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Institute for Economic Studies, Keio University
2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan
ies-office@adst.keio.ac.jp
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Abstract

This paper evaluates the impact of a market-oriented agricultural extension program called Smallholder Horticulture Empowerment and Promotion (SHEP) in Kenya. The SHEP approach prioritizes practical training for farmers to act as producers in a market by encouraging decentralized decision-making. Using a cluster randomized controlled trial (RCT) over a two-year period, we find that, on average, SHEP increased horticultural income significantly by 70% and the positive effect was more pronounced in vulnerable households whose head of household is female, less educated or older. The effect is not relevant to horticultural experience prior to the intervention. Our findings suggest that a market-oriented agricultural extension can provide a pathway to improve the living standards of small-scale farmers through an increase in horticultural income.

Satoshi Shimizutani
JICA Ogata Sadako Research Institute for Peace and Development
10-5 Ichigaya Honmuracho, Shinjuku-ku, Tokyo
Shimizutani.Satoshi@jica.go.jp

Shimpei Taguchi
JICA Ogata Sadako Research Institute for Peace and Development
10-5 Ichigaya Honmuracho, Shinjuku-ku, Tokyo
Taguchi.Shimpei@jica.go.jp

Eiji Yamada
JICA Ogata Sadako Research Institute for Peace and Development
10-5 Ichigaya Honmuracho, Shinjuku-ku, Tokyo
Yamada.Eiji@jica.go.jp

Hiroyuki Yamada
Faculty of Economics, Keio University
2-15-45 Mita, Minato-ku, Tokyo
hyamada@econ.keio.ac.jp

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Our special appreciation is extended to late professor Nobuhiko Fuwa who made extraordinary commitments towards designing the research framework and his collaborators as well as Innovations for Poverty Actions (IPA) for their data collection efforts. We also thank Hamza Umer for his excellent research assistance. Finally, yet most importantly, our special gratitude goes to the Kenyan farmers, who spent many hours answering questions. This research is dedicated to these farmers, who have a deep passion for making a difference in their lives. The views expressed in the paper are those of the authors and do not necessarily represent the official positions of either the JICA Ogata Sadako Research Institute for Peace and Development or JICA.

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"We are all farmers. Even if we do not work the land, our parents did."

– H.E. President Uhuru Kenyatta, Africa Green Revolution Forum, 2016

1. Introduction

This paper examines the impacts of a new market-oriented agricultural extension program in Kenya that endeavored to improve the living standards of smallholder farmers by providing practical training on the use of market principles. The approach emphasizes farmers' autonomy to act as independent producers in the market and is universally accessible to general smallholder farmers.

The agricultural sector in Kenya plays a major role in the economy by contributing approximately one-third of the country's GDP and about 60% of its exports. The sector employs more than 40% of the total population (70% of the rural population),[1] with most farms considered to be small-scale in Kenya. There are 8.6 million smallholder farmers (corresponding to 4.5 million farming households) whose land under cultivation ranges from 1.2 acres (0.5ha) to 12 acres (5ha) (MoALF&I, 2019). Small-scale farmers produce more than 60% of national agricultural outputs in Kenya from 86% of the country's total land under agriculture.[2] Thus, transforming smallholder farmers to help them become more productive and commercial is crucial for the country's sustainable economic growth, and there have been calls for new effective interventions to improve their living standards.

Indeed, among the nine flagship projects in the mid-term agricultural plan,

[1] Kenya National Bureau of Statistics (2019) shows that the contribution to GDP from agriculture, forestry and fishing sector was 34.2% in 2018 (32.8% by agriculture sector only). The figures on exports and employment are from 2015 and available from the Ministry of Agriculture, Livestock, Fisheries and Irrigation (2019).

[2] The proportions out of national output and national land under agriculture come from FAO (2011) "Dairy Development in Kenya," and McKinsey & Company (2017) "Successful agricultural transformations: Six core elements of planning and delivery," respectively. Kenya National Bureau of Statistics (2019) shows the proportion of agricultural product sales by small farms is 73% in 2018.

Agricultural Sector Transformation and Growth Strategy (ASTGS), the Kenyan government places the top priority on increasing annual income for small-scale farmers by 40% over the 2019-2029 period (MoALF&I, 2019). While it is clearly stated that achieving higher incomes depends on successful transformation from subsistence farming to commercial farming, many small-scale farmers face a variety of serious challenges: they have little capital to afford key inputs, there is a shortage of machines and new technologies to achieve higher productivity, farmers sell smaller volumes and lower quality products leading to weaker negotiating power, there is less formal access to the channels for sale, and fewer business linkages with value chains.

This paper examines the impact of a market-oriented agricultural extension program called "Smallholder Horticulture Empowerment and Promotion (SHEP)," an attempt by the Kenyan government to overcome the abovementioned obstacles to enhancing market-oriented agriculture. The SHEP approach was developed and formed in the initial phase between 2006 and 2009 in a technical cooperation project supported by the Japan International Cooperation Agency (JICA) in Kenya. The goal of the project is to improve the living standards of small-scale farmers through horticultural activities by increasing incomes instead of yields (JICA, 2020).[3] The horticultural sector has been growing steadily in Kenya, becoming one of the leading sectors through exports of tea and coffee (Kenya National Bureau of Statistics, 2019). It also provides a promising cash crop market for smallholder farmers and requires only a small initial investment to enter (Seo, 2019). More than 80% of smallholder farmers are engaged in horticultural production and most national horticultural crops are produced by small-scale farmers

[3] Horticultural Crops Directorate (HCD) and Agriculture and Food Authority of the Republic of Kenya (2018) defines seven categories of horticultural crops; cut flowers, exotic vegetables, fruit, indigenous (African leafy) vegetables, aromatic plants, Asian vegetables and medicinal plants.

(Republic of Kenya, 2012). However, the sector suffers from its own specific challenges, notably, the labor-intensive nature of the work and the need for larger inputs and finer techniques than general crop production. Moreover, horticultural products can be stored for only a short period, and the sales prices can be seriously affected by market fluctuations (Aikawa, 2013), resulting in estimated post-harvest losses of 40% (Republic of Kenya, 2012). These crops are often dumped by a limited number of fixed traders during harvest seasons.

The SHEP approach holds a unique place among agricultural extensions in that it provides practical training in the principles of "market-oriented" activities for smallholder farmers, who are neither commercial nor subsistence farmers. Most agricultural extension programs have made their primary target the provision of a technical solution to a specific production problem for farmers by delivering knowledge on new crops or techniques of crop production (Anderson & Feder, 2007; Aker, 2011; Cook et al., 2021).[4] Building on numerous previous efforts of agricultural extension programs, the SHEP approach contains hybrid elements and shares some essential elements with other extension programs.[5] The SHEP approach is a public extension and free of charge. The approach provides training of trainers (ToT) to work as extension officers and they conduct training for farmers by communicating technical information.

[4] Cook et al. (2021) reviewed a tremendous volume of the literature on agricultural extension and identified four dominant approaches; (1) technology transfer approaches (the key periods are 19th century, 1950s and 60s) aiming at the top-down transfer of expert-generated agricultural knowledge to farmers (e.g., Training and Visiting (T&V) methodology), (2) participatory approaches (in the 70s, 80s and 90s) focusing on mutual dialogue between farmers and extensionists to complement technology transfer (e.g., Farmer Field Schools), (3) decentralized approaches (in the 70s and 80s) to grant farmers more control over extension programs and develop links to global markets through value chains, and allowing private agencies and NGOs to reduce bureaucratic inefficiencies (e.g., fee-for-extension) and (4) systems thinking approaches (in the 90s and 2000s) emphasizing co-learning and codesign through shifting from technology to system-oriented innovation and agricultural research.

