be difficult, but it is critical to understanding the project's ultimate success. Here, differences in trend adoption rates between the intervention communities and the control group communities after the control groups received planting material may indicate that messages provided during the project induced higher rates of adoption than could be obtained when OSP vines were distributed with no additional supporting trainings. However, we cannot rule out other explanations for these differences, such as differences in the quantity of planting material provided.

The differences in sustainability of adoption across districts suggest substantial differences in the cost-effectiveness of the intervention in these districts. In Mukono, the intervention is in a sustainable phase, creating a stream of benefits from the initial project that continue to accrue to a large number of households each season, improving the long-run cost-effectiveness of the intervention there. In Kamuli, the benefits of the intervention also continue to grow, and cost-effectiveness improves, albeit at a slower rate than in Mukono. In Bukedea, only limited benefits of the intervention continue to accrue. With an eye toward cost-effectiveness, these results suggest criteria on which to target the intervention in the future. Promotion of OSP is likely to be more sustainable and cost-effective in communities where conventional sweet potato is already a major crop, revealing both a comparative advantage in growing the crop in these areas and a preference for consuming it.

As an agricultural intervention with objectives in nutrition and human development, one measure of success of biofortification interventions like this one will be whether large enough numbers of vulnerable children and women can be reached sustainably with the intervention, either as a crop grown on their own fields or through markets for OSP root, to reduce the public health burden in those communities. Even better would be to eliminate the need for vitamin A supplementation campaigns in areas were adoption of the crop is widespread and, as a result, dietary sources of vitamin A are plentiful.

Figure 1: Schematic of evaluation design

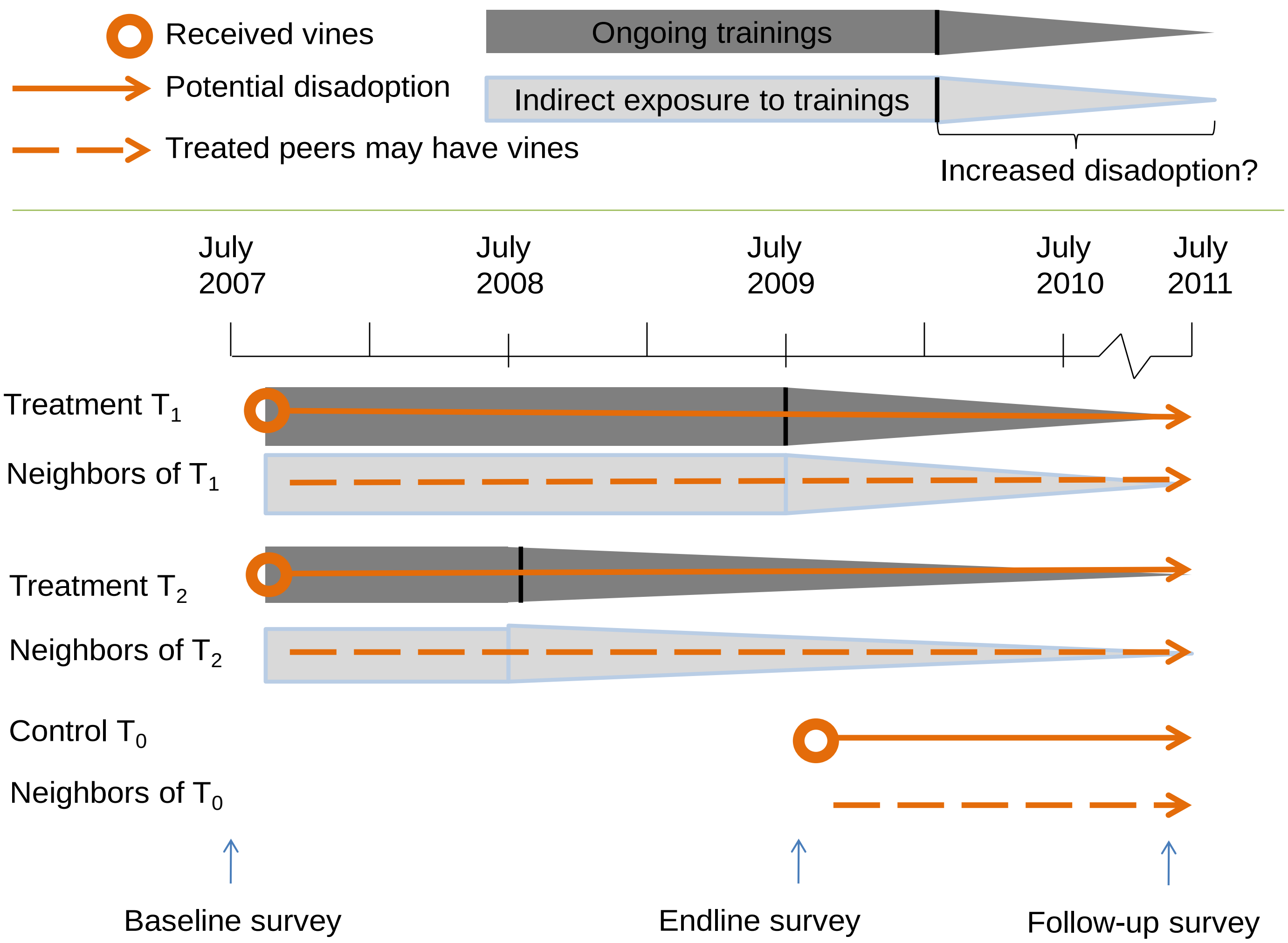


Figure 2: Adoption profile for OSP across eight seasons from initial distribution, by district

