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An impact assessment of EAMDA's banana initiative to increase technology adoption by smallholder farmers in Kenya

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Summary

Improving the productivity of smallholder farmers is a critical policy priority in most of the developing world due to its direct links to food security and economic growth. The adoption of advanced technologies for improving farm productivity is widely accepted as an important means of increasing farmers' and national income. Kenya is no different, with 73% of its population living in rural areas, and agriculture functioning as the primary source of livelihood. However, the contribution of the agricultural sector to GDP growth fell from 23.9 percent in 2001-2012 to 21.9 percent in 2013-2017. At the national level, the number of people working in agriculture has been increasing, and the sector accounted for about 37% of total employment in 2017. This increase in the number of people relying on agriculture and the decline in productivity makes the adoption of new technologies extremely critical for the country.

Bananas are consumed both as a fruit and as cooked food in Kenya, and they are an important source of carbohydrates, essential vitamins and minerals. The Kenya Population and Housing Census (2019) shows that over 2.1 million households are currently growing bananas in the country. However, a large majority (84%) of them are smallholder farmers with plots of less than 0.2 hectares. Moreover, smallholder farmers are more likely to be women. In recent years, the Kenyan government and development partners have tried to increase banana cultivation by smallholder farmers in Kenya in order to improve their food security. According to the FAOSTAT database, the area used for banana production has increased from 50 thousand hectares to 72 thousand hectares between 2011 and 2018. However, total banana production in the country has only increased from 1.2 million tonnes to 1.4 million tonnes during the same period, indicating declines in yield. Improving the productivity of banana plantations thus continues to be a priority in Kenya, and promoting the adoption of tissue culture banana (TCB) and related farming practices has been identified as one of the means of increasing farmers' productivity in Kenya.

The interventions that we have evaluated under this project are part of the Farmer Organization Support Centre in Africa (FOSCA), which was initiated by the Alliance for a Green Revolution in Africa (AGRA) to strengthen the capacity of Farmers' Organizations. The project, titled "Building a competitive export banana industry in Kenya", was implemented by East Africa Market Development Associates (EAMDA) and targeted about 11,000 farmers in Kirinyaga county. In this study, we assess the impacts of this program in the short run (6 months post-intervention) and up to 32 months post-intervention. EAMDA promoted the cultivation of modern banana varieties and TCB plantlets by providing information on the benefits of this technology and associated agronomic practices. A randomized controlled trial (RCT) was implemented to measure the impacts of information-sharing and a goal-setting intervention on farmers' adoption of TCB, banana productivity and household income. In addition, we measured the spillover effects on farmers who live in the treatment villages but did not receive the training. We adopt two different means of measuring spillover effects: a) varying the intensity of intervention whereby different proportions of farmers in the treatment villages are provided with the training, and b) comparing the social network of the non-treated farmers with the treated farmers. For the goal-setting intervention, we implemented a "behavioural nudge" with half of those in the treatment group. The selected farmers were asked about their intentions to use TCB. Those who reported being interested in using TCB were then asked to make a basic plan of when, from where and how many plantlets they would buy.

This report is based on four rounds of survey data. The first round (baseline) was collected before the intervention to measure the baseline condition. The second (midline), third (endline 1), and fourth (endline 2) rounds of surveys were conducted after 6 months, 18 months and 32 months of intervention implementation, respectively. We find that information dissemination through EAMDA's training increased farmers' adoption of TCB by 4 percentage points (pp) by the midline, which increased by another 9 pp at endline 1 for those farmers who also took part in the goal-setting exercise. Surprisingly, we see a large positive effect of an increase of 30 percentage points at endline 2. This large late effect suggests possible learning effects from early adopters in the treatment villages. At endline 2, we observe a large reallocation of land from other crops to banana plants as well as higher spending on banana cultivation The magnitude of the impact on land use for banana cultivation is high (almost 10 decimal) and about 75% higher than the control group average at endline 2. This reallocation resulted in a drop in income from non-banana crops. However, though the negative effects on total income were observed at both endline 1 and 2, it was only statistically significant at endline 2. There were some indications of spillover effects on farmers who did not receive the training but reside in the treatment villages. However, it appears that the possible learning effect that created the late adoption of TCB is limited to the treatment group only. While the goal-setting intervention had a short-term impact on TCB adoption (the marginal effect during endline 1 was over 5pp), there is no significant marginal effect of this intervention by endline 2.

This quantitative approach is complemented by a qualitative study that was conducted before the endline 1 survey. The qualitative study found that both treatment and control farmers acknowledged that the cultivation of traditional bananas is declining, while the uptake of modern and TCB varieties is increasing. They cited land and water shortages (e.g. due to a lack of irrigation facilities) as the most critical barriers to the adoption of TCB varieties. Though there is gender parity in banana production and commercialization, youth participation is limited due to factors such as land shortage. Farmers who participated in various training sessions reported that their agricultural needs concerning banana farming were largely addressed. However, though they adopted TC bananas with an expectation of higher income, this was not realized due to the severe drought that was experienced in the area. This aligned with the quantitative component that shows that the total income for the farmer households did not significantly increase at endline 1.

Overall, the study finds that information provided through training can have positive effects on technology adoption. In addition, a simple behavioural intervention—whereby farmers set specific goals to adopt new technologies— can significantly increase adoption. Therefore, this type of goal setting can easily be made a part of farmers' training. However, the effects of technology adoption on well-being are less clear and primarily depend on the economic value of the technology being promoted. TCB does not seem to be economically rewarding in the short to medium term. Therefore, it is of paramount importance to conduct proper economic returns analyses and to measure returns in the long run before scaling up any interventions to promote new technology. The other major consideration for promoting this technology is access to irrigation, and it would be prudent to only promote TCB to farmers who have reasonable access to irrigation.

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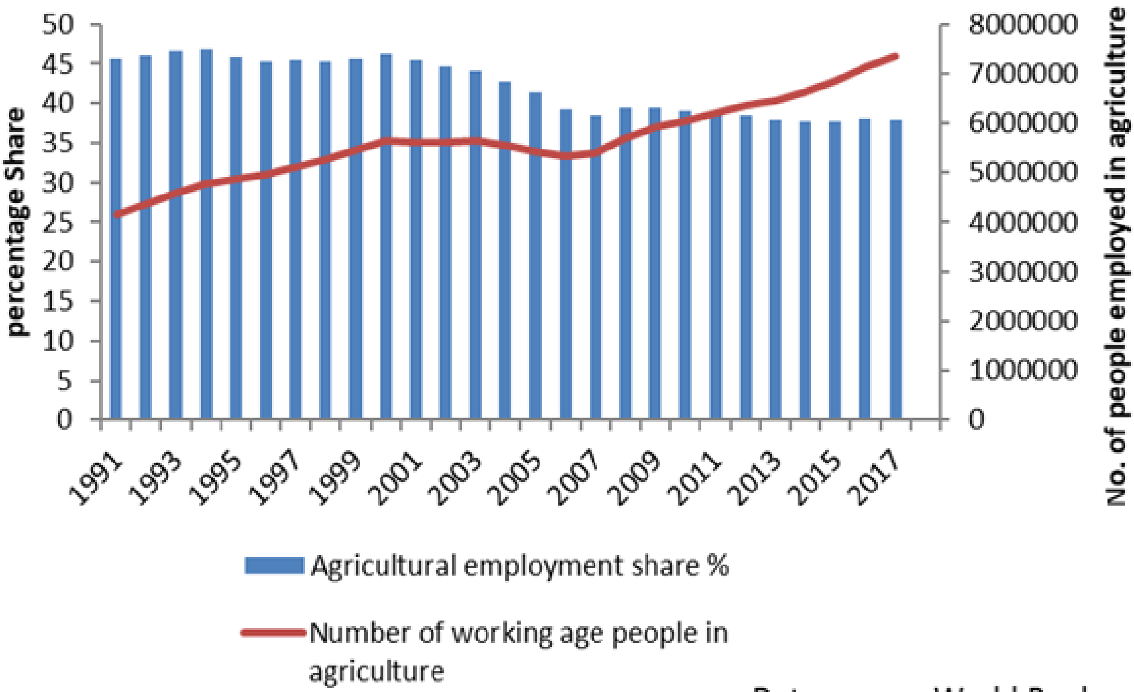
1. Introduction

Adoption of advanced technologies for improving farm productivity is widely accepted as an important means of increasing farmers' and national income. Kenya is no different with 73% of its population living in rural areas and agriculture functioning as the primary source of livelihood. However, the contribution of the agriculture sector to real GDP growth fell from 23.9 percent in 2001-2012 to 21.9 percent in 2013-2017 (World Bank, 2019). At the national level, the number of working people in agriculture has been increasing and the sector accounted for about 37% of total employment in 2017(Figure 1). This increase in the number of people relying on agriculture and the decline in productivity makes adoption of new technologies extremely important for the country.

Figure 1: Agriculture sector employment in Kenya



Data source: World Bank

In Kenya, bananas are consumed both as a fruit as well as a cooked food, and they are an important source of carbohydrates, essential vitamins and minerals. The Kenya Population and Housing Census - 2019 (KPHC, 2019) shows that over 2.1 million households are currently growing bananas in the country. However, a large majority (84%) of them are smallholder farmers with plots of less than 0.2 hectares (D'Alessandro et al, 2015). Moreover, smallholder farmers are more likely to be women (ibid). In recent years, there have been efforts by the government and development partners to increase banana cultivation by smallholder farmers in Kenya in order to improve their food security situation. According to the FAOSTAT database, the area used for banana production has increased from 50 thousand hectares to 72 thousand hectares between 2011 and 2018. However, total banana production in the country only increased from 1.2 million tonnes to 1.4 million tonnes during the same period, indicating declines in yield. Therefore, improving the productivity of banana plantations continues to be a priority in the country.

There are many important barriers to technology adoption and not adopting a particular technology is often the optimal decision for farmers. For example, Suri (2011) provides evidence of heterogeneity among farmers that influence them not to adopt a new technology either because the adoption is not economically viable due to its low productivity, or due to the high cost associated with adopting the technology. Many studies have looked at the impacts of different agricultural interventions on adoption decisions and productivity. In their evidence gap map on agricultural innovations, Lopez-Avila et al (2017) find that the evaluations of technology adoptions are concentrated on the impacts of input provisions and practices on productivity. They also note a lack of evidence on spillover effects. The evidence points to the existence of real barriers to adoption that include lack of information, lack of access to inputs, credit constraints to purchasing inputs, or limited markets for selling crops. There are also behavioural constraints (such as procrastination) whereby the farmers fail to adopt a profitable technology even though they are willing to adopt it. In this study, we assess how countering specific barriers to adopting tissue culture banana (TCB) that can potentially improve productivity among smallholder banana growers. However, adoption of the technology in Kenya is limited due to both limited awareness about the benefits and the changes in farming practices associated with the technology by smallholder farmers (Kabunga et al, 2012).

In this study, we assess the impacts of a programme of EAMDA in Kirinyaga county up to 32 months post-intervention. EAMDA promotes banana cultivation, especially the modern varieties and TCB plantlets, by providing information on the benefits of this technology and associated agronomic practices. A randomized control trial (RCT) was implemented to measure the impacts of information sharing and goal setting interventions on farmers' adoption of TCB, banana productivity and household income. In addition, we intend to measure the spillover effects on farmers in the treatment villages who do not receive the training. We adopt two different means of measuring spillover effects: a) varying the intensity of intervention whereby different proportions of farmers in the treatment villages are provided with the training, and b) measuring the social network of the non-treated farmers with the treated farmers. Finally, we initiate a "behavioural nudge" with half of the treatment group farmers to assess whether setting goals of buying TCB leads to adoption of TCB in their farms.

This report is based on four rounds of survey data. The first round (baseline) was collected before the intervention to measure the baseline condition. The second (midline), third (endline 1) and fourth (endline 2) rounds of surveys were conducted after 6 months, 18 months and 32 months of intervention implementation, respectively. We find that information dissemination through EAMDA's training increased farmers' adoption of TCB by 4 percentage points (pp) by midline, which increased by another 9 pp at endline 1 for those farmers who also took part in the goal-setting exercise. Surprisingly, we see a large positive effect of an increase of 30 percentage points at endline 2. This large late effect suggests possible learning effects from early adopters in the treatment villages. Consequently, there is a large reallocation of cultivable land to more banana cultivation from other crops and more spending on banana cultivation observed at endline 2. The magnitude of impact on land use for banana cultivation is high (almost 10 decimal) and about 75% higher than the control group average at endline 2. This reallocation resulted in a drop in income from non-banana crops.

Although measured imprecisely and not statistically significant in the first follow-up survey, we find negative effects on total income persisting even at endline 2. There were some indications of spillover effects on farmers who did not receive the training but reside in the treatment village. However, it appears that the possible learning effect that created late adoption in TCB is limited to the treatment group only. While the goal setting intervention had a short-term impact on TCB adoption (the marginal effect during endline 1 was over 5pp), there was no significant difference in the impact of this intervention by endline 2.