[5] Aker (2011) groups the types of agricultural extension programs into five categories; Farmer Field Schools (FFS), Training and Visit (T&V), farmer to farmer, social networks and general extension.

This approach is common among most traditional extension programs and stems from Training and Visit (T&V) methods used to "contact farmers" through field agents.[6] Moreover, the SHEP approach emphasizes participatory training methods to build farmers' capability. In this way, it resembles the Farmer Field School (FFS) by conveying agro-ecosystem knowledge to field school participants (Anderson & Feder, 2007).

However, a distinct feature of the SHEP approach is the priority given to the training of farmers to be independent and active market participants as producers. The SHEP approach does not target local elite farmers who traditionally benefit from the adoption of new technologies. Instead, it focuses more on general smallholder farmers in an open and accessible way while promoting the autonomy of those farmers. An innate feature of the SHEP approach is its characterization as "market-oriented" to establish decentralized decision-making by farmers in a market. The SHEP approach contains crop production technology transfer in its activities, but this comes in the last place. Most of the activities in the SHEP approach are intensively devoted to practical training for smallholder farmers and extension officers to understand the principle of markets and their essential variables, such as price, quantity and quality. These principles are universally effective across horticultural crops and even for agricultural production in general.

The elements of the market-oriented approach can be further categorized into three aspects. First, the SHEP approach is directly targeted at increasing the income

[6] The T&V system was introduced into Kenya in 1982. Gautam (2000) argues that the system had no significant impact on farmer efficiency or crop productivity partly because it was based on a traditional "top down and supplied driven" approach. Other extension services such as Commodity-based, Focal Area Approach and FFS were introduced in Kenya too.

level of smallholder farmers, in contrast to other extension programs that aim to enhance specific crop yields through technology adoption. The SHEP approach motivates farmers to be actively engaged in agricultural markets and behave as entrepreneurs in a sustainable way. To this end, SHEP focuses on horticultural crops that are very popular and universal among smallholder farmers and is designed to target general farmers, not talented, skilled, or experienced farmers. If farmers want to increase their income, they need to learn about how a market works. The SHEP approach places top priority on farmers' learning and understanding of the principles of markets without rushing into technological extensions.

Second, farmers become responsible for regularly gaining essential information on market variables by themselves to mitigate the asymmetry of information between producers and consumers. This is an essential process for farmers, making them active in agricultural markets under the SHEP project slogans: "from "Grow AND Sell" to "Grow TO Sell" or "Starting in the Market and Ending in the Market" (JICA et al., 2020). In reality, most small-scale farmers are disadvantaged when obtaining information and have little understanding of the basic concept of a market – thus, they supply what they want to grow. In the SHEP approach, farmers are not given market information by third-party experts but trained to gather vital market information directly by themselves through market surveys. These market surveys encourage decentralized decision-making by farmers on what/how/when to produce.

Third, farmers decide on specific horticultural crops to grow to sell based on their own market surveys. Therefore, the extension of production techniques will arise through an on-demand need for information by farmers. Crop selection depends on the majority of farm group members, and the outcome is not affected by opinion leaders or extension staff. Farmers trade with partners on their own initiative.[7]

In this paper, we provide the first evidence on the impact of the SHEP approach on farmers' living standards and farming activities. We aim to contribute to the literature by examining this new type of agricultural extension program, which is "market-oriented." Previous studies examined the impact of agricultural extension programs on a variety of development outcomes, but the results have largely been mixed and the evidence from large-scale surveys remains limited (Anderson & Feder, 2007; Aker, 2011; Davis et al., 2012). Aker (2011) argues that measurement error problems in the outcome variables of interest and endogeneity bias in the correlation between observable and unobservable characteristics are serious challenges when seeking to identify a causal relationship between agricultural extensions and outcomes.[8]

In order to tackle these econometric issues, we utilize a dataset collected through randomized control trial (RCT) that was carried out in fourteen counties in Kenya from 2015 to 2019 to measure the impact of the intervention of SHEP PLUS (Smallholder Horticulture Empowerment and Promotion Project for Local and Up-Scaling). In total,

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[7] The SHEP approach is now expanding to African countries other than Kenya. As of the beginning of 2020, twenty-four countries in Africa have introduced the SHEP approach with 110,000 beneficiaries. Moreover, "SHEP one million" was declared at the 7th TICAD (Tokyo International Conference on African Development), held in Yokohama in 2019, stating that "[m]embers of the joint declaration affirm their resolve towards ensuring, through introducing and making effective use of SHEP approach, that at least one million of small scales farmers will achieve better lives by 2030."

[8] Evenson (2001) and Aker (2011) provide a concise literature review up to the 2000s. Among papers published on the T&V approach since 2000, Evenson & Mwabu (2001) and Owens et al. (2003) found heterogeneous effect, while Gautam (2000) found no significant effect. Among studies on FFS, some studies found positive impact of adoption and diffusion (Tripp et al., 2005; Mancini et al., 2008; Godtland et al., 2004; Van den Berg & Jiggins, 2007), productivity (Godtland et al., 2004; Mutandwa & Mpangwa, 2004; Davis et al, 2012) and externality (Weir & Knight, 2004) but others did not find similar results on productivity and yields (Feder et al., 2004) nor externality (Tripp et al., 2005). Subsequent studies found positive and significant impact of BRAC's agricultural extension program in Uganda on food security (Pan et al., 2018) and health (Pan & Singhal, 2019). Moreover, Emerick et al. (2016) found farmer field days (FFDs) increased adoption of improved seeds in India while Maertens et al. (2017) reported that FFDs were not effective in Malawi.

4,405 farmers from 212 farmer groups participated in the baseline survey conducted before the intervention. A follow-up survey was conducted for the same farmers after two years from the baseline survey. The attrition rate between baseline and follow-up surveys was 10.2%. The follow-up survey showed that the SHEP intervention was not necessarily adopted by all farmers in the treatment group. Thus, the treatment group in our sample is considered as an "intention-to-treatment" (ITT) group, and the impact is captured in terms of an ITT estimate instead of average treatment effect (ATE). Next, we assess the impact of introducing the SHEP approach through several predefined indicators in terms of consumption, income, and assets, as well as horticulture crop income. Finally, we seek to detect any change in farming activities to understand the welfare of farmers.

We find that, on average, farmers in the SHEP program enjoyed a significantly higher horticultural income increase by 70% over two years, and the positive effect is more pronounced in vulnerable households whose head of household is female, less educated, or older. The effect is not related to horticultural experience prior to the intervention. Moreover, this increase is attributed to the main training activities in terms of local average treatment effect (LATE), and the impacts are likely to be larger if confined to participating farmers.

This paper proceeds as follows. The next section describes the intervention used in the SHEP approach, and Section 3 explains the research design. Section 4 provides the data description, while Section 5, the main body of this paper, presents and discusses estimation results of the impact evaluation. Section 6 focuses on heterogeneous treatment effects by subgroup analyses. Section 7 examines the impact of each training activity, and Section 8 provides our main conclusion and discusses implications for further research.