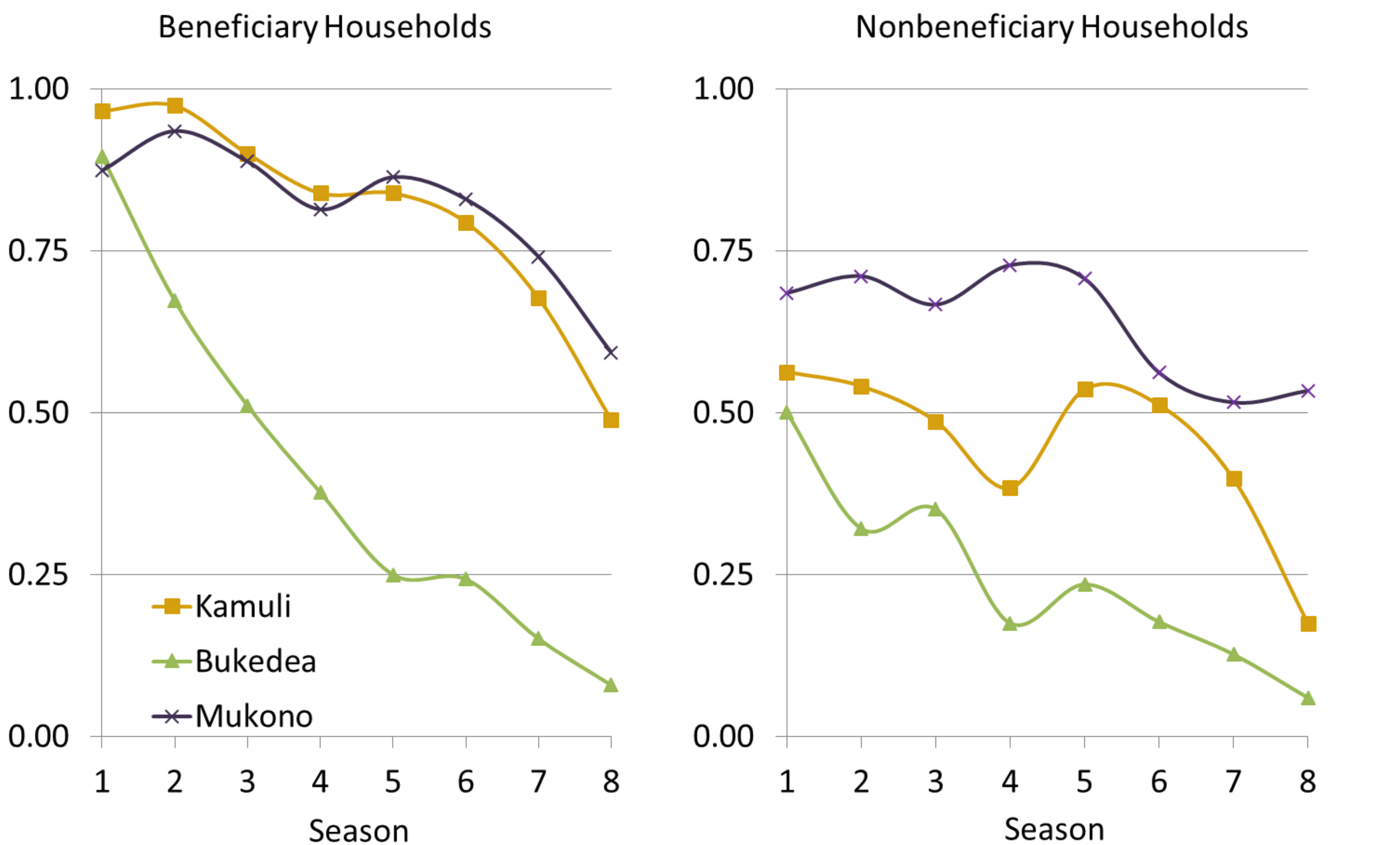
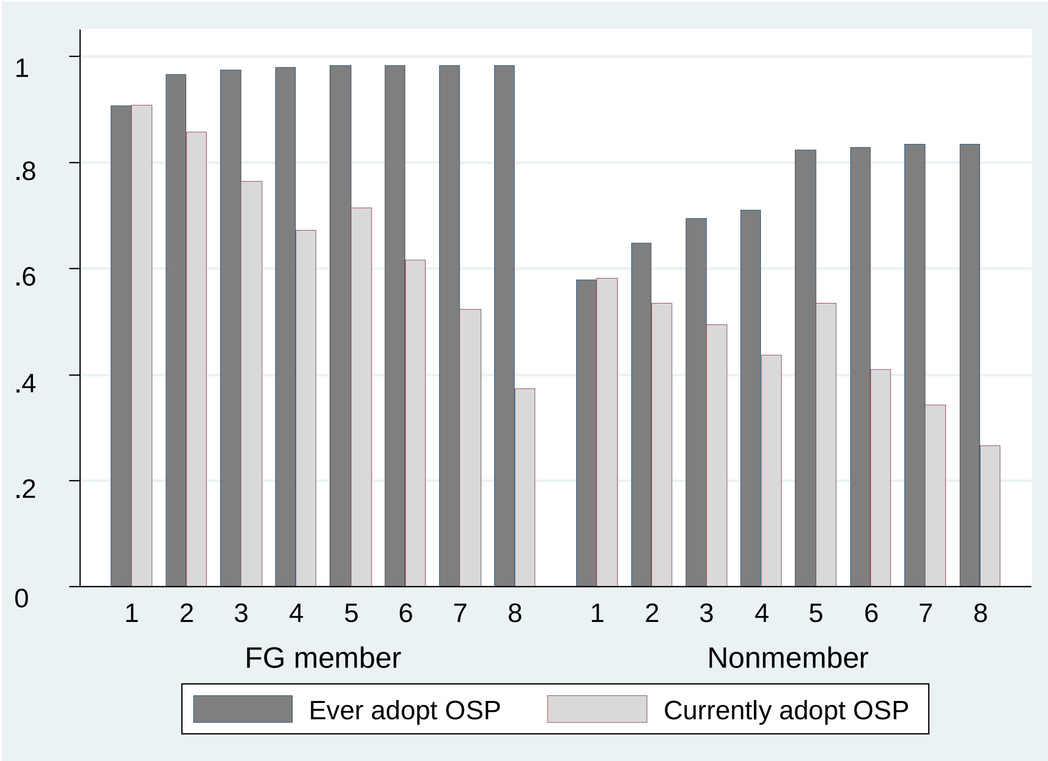
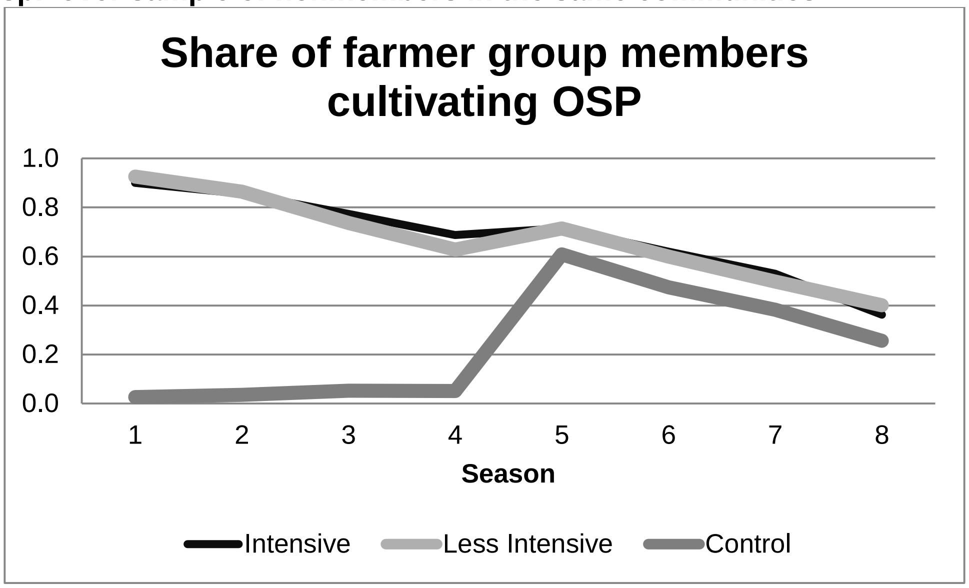