This quantitative approach is complemented by a qualitative study that was conducted before the endline 1 survey. The qualitative study found that both treatment and control farmers acknowledged that the cultivation of traditional bananas is declining, while uptake of modern and TC varieties is increasing. They cited land and water shortage (lack of irrigation facilities) as the most critical barriers to adoption of TC varieties. Though there is gender parity in banana production and marketing groups, youth participation is limited due to factors such as land shortage. Farmers who participated in various training sessions agreed that their agricultural needs concerning banana farming were largely addressed. However, though they adopted TC bananas with an expectation of higher income, this was not realized due to the severe drought that was experienced in the area. This aligned with the quantitative component that shows that the total income for the farmer households did not significantly increase at endline 1.

Overall, the study finds that information provided through training can have positive effects on technology adoption. In addition, a simple behavioural intervention - whereby the farmers set specific goals to adopt a new technology – can significantly increase adoption. Therefore, this type of goal setting can easily be made a part of farmers' training. However, the effects of the technology adoption on wellbeing are less clear and primarily dependent on the economic value of the technology being promoted. TCB does not seem to be economically rewarding in the short to medium term. It is, therefore, of paramount importance to conduct proper economic returns analyses and to measure return in the longer term before scaling up any efforts to promote technology adoption. The other major consideration for promoting this technology is access to irrigation, and it would be prudent to only promote TCB to farmers who have reasonable access to irrigation.

2. Intervention, theory of change and research hypotheses

2.1 Interventions

The programme we evaluate was implemented by the East Africa Market Development Associates (EAMDA), which is a consulting firm for enterprise development and business coaching. The intervention received financial support from the Alliance for a Green Revolution in Africa (AGRA). The EAMDA's farmers' training covered good agronomical practices in banana farming. These included land preparation and planting, the management of banana pests and diseases, improving banana productivity and post-harvest handling. Although the EAMDA has also organized farmers for collective marketing of bananas in the past, in recent years they have been relying on the private sector to fill this gap rather than providing direct marketing support. The training intervention was rolled out by inviting the selected farmers to attend the training 2-3 days prior to the training date. The training sessions were conducted in the community and involved a trainer from the EAMDA providing the relevant information. Each session lasted for 3-4 hours and only one session was held for each community. Besides sharing information on the benefits of TCB and better farming practices, the farmers were encouraged to ask questions and have discussions on mitigating their constraints to adopting TCB. Overall, the training intervention was relatively “low touch”. However, feedback from the enumerators who conducted the surveys and qualitative interviews suggested that some farmers may have anticipated receiving marketing services following training even though the EAMDA did not plan to provide such support.

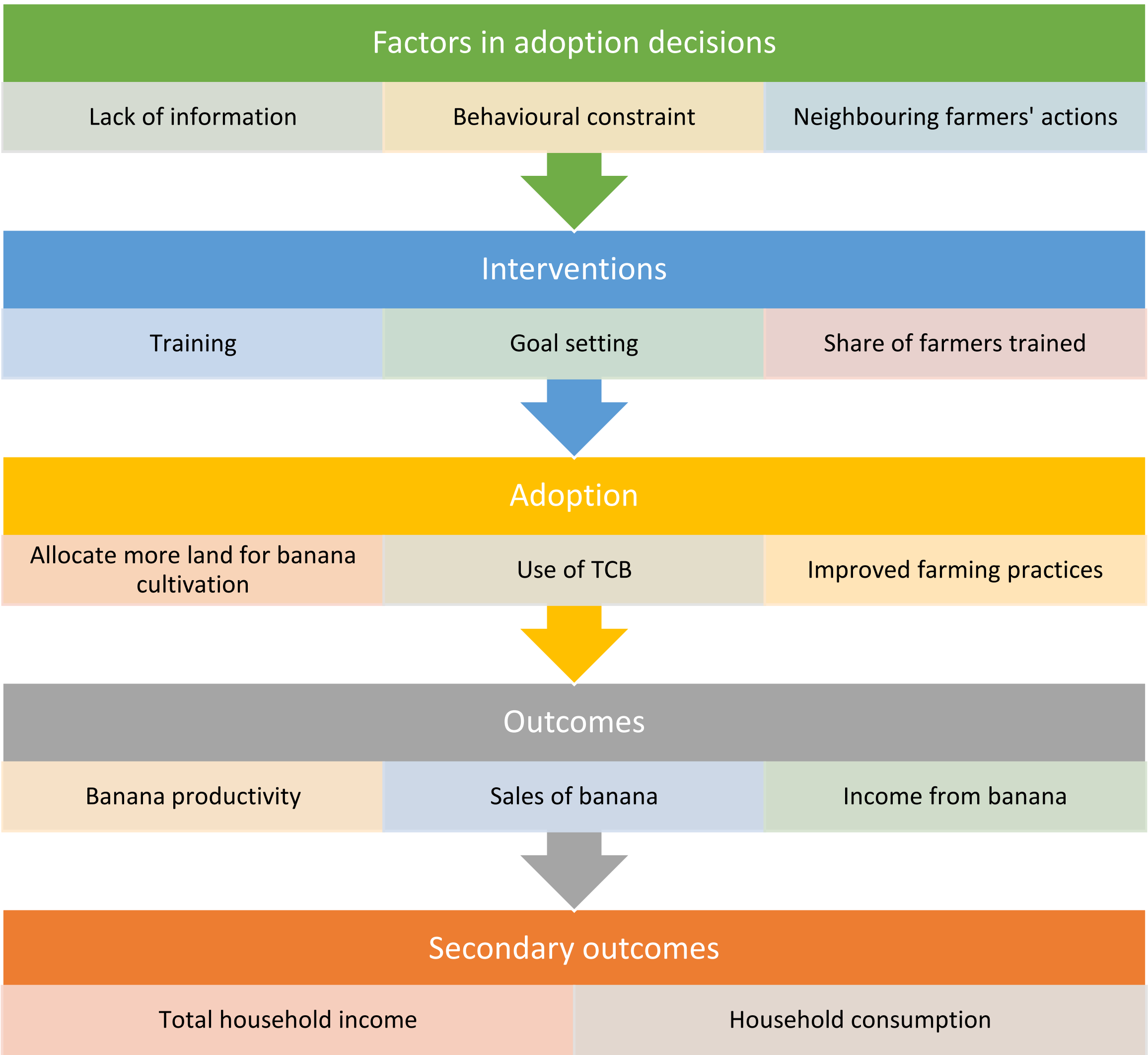
In addition to this training, a “goal setting” intervention was provided to a random sample of half of the farmers who participated in the EAMDA training. The goal setting exercise involved calling farmers over phone or through a household visit by research assistants to help them in making plans for purchasing TCB. They were asked questions regarding their preparedness for the purchase of TCB plantlets in the next planting seasons. Specifically, the selected farmers were asked whether they were planning to use TCB for their banana cultivation. The farmers who responded positively were asked to share their plans on how many plantlets they wanted to purchase, when and from where they wanted to purchase the plantlets, the cost they estimated for the purchase and how they planned to source the money.

2.2 Theory of change and research hypothesis

The theory of change for this evaluation is relatively simple wherein two specific constraints (viz. information and behavioural) in adopting new technologies -TCB and farm management practices related to banana cultivation- are addressed by two interventions (Figure 2). While the training intervention addresses the information constraint, the goal setting intervention addresses the behavioural constraint (such as procrastination) in taking actions as per one’s intention (Figure 3).

In addition, our research also considers actions by neighbouring farmers in technology adoption. Neighbouring farmers’ adoption decisions can influence farmers to either adopt or delay adopting technologies (e.g., Bandiera and Rasul, 2006). On the one hand, if the farmers anticipate that they will share information with others, we expect farmers to be more likely to adopt a new technology when they know many other farmers in their neighbourhood are doing so. Conversely, when farmers want to be strategic, they can delay adoption and wait to observe the output/returns to adoption by the neighbouring farmers. In fact, Bandiera and Rasul (2006) find evidence of an inverted-U shape relationship between a farmer’s probability of technology adoption and the number of farmers in their network who adopt the same technology.

Figure 2: Theory of change for the project

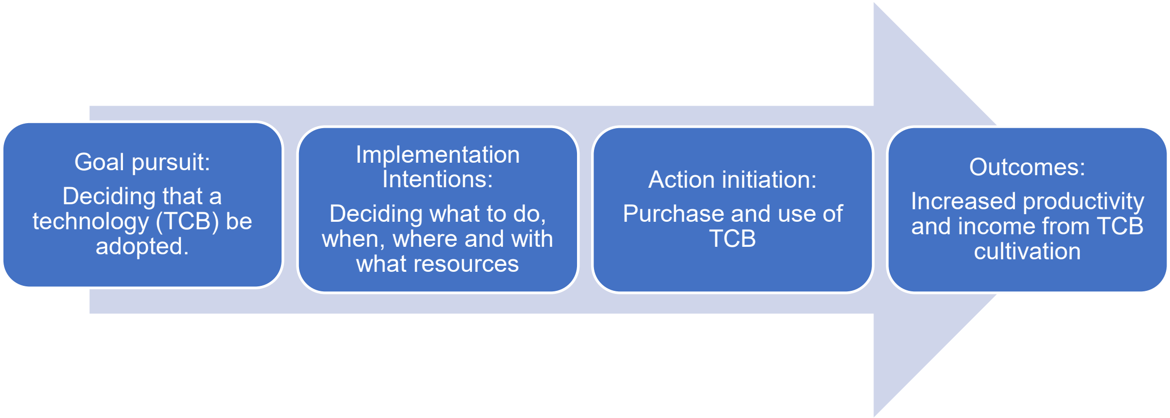


Therefore, in this evaluation, we test three key hypotheses:

- Whether the information sharing by EAMDA training induces farmers to adopt the technologies of TCB and banana farming practices.
- Whether the addition of goal setting information can address behavioural constraints for farmers and encourage them to translate their intentions into action.
- Whether there is any relationship between the proportion of farmers who are being trained in a community and the likelihood of the remaining farmers deciding to adopt TCB technology.

To test these hypotheses, we use TCB and farming practices (the inputs used) as our key primary outcome variables. However, these technologies are being promoted with the anticipation that the farmers will yield higher harvests and gain more income. Therefore, we also measure productivity and income as additional outcomes.

Figure 3: Theory of change for goal setting intervention



One of the implicit assumptions in this evaluation is greater profitability from TCB adoption. Horticulture is among the leading contributors to the agricultural GDP in Kenya at 36% and continues to grow at between 15% and 20% per year (Horticultural Crops Directorate (HCD), unpublished data). Banana production is attractive to smallholder farmers because it is appropriate for intercropping and its returns are high compared to other available alternative crops such as maize or cassava. Farmers can rely on bananas for a constant source of income because harvesting begins fourteen months after planting and may last up to ten years. Although we have measured the impacts 32 months after the interventions started, it is possible to make more longer-term assessments in the future.

3. Context

The evaluation was conducted in 90 villages (also referred to as communities or clusters) in Kirinyaga County of Central Kenya. About 80% of the country's poor reside in rural Kenya and primarily source their livelihoods from agriculture related activities (Republic of Kenya, 2015). The importance of the agricultural sector in Kenya is also evidenced by the positive correlation between growth in the agricultural sector and national economic growth. It is for these reasons that the Kenyan government has continued prioritizing agriculture in national development plans. Kenya's Vision 2030 and the Agriculture Sector Development Strategy (ASDS, 2010-2020) identify the agricultural sector as a key driver of economic growth and target to transform it from smallholder subsistence farming to a modern, innovative, and commercially sustainable sector (Republic of Kenya, 2012a).

Horticulture has, in the recent decades, emerged as one of the leading sub-sectors in Kenya in terms of foreign exchange earnings, food security, employment creation and poverty alleviation. As aforementioned, it is among the leading contributors of the Agricultural GDP at 36 percent. The sub-sector directly and indirectly employs over 6 Million Kenyans (Republic of Kenya, 2012b; HCD, unpublished data). It contributes to the household income and food security of many Kenyans, especially in the rural areas, who carry out one form of horticultural production or another. Data from the Horticulture Crop Directorate shows that though 90 percent of the total horticultural output is consumed locally, the rest brings a lot in export earnings. Kenya is a major exporter of horticultural products to Europe and the Middle East and earned USD 1.37 billion from these exports in 2019. The importance of horticultural products to the pharmaceutical, health, nutrition and confectionery industries exists, though it is largely unexploited. Horticulture is among the few sub-sectors of the Kenyan economy that has recorded continuous growth over recent years in the background of declining performance of other sectors like tourism and general agriculture. However, the success and potential of the horticultural sector might not be sustained because of the many challenges facing it. Kenya is increasingly becoming uncompetitive in horticultural production compared to the neighbouring countries. This is attributed to high costs of production, low farm productivity, low adoption of modern technologies and poor marketing systems faced by local farmers.

Bananas are the leading horticultural fruit crop produced in Kenya. They account for at least 40% of all the fruit revenue generated in the country (Republic of Kenya, 2015). The crop is predominantly cultivated in smallholder farms which average 0.1 -3 hectares. Though bananas have been extensively farmed for ages by local communities as a food and cash crop, its cultivation has significantly expanded in the recent years. As with other subsistence food crops in Kenya, bananas were traditionally a women's crop. This has, however, changed with banana farming becoming popular for improving household food security and as an alternative source of household income.[1] This has become even more important as the potential of other crops such as coffee, tea, maize, and beans declines. Banana orchards have been replacing coffee plantations in rural Kenya. Unlike other horticultural fruit crops, bananas are not a seasonal crop and are produced all year round. Moreover, the demand for banana has been rising with changing consumption habits and lifestyles.