2. The SHEP approach

SHEP is a form of agricultural extension comprised of consecutive activities designed for both smallholder horticulture farmers and agricultural extension officers. The approach was originally developed in a technical cooperation project jointly conducted by the Republic of Kenya and the Japan International Cooperation Agency (JICA).[9] To date, SHEP has been introduced to 21,000 beneficiaries in 33 counties across Kenya.

SHEP consists of a full training package that includes a series of activities for farmers and extension officers (JICA et al., 2020).[10] First of all, several activities are provided as prerequisites to share the principles of the SHEP approach among stakeholders such as farmers, extension officers, and county-level government officials. Once farmers decide to participate in the project, all members of the farmers' group undertake a baseline survey to meticulously review the performance of their current farming practices in terms of crop yields and income, as well as production techniques. The baseline survey serves as a benchmark to measure the outcomes of the project and allows farmers to set a goal for increases in income and extension officers to determine

[9] The most recent and concise description on the SHEP program is provided by "The SHEP Approach: Implementation Guidebook for Extension Officers" (JICA et al., 2020). The canonical activities of the SHEP approach were formed during the initial phase in 2006-2009 (Smallholder Horticulture Empowerment Project, "SHEP Phase 1" for short) (MoA and JICA, 2009) and the approach has improved and deepened in the consecutive phases in Smallholder Horticulture Empowerment and Promotion Unit Project ("SHEP UP") (MoALF and JICA, 2014), followed by Smallholder Horticulture Empowerment and Promotion Project for Local and Up-Scaling ("SHEP PLUS") in 2015-2020 (MoALF&I and JICA, 2020).

[10] The SHEP approach distinguishes between "adoption" and "adaption". The "adoption" is the application of a full package of the approach while the "adaption" is some modifications implementing with other projects/programs. Our research design to evaluate an "adoption" case.

an adequate level for the provision of advice.[11]

Next, some representative farmer groups engage in business talks with stakeholders in a process called a "Farm Business Linkage Stakeholder Forum" (FABLIST). This is a match-making opportunity between farmers and market participants, supported by an extension officer to facilitate farmer group representatives. It provides a chance for farmers to talk with market actors and explore potential farming activities and trading products along the horticulture value chain.[12] The final preparatory activity consists of gender mainstreaming training, farm family budgeting, and group empowerment training.

In the next stage, farmers work through the core components of the SHEP approach. The market survey is one of the most important training activities to change farmers' behavior from "Grow AND Sell," in which farmers sell the surplus with no prior commercial production, to "Grow TO Sell," in which farmers learn to promote their farming business. The market survey motivates farmers to be sensitive to market demands and farmers are encouraged to visit the market and to collect vital market information on price, quality, quantity of crops, and other essential information on their own (illustrated in Figure 1). The market survey covers the names of products and varieties, production quality requirements, peak season demands, quantity and frequency of supply, place of production, unit purchase prices, modes and terms of products, marketing challenges and dealers' willingness to purchase the product from the group, as well as the contact information of product dealers. The markets that

[11] Note that the baseline survey described in this section differs from that in the RCT, which is explained in the next section.
[12] Business stakeholders include input suppliers, local market buyers, hotels, schools, hospitals, traders, exporters, product processors, transportation providers, extension service providers, and financial institutions.

farmers visit are not limited to typical agricultural markets but to alternatives, including learning institutions, supermarkets, hospitals, exporters, processors, hotels and schools.

Upon reviewing the results of the market survey, farmers select one or two of the most appropriate horticultural crops to “grow to sell” by themselves and set a crop-planting calendar. The crop selection is diverse and decentralized at the group level, depending on their past experiences and the relationship to sales channels. The decision on crop selection by the farmers is made through their own community discussion and vote, which extension officers facilitate but should respect. The most popular crops are tomatoes, kale, and onions, followed by black nightshade, an indigenous leafy vegetable.[13] The decision on crop selection is further supported by the crop planting calendar to guide farmers on when farming activities should be conducted to grow a better quantity of products and their best selling price by synchronizing farming activities in a group (JICA et al., 2020).

After completing considerable preparation of market survey and crop selection, farmers receive an extension advisory service on crop production techniques from extension officers based on farmers’ requests.[14] In the field, extension officers conduct a series of training sessions with farmers to deliver skills and knowledge for practical production and post-harvest handling of the selected crops. In order to facilitate extension activities to general farmers, pictorial materials are provided as training

[13] The total number of selected crops was 24 in SHEP Phase 1, 46 in SHEP UP and 35 in SHEP PLUS. African indigenous vegetables have advantages in lower production costs, shorter harvest times, less need for pest control, and frequent harvesting for regular shipping (Muhanji et al., 2011).

[14] The general crop production techniques cover market survey, crop planting calendar, soil testing, manure/composting, quality planting materials, land preparation practices, crop residues, basal application, raising seedlings, planting/transplanting spacing, fertilizer application, supplemental water application, timely weeding, top-dressing, pest and disease management practices, safe and effective use of pesticides, harvesting indices, appropriate containers, value addition techniques and farm records for cost and income analysis.

materials. The progress of the actual crop production process is regularly monitored and reviewed by extension officers.

3. Research design

Our research design sets its primary goal to rigorously measure the impact of the SHEP approach on living standards of the beneficiary farmers by separating non-random selection into program participation (Banerjee & Duflo, 2009). In order to construct a credible counterfactual, we conducted a cluster randomized controlled trial (RCT) at the sub-county level, including treatment and control groups. The impact assessment of the SHEP approach is to be carried out in accordance with the implementation of the third phase of SHEP ("SHEP PLUS"). The survey was conducted by Innovations for Poverty Action (IPA) with the support and approval of relevant Kenyan authorities.

First of all, the SHEP team and county governments selected a sub-county within each of fourteen counties to implement the SHEP approach.[15] The selection of counties and sub-counties is based on criteria consisting of sixteen objective indicators.[16] Then, sub-county government officials identified ten farmer groups in each selected sub-

[15] The SHEP approach sets general target group selection criteria for five aspects: group status (existing groups, either formal or informal), membership (20-50 members with youth not attending schools and adults less than 60 years old), group activities (most members are practicing horticulture farming, members that are engaged in collective activities comprise less than 40%, groups are not affected by other projects), group attitude, area under coverage (production area uniformly covered by a target group) and accessibility (motorcycle and vehicles).

[16] The indicators are the proportion of budget allocation to horticulture, the system of resource allocation, the number of staff at sub-county headquarters, the number of staff at ward level, the average number of motor vehicles in each sub-county, the average number of motorcycles in each ward, the presence of a sub-county agricultural coordinator, the availability of FEOs, horticultural policies, horticultural interventions, prioritized future horticulture projects, average annual rainfall, average number of smallholder irrigation facilities, horticultural projects similar to SHEP, horticultural project complementary, and the number of SHEP UP sub-counties.

county as potential beneficiary groups who were randomized in accordance with a guideline set by SHEP PLUS. These ten groups were randomly assigned through the "out-of-a-hat" technique to the "treatment group" to receive the intervention from the first year or the "sub-county control group," which was designed to receive the intervention in the third year after the baseline (with no intervention during the survey period).