Figure 3: Proportion of households ever adopting OSP and currently adopting OSP, by season and farmer group member status



Note: Sample includes farmer group member households and nonmember households in treated communities.

Figure 4: Pattern of OSP adoption by treatment arm for farmer group members and spillover sample of nonmembers in the same communities



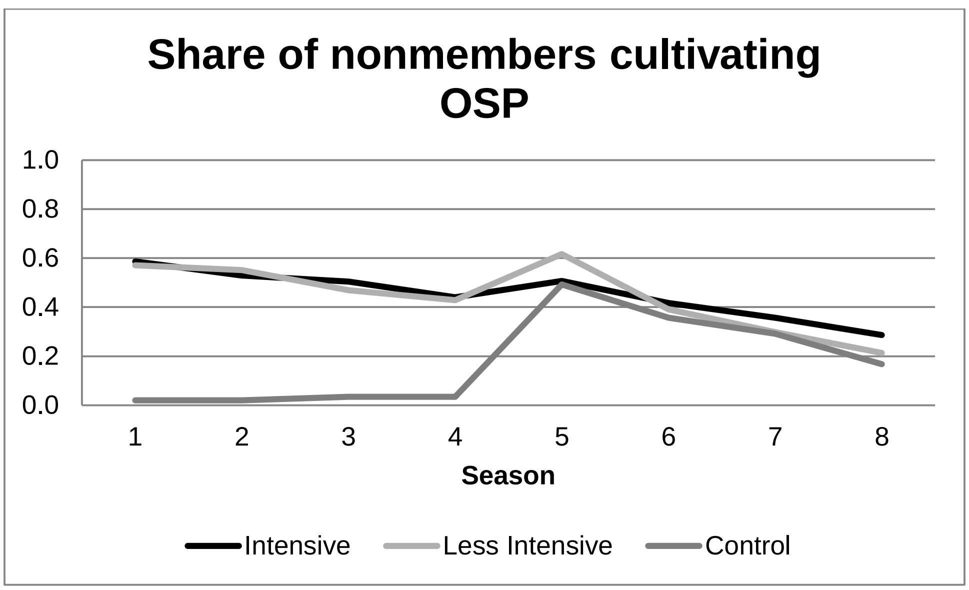


Table 1: Summary of farmer groups and households sampled

Panel A. Groups and Households in REU Communities

	Community Type		
Sample sizes	Treated	Control	Total
Number of farmer groups	48	36	84
Farmer group members sampled at baseline	672	504	1,176
Farmer group members in three-round panel	596	445	1,041
Nonmembers sampled at baseline	240	180	420
Nonmembers in three-round panel	211	155	366
Nonmembers, first sampled at follow-up	1,118	214	1,332
Networks communities	923	0	923
Non-networks communities	195	214	409

Panel B. Groups and Households outside of REU Communities

	Diffusion Farmer Group Type			
	Cultivating	Disadopted	Never Adopted	Total
Number of types of diffusion farmer groups sampled	30	44	28	102
Sampled diffusion households	197	245	92	534
Cultivating households	64	–	–	64
Disadopting households	40	108	–	148
Never-adopting households	93	137	92	322

Table 2: Descriptive statistics and balancing tests of farmer group member and nonmember household characteristics at baseline

	Farmer Group Members (FG)				Originally Sampled Nonmembers (NM)			Member–Nonmember Difference in Treated Communities	
	Treated Communities	Control Communities	T−C		Treated Communities	Control Communities	T−C	FG−NM	
Cultivated sweet potato	0.73	0.75	–0.02		0.64	0.58	0.06	0.09	**
	(0.05)	(0.05)	(0.07)		(0.07)	(0.09)	(0.11)	(0.04)	
Log total cultivated area	0.65	0.50	0.15		0.51	0.36	0.15	0.14	*
	(0.07)	(0.10)	(0.12)		(0.10)	(0.11)	(0.14)	(0.07)	
Any lowland parcels?	0.45	0.44	0.00		0.43	0.44	–0.01	0.02	
	(0.03)	(0.04)	(0.05)		(0.06)	(0.05)	(0.07)	(0.06)	
Lower tertile of area of good soil	0.30	0.34	–0.04		0.25	0.24	0.02	0.05	
	(0.03)	(0.03)	(0.05)		(0.05)	(0.05)	(0.07)	(0.04)	
Upper tertile of area of good soil	0.37	0.31	0.06		0.36	0.34	0.02	0.02	
	(0.04)	(0.04)	(0.06)		(0.07)	(0.06)	(0.09)	(0.05)	
Any irrigated land?	0.04	0.04	–0.01		0.06	0.08	–0.01	–0.03	
	(0.01)	(0.01)	(0.01)		(0.02)	(0.03)	(0.03)	(0.02)	
Secondary education (>=7 years)	0.63	0.67	–0.04		0.56	0.58	–0.01	0.07	*
	(0.03)	(0.03)	(0.04)		(0.03)	(0.08)	(0.09)	(0.04)	
Age of female/mother	31.23	31.74	–0.51		30.52	30.65	–0.13	0.69	
	(0.30)	(0.33)	(0.45)		(0.52)	(1.04)	(1.15)	(0.60)	
Age of head − age of female/mother	7.31	7.55	–0.24		6.60	6.66	–0.06	0.71	
	(0.26)	(0.29)	(0.38)		(0.52)	(0.48)	(0.70)	(0.52)	
Polygamous household?	0.22	0.29	–0.07	*	0.19	0.17	0.02	0.02	
	(0.02)	(0.03)	(0.04)		(0.03)	(0.03)	(0.04)	(0.03)	