The 90 sampled villages/clusters are spread across all the sub-counties of Kirinyaga County - 15 clusters are in Kirinyaga East, 52 in Kirinyaga West, 10 in Kirinyaga Central, 7 in Mwea East and 6 in Mwea West. In terms of agronomical zoning, the majority of these clusters are located within the mid-zone, which is predominantly a coffee-growing zone. Fewer villages are in the high tea-zone close to Mt. Kenya and the low-zone of Mwea plains where rice farming is more common.

The type of crops grown in Kirinyaga is influenced by the various ecological zones. Main crops include rice which is grown in the lower zones and tea which is grown in the upper parts of the county. Coffee is also a major crop grown in the upper and middle zones. Other major crops grown include bananas, tomatoes, beans, mangoes, maize and other horticultural crops. Recently, the County Government of Kirinyaga has identified bananas as one of the major crops for increasing productivity and the development of a banana-centred value chain in their County's Integrated Development Plan 2018-2022. However, the extent of government service provision is still highly limited. For example, in the 2016-17 fiscal year, the County Government distributed only 4,000 banana seedlings as part of their horticulture clean planting materials distribution initiative. However, the seedlings covered less than 1% of the 3.6 thousand hectares of land used for banana cultivation in the county (KNBS, 2015).

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[1] Our qualitative survey showed that the traditional banana crop was considered a women's crop, alongside other food crops, while men's crops were cash crops (tea, coffee and sugarcane). This is still the case in communities where modern banana varieties have not been adopted. However, Tissue culture bananas and other modern varieties are farmed by both men and women and we observed almost gender parity in production and marketing activities.

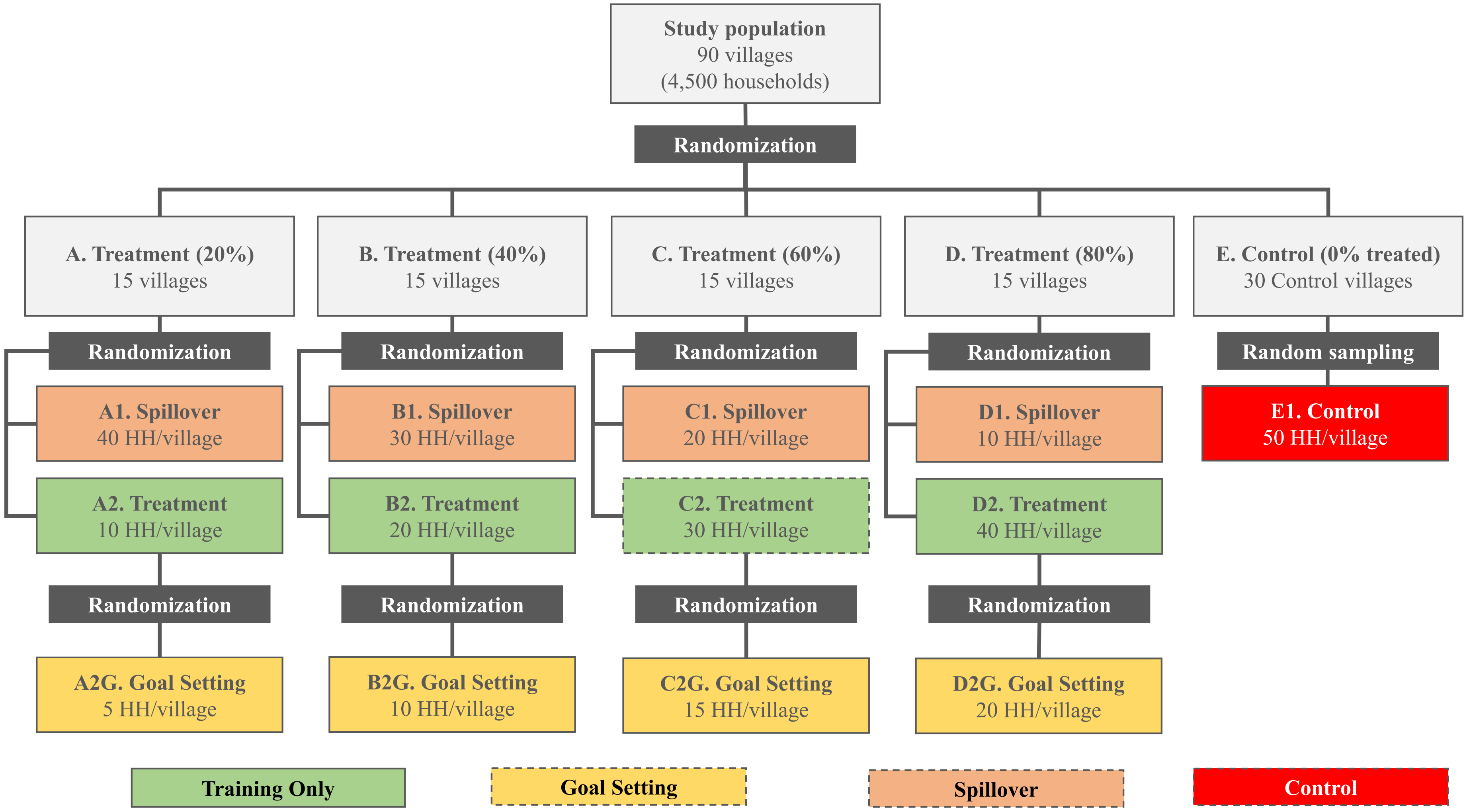
4. Evaluation: Design, data and analysis method

In this section we explain the research design and discuss the methodological issues related to our analysis and conclusions.

4.1 Experiment design

The study used a stratified randomized controlled treatment (at both village and household level) (Figure 4). We targeted 90 villages for the study that were identified by the EAMDA as possible intervention sites in Kirinyaga. We aimed to survey 50 households per village at baseline with a total sample of 4,500 farmer households. At the first stage of randomization, villages were randomly assigned to five groups to vary the intensity of interventions. 15 villages were assigned to each of the four treatment groups, and 30 villages were assigned to the pure control group which did not have any intervention from the EAMDA during the entire evaluation period. Stratification variables for this village level randomization were constructed by classifying villages based on the median values of the following variables: the proportion of farmers cultivating improved varieties of bananas; the village-level average of land used by farmers for banana cultivation; the amount of bananas sold; and the distance to the nearest collection center.

Figure 4: Randomization design

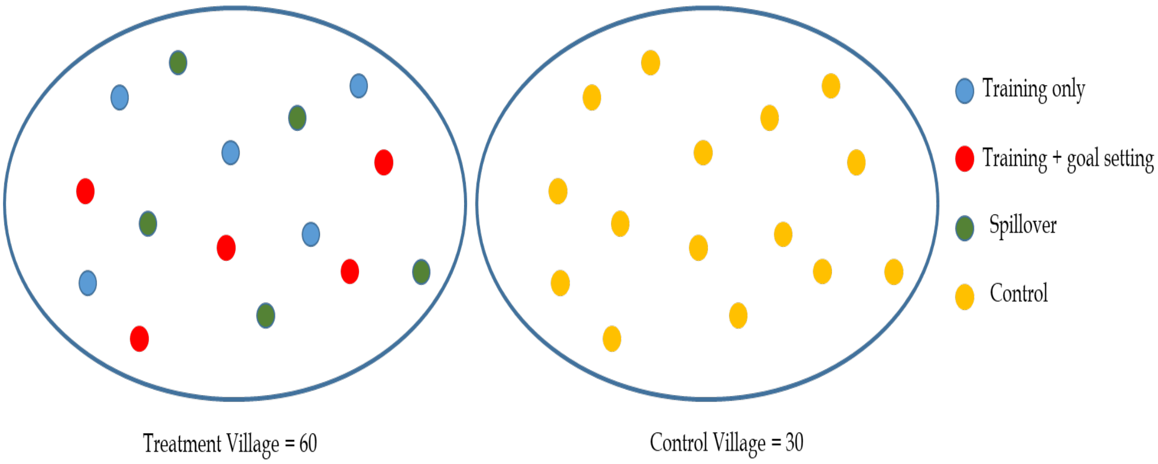


In the other four types of villages, comprised of 15 village each, the number of intervention households were 10, 20, 30 and 40 respectively, representing approximately 20%, 40%, 60% and 80% of the eligible farmers targeted for intervention in these villages. The same stratification variables used for village level randomization were also used for the household level randomization.[2] In these villages, the treatment households were randomly selected from the baseline survey, and a list of these farmers was provided to the implementation teams to invite them to the EAMDA training sessions. The control households in these intervention villages were our "spillover sample". Finally, half of the households from the treatment group were randomly selected for the goal setting intervention. Therefore, five types of villages and four types of households were targeted in this study. While the village types varied in the proportion of treatment households, the household types were as follows:

Group 1: Control group (E1 in the figure above)
Group 2: Spillover group (A1, B1, C1 and D1)
Group 3: Treatment households (A2, B2, C2 and D2)
Group 4: Goal setting households (A2G, B2G, C2G and D2G, which is a sub-sample of Group 3)

Figure 5 gives another way of visualizing the four sample groups. The training only, training + goal setting and spillover samples come from treatment villages, and the control refers to the 30 villages where neither of the two interventions was introduced. See Annex H for a map of the 90 villages and a zoomed in image of four neighbouring villages containing households allocated the different treatments in our study.

Figure 5: Visualizing study sample groups



[2] The definition of the stratification variables is different for the two types of randomization because of data (dis)aggregation. For example, we used the proportion of farmers in a village cultivating modern varieties of bananas (and divided village as below median across sites or not) for the village level randomization, we used whether a farmer household cultivated a modern variety or not during household level randomization. The same distinction applies to all four stratification variables.

4.2 Data

We conducted a baseline survey during May-June of 2016 in 90 potential intervention clusters identified by the EAMDA. On average, 53 households per village were interviewed with a total sample of 4,719 (instead of a target 4,500 households).[3] These households were randomly allocated into the different arms as per the design (Figure 4). The number of households in the spillover sample (i.e., A1, B1, C1 and D1) was slightly higher as the number of treatment households in each village was assigned as per this design and the rest were allocated to the spillover group. The midline survey was conducted in Oct-Nov of 2017 where 4,344 households were re-interviewed with an overall attrition rate of 8%. The third survey (endline 1) was conducted during Sep-Oct of 2018 to reach 4,347 households with an overall attrition rate of 8%. In endline 2, which was conducted during December 2019 and January 2020, we managed to interview 4,190 of the baseline households for an overall attrition rate of 11.2% (Table 1). Figure 7 in Section 6 provides the study timeline.

Table 1 shows the sample distribution and attrition rates between baseline and endline 2 across the four study arms. Overall, the attrition rate was slightly higher in the 'training + goal setting' group (13.1%) than the other groups, whereas the other three arms had almost identical attrition rates. However, the difference in rates across the four arms is not statistically significantly.

Table 1: Study sample by intervention groups

	Control	Spillover	Training only	Training + goal setting	Total
Baseline	1,586	1,633	750	750	4,719
Endline 2	1,408	1,461	669	652	4,190
Attrition rate	11.2%	10.5%	10.8%	13.1%	11.2%

In order to assess the determinants of attrition, we used 14 baseline characteristics: gender, age and education of the respondent farmer, household size, number of plots owned by the household, number of rooms in the house, access to electricity, ownership of livestock, access to cash saving, and access to radio and television. The important part of this analysis was to assess whether there was differential attrition across the treatment groups even though their overall attrition rates were statistically indistinguishable. The is because the same attrition rate does not necessarily imply that the people who are lost in follow-up from one group are comparable to the attrited households of the other groups.

In order to test if attrition was correlated with treatment assignments, we looked at the joint significance of the baseline characteristics interacted with the treatment arms, which is a measure of differential attrition by baseline characteristics. The results are presented in Appendix Table A1. As can be seen in the Table, the results do show significant association of the characteristics with the likelihood of attrition for the training only group (the joint F-stat for the interactions is 2.75 and significant at <1% level) and the spillover group (the joint F-stat for the interactions is 2.79 and significant at <1% level). The main contributor to this differential attrition is access to electricity. In the main analysis, therefore, we used inverse probability weights for correcting this differential attrition by its contributors.

[3] The minimum number of households interviewed in any given village is 50, which was our target number of households.

4.3 Comparability at baseline

Although the study used randomization, it is useful to check whether the treatment and control groups are statistically similar for the panel sample. We present a balance check in Table A2 where the variables in Panel A are related to household characteristics and the variables in Panel B shows the result of our key outcome variables. As we can see, the four groups have statistically similar average values for at least 24 of the 28 variables. This confirms successfulness of the randomization and balance of the panel. The variables that show statistical difference are the ownership of a tv, total household income and income from sources other than banana cultivation. Access to electricity is lower among both the training only and training with goal setting intervention arms. As noted earlier, electricity access was also correlated with attrition and was thus used in correcting for probability of participation.