In addition, "pure control groups" were selected in neighboring sub-counties that were not currently included in the SHEP PLUS intervention program and were likely to be exempt from potential spillover effects. The sub-counties that contained the pure control groups were those most comparable to the sub-counties, with the treatment and sub-county control groups in terms of cropping patterns, types of planting horticultural crops planted, scale of farmers, rainfall patterns, altitude and climatic conditions of the area and development in terms of infrastructure, exposure and access to information especially on agriculture.

The final outcomes for the impact evaluation were set up after careful examination of the project. The overall goal of SHEP PLUS is stated as "livelihood of smallholder horticulture farmers applying the SHEP Approach in implementing Counties is improved" and one of the outputs is defined as "income of individual members of smallholder horticulture is improved through the implementation of the SHEP Approach at implementing Counties" (MoALF&I & JICA, 2020). Given these documents, we set up two types of target outcomes. One group contains variables to measure the living standard of farmers relevant to their welfare: income, consumption, and assets. The other group includes variables to measure the transformation of farming activities in terms of the purchase of fertilizer, chemicals, and seeds. We examine these two types of outcomes separately but use the same analytical framework below.

4. Data description

The data collection was conducted in two “Batches” with the common questionnaire (Figure 2). The timeline of randomization, intervention, and data collection is summarized in Figure 3.

The Batch 1 survey that started with the randomization of participating farm groups took place in October 2015. The study area in the Batch 1 survey covered six counties in the Central region (Kirinyaga, Muranga, Kiambu) and Rift Valley region (Uasin Gishu, Elgeyo Marakwet, Nakuru).[17] Ten farmer groups that were identified in each sub-county were randomly assigned into the treatment (five groups) and the sub-county control (five groups) groups. The baseline survey was conducted from mid-November to December in 2015 and was completed at the commencement of the SHEP PLUS intervention.[18] The pure control data collection was conducted from January to February 2016. The total sample size at baseline was 585 farmers from 30 treatment groups, 361 farmers from 23 sub-county control groups, and 640 farmers from 34 pure control groups.

After two years, the follow-up survey was conducted. The data collection for the treatment and sub-county control groups was conducted from January to March in 2018 and from March to April in 2018 for the pure control group. Among the farmer groups surveyed at the baseline, five farmer groups in the sub-county control group started the

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[17] Each country has one sub-county to be surveyed (Appendix 1).

[18] In the Batch 1 survey, an additional 5 groups were selected as another treatment group which started the intervention with a one-year lag. These groups were surveyed at baseline but not at follow-up due to a tight budget. Thus, we excluded these samples from all analyses throughout this paper.

SHEP activities one year after the baseline.[19] Six farmer groups collapsed between the baseline and the follow-up or declined to participate.[20] As a result, the sample size at the follow-up was 775 for the treatment and sub-county control group and 561 for the pure control group.

The Batch 2 survey was implemented in the same way as Batch 1 in eight different counties in the Eastern provinces (Meru, Embu, Kitui, Machakos, Makueni) and Nyanza (Kisumu, Homa Bay, Nyamira).[21] The randomization of the participating farm groups took place in August and September 2016 in the same way, and the ten identified groups were randomly assigned into the treatment (five groups) or the sub-county control (five groups) groups. The baseline survey was conducted from October to November 2016 before starting the intervention. In addition, pure control groups were surveyed in November and December 2016.[22] The total sample size at baseline was 824 farmers from 41 treatment groups, 826 farmers from 41 sub-county control groups, and 809 farmers from 43 pure control groups. The follow-up for the Batch 2 survey was conducted in the same way from March to May in 2019. The sample size at follow-up was 1,528 for the treatment and sub-county control group and 765 for the pure control group.

The total sample size for both batches was 4,045 farmers from 212 farmer groups at the baseline. We pooled all households into two batches to maximize the number of samples to improve the statistical power in the estimation. At the start, we needed to

[19] The farms that started an intervention earlier are two groups in Kiambu county, two in Kirinyaga county and one in Elgeyo Marakwet county.
[20] The farms that declined a follow-up survey were three in Kiambu, one in Uasin Gishu, one in Kirinyaga (pure control group) and one in Muranga (pure control group).
[21] Each country has one sub-county except Homabay country (Appendix 1).
[22] Each country has one sub-county as pure control group (Appendix 1) .

confirm whether the randomization into treatment and control groups was successful with the same observable characteristics. We trimmed the households at baseline survey in the top 10% for each outcome variable to deal with extreme outliers. Table 1 presents the balance test of the outcomes and farmers' characteristics at the baseline. We made a logarithmic conversion to several variables in the estimation when they were used as dependent variables. Moreover, in order to capture seasonal patterns, we adjusted the variables related to consumption and assets for the effect of the timing of the survey.[23]

We observe that the difference in average between the treatment group and control group is not statistically significant in most variables at a 5% level and the randomization at the baseline succeeded. First, we see no difference in the outcome variables. The average of total crop sales is more or less 200,000 KSh (Kenyan shillings), and the average of total sales of horticultural crops, the main outcome variable, is more than 40,000 KSh in both groups. The average household annual consumption exceeds 260,000 KSh, and the average per capita household income is larger than 50,000 KSh. There is no statistical difference in the average total farming assets, total livestock, or household assets.

Second, we do not observe a statistical difference in most of the variables related to farming activities. While the average total costs of agricultural inputs are not different between the treatment and control groups, there are some specific items with a significant gap between the two groups in total fertilizer costs and total pesticide costs, but the significant difference vanishes if we limit them to horticulture. We do not see any statistical difference in chemical costs, seed purchases, transportation costs or labor

[23] We regress each variable related to consumption and assets on dummy variables for each survey month and remove the effect of these dummies (i.e., adjusted value is the sum of the constant term plus residuals).

inputs. Third, we do not see a significant gap in household characteristics in terms of the number and composition of household members and gender of the head of household. The average age of head of household is slightly older for the treatment group and the average years of schooling is statistically longer for the control group, though the gap is small at 0.4 years.

In sum, we see no difference in most of the outcome variables, farming activities, or household characteristics, and the samples in the treatment and control groups appear reasonably balanced.

5. Estimation strategy and results

(1) Estimation strategy

We employ five types of estimation strategies to obtain the intention-to-treat (ITT) effect of the SHEP approach (Ksoll et al., 2016). In all specifications, we limit our sample to the households who participated in both the baseline and the end-line surveys. First, we estimate the ITT effect by "difference-in-mean" at the end-line by comparing the average effect of the intervention of the SHEP approach for all farmers in the treatment group with those in the control group without considering whether farmers in the treatment group have really participated in the program. In other words,

$$Y_{ij} = \alpha + \beta D_i + \epsilon_{ij} \qquad (1)$$

where; Y_{ij} is our outcome variable for household i in sub-county j at the end-line. α is a constant term. D_i is a dummy indicating whether farmer households are assigned as a treatment group or not; they are in the treatment group if taking $D_i = 1$ and are in the control group if taking $D_i = 0$. ϵ_{ij} is a well-behaved error term. The coefficient of interest is β which captures the difference-in-means ITT estimate.

The second specification includes a lagged dependent variable as a covariate:

$$Y_{ijt} = \alpha + \beta D_i + \theta Y_{ijt} \quad + \epsilon_{ijt} \qquad (2)$$

where the notations are the same as in specification (1) except that the dependent variable at baseline is now included as a covariate. Period t indicates that the dependent variables are measured at the end line, and the lagged dependent variables $(t-1)$ at the baseline. The coefficient of interest is again β to capture the difference-in-means ITT estimate.