Household recruited into	0.33	0.24	0.09	*						
farmer group?	(0.03)	(0.03)	(0.05)							
Number of household	3.23	3.34	–0.11		3.04	2.94	0.10		0.28	
members above age 5	(0.15)	(0.14)	(0.20)		(0.18)	(0.36)	(0.40)		(0.22)	
Number of household	0.89	0.98	–0.09		1.06	0.99	0.07		–0.17	***
members aged 0–2	(0.04)	(0.04)	(0.06)		(0.06)	(0.09)	(0.11)		(0.06)	
Number of household	1.27	1.24	0.03		1.14	1.27	–0.13	*	0.13	***
members aged 3–5	(0.03)	(0.04)	(0.04)		(0.05)	(0.06)	(0.08)		(0.04)	
Log total per capita	0.38	0.37	0.01		0.36	0.36	0.01		0.02	
expenditures	(0.01)	(0.01)	(0.02)		(0.02)	(0.02)	(0.03)		(0.02)	
Log kilometers from farmer	–1.17	–1.16	–0.01		–0.70	–0.58	–0.12		–0.48	***
group meeting place	(0.10)	(0.12)	(0.16)		(0.11)	(0.13)	(0.17)		(0.13)	

Notes: Column 7 tests differences in means at baseline across farmer group members and nonmembers. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 3: OSP cultivation, area under OSP cultivation, and OSP purchases among treated farmer group members, seasons 4 and 8

Panel A. Proportion of Farmer Group Members Reporting OSP Cultivation

	All Districts	Kamuli	Bukedea	Mukono
Season 4	0.66	0.84	0.38	0.81
Season 8	0.37	0.49	0.08	0.59
Change between Seasons 4 and 8	-0.29 ***	-0.35 ***	-0.30 ***	-0.22 ***
	(0.03)	(0.05)	(0.05)	(0.06)

Panel B. Acres of OSP Cultivated among Farmer Group Members Reporting OSP Cultivation

	All Districts	Kamuli	Bukedea	Mukono
Season 4	0.24	0.20	0.36	0.22
Season 8	0.12	0.15	0.08	0.09
Change between Seasons 4 and 8	-0.12 ***	-0.05	-0.28 ***	-0.13 ***
	(0.04)	(0.07)	(0.05)	(0.02)

Panel C. Proportion of Farmer Group Members Reporting OSP Purchases for Home Consumption

	All Districts	Kamuli	Bukedea	Mukono
Season 4	0.07	0.03	0.15	0.03
Season 8	0.08	0.04	0.14	0.05
Change between Seasons 4 and 8	0.00	0.01	-0.01	0.02
	(0.02)	(0.02)	(0.04)	(0.01)

Notes: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4: OSP cultivation, area under OSP cultivation, and OSP purchases in seasons 4 and 8 among nonmembers in treated communities

Panel A. Proportion of Nonmembers Reporting OSP Cultivation

	All Districts		Kamuli		Bukedea		Mukono	
Season 4	0.39		0.38		0.18		0.73	
Season 8	0.25		0.18		0.06		0.53	
N	401		131		146		124	
Change between Seasons 4 and 8	-0.15	***	-0.21	***	-0.12		-0.19	**
	(0.05)		(0.06)		(0.07)		(0.08)	

Panel B. Acres of OSP Cultivated Among Treated Nonmembers Reporting OSP Cultivation

	All Districts		Kamuli		Bukedea		Mukono	
Season 4	0.24		0.14		0.29		0.26	
Season 8	0.12		0.03		0.43		0.10	
N	142		44		20		78	
Change between Seasons 4 and 8	−0.12	**	−0.11	***	0.15		−0.17	***
	(0.05)		(0.02)		(0.17)		(0.05)	

Panel C. Proportion of Treated Nonmembers Reporting OSP Purchases for Home Consumption

	All Districts		Kamuli		Bukedea		Mukono	
Season 4	0.15		0.03		0.26		0.07	
Season 8	0.07		0.04		0.12		0.05	
N	359		117		132		110	
Change Between Seasons 4 and 8	−0.08	*	0.00		−0.14	*	−0.02	
	(0.04)		(0.03)		(0.08)		(0.04)	

Notes: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

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Table 5: OSP adoption and disadoption rates of treated farmers' group members by season and district

	Farmer Group Members				Nonmembers			
	All Districts (1)	Kamuli (2)	Bukedea (3)	Mukono (4)	All Districts (5)	Kamuli (6)	Bukedea (7)	Mukono (8)
Panel A. Proportion of Treated Farmer Group Members Adopting OSP by Season								
Second Season 2007	0.92	0.97	0.90	0.87	0.57	0.56	0.50	0.70
First Season 2008	0.85	0.97	0.67	0.94	0.50	0.54	0.33	0.72
Second Season 2008	0.75	0.90	0.51	0.89	0.48	0.49	0.36	0.67
First Season 2009	0.66	0.84	0.37	0.81	0.39	0.38	0.18	0.73
Second Season 2009	0.70	0.87	0.39	0.89	0.46	0.54	0.23	0.70
First Season 2010	0.60	0.80	0.24	0.83	0.39	0.52	0.18	0.56
Second Season 2010	0.50	0.68	0.15	0.74	0.33	0.42	0.13	0.51
First Season 2011	0.37	0.49	0.08	0.59	0.25	0.18	0.06	0.53
Panel B. New Adoption Rate: Proportion of Treated Farmer Group Members Reporting OSP Adoption among Those Not Cultivating OSP in the Previous Season								
Second Season 2007	0.92	0.97	0.90	0.87	0.57	0.56	0.50	0.70
First Season 2008	0.62	0.69	0.47	0.77	0.15	0.03	0.13	0.32
Second Season 2008	0.31	0.33	0.32	0.23	0.19	0.02	0.27	0.15
First Season 2009	0.29	0.37	0.26	0.40	0.11	0.02	0.06	0.37
Second Season 2009	0.50	0.76	0.38	0.81	0.34	0.50	0.23	0.56
First Season 2010	0.13	0.26	0.08	0.22	0.12	0.16	0.12	0.08
Second Season 2010	0.09	0.14	0.05	0.26	0.07	0.05	0.08	0.08
First Season 2011	0.09	0.12	0.06	0.19	0.05	0.05	0.01	0.13
Panel C. Disadoption Rate: Proportion of Treated Farmers' Group Members Reporting No OSP Cultivation among Those Cultivating OSP in the Previous Season								
First Season 2008	0.13	0.02	0.30	0.04	0.25	0.06	0.48	0.11
Second Season 2008	0.18	0.09	0.40	0.07	0.22	0.11	0.44	0.13
First Season 2009	0.22	0.11	0.52	0.13	0.30	0.24	0.61	0.09
Second Season 2009	0.20	0.10	0.59	0.07	0.28	0.26	0.70	0.13
First Season 2010	0.20	0.12	0.51	0.10	0.30	0.18	0.64	0.23
Second Season 2010	0.23	0.18	0.53	0.17	0.28	0.25	0.64	0.16
First Season 2011	0.36	0.33	0.79	0.26	0.34	0.63	0.60	0.09