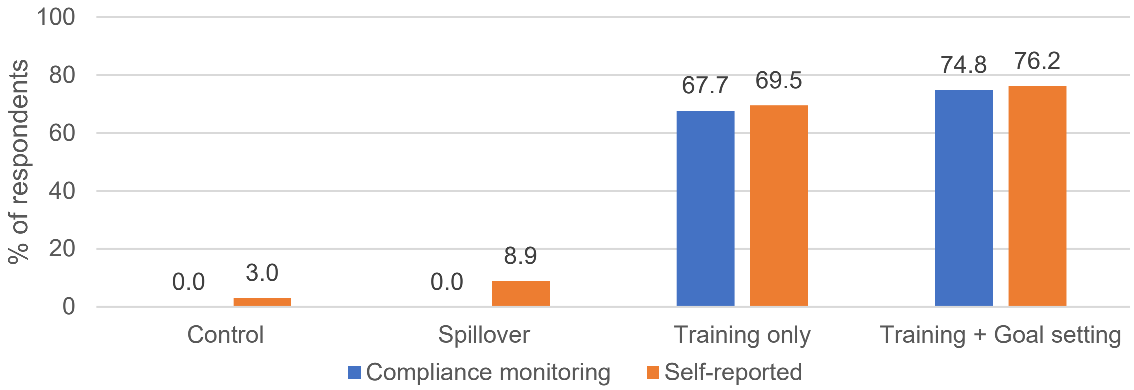
The difference in baseline total income seems relatively high – over Ksh 10,000 for training with goal setting group, which is almost 20% lower than that of the control group. However, as it is well known, income measure in rural areas in developing countries is generally very noisy (reflected by a relatively high standard error). Another way to assess the implication of observed difference in randomized control trials is by measuring the normalized difference. Following Imbens and Wooldridge (2009), the normalized difference between the lowest and highest means (control vs. training+goal setting) for total income is 0.15. This is lower than the rule of thumb cut-off (0.25) for normalized difference considered large for linear regression methods to be sensitive to the specifications for impact evaluation. Nonetheless, we control for the baseline values in our impact estimates for all outcome indicators.

4.4 Intervention compliance with randomization

In this section we present compliance of the intervention to the randomization. We have two separate measures for compliance checks – a) direct monitoring by the research team while the interventions took place,[4] and b) asking the respondents to recall the training and goal setting at the endline 2 survey (Figure 6). According to the compliance monitoring data, 68% of those in the 'training only' category and 75% in the 'training plus goal setting' category participated in the training. Those who did not receive the interventions failed for a variety of reasons including inability to be reached, wrong phone numbers, inability to be reached, or absence from Kirinyaga during the testing period. The recall data also showed similar rates although about 9% of the households from spillover and 3% of control groups reported receiving the training.[5]

[4] A field coordinator based in Nairobi who was involved full-time throughout the project implementation phase was there so that the study team could directly monitor the implementation partner's activities. Two additional assistants were also hired for the first year and they worked closely with the EAMDA so as to address slow listing of target households for the baseline survey.
[5] It is possible that most of these control village households confused the EAMDA's intervention with another banana intervention that was in place in the area before this intervention. More details are provided in the sub-section below on main findings from the qualitative study.

Figure 6: Compliance with randomization for EAMDA training



For the goal setting component, 91% of those assigned to this treatment arm could be reached for the intervention. Therefore, about 15% of the farmers in the goal setting arm did not attend the training but took part in the goal-setting session.

4.5 Analysis method

Given the reasonably high level of compliance and low contamination, we use intention to treat (ITT) effect for the impact analysis. This essentially means we measure the average effects on all the households assigned to treatment groups irrespective of their actual participation, using the following specification

$$Y_{(endline2)\ iv} = \alpha + \beta_1 * T_{iv} + \beta_2 * G_{iv} + \beta_3 * S_{iv} + \beta_4 * Y_{(baseline)\ iv} + \mu_{vi} \qquad (1)$$

$Y_{(endline2)\ iv}$ are the outcome indicators at the 2nd endline survey for household *i* in village *v*. T_{iv} and G_{iv} are dummies for treatment assignment of the households into "training farmers group only" and "training + goal setting" interventions respectively. Therefore, β_1 is the ITT impact estimate of the training interventions at endline 2, and β_2 is the same for training plus goal setting intervention. S_{iv} is a dummy variable equal to 1 if the household belongs to the spillover sample (i.e., control households in the treatment villages) and hence β_3 is the spillover effect after controlling for the baseline values, ($Y_{(baseline)\ iv}$) of respective outcomes. All estimates use errors clustered at village level, and scales variables (for monetary values) are winsorized at 95% for outliers at the high end. To account for false discovery rates due to multiple hypothesis tests, we report q-values following the methods used in Anderson (2008) for each set of outcomes across the intervention groups.

In the main text, we present the impact results of the 2nd endline survey using the above specification, which is supplemented by the following specification that measure the impact at midline, and compare the endline 1 and endline 2 impacts with the respective estimates at midline:

$$\begin{aligned} Y_{(follow-up)iv} = \alpha &+ \beta_1 * T_{iv} * \text{endline2} + \beta_2 * G_{iv} * endline2 \ + \beta_3 * S_{iv} * endline2 \\ &+ \beta_4 * T_{iv} * endline1 + \beta_5 * G_{iv} * endline1 + \beta_6 * S_{iv} * endline1 \\ &+ \beta_7 * T_{iv} + \beta_8 * T_{iv} * G_{iv} + \beta_9 * S_{iv} \\ &+ \beta_{10} * endline1 + \beta_{11} * endline2 + \beta_{12} * Y_{(baseline)\ iv} + \mu_{vi} \qquad (2) \end{aligned}$$

In this specification, $Y_{(follow-up)iv}$ are the outcome variables at follow-up (either midline, endline 1 or endline 2). Coefficients β_7, β_8 and β_9 are the midline impacts of training only, training combined with goal setting and spillover effect, respectively. β_1, β_2 and β_3 are estimates of the impact difference at endline 2 from their respective midline results. β_4, β_5 and β_6 provide similar comparison of impacts at endline 1 vs. midline. In other words, these coefficients show whether the impacts at endlines 1 and 2 changed from the estimated impacts at midline.

We also used the random variation in the intensity of intervention (i.e., the proportion of farmers treated in a village) to explore whether having more treated farmers in a village creates stronger effects on the treatment and spillover groups. We measure how the effects vary as the proportion of treated farmers increases using the following specification:

$$Y_{(follow-up)iv} = \alpha + \beta_1 * T_{iv} + \beta_2 * T_{iv} * G_{iv} + \beta_3 * S_{iv} + \beta_4(T_{iv} * I_v) + \beta_5(S_{iv} * I_v) + Y_{(baseline)\ iv} + \mu_{vi} \quad (3)$$

where I_v is the intensity of intervention in village v, which takes the value of 0.2, 0.4, 0.6 and 0.8 based on the random assignment for different fraction of the sample households receiving the EAMDA interventions, and 0 for 'pure control' villages. Therefore, β_4 and β_5 are the estimates of how the ITT on treatment group and spillover effects changes respectively with saturation. These slope effects take a linear slope assumption. β_1 and $\beta_2$are the effect of the training at zero intensity and therefore, do not have any direct interpretation and can be used only for estimation purposes. For example, if the values of the coefficients for β_1 and $\beta_4$are 0.20 and -0.15 respectively, this means that the average effects at 50% intensity villages would be 7.5 percentage points (0.2-0.15X50%) and 11 percentage points (0.2-0.15X60%) at 60% intensity villages. In other words, the effect size declines by 1.5 percentage points as the share of households receiving treatment increases by 10 percentage points.

5. Programme or policy: Design, methods and implementation

The interventions that we have evaluated under this project are part of the Farmer Organization Support Centre in Africa (FOSCA) initiated by the AGRA to strengthen the capacity of Farmers' Organizations (FO). The EAMDA project, titled "Building a competitive export banana industry in Kenya", targeted reaching about 11,000 farmers in Kirinyaga county.

The initial design of the intervention included two key components: a) providing information to farmers through training and visits to demonstration plots and b) connecting farmers with exporters to reach the export market through building the institutional capacity of FOs. The target group was intended to be farmers who are part of farmers' groups.6 The approach of the EAMDA was to target improving banana productivity of the farmers' groups, with the anticipation of spillover effects on the other farmers who are living in the same communities but not part of any farmers' groups. Accordingly, the baseline survey was conducted on two sample groups: farmer group members and general farmers who are not part of any group. However, it was later

[6] See the component and cost information in the project budget in Annex I.

established from the baseline survey data that the extent of banana cultivation and interest in participating in banana cultivation related training were equally prevalent between the two groups. Consequently, EAMDA agreed to extend the training to farmers beyond the groups and all the farmers were given an equal chance of being in the treatment groups irrespective of their group membership. This enabled us to measure spillover effects in a more robust way since the treatment and control groups within intervention villages were comparable due to randomized assignment instead of the criterion of group membership.

A second important change that took place from the original intervention design is related to linking farmers to exporters/export markets. After initial training sessions were rolled out, the EAMDA assessed the needs of market linkages and decided that the existing market channels are adequate for the farmers to market their produce. Therefore, this component was dropped from the intervention package. It is also noteworthy that farmers anticipated marketing services as other business and non-business entities are currently taking such initiatives (e.g., Twiga Food as part of a USAID project).

The EAMDA training primarily focused on production and post-harvest handling practices. These included orchard establishment and allied practices such as site selection, land marking, hole-digging and planting; and orchard management practices such as weeding, pests and diseases control, de-leafing, de-suckering, watering and propping. Farmers were also trained on how to identify a banana crop ready for harvesting, and how to harvest and handle the produce before it reached the market. Each training session ended with a question/answer session, a discussion and a demonstration. The critical pieces of information that were delivered to the training participants were the productivity and economic value of using TCB plantlets.

After the randomized list of treatment farmers was provided to the EAMDA management, they prepared an intervention rollout plan for their three trainers. The plan included the location and time of the training session conducted by trainers. The EAMDA sent out bulk mobile text messages to the target farmers inviting them to the training. However, additional efforts were taken to increase uptake rates after the research team observed low participation (below 25%) in the first week of training. Two research assistants (RA), who were assigned to monitor compliance during the fieldwork, called the farmers to invite them to the training. Farmers who could not be reached over phone were visited physically by the RAs. Most of the training (about 90 per cent) took place at the farmer's homestead/plot. The rest took place at a landmark facility in the village such as a tea buying center, a chief's camp or a coffee factory.

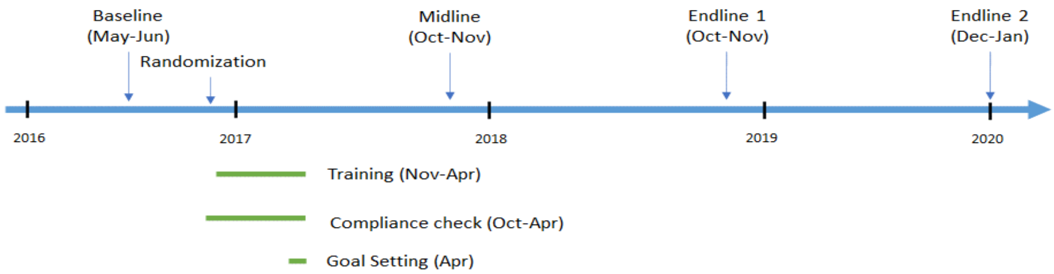
All treatment groups received training in a single session that lasted 3 - 4 hours. 19 percent of the groups/villages received a repeat training session for varied reasons. These included disruption by poor weather, abrupt social events e.g., burial services that coincided with the already scheduled sessions, and poor mobilization for participation. However, the content of the training offered to all groups was the same.

The goal setting component was introduced by the research team as an additional component to this project. The objective of this component is to assess whether a simple behavioural nudge that could be introduced easily as part of farmers' training sessions could result in the desired impact. Since TCB was found to be the key component of EAMDA training, we took “adoption of TCB” as our goal setting intervention. This involved discussions with the farmers to help them prepare a plan for procuring TCB if they were willing and interested in adopting this technology. This discussion was done over phone and after the main EAMDA training rollout was complete.

6. Timeline

As noted earlier, the study started with a baseline survey that was conducted during May-June of 2016. The program team from the EAMDA identified the villages that they considered suitable for their interventions (Figure 7). The survey included smallholder farmers, with 95% of them having access to less than 5 acres of land (owned or rented) with an average of 1.36 acres (Table A2). Additional characteristics used for the sample selection were whether farmers were currently cultivating bananas or were interested in cultivating bananas. We conducted this randomization in October 2016 and provided the list of treatment farmers and villages to the EAMDA for intervention rollout, as well as the list of control villages to ensure that no EAMDA intervention took place there.

Figure 7: Study timeline



Training of farmers started from November 2016 and continued till April 2017. Compliance checks were conducted throughout this period, including a month prior to the rollout to avoid possible contamination. The goal setting intervention was implemented in April 2017. The midline survey was conducted in Oct.-Nov. 2017, which was 6-8 months after the implementation of the interventions. The endline 1 survey was conducted a year later about 18-20 months after the interventions were completed. The second endline survey was conducted between Dec 2019 and Jan 2020, approximately 32-33 months after the end of the interventions.