The third specification is the first difference specification to remove any time-invariant unobserved heterogeneity at the household level:

$$\Delta Y_{it} = \alpha + \beta D_i + \Delta \epsilon_{it} \quad (3)$$

where the dependent variable is now the first difference in each outcome variable at the household level. No covariates are used except D_i which captures the ITT estimate.

The fourth and fifth specification are to obtain the pooled difference-in-difference (DID) estimator:

$$Y_{ijt} = \alpha + \beta(D_i \times POST_t) + \gamma POST_t + \delta D_i + \epsilon_{ijt} \qquad (4)$$

or

$$Y_{ijt} = \alpha + \beta(D_i \times POST_t) + \gamma POST_t + \delta D_i + \zeta SC_j + \epsilon_{ijt} \qquad (5)$$

where $POST_t$ is an indicator to take 1 for the observations at the end-line and 0 for those at the baseline. t takes 0 or 1 indicating $t = 0$ for the baseline and $t = 1$ for the endline. In this specification, the coefficient of interest is the interaction term between the dummy variable for the treatment group and dummy variable for the end-line observations $(D_i \times POST_t)$ which captures the ITT estimate. We perform regression analysis using this specification with and without covariates (ζSC_j) as shown in equation (5). In all specifications, the standard errors are clustered at the agricultural group level.

(2) Estimation results

Table 2 reports the ITT estimate for each outcome variable. The first row shows the impact of the SHEP approach on total sales of crops. The coefficients are positive and the size ranges from 0.23 to 0.35 but they are not statistically significant. The second row reports the ITT estimates for total sales of horticultural crops, the main goal of the SHEP approach. We see that all the coefficients are positive and they are statistically significant at least at the 10% level except specification (1). The size of the coefficients is close to 0.7, ranging from 0.66 to 0.68, implying that farmers in the treatment group enjoyed larger horticultural crop sales than those in the control group by 70% on average. In contrast, the remaining coefficients in the table are not statistically significant and imprecisely estimated; we do not see a systematic pattern in household consumption or a variety of measures of household assets.

We understand that the positive and significant ITT estimate for horticultural crop income is not inconsistent with the other insignificant estimates. The ITT estimate for total crop income is not significant, showing that an increase in the horticultural crop income was not associated with an increase in total crop income. As a result, we do not see significant effects on household consumption or assets. We need to be cautious in interpreting these results since the values of consumption and assets are more susceptible to measurement errors than the value of income, since food consumption covers only the previous week, and assets are self-reported and thus possible measurement error may make the estimates imprecise.

Table 3 reports the ITT estimate for each farming activity so that we can explore the mechanism for income increase in horticultural crops in Table 2. The first two rows show that the coefficients for total costs of agricultural inputs are positive and insignificant, while those for total costs for agricultural inputs specific to horticulture are positive and significant. This result shows that households in the treatment group increased inputs to horticulture crops by 60%. The coefficients for total fertilizer costs are positive and insignificant, but those for fertilizer costs of horticultural crops are positive and significant in Columns (1) and (2). The size of the ITT estimate ranges from 0.66 to 0.81. Turning to pesticide costs, the coefficients are positive but not significant for total crops while they are positive and significant in all columns for horticultural crops. This suggests that farmers in the treatment groups increased pesticide inputs on horticulture by slightly less than 50%. The coefficients are not significant or negatively significant for total chemical costs, but they are insignificant if we confine chemical costs to horticultural crops. The pattern of the coefficients for seed purchase is similar to those for pesticide costs. We do not see any significant coefficients in transportation or annual labor inputs, neither for total crops nor horticultural crops.

In sum, we see positive and significant effects on total agricultural inputs, fertilizer costs, purchased seeds and pesticide costs if we confine inputs specific to horticultural crops. These ITT estimates confirm that an increase in horticultural income in Table 2 is associated with larger agricultural inputs into horticultural crops.

6. Heterogeneous treatment effects

Next, we calculate the ITT estimates at several margins of the baseline characteristics of the head of the household in order to examine the heterogeneous treatment effects of the SHEP approach. We focus on the impact on total sales of horticultural crops using the first-difference estimation that we most prefer. We confirm that the estimation results are intact if we use a different estimation other than the first difference.

Table 4 reports the difference in the coefficients by sub-groups. First, we divide the sample by gender of the head of households. The coefficients are positive for both sexes but significant only for female-headed households. The size of the ITT estimate is large at 1.2, showing that the SHEP approach grew horticultural income by 2.2 times for female-headed households in the treatment group compared with those in the control group. As explained in Section 2, the SHEP approach contains gender mainstreaming training. Each group needs to prepare a gender action plan, which is regularly reviewed. This makes farmers aware of the gender gap in productive/reproductive roles and access to and control of resources.

Second, we divide the sample by educational attainment by head of household:

junior secondary school or above, and less than junior secondary school. The coefficients are positive for both sub-groups but statistically significant only for households whose heads are less educated. The ITT estimate is 0.71, showing that households with heads whose education level is junior secondary education or less enjoyed a horticultural crop income increase of 70%. Third, we grouped the sample by the age of head of household: aged 50 or over, and less than 50. The coefficients are positive for both sub-groups but statistically significant only for households whose heads are older. The ITT estimate is 0.94, showing that households with older heads doubled horticultural crop income.

Fourth and lastly, we divided the sample by whether a farmer household had positive horticultural income at baseline, a proxy for experiences in commercial horticultural agriculture prior to the intervention. We adopt this grouping to examine whether households with some experience in commercial horticultural agriculture had a larger income increase. Note that households with no horticultural income may have grown crops but did not sell them. The coefficients are positive and significant for both groups and the size is comparable. This result implies that the positive effect of the SHEP approach is irrelevant to any market experience prior to receiving the intervention. This result is consistent with the target of the SHEP approach, which is aimed at general farmers and is designed to be simple and accessible.

In sum, the positive and significant ITT estimate on horticultural crop income is pronounced for farmer households whose head is female, less educated, or older, but it is irrelevant to having any market experience prior to the intervention. The larger and significant impact of the SHEP approach for more vulnerable groups might be counterintuitive. Birch (2018) showed that the proportion of farmers who received agricultural extension advice was low in Kenya at 21%. While extension services have been increasingly delivered by a pluralistic system that includes the private sector (Bebe et al., 2016), 60 % of extension services offered for smallholder farmers have been offered through public extension programs. Birch (2018) reported 81% of previous beneficiaries were male-headed households, while Wanyama et al. (2016) argued that agricultural extension services tend to favor wealthy farmers in Kenya.

Under the circumstances, our findings shed light on the importance of socio-political factors. This is a point that has been well recognized but largely neglected in real agricultural extension discourses. The focus is instead on achieving unrealistic economic rewards through increased on-farm production by adopting available technologies (Cook et al., 2021). In order to maximize the impact and efficiency of technology transfer, the main target of agricultural extension has been local elites or experts who are higher educated and wealthier, though the intensity has varied across decades. While a gender-aware approach toward extension has been gaining popularity in recent decades, many of the characteristics of individual farmers have not been fully considered in the implementation of agricultural extension services.