Table 6: Linear probability models of the determinants of OSP cultivation for treated farmer group members

			Un-interacted	Interacted with Season
	(1)	(2)	(3a)	(3b)
Grew any sweet potato	0.0671**	0.0388	-0.151***	0.0424***
	(0.031)	(0.034)	(0.046)	(0.007)
Log total cultivated area at baseline	-0.00724	-0.0026	0.0198	-0.00494
	(0.015)	(0.017)	(0.026)	(0.004)
Had a lowland parcel?	0.0225	0.0195	0.087***	-0.015**
	(0.022)	(0.023)	(0.025)	(0.007)
First tertile of cultivated area with good soil	0.00441	0.0118	-0.00217	0.00314
	(0.030)	(0.031)	(0.039)	(0.009)
Third tertile of cultivated area with good soil	-0.0109	-0.0144	0.0348	-0.0111
	(0.035)	(0.037)	(0.048)	(0.009)
Had any irrigated land?	0.00915	-0.00783	0.0386	-0.0104
	(0.051)	(0.060)	(0.071)	(0.013)
Household with secondary or higher education?	0.0321	0.0351*	-0.0498	0.019***
	(0.019)	(0.019)	(0.033)	(0.006)
Age of mother	-0.00096	-0.00020	0.00112	-0.000293
	(0.001)	(0.001)	(0.002)	(0.001)
Age of father − age of mother	0.000248	0.000324	-0.00216	0.000554
	(0.002)	(0.002)	(0.002)	(0.001)
Polygamous household?	-0.00939	-0.0218	-0.0143	-0.00179
	(0.026)	(0.029)	(0.031)	(0.006)
Household recruited by farmer group?	-0.0566**	-0.0361	-0.0568	0.00467
	(0.024)	(0.027)	(0.037)	(0.007)
Number of household members over age 5	0.00276	0.000946	0.00203	-0.000225
	(0.004)	(0.004)	(0.005)	(0.001)
Number of household members under age 2	-0.00401	-0.00183	0.0141	-0.00348
	(0.014)	(0.015)	(0.023)	(0.005)
Number of household members aged 3–5 years	-0.0103	-0.00045	0.0186	-0.00436
	(0.018)	(0.019)	(0.022)	(0.005)
Log total expenditures	0.0648	0.0449	-0.0651	0.0246
	(0.048)	(0.040)	(0.064)	(0.017)
Log km to farmer group meeting place	0.00565	-0.00532	-0.0116	0.00144
	(0.008)	(0.011)	(0.014)	(0.003)
Model 1?	0.00847			
	(0.027)			
District FE	Yes	No	No	
Community FE	No	Yes	Yes	
Season FE	Yes	Yes	Yes	

Notes: Three separate linear probability models are presented. Columns (1) and (2) present regressions that do not interact household characteristics with season. Columns (3a)–(3b) present a regression that interacts household characteristics with season. Column (3a) presents the coefficients of the variable named in the row header. Column (3b) presents the coefficients of the variables named in the row header interacted with season. Each regression has 3,634 observations. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels. Standard errors are clustered at the community level.

Table 7: Ordered logit and proportional hazard models of the determinants of OSP cultivation for treated farmer group members

	Outcome of Ordered Logit Model			Cox Proportional Hazards Models		
	Never Adopted	Disadopted	Still Cultivating	No District Influence	District Indicators	District Strata
	(1a)	(1b)	(1c)	(2)	(3)	(4)
Grew any sweet potato	-0.00722	-0.0812	0.0884	0.392***	0.815*	0.866
	(0.008)	(0.055)	(0.061)	(0.047)	(0.100)	(0.094)
Log total cultivated area at baseline	0.00248	0.0292	-0.0316	1.195**	1.031	1.021
	(0.002)	(0.022)	(0.023)	(0.087)	(0.070)	(0.069)
Had a lowland parcel?	-0.000581	-0.00684	0.00742	0.886	0.932	0.908
	(0.003)	(0.033)	(0.036)	(0.089)	(0.093)	(0.094)
First tertile of cultivated area with good soil	-0.000246	-0.0029	0.00314	0.680***	0.929	0.935
	(0.004)	(0.043)	(0.047)	(0.094)	(0.126)	(0.127)
Third tertile of cultivated area with good soil	0.00211	0.0248	-0.0269	1.022	0.915	0.943
	(0.005)	(0.054)	(0.059)	(0.151)	(0.144)	(0.145)
Had any irrigated land?	0.014	0.142**	-0.156**	1.500**	1.063	1.091
	(0.012)	(0.059)	(0.066)	(0.292)	(0.206)	(0.177)
Household with secondary or higher education?	-0.00543	-0.0622**	0.0677*	0.798***	0.97	0.972
	(0.005)	(0.031)	(0.035)	(0.063)	(0.088)	(0.083)
Age of mother	0.000104	0.00123	-0.00133	0.999	1.003	1.002
	(0.000)	(0.003)	(0.003)	(0.008)	(0.007)	(0.006)
Age of father − age of mother	-0.000121	-0.00142	0.00154	0.999	1.01	1.01
	(0.000)	(0.003)	(0.003)	(0.009)	(0.007)	(0.007)
Polygamous household?	-0.000939	-0.011	0.012	0.943	1.103	1.093
	(0.003)	(0.038)	(0.042)	(0.098)	(0.114)	(0.111)
Household recruited by FG?	0.00483	0.0557	-0.0605	0.989	1.141	1.141
	(0.005)	(0.036)	(0.040)	(0.101)	(0.121)	(0.117)
Number of HHers over age 5	-0.000311	-0.00366	0.00397	0.973	0.975	0.979
	(0.001)	(0.007)	(0.008)	(0.023)	(0.024)	(0.022)
Number of HHers under age 2	0.000671	0.0079	-0.00857	1.084	1.055	1.057
	(0.002)	(0.026)	(0.028)	(0.057)	(0.061)	(0.060)
Number of HHers aged 3–5 years	0.00326	0.038	-0.0413	1.1	1.021	1.023
	(0.003)	(0.025)	(0.027)	(0.064)	(0.083)	(0.077)
Log total expenditures	-0.0147	-0.173**	0.188**	0.417***	0.647*	0.675*
	(0.013)	(0.067)	(0.077)	(0.117)	(0.162)	(0.160)
Log km to FG meeting place	-0.00151	-0.0177	0.0193	1.048	0.999	0.993
	(0.001)	(0.015)	(0.016)	(0.056)	(0.048)	(0.045)
Model 1?	0.00498	0.0574	-0.0624		0.235***	
	(0.005)	(0.046)	(0.049)		(0.041)	
Kamuli					0.208***	
					(0.040)	
Bukedea					1.017	
					(0.145)	