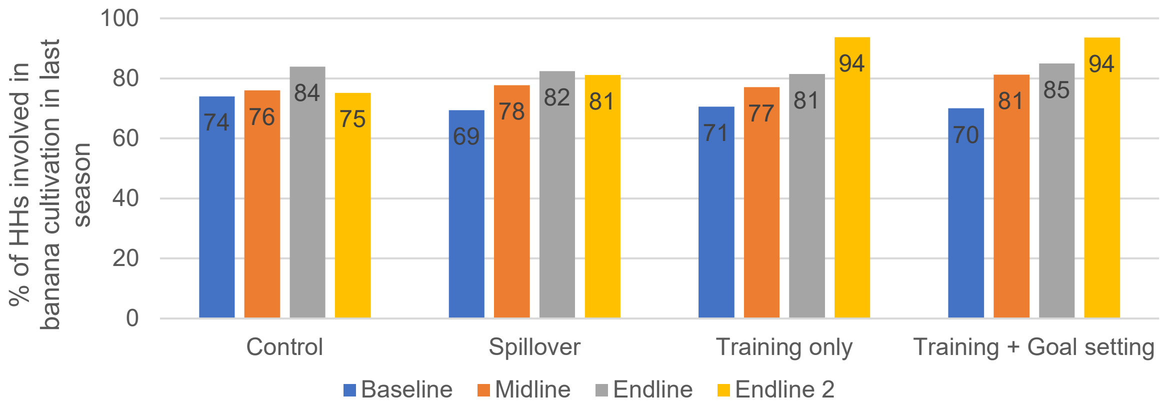
7. Impact results

We present four sets of impact results, starting with the ITT effects as our main analysis. This is followed by an analysis of how the impacts vary based on the intensity of interventions at the village level. The third set of analyses focus on understanding the spillover effects by using social network data. Finally, we discuss summary results from our exploratory heterogeneity analysis in the fourth sub-section.

7.1 Intention to treat (ITT) effects

Figure 8 shows the proportion of households engaged in banana cultivation. As we can see, the control group did not have any major change between the baseline and midline, but there was a 10 percentage points increase by the endline 1 followed by a decline to baseline level by endline 2. The percentage of farmers cultivating bananas consistently increased from baseline to midline to endline 1 for all three groups in the treatment villages. Between endline 1 and 2, both training groups (i.e., training with/without goalsetting) showed a jump in banana cultivation to 94%. In the regressions, we present these effects measured against the control group.

Figure 8: Proportion of farmers doing banana cultivation



7.1.1 Banana cultivation

We include five primary banana cultivation outcomes: i) cultivation of any variety of banana; ii) cultivation of modern banana variety; iii) use of tissue culture bananas; iv) land use for bananas; and v) expenditure on banana production. The main modern variety is cavendish while there are several local varieties such as *muraru* or *sukari*. TCB plantlet use is promoted and available for both modern and local varieties. The estimation results are based on the specification provided above in Equation 1. The corresponding results that compare the two endline impacts with those of midline (Equation 2) are presented in Table A3.

We find significant effects of both training only and training with goal setting arms on the likelihood of banana cultivation. There is also no significant spillover effect of this outcome. The effect sizes are over 20 percentage points for both arms. When we compare the endline impact estimates with those of the midline (Table A3), we see that the bulk of this impact has happened after endline 1. The impact estimates on this outcome were not significant at both midline and endline 1 although point estimates were positive. Impact endline 2 are 18pp higher for training only and 13pp higher for training with goalsetting compared to midline results and statistically highly significant. The point estimate for impact on spillover sample at endline 2 is 6.5pp and the q-value shows a 5% level of significance. As we can see from the descriptive statistics in Figure 8, part of the large impacts observed in endline 2 is due to the reduction of banana cultivation in the control group. Although we cannot rigorously explain the change in control group, the apparent "disadoption" can be by farmers' decisions to abandon banana cultivation due to lower return than alternative crops and/or plant disease. The data suggests that banana disease may have played some role.[7]

[7] For example, when we look at the rates of banana cultivation at endline 2 by their experience of banana diseases in the previous round (endline 1), 70% of the control group farmers continued banana cultivation compared to 91% of treatment group farmers.

Table 2: Impact estimates for outcomes related to banana cultivation at endline 2

	Cultivated banana	Cultivated modern variety	Used Tissue culture banana	Land used for banana	Money spent on banana
Training (Endline2)	0.220 (0.000) [0.001]	0.318 (0.000) [0.001]	0.349 (0.000) [0.001]	0.098 (0.000) [0.001]	250.990 (0.013) [0.008]
Training plus goal setting (Endline2)	0.211 (0.000) [0.001]	0.329 (0.000) [0.001]	0.311 (0.000) [0.001]	0.097 (0.000) [0.001]	225.240 (0.000) [0.001]
Spillover (Endline2)	0.065 (0.121) [0.043]	0.087 (0.024) [0.014]	0.055 (0.165) [0.052]	0.015 (0.173) [0.052]	-1.535 (0.969) [0.228]
Observations	4,190	4,190	4,190	4,190	4,190
R-squared	0.056	0.086	0.095	0.095	0.020
Training = Training plus goal setting	0.494	0.647	0.257	0.936	0.779
Control mean (Endline2)	0.752	0.572	0.232	0.135	208

Note: p values after robust standard errors clustered at village level in parentheses; [] includes the q-values that adjust multiple hypothesis testing of the 15 impact coefficients in the table using Anderson (2008) method. Baseline values were not controlled for modern variety and TCB outcomes as the data was incomplete at baseline.

Moreover, there is a substantial effect on farmers adopting modern variety and tissue culture banana (TCB) at endline 2 (Table 2) and significantly higher than the effects observed at midline (Table A3). The point estimates at endline 2 are over 30pp for both treatment arms. When compared with the control mean, this reflects about a 50% increase in cultivating modern varieties of banana and over 125% increase in TCB adoption. There is also a spillover effect on both outcomes with a 8.7pp increase in modern variety cultivation and 5.5pp increase in TCB adoption for this sample. Although the p-value for TCB adoption for the spillover sample is above the 10% threshold, it becomes significant at that level after adjusting for multiple hypothesis test.

This impact on TCB adoption corresponds with positive effects on amount of land used and expenditure on banana cultivation. Even though the endline 2 effect size of almost 0.1 acre on land use for banana cultivation is small, it is economically meaningful since the average household in the control group used 0.14 acres land for banana cultivation. There is no additional effect of goal setting on this indicator, and the spillover effect is smaller and significant at the 10% level. Training increased money spent on banana cultivation by Ksh 252 and Ksh 225 (or USD 2.5 and 2.2 respectively) for the two treatment groups which are over 100% of the control group mean at endline. However, there is no significant effect on money spent for banana cultivation in the spillover group. Overall, the results show that the training intervention had large effects on technology adoption at endline 2. Although training plus goal setting had some additional effects at endline 1, further increase between the two rounds of the survey result in no such additionality by endline 2. The increase in effect sizes between endline 1 and 2 suggests possible learning effects from early adopters at midline and endline 1 taking place in treatment villages.

7.1.2 Banana farming practices

As mentioned earlier, the training focused on promoting the use of TCB and discussed advantages of adopting TCB. However, farmers also received information on the value of various good practices of banana farming and were encouraged to adopt them. Table 3 shows the endline 2 impacts on primary indicators related to cultivation practices. We find statistically significant effects on weeding practice and hiring labour for weeding for both treatment groups. Around 18pp additional farmers in the treatment groups reported weeding practice reflecting a 35% increase compared to the control group at endline 2. The effect size on hired labour for weeding is 12pp for training only and 9pp for training with goal setting. The effect on use of fertilizer are also significant and around 45% higher compared to the control group. There is, however, no significant effect on pesticide use. Overall, the results show large positive impacts of the training at endline 2 on farming practices. However, there is no significant marginal effect of goal setting or spillover effect on untreated farmers. Similar to the trends in banana cultivation, there is a delayed effect on these cultivation practices when we compare the endline effects with midline results (Table A4).

Table 3: Impact estimates for outcomes related to adoption of farming practices at endline 2

	Did weeding for banana	**Hired labour for weeding banana**	**Used fertilizer for banana**	**Used pesticides for banana**
Training (Endline2)	0.170 (0.000) [0.001]	0.117 (0.019) [0.033]	0.179 (0.000) [0.002]	0.029 (0.551) [0.283]
Training plus goal setting (Endline2)	0.185 (0.000) [0.001]	0.085 (0.050) [0.063]	0.193 (0.000) [0.001]	0.047 (0.33) [0.257]
Spillover (Endline2)	0.066 (0.136) [0.114]	0.010 (0.793) [0.360]	0.055 (0.136) [0.114]	0.019 (0.683) [0.331]
Observations	4,190	4,190	4,190	4,190
R-squared	0.021	0.011	0.025	0.021
Training = Training plus goal setting	0.654	0.330	0.725	0.628
Control mean (Endline2)	0.55	0.326	0.396	0.276

Note: p values after robust standard errors clustered at village level in parentheses; [] includes the q-values that adjust multiple hypothesis test of the 12 impact coefficients in the table using Anderson (2008)'s method.

7.1.3 Banana production

We explore here how the interventions affected banana production and banana yield, which are essentially the outcome variables from technology adoption. There is a positive and significant increase in banana production because of the treatment. The magnitude of the impact is also large (over 350 kg or about 140% of control group mean) and highly significant at the 1% level (Table 4). There is also significant spillover effect on production although at a smaller magnitude (about 50 kg). Productivity increase (measured by production per acre of cultivated land) is also significantly higher among the treatment groups, and the spillover sample shows a weak increase in productivity compared to the control group.

Looking at the impact trends (Table A5), we find that there are significant effects on production both at midline and endline 1, but the impacts in endline 2 are significantly higher. For example, the training only group had 84 kg of additional banana produced at midline compared to the control group, and this impact had increased by 108 kg at endline 1 and by 284 kg at endline 2. Therefore, a large portion of the 361 kg production impact observed at endline 2 materialized after the midline. This trend is understandable given that it takes about 14 months from banana plantation to harvesting. This also indicates possibilities of larger effects on production in the future because of the lagged effect on banana cultivation and TCB adoption observed after endline 1.

Table 4: Impact estimates for outcomes related to banana production at endline 2

	Amount of banana produced (in kg)	**Banana yield (per acre)**
Training (Endline2)	361.240 (0.000) [0.001]	1,298.266 (0.000) [0.001]
Training plus goal setting (Endline2)	352.488 (0.000) [0.001]	1,267.245 (0.000) [0.001]
Spillover (Endline2)	49.584 (0.071) [0.03]	237.484 (0.156) [0.055]
Observations	4,190	4,190
R-squared	0.150	0.076
Training = Training plus goal setting	0.788	0.845
Control mean (Endline2)	253	1633

Note: p values after robust standard errors clustered at village level in parentheses; [] includes the q-values that adjust multiple hypothesis test of the 6 impact coefficients in the table using Anderson (2008)'s method.

7.1.4 Banana marketing

Apart from production and yield, sales and income from bananas are the key outcomes in our theory of change. We consider next the amount and revenue on banana sales, and whether there was a contract written with the individuals the bananas were sold to (Table 5). In the control group, there are very few farmers (less than 1%) who are growing bananas as part of contract farming schemes in Kirinyaga. There has been a recent initiative (not part of the EAMDA) by a marketer (Twiga Food) which started banana sourcing from the county in 2018. We find around 6 pp increase in the likelihood of selling bananas on contract by the training intervention and this increase is statistically significant at the 5% level. From our qualitative interviews and feedback from survey teams, the Twiga Food company was the purchaser in almost all these cases. This is corroborated by the fact that we did not see any effect on selling bananas on contract at midline and only a weak effect in endline 1 (Table A6). Similar to earlier results, some effect (around 2 per cent) took place after the midline and the bulk of it occurred after endline 1, coinciding with the operational start of Twiga Food. This suggests a possible synergy between training for technology adoption and marketing whereby adopters are better able to utilize new marketing services.

Training also increased the volume of bananas sold by the farmers to a magnitude of over 350 kg per farmer, which is almost 200% of the control group mean at endline 2. The spillover sample also shows a 44 kg increase in banana sales over the control group. Our impact estimates on income from banana sales (gross revenue) are positive for both training only (by about Ksh 7,000 or USD 70) and training with goal setting (by almost Ksh 6,500 or USD 65). Spillover samples also show a positive impact of over Ksh 800 (or USD 8). Given the large effect size, we also looked at this outcome by taking the log value of revenue to account for the large dispersion in the monetary outcome. The estimates remain significant when the log values are used instead of the nominal amounts. When comparing the impact results at midline and endline 1, the positive effects on sales and revenue are observed also at endline 1 but the point estimates are lower than those at endline 2 (Table A6). There was, however, no significant effect on banana marketing and revenue at midline for the training only group. This is again due to the production period of bananas being longer than the duration between intervention and our midline survey. In analysing the treatment effect in quantile regression, we find significant positive effects of Ksh 7,000 for the training at median level. Although there is an increasing trend in the effect size by quantile analysis, the p-value of the effect size is less than 0.01 at 20th percentile and higher. This suggests that the revenue earnings from banana cultivation have been significantly higher for almost everyone in the treatment group by endline 2.