In this respect, the SHEP approach may be an example of a successful "humanized agricultural extension" in its approach toward supporting farmers, with implications for social, cultural and political factors. The approach is simple and accessible in that it includes not only local elite farmers but also more general smallholder farmers. Neither specific knowledge nor previous experience is required for participation. Moreover, the approach emphasizes the autonomy and motivation of farmers, in contrast to the traditional approach of "educating farmers." The extension officers refrain from exerting control over the extension process, and farmers are encouraged to decide which crops to grow and how to sell them in the market on their own. Participation in each training program in the approach is flexible, something that is examined below. These features of the SHEP approach motivate farmers to think independently about how to improve horticultural income, which may fit more with more marginalized groups.

7. Effects of each training activity

Lastly, we explore the effects of the main components of the SHEP approach on horticultural crop income. So far, we have calculated and discussed the ITT estimate since there are some no-compliance cases in the treatment group. In other words, some farmer households in the treatment group did not participate in the SHEP approach. The incidence of these non-compliers is the reason why we estimate the above ITT effect rather than the average treatment effect (ATE). At the same time, some households in the control group were familiar or gained some knowledge about the SHEP approach. Indeed, 16.4% of households in the control group were affirmative to the question "are you familiar with the SHEP project implemented by JICA?" at the baseline. Thus, we observe a spillover of the SHEP approach into some households in the control group, and a portion of households in the group might be contaminated.

Thus, we estimate the local average treatment effect (LATE) of the main training components of the SHEP approach to capture the effect for compliers (Imbens & Angrist, 1994).[24] We use an indicator for whether a household is originally assigned to a treatment group or not as an instrumental variable to estimate the effect of training components for compliers. The survey did not ask households in the control group

[24] The LATE is also known as the complier average causal effect (CACE).

whether the household actually participated in specific activities of SHEP but whether they were familiar with the corresponding SHEP activity. Due to this limitation, the LATE estimates reported below should be interpreted with caution.[25]

Table 5 reports the estimation results by the first difference specification. Since the compliance rate varies across activities in the SHEP approach, we separately examine each of three activities: group exercises such as the market survey and crop selection, the Farm Business Linkage Stakeholder Forum (FABLIST), and gender mainstreaming training.[26]

First, we estimate the average compliers' impact from participating in the SHEP group exercises on subjects such as the market survey and crop selection.[27] Column (1) reports that 70% of households in the treatment group participated in this activity. The coefficient is 1.025 and significant, meaning that these general trainings doubled the horticultural sales among the compliers. Second, we see a larger impact from the Farm Business Linkage Stakeholder Forum (FABLIST). This activity aimed at facilitating business engagements between farmers and stakeholders, such as input sellers and traders in agricultural products. While only farmer group representatives joined in the forum, some non-participant farmers have learned from them. The compliance rate is 55% in the treatment group. Among the compliers, participating in the forum increases horticultural crop sales by 128%. While the asymmetrical interaction between farmers

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[25] In addition, we note that a larger LATE estimate for one activity when compared to that of another activity does not necessarily mean the former is more effective activity than the latter, since we did not randomly assign activities across different arms of treatment.

[26] While all households were supposed to join in group activities and gender mainstreaming training, farm group representatives including group leaders were expected to join in FABLIST forum and other households were expected to indirectly benefit from the trained group leader.

[27] More precisely, we regard compliers as those respondents who answered that they participated in exercises including the market survey, crop selection & ranking, preparation of problem & objective maps, and action plan making.

and transporters or buyers has been long recognized (Fafchamps & Mintena 2012), the result suggests that more symmetrical and equal connections would benefit farmers substantially. Third, gender mainstreaming training was implemented to raise awareness of gender issues within farming groups. The compliance rate is 62% in the treatment group. The impact of this training on the horticultural crop sales is again large and significant. This is also consistent with the impact for farmer households whose head is female in the previous section. Finally, the last column reports the LATE estimate of participating in at least one activity in the SHEP approach. The coefficient is significant and the size is 0.86. Even with this broader definition of participation in SHEP activities, the impact is still large enough among compliers to almost double horticultural crop sales.

In sum, we observe the overall positive and significant impact of participating in each of the SHEP activities in Table 5. The estimated coefficients are larger than ITT estimates in the previous sections, and the positive effect of the SHEP approach on income from horticultural crops is larger among compliers.

8. Conclusion

This paper provides the first evidence on the impact evaluation of a market-oriented agricultural extension program called Smallholder Horticulture Empowerment and Promotion (SHEP) in Kenya. The most important feature of the SHEP approach is that it places top priority on practical training for general farmers to act as producers in a market. We find that, on average, farmers in the SHEP program enjoyed a significantly higher horticultural income increase of 70% over two years. The positive and significant effect is pronounced in vulnerable farmer households whose head is female, less educated, or older, and previous market experience prior is irrelevant. Moreover, each training component contributed to an increase in horticultural crop income.

Thus, our findings confirm that a market-oriented agricultural extension can be a pathway to improving the living standards of small-scale farmers through an increase in horticultural incomes. Further research should examine the mechanisms of the positive effect for vulnerable groups in a more nuanced way so that we can explore the implications for agricultural extensions in general. It would also be useful to examine the effects of the SHEP approach in countries outside of Kenya. By doing so, we can identify which agricultural extension programs may be suitable for specific types of farmers and how to make agricultural extension programs more effective and beneficial.

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Figure 1 Market survey

(Source) JICA et al. (2020).