Notes: Four separate models are presented. Columns (1a)–(1c) present the average marginal effects on the likelihood of the outcome named in the column header estimated using an ordered logit function form. Columns (2)–(4) present three separate Cox proportional hazard regressions. Column (2) includes only household and farm characteristics. Column (3) adds district indicators. Column (4) is instead stratified on district, thereby allowing the base hazard to vary by district. Each regression has 3,634 observations. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels. Standard errors are clustered at the community level.

Table 8: Linear probability models of the determinants of OSP cultivation for treated nonmember households originally sampled at baseline

			Uninteracted	Interacted with Season
	(1)	(2)	(3a)	(3b)
Grew any sweet potato	0.0105	0.0606	-0.0474	0.024
	(0.069)	(0.070)	(0.106)	(0.016)
Log total cultivated area at baseline	0.0499	-0.00425	-0.0325	0.0062
	(0.040)	(0.040)	(0.072)	(0.014)
Had a lowland parcel?	-0.0155	-0.0544	-0.0721	0.00386
	(0.054)	(0.053)	(0.085)	(0.017)
First tertile of cultivated area with good soil	-0.0372	0.0709	-0.0226	0.021
	(0.070)	(0.073)	(0.104)	(0.018)
Third tertile of cultivated area with good soil	-0.0609	0.0282	0.0629	-0.0077
	(0.070)	(0.081)	(0.128)	(0.019)
Had any irrigated land?	-0.0788	-0.11	-0.0134	-0.0215
	(0.104)	(0.093)	(0.195)	(0.028)
Household with secondary or higher education?	-0.04	-0.0361	-0.109	0.0162
	(0.045)	(0.047)	(0.091)	(0.017)
Age of mother	0.00471	0.00135	-0.00066	0.00044
	(0.005)	(0.005)	(0.006)	(0.001)
Age of father − age of mother	-0.00582	-0.00873	-0.0129	0.000912
	(0.005)	(0.005)	(0.009)	(0.002)
Polygamous household?	0.0848*	0.0804	0.0239	0.0126
	(0.044)	(0.052)	(0.114)	(0.026)
Number of household members over age 5	0.00673	0.0185	0.0138	0.00109
	(0.013)	(0.013)	(0.028)	(0.004)
Number of household members under age 2	0.0221	0.0192	0.0583	-0.00866
	(0.033)	(0.033)	(0.053)	(0.009)
Number of household members aged 3–5 years	0.0213	0.0429	0.11*	-0.0149
	(0.039)	(0.040)	(0.062)	(0.012)
Log total expenditures	0.147	0.121	0.0477	0.0164
	(0.118)	(0.116)	(0.195)	(0.033)
Log km to farmer group meeting place	-0.022	0.0218	-0.041	0.014
	(0.034)	(0.038)	(0.070)	(0.010)
Model ?	0.0248			
	(0.047)			
District FE	Yes	No	No	
Community FE	No	Yes	Yes	
Season FE	Yes	Yes	Yes	

Note: Three separate linear probability models are presented. Columns (1) and (2) present regressions that do not interact household characteristics with season. Columns (3a)–(3b) present a regression that interacts household characteristics with season. Column (3a) presents coefficients of the variable named in the row header. Column (3b) presents coefficients of variables named in the row header interacted with season. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels. Standard errors are clustered at the community level.

Table 9: Linear probability models of the determinants of OSP cultivation for treated nonmember households for originally and newly sampled nonmember households

			Uninteracted	Interacted with Season
	(1)	(2)	(3a)	(3b)
Grew any white or yellow sweet potato, season 5	0.139***	0.17***	0.252**	-0.0129
	(0.040)	(0.036)	(0.118)	(0.019)
Log total cultivated area, season 5	0.0383***	0.0371***	0.0676***	-0.00476
	(0.013)	(0.013)	(0.025)	(0.004)
Had a lowland parcel, seasons 7 or 8	0.0758**	0.0775**	0.189*	-0.017
	(0.033)	(0.034)	(0.104)	(0.016)
Had any irrigated land, seasons 7 or 8	-0.0879	-0.0187	-0.0641	0.00696
	(0.059)	(0.052)	(0.197)	(0.028)
Household with secondary or higher education (at follow-up)	0.0336	0.0412	-0.026	0.0103
	(0.038)	(0.038)	(0.102)	(0.016)
Age of mother at follow-up	-0.00108	-0.000737	-0.00007	-0.00011
	(0.002)	(0.002)	(0.005)	(0.001)
Number of household members under age 2	0.0226	0.0184	-0.0671	0.0131
	(0.026)	(0.024)	(0.046)	(0.008)
Number of household members aged 3–5 years	-0.0101	-0.0222	0.0548	-0.0119
	(0.024)	(0.026)	(0.062)	(0.009)
Number of household members aged 6–17 years	0.0249***	0.0255***	0.0186	0.00107
	(0.008)	(0.008)	(0.026)	(0.004)
Number of female household members aged 18–64 years	-0.0115	-0.00286	0.0655	-0.0105
	(0.024)	(0.021)	(0.066)	(0.010)
Number of household members aged 64 and over	-0.00984	-0.0133	-0.031	0.00271
	(0.037)	(0.035)	(0.124)	(0.018)
Log km to farmer group meeting place	-0.0242	-0.0663**	-0.109*	0.00646
	(0.022)	(0.026)	(0.058)	(0.008)
Model 1?				
Newly sampled nonmember?	-0.0351	-0.0239	-0.0237	
	(0.028)	(0.032)	(0.032)	(0.000)
District FE	Yes	No	No	
Community FE	No	Yes	Yes	
Season FE	Yes	Yes	Yes	

Notes: The data include nonmember households interviewed at baseline and those interviewed in the follow-up survey only. Only seasons 5–8 are included in these models. Three separate linear probability models are presented. Columns (1) and (2) present regressions that do not interact household characteristics with season. Columns (3a)–(3b) present a regression that interacts household characteristics with season. Column (3a) presents the coefficients of the variable named in the row header. Column (3b) presents the coefficients of the variables named in the row header interacted with season. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels. Standard errors are clustered at the community level.