Table 5: Impact estimates for outcomes related to banana marketing at endline 2

	Sold banana on contract	Amount of banana sold (kg)	Revenue from banana sales (Ksh)	Log of Revenue from banana sales (Ksh)
Training (Endline2)	0.066 (0.024) [0.016]	389.487 (0.000) [0.001]	7,171.153 (0.000) [0.001]	1.625 (0.000) [0.001]
Training plus goal setting (Endline2)	0.059 (0.001) [0.001]	358.142 (0.000) [0.001]	6,408.725 (0.000) [0.001]	1.529 (0.000) [0.001]
Spillover (Endline2)	0.011 (0.066) [0.035]	43.750 (0.074) [0.035]	838.465 (0.073) [0.035]	0.246 (0.105) [0.038]
Observations	4,190	4,190	4,190	4,190
R-squared	0.026	0.165	0.175	0.149
Training = Goal setting	0.755	0.407	0.272	0.491
Control mean (Endline2)	.00355	191	3598	7.03

Note: p values after robust standard errors clustered at village level in parentheses; [] includes the q-values that adjust multiple hypothesis test of the 12 impact coefficients in the table using Anderson (2008) method. Both amount sold and revenue are winsorized at the 95% level.

7.1.5 Household income and expenditure

The final set of outcomes for our impact study are related to total household income and expenditure (as a proxy for wellbeing). In our midline assessment, we found a negative effect on total income of the treatment group, which was about 10% of the total income of the control group. The negative effect on total income at midline was almost entirely driven by a reduction in their income from non-banana crops (Table A7). This short-term negative effect can likely be attributed to treatment group farmers allocating more land to banana cultivation.[8] Moreover, there had been no harvest of bananas from the recently grown banana plantlets at midline. However, by the endline 1 survey, the negative effect had disappeared (Table A7). That said, when we look at the endline 2 results only, we again find large negative point estimates (Table 6). However, none of the estimates in Table 6 are statistically significant.

Table 6: Impact estimates on household income and expenditure at endline 2

	Total income	**Log (total income)**	**Non-banana crops income**	**Log (non-banana income+1)**	**Per capita monthly expenditure**	**Log (Per capita exp+1)**
Training (Endline2)	-13,805.25 (0.085) [1.000]	-0.015 (0.438) [1.000]	-9,103.52 (0.212) [1.000]	-0.434 (0.372) [1.000]	313.90 (0.764) [1.000]	0.080 (0.552) [1.000]
Training plus goal setting (Endline2)	-11,144.04 (0.062) [1.000]	-0.070 (0.335) [1.000]	-8,659.48 (0.321) [1.000]	-0.254 (0.578) [1.000]	-54.42 (0.913) [1.000]	-0.032 (0.856) [1.000]
Spillover (Endline2)	-11,780.57 (0.043) [1.000]	-0.085 (0.863) [1.000]	-6,971.15 (0.228) [1.000]	-0.161 (0.156) [1.000]	-19.76 (0.15) [1.000]	-0.009 (0.194) [1.000]
Observations	4,190	4,190	4,190	4,190	4,190	4,190
R-squared	0.025	0.012	0.064	0.045	0.003	0.003
Training = Goal setting	0.631	0.422	0.898	0.318	0.0251	0.0169
Control mean (Endline 2)	122263	11.3	45176	9.08	3672	8.03

Note: p values after robust standard errors clustered at village level in parentheses; [] includes the q-values that adjust multiple hypothesis test of the 18 impact coefficients in the table using Anderson (2008) method.

Given the trends between midline and endline 1, there was an anticipation of a positive effect on total income through enhanced impact on banana revenue. However, contrary to our expectations, we still find negative point estimates. Since we also observed an unanticipated increase in adoption after endline 1, it is possible that late adopters will generate additional revenue in the future. Nonetheless, with the available information we can rule out an overall positive effect on income although we cannot rule out the possibility of farmers generating higher total income in future.

7.2 Impact by the intensity of interventions

In this section, we assess the trend in impact by the intensity of intervention in the village. The main goal is to assess whether training more farmers from a village can affect the impacts obtained by the training. Table 7 shows the endline results by intervention intensity using the specification of Equation 3. We do not find any strong association between intervention intensity and impacts on technology adoption for banana cultivation at endline 2. Although the p-value of modern verity of banana cultivation and land size used for banana showed significant association with intensity at

[8] Point estimates of the effects of the interventions on land used for non-banana crops are between 5 and 8 decimal (estimates not shown in table) although not statistically significant.

5% level, this statistical significance does not persist after adjustment for multiple hypothesis testing. It is to be noted here that there was also no association between intervention intensity and impacts measured at both midline and endline 1 (results not shown).

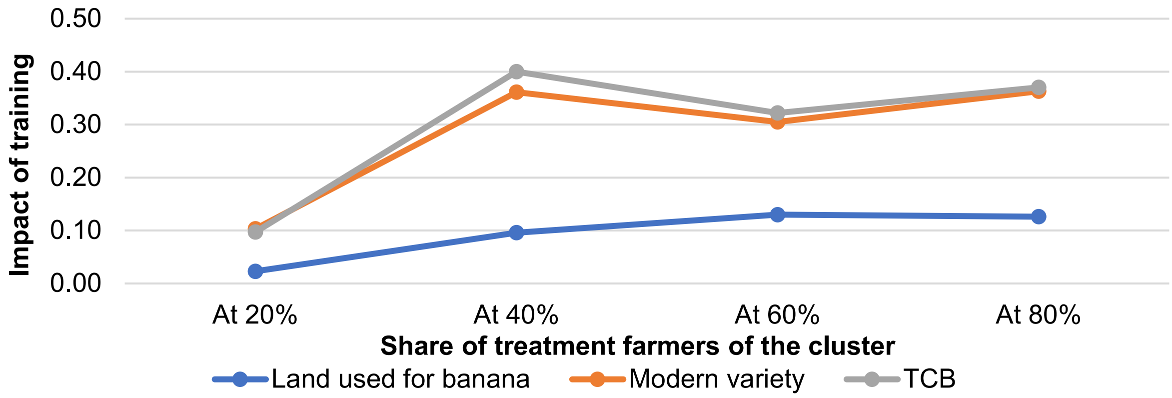
Table 7: Intensity of intervention and impacts on banana cultivation at endline 2

	Cultivated banana	**Cultivated modern variety**	**Used Tissue culture banana**	**Land used for banana**	**Money spent on banana**
Training (Endline2)	0.201 (0.000) [0.004]	0.160 (0.101) [0.272]	0.206 (0.092) [0.272]	0.032 (0.419) [0.554]	-8.716 (0.956) [0.703]
Training plus goal setting (Endline2)	0.192 (0.000) [0.004]	0.174 (0.043) [0.207]	0.170 (0.143) [0.372]	0.036 (0.36) [0.513]	-30.573 (0.872) [0.703]
Spillover (Endline2)	0.008 (0.920) [0.703]	-0.015 (0.831) [0.703]	-0.013 (0.864) [0.703]	-0.007 (0.762) [0.703]	-62.709 (0.253) [0.39]
Training X Intensity	0.031 (0.621) [0.646]	0.256 (0.045) [0.207]	0.233 (0.186) [0.374]	0.129 (0.043) [0.207]	423.375 (0.171) [0.372]
Spillover X Intensity	0.142 (0.255) [0.39]	0.253 (0.04) [0.207]	0.168 (0.264) [0.39]	0.065 (0.094) [0.272]	151.578 (0.157) [0.372]
Observations	4,190	4,190	4,190	4,190	4,190
R-squared	0.059	0.095	0.100	0.087	0.024

Note: p values after robust standard errors clustered at village level in parentheses; [] includes the q-values that adjust multiple hypothesis test of the 25 impact coefficients in the table using Anderson (2008)'s method. Baseline values were not controlled for modern variety and TCB outcomes as the data was incomplete at baseline. Training dummy combines training only and training with goal setting arms.

The estimates in Table 7 assume a linear relationship between treatment intensity and effect sizes. An alternative approach, therefore, is to use the dummy variables for the percentage of farmers who are treated in a village and measure impacts across the four types of villages. As discussed in the evaluation design, we have four types of treatment villages who were randomly assigned for 20%, 40%, 60% and 80% of the sampled farmers to receive the training intervention. Figure 9 gives a graphical presentation of the impact estimates at endline 2 across these four types of villages for the training intervention on three adoption indicators – whether farmers have cultivated a modern banana variety; whether they have cultivated TCV plantlets; and the amount of land (in acres) used for banana cultivation. While we find a generally low level of impact in villages where 20% of the farmers were treated, there is no visible difference in impact sizes among the villages with 40%, 60%, and 80% intervention intensities.

Figure 9: Intensity dummy and impact of training on technology adoption at endline 2



7.3 Social network and spillover effects

Although we find some evidence of spillover effects, it is possible that these effects are concentrated among the farmers of control group in the treatment villages (i.e., our spillover sample) who are connected only with the farmers in treatment groups. This can create a small spillover effect if there are many farmers in the spillover group who are not connected to any treatment farmers. In order to assess the influence of social networks on the spillover effects, we analysed the effect of social networks of farmers on the endline 2 outcomes of the spillover samples.

Table 8: Association between social network with treatment groups and outcome indicators

	Cultivated banana	Cultivated modern variety	Used Tissue culture banana	Land used for banana	Money spent on banana
Social network with treatment farmers at endline 1	0.003 (0.031)	0.043 (0.044)	-0.022 (0.048)	0.015 (0.021)	-195.565 (170.584)
Social network with treatment farmers	0.008 (0.027)	-0.017 (0.032)	-0.022 (0.022)	-0.014 (0.016)	97.468 (108.828)
Social network in the village at endline 1	0.013 (0.016)	-0.010 (0.022)	0.050 (0.026)*	-0.011 (0.013)	107.062 (86.803)
Social network in the village	0.038 (0.014)**	0.057 (0.016)***	0.050 (0.014)***	0.032 (0.013)**	210.739 (63.799)***
Endline 1 dummy	0.053 (0.024)**	0.024 (0.029)	0.069 (0.023)***	0.017 (0.009)*	-268.687 (74.688)***
Constant	0.744 (0.030)***	0.629 (0.032)***	0.091 (0.014)***	0.162 (0.012)***	575.518 (76.923)***
Observations	2,973	2,973	2,973	2,973	2,973
R-squared	0.021	0.017	0.046	0.015	0.063

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Social network is measured by number of households from the study sample in the village that the farmer is connected to in terms of sharing information on farming, collective sales or belonging to farmers' groups. Only spillover sample is included in this analysis.

Social network data was collected at midline and endline 1 by asking each respondent about their relationship with the other farmers in their respective villages. The social network questions included basic information about whether s/he knows the person, have been part of the same farmers' group, exchanged information about banana cultivation and whether they have any credit relationship. Table 8 shows the result where the social network is defined as the number of other farmers that the respondent said they "belong to a common farmers group with or have shared information on farming in the last one year or done sales together". This analysis uses only the spillover sample. The coefficients of the second column control for overall connection of the farmers with any of the sample group in the village. After controlling for their connection, the first column shows the association between the connection with the number of treatment groups' farmers and the outcomes.

In this measure of spillover through social networks, we do not find any association of outcome variables with the number of social connections with treatment farmers. This implies that the spillover effect is generally weak for this intervention. Although the association between general social network is statistically significant for most of the outcomes, it does not reflect the effect of social networks as it is not exogenous. It is possible that more advanced farmers build stronger social networks (reverse causality) or there are other omitted factors driving the correlation.

7.4 Heterogeneity of impact

We also conducted some exploratory analysis of the heterogeneity of impacts at endline 2. Table A8 to A10 present results of the different dimensions of heterogeneity that we identified as "potentially important" in our pre-analysis plan. Table A8 shows the results for the farmers according to their land size and gender marked by the shaded rows. We do not find major gender differences in banana cultivation and adoption of TCB. However, the effect of the training is about 20pp higher for male farmers than their female counterparts. It is also to be noted that male farmers in control groups are about 14 pp less likely to cultivate modern varieties of bananas. Therefore, the training interventions seem to have counteracted to balance this gendered difference. Farm sizes were categorised as "large" if a farmer's total cultivable landholding at baseline is higher than the median. We do not find major impact differences by their baseline farm size. Finally, there is also no clear trend in terms of interaction of farmers' gender and land sizes. There is no significant impact heterogeneity in terms of farmers' access to credit at baseline (Table A9). We used baseline survey value of whether the farmer has any outstanding loan (either from an individual or an institution) as a proxy for access to credit. Out of the 10 estimates of impact heterogeneity on banana cultivation by access to credit, only one shows statistical significance (p-value of 0.07).