Figure 2 Study areas

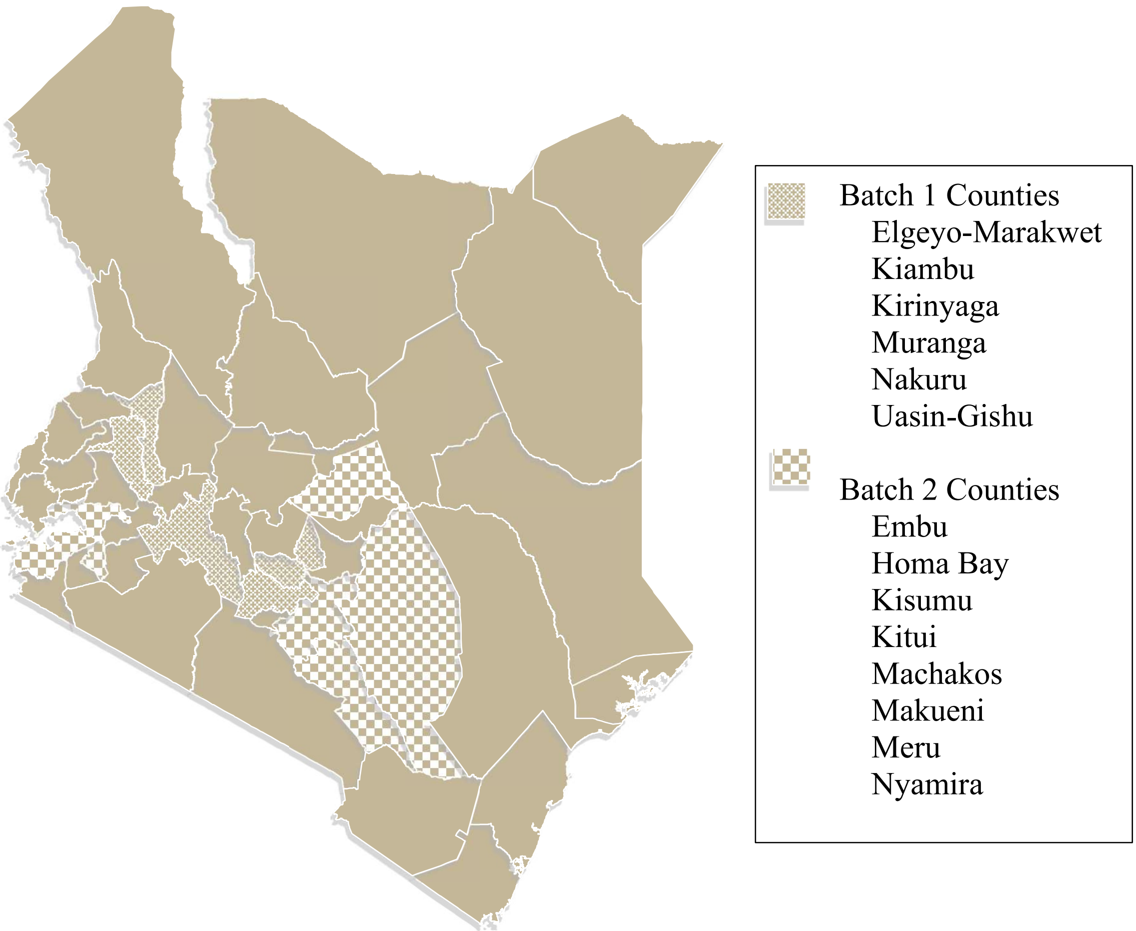

Figure 3 Timeline of intervention and data collection.

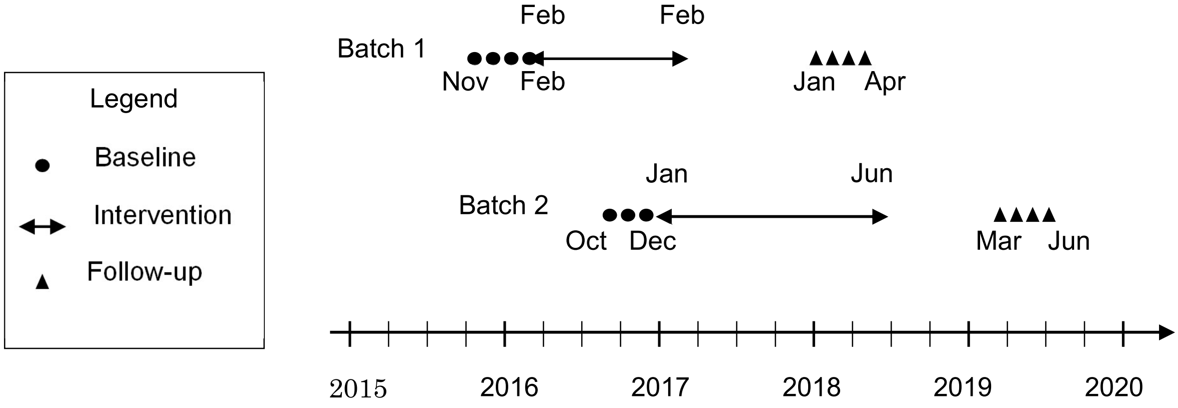

Table 1 Baseline balance of the main variables

Variables	Treatment group	Obs.	Control group	Obs.	Difference: Treatment - Control Groups	p-value and significance	
1. Outcomes							
Total sales of crops (in KSh)	179191.6	1072	205817.9	2107	-26626.28	0.24	
	542154.1		625638.0				
Total sales of horticultural crops (in KSh)	41612.1	1086	41857.7	2093	-245.61	0.95	
	113503.8		107815.8				
Household annual aggregate consumption (in KSh)	263892.4	1065	260152.1	2114	3740.26	0.45	
	132858.3		130573.2				
Annual aggregate consumption per capita (in KSh)	52774.1	1077	52295.3	2102	478.74	0.66	
	28146.3		29061.9				
Total farming assets (in KSh)	5219.2	1070	5587.3	2110	-368.11	0.29	
	8960.1		9355.8				
Total livestock assets (in KSh)	67635.5	1092	69585.1	2087	-1949.60	0.38	
	57125.7		60946.2				
Household assets purchased in last one year (in KSh)	244.9	1069	252.8	2110	-7.94	0.87	
	1272.4		1313.4				
Household assets (current Value)	9032.6	1066	8956.0	2115	76.60	0.90	
	16580.5		15794.6				
2. Agricultural activities							
Total costs of agricultural inputs (in KSh)	14709.5	1067	14080.0	2112	629.49	0.17	
	12237.4		12198.1				
Total costs of agricultural inputs (horticulture) (in KSh)	6363.5	1071	6634.4	2108	-270.92	0.36	
	7649.7		7974.2				
Total fertilizer costs (in KSh)	5507.7	1068	4978.1	2111	529.58	0.01	**
	5493.2		5538.9				
Total fertilizer costs (horticulture) (in KSh)	2406.5	1069	2240.6	2112	165.86	0.18	
	3285.2		3277.1				
Total pesticide costs (in KSh)	1061.5	1081	1167.9	2098	-106.46	0.07	*
	1467.2		1596.2				
Total pesticide costs (horticulture) (in KSh)	548.4	1078	600.5	2101	-52.06	0.15	
	913.8		978.4				
Total chemical costs (in KSh)	104.0	1071	115.7	2109	-11.67	0.27	
	265.3		293.3				
Total chemical costs (horticulture) (in KSh)	47.5	1084	42.1	2101	5.34	0.32	
	150.6		140.6				
Total seeds purchase (in KSh)	5020.8	1061	4881.1	2118	139.63	0.38	

	4049.4		4351.3				
Total seeds purchase (horticulture) (in KSh)	1899.9	1086	1879.1	2094	20.77	0.81	
	2300.4		2344.1				
Total transportation costs (in KSh)	340.5	1073	329.4	2108	11.14	0.65	
	649.5		665.1				
Total transportation costs (horticulture) (in KSh)	152.5	1080	136.0	2099	16.49	0.23	
	382.4		362.8				
Annual labor inputs (in KSh)	13470.9	1068	12339.7	2111	1131.22	0.16	
	22421.4		21180.2				
Annual labor inputs (horticulture) (in KSh)	5244.2	1070	5268.1	2109	-23.86	0.95	
	10950.9		11038.3				
3. Household characteristics							
Number of household members	5.55	1199	5.52	2387	0.03	0.69	
	2.31		2.37				
Number of children (<15)	2.04	1199	2.08	2387	-0.04	0.52	
	1.61		1.67				
Number of adults (15-65)	3.27	1199	3.21	2387	0.06	0.29	
	1.64		1.67				
Number of elderly people (>65)	0.24	1199	0.23	2387	0.01	0.65	
	0.51		0.51				
Age of head of household	50.45	1199	49.38	2387	1.07	0.03	**
	14.04		13.84				
Gender of head of household (1=male, 0=female)	0.80	1199	0.82	2387	-0.02	0.21	
	0.40		0.38				
Years of schooling	8.21	1199	8.62	2387	-0.40	0.00	***
	3.99		3.82				

(Note) The control group combines the sub-county control groups and pure control groups.
*** p<0.01, ** p<0.05, * p<0.1.