Table 10: Ordered logit models of the determinants of OSP cultivation for treated farmer group members

	Outcome of Ordered Logit Model		
	Never Adopted	Disadopted	Still Cultivating
	(1a)	(1b)	(1c)
Grew any white or yellow sweet potato, season 5	-0.0834***	0.00113	0.0822***
	(0.026)	(0.007)	(0.030)
Log total cultivated area, season 5	-0.0279	0.00444	0.0235
	(0.019)	(0.004)	(0.016)
Had a lowland parcel, seasons 7 or 8	-0.0964***	-0.00134	0.0977***
	(0.020)	(0.010)	(0.027)
Had any irrigated land, seasons 7 or 8	0.0213	-0.00403	-0.0173
	(0.065)	(0.014)	(0.051)
Householder with secondary or higher education (at follow-up)	-0.00978	0.00158	0.0082
	(0.039)	(0.006)	(0.034)
First tertile of cultivated area with good soil, season 8	0.042	-0.0091	-0.0328
	(0.049)	(0.014)	(0.035)
Third tertile of cultivated area with good soil, season 8	-0.0817**	0.00138	0.0803**
	(0.033)	(0.008)	(0.038)
Age of mother at follow-up	0.000662	-0.000105	-0.000557
	(0.002)	(0.000)	(0.002)
Number of household members under age 2	-0.0197	0.00312	0.0166
	(0.024)	(0.004)	(0.020)
Number of household members aged 3–5 years	0.0122	-0.00193	-0.0103
	(0.019)	(0.003)	(0.016)
Number of household members aged 6–17 years	-0.0232***	0.00368*	0.0195***
	(0.008)	(0.002)	(0.007)
Number of female household members aged 18–64 years	0.00977	-0.00155	-0.00822
	(0.021)	(0.003)	(0.017)
Number of male household members aged 18–64 years	0.0386**	-0.00609*	-0.0325*
	(0.019)	(0.004)	(0.017)
Number of household members aged 64 and over	0.0398	-0.00629	-0.0335
	(0.043)	(0.007)	(0.037)
Log km to farmer group meeting place	0.0428*	-0.00679	-0.036*
	(0.023)	(0.005)	(0.019)
Model 1?	-0.0304	0.00575	0.0247
	(0.040)	(0.006)	(0.034)
Newly sampled nonmember?	0.154	-0.0146	−0.139
	(0.041)	(0.022)	(0.022)

Table 11: Cox proportional hazard models of the determinants of OSP cultivation for treated farmer group members

	Originally Sampled Nonmember Households			Initially Adopting Originally Sampled Nonmember Households		
	No District Influence	District Indicators	District Strata	No District Influence	District Indicators	District Strata
	(1)	(2)	(3)	(4)	(5)	(6)
Grew any sweet potato	0.628***	0.871	0.812	0.348***	0.517***	0.514***
	(0.109)	(0.15)	(0.173)	(0.091)	(0.118)	(0.125)
Log total cultivated area at baseline	0.842	0.753**	0.762**	0.859	0.689**	0.709*
	(0.0996)	(0.098)	(0.092)	(0.149)	(0.127)	(0.136)
Had a lowland parcel?	1.206	1.254	1.390*	1.024	1.309	1.421
	(0.207)	(0.216)	(0.245)	(0.284)	(0.356)	(0.385)
First tertile of cultivated area with good soil	1.204	1.435	1.398	1.122	1.565*	1.522
	(0.283)	(0.338)	(0.306)	(0.305)	(0.410)	(0.426)
Third tertile of cultivated area with good soil	2.055***	1.573**	1.512*	2.551**	1.571	1.583
	(0.536)	(0.322)	(0.331)	(1.021)	(0.525)	(0.552)
Had any irrigated land?	1.488	1.071	1.081	1.055	0.687*	0.654*
	(0.439)	(0.268)	(0.319)	(0.336)	(0.144)	(0.153)
Householder with secondary or higher education?	0.896	0.955	0.944	0.633**	0.662*	0.649**
	(0.127)	(0.125)	(0.121)	(0.146)	(0.146)	(0.140)
Age of mother	0.984	0.986	0.981	0.96	0.964	0.961*
	(0.016)	(0.016)	(0.0143)	(0.026)	(0.024)	(0.023)
Age of father − age of mother	1.02	1.027*	1.035**	1.008	1.031	1.033
	(0.0139)	(0.0147)	(0.0155)	(0.018)	(0.020)	(0.020)
Polygamous household?	0.828	0.752*	0.693**	0.807	0.630*	0.581**
	(0.135)	(0.112)	(0.127)	(0.197)	(0.152)	(0.149)
Number of household members over age 5	0.981	0.992	1.015	1.021	1.029	1.05
	(0.0447)	(0.0437)	(0.0485)	(0.071)	(0.074)	(0.080)
Number of household members under age 2	0.983	0.981	0.996	1.122	1.127	1.134
	(0.0786)	(0.0761)	(0.0791)	(0.127)	(0.120)	(0.122)
Number of household members aged 3–5 years	0.85	0.92	0.961	0.862	1.01	1.015
	(0.11)	(0.122)	(0.131)	(0.195)	(0.240)	(0.238)
Log total expenditures	0.605	0.792	0.888	0.553	0.808	0.793
	(0.251)	(0.33)	(0.352)	(0.354)	(0.487)	(0.470)
Log km to farmer group meeting place	1.101	1.124	1.147	0.965	1.038	1.047
	(0.115)	(0.104)	(0.0986)	(0.107)	(0.099)	(0.104)
Model 1?	0.926	0.892	0.84	0.885	0.824	0.782
	(0.154)	(0.144)	(0.132)	(0.216)	(0.186)	(0.176)
Kamuli		0.572**			0.379***	
		(0.152)			(0.120)	
Mukono		0.326***			0.180***	
		(0.119)			(0.076)	
Observations	629	629	629	547	547	547

Notes: Six separate Cox proportional hazard regressions. Columns (1)–(3) use all originally sampled nonmembers. Columns (4)–(6) employ only originally sampled nonmembers that cultivated OSP in the program's first season. Columns (1) and (4) include only household and farm characteristics. Columns (2) and (5) add district indicators. Columns (3) and (6) instead are stratified on district, thereby allowing the base hazard to vary by district. Each regression has 629 observations. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels. Standard errors are clustered at the community level.