Access to irrigation, however, seems to be an important dimension of impact heterogeneity (Table A10). Although there is no differential impact on their likelihood of adopting modern varieties or TCB plantlets, farmers with access to irrigation at baseline increased the land used for banana cultivation compared to those without access to irrigation in both intervention groups (training only and training with goal setting). While the impacts of training only on land used for banana cultivation is about 8 decimals of land for those who did not have access to irrigation, the average impact is twice the magnitude for those who had access. There is also a weak differential effect on money spent for banana cultivation for the treatment group who received training with goal setting with those with access to irrigation spending more than those without access.

7.5 Main findings from the qualitative study[9]

In this sub-section, we discuss the main findings from the qualitative study where both focus group discussions (FGDs) and key informant interviews (KIIs) were used. Fifteen (15) of the ninety (90) groups that were part of the larger study were randomly selected from these villages to take part in the qualitative study: four (4) control (those who never received the EAMDA intervention) and eleven (11) treatment (those who received the EAMDA intervention). In total, fifteen (15) FGDs were interviewed for this study. Purposively, thirty (30) key informants were interviewed: fifteen (15) group leaders five (5) extension officers, five (5) local chiefs, and five (5) banana traders with some expert knowledge concerning improved banana varieties in the area. The qualitative component is expected to provide additional insights on the results obtained from the quantitative study.

Adoption of Modern and Tissue Culture Bananas: Prevalence of Modern and Tissue Culture Bananas

As mentioned earlier, TC varieties are also grown in control villages. Farmers in both treatment and control groups indicated that they were growing some varieties which they acquired from other interventions that sought to promote these varieties in the area before the EAMDA's 2016 intervention. These interventions include those implemented by Technoserve, MOA and extension services, Eco-seed, Aberdare technologies, Shamba shape up, Jomo Kenyatta University of Agriculture and Technology (JKUAT), Africa harvest, Njaa marufuku, and Twiga foods.

Nevertheless, all farmers in the treatment groups acknowledged the fact that cultivation of traditional banana varieties that have been planted for decades has been declining, while the uptake of modern and TC bananas has been increasing. This fact was also acknowledged by all farmers in control groups, who mentioned that interventions by groups such as Twiga foods have assisted them to appreciate new varieties of bananas.

When the members who were growing TC bananas for the first time (both treatment and control) were probed further concerning their reasons for not planting the varieties earlier, they indicated that they preferred to first understand the cost incurred in the management of TC varieties, and also to wait and observe from adopters if TC bananas had extra benefits compared to conventional varieties. However, all new adopters agreed that due to training, they were now satisfied with their findings concerning the costs and benefits of adopting TCB technology.

The study also noted that adoption of some traditional varieties such as the sweet banana is diminishing since it is prone to diseases even though it has a good market. Various reasons were cited when farmers were asked why they adopted different varieties of bananas. A short maturity period (72.7% of farmers in treatment groups), disease resistance and better markets (63.6% of farmers respectively) topped the list as reasons for adoption of TC varieties in treatment villages. In control villages, disease resistance and better markets were equally ranked (75% of farmers each respectively), while half of them (50% each respectively), mentioned a short maturity period, and the fact that TC varieties are shorter in size and thus do not require propping. Similarly, the

[9] The full qualitative report is provided separately.

majority of farmers interviewed in the treatment groups (90.9%), mentioned a short maturity period as the main reason for adopting modern varieties while better markets came second with 63.6% farmers mentioning the reason. Conversely, a short maturity period and disease resistance topped the list as the reasons for adopting modern varieties in control groups (75% of farmers each respectively). On the other hand, half of the farmers in the control groups (50% each respectively), mentioned better markets and the sweeter taste of ripe modern bananas as reasons to adopt TC varieties.

The fact that adopting modern and TC varieties over traditional banana varieties is mentioned as a priority by the farmers suggests that farmers in the study area realize the importance of adopting the improved varieties. Therefore, there is a need to ensure that barriers to adoption of modern and TC banana varieties are addressed. The study noted that some adopters had planted fewer TC varieties compared to others. When asked why this was the case, most farmers in both treatment and control groups mentioned land and water shortages as the most critical barriers to adoption of TC bananas (63.6% of treatment groups and 50% of the control group, respectively). Other major barriers mentioned by farmers in both groups included the cost of TC plantlets (45.5% of farmers in treatment groups and 25% in control.), and a lack of information about how to access TC plantlets from certified and reliable sources (45.5% in treatment groups and 25% control). For example, one of the key informants (a chief), said that management of TC bananas is mostly relayed through farmer groups meaning that non-members lack this knowledge which contributes greatly to the lack of adoption of the variety.

Farmers' Perceptions on EAMDA's Banana Interventions

The study sought to explore the farmers' perceptions concerning the intervention and specific information on the number of farmers who attended the EAMDA training sessions, the training received, changes in farmers' income after the intervention, specific barriers faced by farmers who had not adopted TC varieties at all and whether adopters passed information to non-adopters.

In the treatment groups, the lowest number of members trained in a group was 4, while the highest was 40. Notably, 7 groups (64%) had more women in comparison to men. The primary criterion determining which family members would attend the training sessions was availability. This is attributed to the EAMDA's adherence to on-farm trainings, a scenario that narrows the gender gap in access to information, usually due to gender related factors such as household chores. It should be noted that training sessions were only offered to members in farmer groups and non-members were thus not trained.

When asked if adopters passed on information to non-adopters, some group leaders indicated that plans were underway to start such initiatives, a sentiment affirmed by another key informant (a chief). The study also noted that various marginalized persons received training since 81.8% of the groups had incorporated elderly members while 27.3% had disabled persons who were trained.

All trained farmers agreed that the EAMDA intervention had helped them better market. They mentioned that the EAMDA had given them contacts of for potential buyers and they had also been provided with marketing insights.

The changes experienced by farmers concerning the income from modern and TC banana varieties after EMDA intervention were also explored. The trained farmers noted that though they adopted TC banana varieties expecting an increase in income, this was not realized. When asked why their income dropped, farmers who adopted TC bananas stated that it was caused by the severe drought experienced during this period and the negative impact it had on the yield of TC bananas which require a lot of water. The decrease in yield thus led to a drop in income.

Most groups (63.6%) were trained in 2016 and the rest (36.4%) in 2017, while the length of the training sessions varied from one to three days. All trained groups mentioned that they were trained on different aspects of banana husbandry such as planting, weeding and desuckering; orchard management; pest and disease control; and marketing information. All trained groups (100%) agreed that the trainings addressed their agricultural needs regarding banana production and marketing in various aspects such as post harvesting techniques, better marketing skills, modern and TCB management, and disease identification and control. All trained farmers indicated that they replaced some traditional banana varieties with modern and TC varieties. However, only 45% of those interviewed noted that they had expanded the area allocated to planting modern and TC varieties, whereas the remaining 55% said they were not planning to expand. As documented earlier, those who were not planning to expand mentioned limited land size and shortage of irrigation water as the major barriers.

With regards to sharing information with each other, both groups of farmers (treatment and control) acknowledged that farmer to farmer visits were paramount. All the farmers in both groups (100%), specified that farmer to farmer visits were the most frequent means of sharing information within the community, followed by group meetings, (54.4% of the control groups and 75% of treatment groups respectively). Moreover, 27.3% farmers in treatment groups and 50% of farmers in the control groups stated that banana farming knowledge was relayed to interested members of their households.

Results show that farmers in the area studied have many sources of knowledge on banana farming which is shared amongst neighbours. This scenario contrasts with other research findings, for example Miriti (2011), which revealed that most farmers could not adopt TC bananas due to lack of information. It can be argued that though access to knowledge of banana cultivation is not a barrier to be overcome, there is a need to ensure that farmers have the right information. This will guarantee that other producers (e.g., neighbours), get the correct information especially on disease control which can be disastrous if conducted incorrectly.

Since farmers in both treatment and control groups affirmed that they received training on post-harvesting (which is important to reduce wastage), the study sought to explore their understanding of this. In both treatment and control groups, results revealed that the most frequently used criteria to sort bananas were banana variety and size and shape of banana fingers. Notably, all farmers in control groups mentioned the three methods, but there were marginal variations among those in treatment groups. Looking at the shape of bananas was mentioned by 90.9% of farmers in treatment groups, followed by banana variety (81.8%), and size of fingers (72.7%). Pests and disease damage were also mentioned by the same proportion of farmers in both groups, (45.5% of farmers in treatment groups and 50% of farmers in control groups). A few farmers mentioned that they also considered the colour of mature fingers (9.1% in treatment groups and 25% in control groups).

Challenges in Banana Production and Marketing

The study sought to determine the challenges that farmers in both treatment and control groups face in producing and marketing bananas. The most significant challenges mentioned by farmers in the treatment groups were a lack of irrigation water and the high cost of inputs (72.7% each respectively). On the other hand, all farmers in the control groups mentioned bad roads during wet weather as the most severe challenge, followed by lack of irrigation water (75%). Compared to the treatment groups, only a few (25%) farmers in the control groups mentioned high input costs as a significant challenge. However, brokers were a problem for both groups of farmers (45.5% of those in treatment groups and 50% of the those in control groups).

Results reveal that farmers in both groups are facing similar challenges. Research has shown that bad roads are one of the most critical constraints, especially during marketing of ripe bananas that are prone to a lot of damage during transportation; (Indimuli, 2013; Thuo et al., 2017; Miriti, 2011). This calls for the county government to provide sustainable infrastructure such as all-weather roads as well as sustainable irrigation. Equally, providence of low interest credits and secured markets is essential for sustainable production and marketing of banana and other horticulture products.

8. Discussion

This report looks at the midline (6-8 months), endline 1 (18-20 months) and endline 2 (32-33 months) effects of a farmers' training program that promoted banana cultivation, use of TCB plantlets and improved farming practices. We find that the training increased the likelihood of farmers cultivating bananas at endline 2 while there was no significant shift to banana cultivation at midline and endline 1. The training has shown effects on the amount of land the farmers used for banana cultivation at midline, and the effects increased by a substantial margin by endline 2. We also find significant lagged effect on their choice of adopting TCB plantlets. At midline, the effect size on TCB adoption was only around 4pp or about 33% higher compared to control mean. By 32 months at endline 2, the impact has increased substantially (by almost 30pp compared to 4pp at midline). Similarly, we find significant effects of the training on cultivation practices (weeding and fertilizer use) at endline 2 although we did not find any impact on cultivation at midline or endline 1.

These effects on technology adoption correspond to positive effects on banana production, yield and income from bananas at endline. At endline 2, the training increased banana production by over 350kg per farmer and banana productivity by over 1,200 kg per acre on average. These are substantial effects when compared to the control group averages at baseline. The average effect on bananas sold is of similar magnitude as the increase in production, which indicates that the majority of the additional bananas grown were marketed. The impact estimate of banana revenue at endline 2 is about Ksh 7,000 (USD 70), which is about 200% higher than the control group mean. Although we observed a positive point estimate at endline 1 on revenue from banana sales, the impact estimates were not consistently significant. This changed by endline 2 when the impacts on marketing and revenue were significantly higher than the control groups.

These positive effects, however, have not yet translated into better wellbeing of the households in terms of per capita consumption. This lack of impact on household wellbeing can partially be explained by the fact that households were earning less income from non-banana crops. In fact, there was a negative impact on total household income at midline because of the redistribution of land to banana plants from other crops. This negative effect was almost entirely driven by reduction in their income from non-banana crops. This short-term negative effect had disappeared at the endline 1 as some farmers started harvesting from their new plantations. However, farmers in the treatment group are yet to have any gain in their total income from their adoption.

Besides the training, we also tested a behavioural intervention of goal setting. Although we found significant marginal effect of this add on intervention at midline and endline 1 on technology adoption (especially on use of TCB), after the large lagged effect of training at endline 2, there is no significant difference between farmers with/without the goal setting component in TCB adoption, cultivation practices or other downstream outcomes. Since the goal setting intervention is designed to address farmers' procrastination, it is understandable that the effects are visible only in the short run. In terms of impact heterogeneity, neither the gender of farmers (female vs. male) nor the amount of land they managed made any differences to the outcomes obtained. There is also no differential impact by access to credit to support possible credit constraint. However, access to irrigation is found to be an important determinant of the amount of land used for banana cultivation.

The study also assessed spillover effects of the training on farmers who reside in the intervention villages but were not invited to the training. At endline 1, we observed weak signs of spillover effects on the amount of land used for banana cultivation, total banana production and yield. The effects on the spillover sample had become more visible by endline 2, especially on cultivation of modern varieties and banana sales. Overall, the results suggest strong learning effects on both treated and non-treated farmers in treatment villages from the early adopters.

9. Specific findings for policy and practice

The evaluation has demonstrated that training farmers on the benefits of TCB can influence them to adopt the technology. However, the benefits from this technology adoption, in terms of additional income to the farmers, are not yet fully established. The trend observed between midline and endline 1 suggested that positive effects on income would be possible in the future as farmers start harvesting the full benefit of the new technology. Although we found that farmers are on average getting more income from bananas compared to the control group at endline 2, there is still no significant increase in income. In fact, the point estimates are negative although not statistically significant. Part of the reason for not realizing higher total household income is reallocation of more land to banana cultivation between endline 1 and 2, resulting in lower income from non-banana crops. While an impact on total household income remains a possibility in future, there are important risks such as preventing crop loss from disease. However, if we consider only the income from bananas and banana productivity, the intervention is highly successful. The lack of impact on total income at endline 1 and 2, and the negative impact at midline demonstrate the need for measuring the effects of any new technology promotion policy on farmers' total income. While it seems somewhat obvious that total income is the ultimate outcome for any technology dissemination policy, a review of agriculture extension and innovation evaluations notes that only a small fraction go beyond the measures of adoption and productivity of the promoted technology (Lopez-Avila et al, 2017).