Table 2 Effects on main outcomes

	(1)	(2)	(3)	(4)	(5)
	Difference at endline	Difference at endline with lag	First difference	Difference in difference	Difference in difference with covariates
Total sales of crops (log)	0.352	0.311	0.226	0.226	0.212
	[0.370]	[0.299]	[0.291]	[0.292]	[0.297]
Total sales of horticultural crops (log)	0.682	0.676**	0.664**	0.664*	0.661*
	[0.413]	[0.342]	[0.337]	[0.337]	[0.342]
Household annual aggregate consumption (log)	0.025	0.014	-0.004	-0.004	0.003
	[0.048]	[0.044]	[0.045]	[0.045]	[0.044]
Annual aggregate consumption per capita (log)	0.034	0.018	0.001	0.001	-0.012
	[0.052]	[0.046]	[0.047]	[0.047]	[0.047]
Total farming assets (log)	0.006	-0.134	-0.232	-0.232	-0.204
	[0.331]	[0.178]	[0.148]	[0.149]	[0.151]
Total livestock assets (log)	0.097	0.062	0.022	0.022	0.036
	[0.138]	[0.101]	[0.108]	[0.108]	[0.111]
Household assets purchased in last one year (log)	0.144	0.144	0.150	0.150	0.152
	[0.197]	[0.197]	[0.211]	[0.211]	[0.210]
Household assets (log)	-0.105	-0.077	-0.058	-0.058	-0.073
	[0.275]	[0.172]	[0.182]	[0.182]	[0.179]
Number of observations	3,177	3,177	3,177	6,354	6,354

Note: Clustered standard errors at agricultural group level in brackets
*** p<0.01, ** p<0.05, * p<0.1. The number of observations refers to that for total sales of horticultural crops but differs only slightly across outcomes.

Table 3 Effects on agricultural activities

	(1)	(2)	(3)	(4)	(5)
	Difference at endline	Difference at endline with lag	First difference	Difference in difference	Difference in difference with covariates
Total costs of agricultural inputs (log)	0.162	0.080	0.016	0.016	0.020
	[0.161]	[0.123]	[0.112]	[0.112]	[0.111]
Total costs of agricultural inputs (horticulture) (log)	0.617**	0.601**	0.568*	0.568*	0.562*
	[0.304]	[0.258]	[0.290]	[0.290]	[0.291]
Total fertilizer costs (log)	0.585	0.193	-0.061	-0.061	-0.088
	[0.416]	[0.232]	[0.178]	[0.178]	[0.180]
Total fertilizer costs (horticulture) (log)	0.812**	0.664**	0.418	0.418	0.395
	[0.354]	[0.272]	[0.287]	[0.288]	[0.290]
Total pesticide costs (log)	0.327	0.302	0.261	0.261	0.259
	[0.318]	[0.256]	[0.258]	[0.258]	[0.258]
Total pesticide costs (horticulture) (log)	0.481*	0.477**	0.470*	0.470*	0.474*
	[0.272]	[0.222]	[0.244]	[0.244]	[0.242]
Total chemical costs (log)	-0.403	-0.402	-0.398*	-0.398*	-0.396*
	[0.265]	[0.248]	[0.228]	[0.228]	[0.229]
Total chemical costs (horticulture) (log)	-0.196	-0.211	-0.260	-0.260	-0.254
	[0.221]	[0.211]	[0.200]	[0.200]	[0.200]
Total seed purchase costs (log)	0.206	0.165	0.037	0.037	0.047
	[0.159]	[0.150]	[0.149]	[0.150]	[0.148]
Total seed purchase costs (horticulture) (log)	0.729***	0.698***	0.594**	0.594**	0.589**
	[0.279]	[0.258]	[0.289]	[0.290]	[0.290]
Total transportation costs (log)	0.342	0.321	0.172	0.172	0.168
	[0.310]	[0.311]	[0.371]	[0.372]	[0.370]
Total transportation costs (horticulture) (log)	0.410	0.382	0.267	0.267	0.264
	[0.254]	[0.249]	[0.267]	[0.268]	[0.267]
Annual labor inputs (log)	0.374	0.314	0.202	0.202	0.180
	[0.293]	[0.247]	[0.279]	[0.279]	[0.278]

Annual labor inputs (horticulture) (log)	0.435	0.438	0.444	0.444	0.427
	[0.317]	[0.287]	[0.334]	[0.335]	[0.337]
Number of observations	3,177	3,177	3,177	6,354	6,354

Note: Clustered standard errors at agricultural group level are in brackets

*** p<0.01, ** p<0.05, * p<0.1. The number of observations refers to total costs of agricultural inputs but differs only slightly across outcomes.

Table 4 Effects on total sales of horticultural crops by subgroup

	Gender		Education		Head's age		Positive horticulture income at baseline	
	Male	Female	Junior secondary or less	Above junior secondary	50 or less	Above 50	No	Yes
Treatment effect	0.521	1.222**	0.706*	0.598	0.420	0.936**	0.800*	0.737*
	[0.357]	[0.598]	[0.353]	[0.479]	[0.398]	[0.379]	[0.455]	[0.382]
Observations	2,555	622	1,916	1,261	1,749	1,428	1,287	1,890

Note: The coefficients are obtained using a first difference specification.
The dependent variable is logarithm of total sales of horticultural crops (in KSh).
Clustered standard errors at agricultural group level are in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 LATE Estimation of SHEP Activities

VARIABLES	Compliance rate (% of treatment group)	(1)	(2)	(3)	(4)
Group Exercise Activities (market survey, crop selection, etc.)	70.4	1.025**			
		[0.519]			
Farm Business Linkage Stakeholder Forum	55.3		1.275**		
			[0.638]		
Gender Mainstreaming Training	62.1			1.115**	
				[0.565]	
At least one SHEP activity	90.20				0.860**
					[0.433]
F-value of the first stage		743.41	393.59	620.19	1466.19
Observations		3,177	3,177	3,177	3,177

Note: The coefficients are obtained using a first difference specification. The Instrument variable is assigned to each activity.
The dependent variable is logarithm of total sales of horticultural crops (in KSh).
Clustered standard errors at agricultural group level are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix 1 List of sub-counties in the treatment and control group

The Batch 1 survey

County	Treatment/Sub-county control group	Pure control group
Elgeyo Marakwet	Marakwet East (117) [9]	Keiyo South (91) [6]
Kiambu	Thika (73) [7]	Juja (75) [6]
Kirinyaga	Kirinyaga East (141) [8]	Kirinyaga Central (97) [5]
Muranga	Kangema (156) [10]	Mathioya (96) [5]
Nakuru	Molo (156) [10]	Njoro (85) [6]
Uasin Gishu	Moiben (132) [9]	Soy (117) [6]
Total	775 [53]	561 [34]

The Batch 2 survey

County	Treatment/Sub-county control	Pure control group
Kisumu	Seme (199) [10]	Nyakach (104) [5]
Nyamira	Manga (181) [10]	Mbita (107) [5]
Homabay	Rangwe/Karachuonyo (168)[10]	Masaba North (88) [6]
Meru	Igembe Central (198) [10]	Igembe South (82) [5]
Embu	Runyenjes (225) [12]	Mwala (91) [5]
Kitui	Kitui South (134) [9]	Mbeere North/Manyatta (101) [7]
Makueni	Mbooni (215) [10]	Kitui East 94) [5]
Machakos	Masinga (208) [10]	Kaiti (98) [5]
Total	1,528 [81]	765 [43]

Note: The numbers refer to farmer and farmer groups that were surveyed at both baseline and endline surveys.