Table 12: OSP cultivation, adoption, and disadoption in farmer groups in parishes just outside the initial introduction area

	Cultivating OSP			Adopting OSP			Disadopting OSP		
	Weights 1	Weights 2	Weights 3	Weights 1	Weights 2	Weights 3	Weights 1	Weights 2	Weights 3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agricultural Production Data Series									
Season 5	0.14	0.05	0.12						
Season 6	0.12	0.05	0.10	0.05	0.02	0.03	0.45	0.40	0.42
Season 7	0.11	0.05	0.09	0.04	0.01	0.03	0.31	0.33	0.33
Season 8	0.09	0.04	0.07	0.01	0.00	0.01	0.26	0.29	0.29
Ever Cultivated OSP?	0.25	0.10	0.20						

Notes: The first weight assumes that a simple random sample was drawn. It is likely to dramatically overestimate the proportion of diffusion households cultivating OSP. The second weight assumes that all of the group's cultivating and disadopting households were sampled by setting their weights equal to 1. The never-adopting households are assumed to comprise the remainder of the farmers' group's population. It is likely to dramatically underestimate the proportions of diffusion households that were cultivating OSP and that disadopted OSP. In the third weight, when the sample target for cultivating or disadopting households could not be met (and the group's household population meets or exceeds the number of targeted households), that household type's weight is set to 1, as per the second weight.

Table 13: Average number of nutrition messages retained

	Number of vitamin A messages the mother recalls (0–3)				Number of child feeding practices the mother recalls (0–3)			
Season	Kamuli	Bukedea	Mukono	Total	Kamuli	Bukedea	Mukono	Total
1	1.00	1.04	0.84	0.96	1.82	1.64	2.09	1.81
4	1.31	1.15	1.21	1.22	1.79	1.39	1.76	1.63
8	1.19	1.22	0.98	1.15	1.46	1.06	1.63	1.36

Table 14: Interview effects among treated nonmember households, OSP cultivation, and OSP vine acquisition

	Sample of Treated Nonmembers			Original − New Sample Difference among Treated Nonmembers			
	All	Original	New	Unconditional		Conditional on Household Demographics	
	(1)	(2)	(3)	(4)		(5)	
Ever Cultivated OSP?	0.59	0.82	0.47	0.35	***	0.31	***
	(0.04)	(0.04)	(0.05)	(0.06)		(0.07)	
Season first acquired OSP vines							
Season 1 (or earlier)	0.27	0.37	0.19	0.18	***	0.17	***
	(0.02)	(0.04)	(0.03)	(0.06)		(0.06)	
Season 2	0.13	0.15	0.11	0.03		0.05	
	(0.02)	(0.03)	(0.03)	(0.05)		(0.04)	
Season 3	0.20	0.20	0.19	0.01		0.00	
	(0.04)	(0.04)	(0.04)	(0.05)		(0.05)	
Season 4	0.10	0.07	0.12	-0.05		-0.05	
	(0.02)	(0.03)	(0.03)	(0.03)		(0.03)	
Season 5	0.18	0.19	0.18	0.00		0.00	
	(0.02)	(0.04)	(0.02)	(0.04)		(0.04)	
Season 6	0.08	0.02	0.13	-0.12	***	-0.11	***
	(0.02)	(0.01)	(0.03)	(0.03)		(0.03)	
Season 7	0.03	0.00	0.06	-0.06	***	-0.05	***
	(0.01)	(0.00)	(0.02)	(0.02)		(0.02)	
Season 8	0.01	0.00	0.01	-0.01	*	-0.01	*
	(0.00)	(0.00)	(0.01)	(0.01)		(0.01)	

Notes: Each pair of cells shows a mean and a standard error from separate specifications. Columns (1) and (2) present mean OSP cultivation for nonmembers first sampled at baseline and nonmembers first sampled at follow-up. Columns (3)–(6) present the differences in these means using various specifications. Column (3) presents unconditional differences. Column (4) presents differences excluding nonmembers first sampled at follow-up from networks communities. Column (5) adds farm and household characteristics as covariates to the specifications in Column (4). Column (6) adds farm and household characteristics to the specification in Column (3). *, **, and *** represent statistical significance at the 0.1, 0.05, and 0.01 levels.

Table 15: Interview effects among treated nonmember households, OSP cultivation by season

Season	Agricultural Production Series Data		Original − New Sample Difference				OSP Conservation Data Series		Original − New Sample Difference			
	Original	New	Unconditional		Conditional on Household Demographics		Original	New	Unconditional		Conditional on Household Demographics	
5	0.45	0.26	0.19	***	0.16	***	0.47	0.27	0.21	***	0.17	***
	(0.06)	(0.04)	(0.04)		(0.04)		(0.07)	(0.04)	(0.05)		(0.04)	
6	0.38	0.32	0.06		0.02		0.39	0.31	0.09	*	0.05	
	(0.04)	(0.04)	(0.04)		(0.05)		(0.06)	(0.04)	(0.05)		(0.05)	
7	0.33	0.27	0.06		0.02		0.37	0.29	0.08	*	0.04	
	(0.04)	(0.04)	(0.04)		(0.04)		(0.04)	(0.04)	1) (0.04)		(0.05)	
8	0.24	0.22	0.02		-0.01							
	(0.05)	(0.04)	(0.05)		(0.04)							
Pooled	0.35	0.27	0.08	**	0.05		0.41	0.29	0.12	***	0.08	**
	(0.04)	(0.04)	(0.03)		(0.03)		(0.05)	(0.04)	(0.03)		(0.03)	

Notes: Each pair of cells shows a mean and a standard error from separate specifications. *, **, and *** represent statistical significance at the 0.1, 0.05, and 0.01 levels.

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