Drawing on behavioural sciences, we tested the effectiveness of a simple intervention that nudges farmers to translate their intention to adopt a technology into action. We found that such a nudge (which removes the mental blocks of a farmer in planning for and taking actions) can be effective in the short to medium term. This is similar to a study in Kenya by Duflo et al. (2011) which showed that creating a commitment device to buy fertilizer can reduce procrastination and increase fertilizer use by the farmers. This has strong practical implications on various farmers' field school and training programs that promote new technology adoption. These initiatives can improve their effectiveness by introducing a planning session that helps the farmers to think through the details of the decisions they have to make in order to convert their intentions into actions.

The effects found in this evaluation have low economic significance, especially after considering the cost of the interventions. While the training was successful in influencing the farmers to shift to banana cultivation as well as achieve a lagged effect, this shift has not translated into higher income for the farmers. Although it is possible to yield more economic benefits due to the higher productivity and disease resistance of TCB, the evaluation period clearly shows the increase is banana income is offset by reduction in income from other crops. The project was implemented at a cost of over USD 450,000 (Annex I). Since the project reached additional beneficiaries beyond the sample, the unit cost of training per farmer could not be established. Nonetheless, the economic benefits during the evaluation period are too minor given the intervention costs.

Various agricultural extension programs often assume demonstration and spillover effects for their cost effectiveness. However, this research shows that such spillover effects can take time to materialize. Any agricultural policy that intends to achieve faster adoption needs to consider the possibility of slow spillover effects. It is also important to note that the findings of spillover effects in this study is specific to TCB adoption. The pace of demonstration effects can vary substantially by the nature of the technology and various other contextual factors that need to be considered on a case-by-case basis.

Appendix A: Supplementary Analysis

Table A1: Test of differential attrition across sample groups at endline 2

	Model1	Model2
Training	-0.004(0.016)	-0.236(0.079)***
Training + Goal setting	0.018(0.018)	-0.067(0.085)
Spillover	-0.007(0.013)	-0.200(0.075)***
Control	No	Yes
Control X treatment groups	No	Yes
Constant	0.112 (0.010)***	0.017(0.049)
F-stat of interactions (Training)		2.75(p=0.005)
F-stat of interactions (Training + GS)		1.31(p=0.240)
F-stat of interactions (Spillover)		2.79(p=0.005)
Observations	4,719	4,719
R-squared	0.001	0.037

Note: Variables used for baseline determinants of attrition include gender, age and education of the respondent farmer, household size, number of plots owned by the household, number of rooms in the house, access to electricity, ownership of livestock, access to cash saving, access to radio and television. F-test shows the joint significance test of the interaction terms of these characteristics with treatment assignments.

Table A2: Balance in baseline of households in baseline and endline2 panel

		Difference with control group			
	Control mean	Spillover	Training	Training + Goal setting	F-test
Panel A: Household characteristics					
Household size	2.84(0.06)	0.08(0.08)	0.06(0.09)	0.14(0.09)	0.788
Gender of the respondent (1=Male)	0.75(0.01)	0.01(0.02)	-0.00(0.02)	0.01(0.02)	0.197
Age of the respondent	50.00(0.50)	-0.43(-0.68)	-0.23(0.77)	0.67(0.84)	0.950
Respondent education (1= Post-primary)	0.50(0.02)	-0.02(0.03)	-0.02(0.03)	-0.04(0.04)	0.430
Access to land (Acres)	1.36(0.07)	-0.03(0.09)	-0.01(0.09)	-0.00(0.09)	0.084
Number of rooms used	3.70(0.09)	-0.08(0.11)	-0.08(0.11)	-0.06(0.12)	0.214
Have electricity (1=Yes; 0 = No)	0.47(0.04)	-0.08(0.05)	-0.09(0.05)*	-0.09(0.05)*	1.343
Have goats (1=Yes; 0 = No)	0.57(0.02)	0.01(0.03)	-0.01(0.03)	0.05(0.03)	1.900
Have radio (1=Yes; 0 = No)	0.91(0.01)	0.00(0.01)	0.01(0.01)	0.01(0.02)	0.273
Have TV (1=Yes; 0 = No)	0.42(0.03)	-0.07(0.04)*	-0.09(0.04)**	-0.09(0.04)**	1.654
Have savings (1=Yes; 0 = No)	0.03(0.01)	-0.01(0.01)	0.00(0.01)	0.01(0.01)	3.587
Panel B: Outcome					
Cultivated banana (1=Yes; 0 = No)	0.74(0.04)	-0.05(0.05)	-0.04(0.05)	-0.05(0.05)	0.317
Land used for banana (in acres)	0.15(0.01)	0.01(0.02)	0.01(0.02)	0.00(0.01)	0.307
Money spent on banana (in Ksh)	989 (113)	-48 (140)	5 (149)	-67 (150)	0.413
Did weeding for banana (1=Yes; 0 = No)	0.60(0.04)	-0.04(0.05)	-0.05(0.05)	-0.07(0.05)	0.794
Hired labour for weeding (1=Yes; 0 = No)	0.20(0.03)	-0.02(0.03)	-0.00(0.03)	-0.02(0.03)	0.339
Used fertilizer for banana (1=Yes; 0 = No)	0.53(0.04)	0.00(0.05)	-0.01(0.05)	-0.04(0.05)	1.089
Used pesticides for banana (1=Yes; 0 = No)	0.39(0.04)	-0.03(0.05)	-0.02(0.05)	-0.02(0.05)	0.099
Used purchased plantlet (1=Yes; 0 = No)	0.10(0.01)	-0.01(0.02)	-0.01(0.02)	-0.01(0.02)	0.189
Amount of banana produced (in kg)	736 (60)	-100(77)	-30(85)	-37(82)	1.110
Banana yield (kg per acre)	4,941(391)	-1,085 (493)**	-482(563)	-591(557)	2.409*
Sold banana on contract (1=Yes; 0 = No)	0.01(0.00)	-0.00(0.00)	-0.00(0.00)	0.00(0.01)	0.931
Amount of banana sold (in kg)	515(47)	10(60)	56 (68)	22(65)	0.593
Revenue from banana sales (in Ksh)	4,568(448)	229 (584)	888(737)	576 (678)	0.637
Total income (in Ksh)	54,955(3,864)	-5,800(4,722)	518(5,819)	-10,591(5,196)**	4.127***
Income from non-banana crops (in Ksh)	28,241(3,589)	-4,744(4,206)	-3,913(4,507)	-7,363(4,163)*	1.912
Income from non-crops (in Ksh)	25,149(2,239)	-2,674(2,808)	2,788(3,669)	-5,123(3,181)	3.165**
Respondent is time consistent	0.73(0.02)	0.04(0.03)	0.04(0.03)	0.05(0.03)	0.965
Respondent is risk averse (1=Yes; 0 = No)	0.57(0.02)	0.01(0.03)	0.02(0.03)	0.04(0.03)	0.581

Note: *, ** and *** significant at 10%, 5% and 1% respectively. Statistical test of mean comparisons is conducted by clustering errors at village level, which is the unit of randomization.

Table A3: Endline2, endline and midline impacts on banana cultivation

	Cultivated banana	Cultivated modern variety	Used Tissue culture banana	Land used for banana	Money spent on banana
Training * Endline2	0.180 (0.041)***	0.296 (0.051)***	0.304 (0.043)***	0.076 (0.015)***	-44.958 (102.251)
Training * Endline1	-0.033 (0.043)	0.038 (0.043)	0.026 (0.031)	0.004 (0.011)	-47.576 (113.054)
Training (Midline impact)	0.011 (0.039)	0.018 (0.048)	0.048 (0.022)**	0.024 (0.011)**	279.795 (94.507)***
Goal setting * Endline2	0.132 (0.040)***	0.254 (0.045)***	0.250 (0.044)***	0.065 (0.012)***	58.531 (96.961)
Goal setting * Endline1	-0.038 (0.042)	0.040 (0.039)	0.092 (0.034)***	0.016 (0.011)	59.751 (111.189)
Goal setting (Midline impact)	0.053 (0.040)	0.059 (0.047)	0.038 (0.020)*	0.025 (0.010)**	177.435 (83.967)**
Spillover * Endline2	0.046 (0.044)	0.059 (0.050)	0.032 (0.038)	-0.008 (0.013)	-260.518 (92.471)***
Spillover * Endline1	-0.031 (0.040)	-0.006 (0.039)	-0.016 (0.027)	-0.003 (0.009)	-207.093 (97.310)**
Spillover (Midline impact)	0.018 (0.042)	0.040 (0.049)	0.018 (0.022)	0.025 (0.011)**	266.512 (94.036)***
Endline2 dummy	-0.009 (0.031)	-0.059 (0.037)	0.126 (0.021)***	-0.003 (0.009)	-300.843 (49.275)***
Endline1 dummy	0.077 (0.034)**	0.017 (0.030)	0.091 (0.016)***	0.006 (0.007)	-131.121 (57.862)**
Baseline value of Y	0.036 (0.022)			0.148 (0.014)***	0.070 (0.008)***
Constant	0.734 (0.039)***	0.630 (0.038)***	0.107 (0.014)***	0.114 (0.008)***	440.057 (53.785)***
Observations	12,715	12,715	12,715	12,715	12,715
R-squared	0.020	0.029	0.087	0.067	0.037
Training = GS (Midline)	0.0313	0.121	0.555	0.924	0.178
Training = GS (Endline 1)	0.856	0.923	0.0149	0.131	0.231
Training = GS (Endline 2)	0.0466	0.170	0.0649	0.350	0.177
Control mean (Midline)	.777	.656	.126	.155	676
Control mean (Endline 1)	.832	.683	.231	.163	475
Control mean (Endline 2)	.832	.705	.351	.171	284

Note: *, ** and *** significant at 10%, 5% and 1% respectively. Errors clustered at village level.

Table A4: Endline2, endline and midline impacts on adoption of farming practices

	Did weeding for banana	Hired labour for weeding banana	Used fertilizer for banana	Used pesticides for banana
Training * Endline2	0.189 (0.049)***	0.016 (0.050)	0.224 (0.046)***	0.048 (0.051)
Training * Endline 1	0.032 (0.053)	-0.082 (0.054)	-0.010 (0.052)	-0.027 (0.046)
Training (Midline impact)	-0.021 (0.044)	0.069 (0.037)*	-0.025 (0.039)	0.010 (0.049)
Goal setting * Endline2	0.135 (0.051)***	0.029 (0.054)	0.190 (0.049)***	0.065 (0.050)
Goal setting * Endline 1	0.019 (0.054)	-0.071 (0.053)	0.020 (0.056)	0.017 (0.046)
Goal setting (Midline impact)	0.021 (0.045)	0.053 (0.037)	-0.028 (0.041)	-0.017 (0.051)
Spillover * Endline2	0.068 (0.053)	-0.070 (0.047)	0.107 (0.041)***	0.016 (0.046)
Spillover * Endline 1	0.012 (0.046)	-0.105 (0.051)**	-0.015 (0.048)	0.014 (0.045)
Spillover (Midline impact)	-0.001 (0.046)	0.070 (0.037)*	-0.052 (0.037)	0.009 (0.054)
Endline 2 dummy	-0.120 (0.035)***	0.050 (0.033)	-0.156 (0.030)***	-0.196 (0.035)***
Endline 1 dummy	-0.044 (0.038)	0.087 (0.041)**	0.059 (0.039)	-0.020 (0.033)
Baseline value of Y	0.036 (0.016)**	0.046 (0.014)***	0.049 (0.013)***	0.155 (0.020)***
Constant	0.652 (0.040)***	0.263 (0.026)***	0.529 (0.030)***	0.412 (0.039)***
Observations	12,715	12,715	12,715	12,715
R-squared	0.009	0.006	0.019	0.049
Training = GS (Midline)	0.0421	0.548	0.912	0.287
Training = GS (Endline 1)	0.636	0.769	0.376	0.203
Training = GS (Endline 2)	0.096	0.757	0.350	0.611
Control mean (Midline)	.672	.316	.529	.475
Control mean (Endline 1)	.641	.342	.585	.458
Control mean (Endline 2)	.627	.348	.475	.301

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A5: Endline2, endline and midline impacts on banana production

	Amount of banana produced (in kg)	Banana yield (per acre)
Training * Endline2	284.517 (53.050)***	873.133 (280.211)***
Training * Endline 1	107.589 (55.406)*	205.256 (296.773)
Training (Midline impact)	84.229 (48.556)*	295.174 (289.989)
Goal setting * Endline2	247.711 (45.666)***	973.211 (281.923)***
Goal setting * Endline 1	129.628 (46.403)***	451.760 (296.192)
Goal setting (Midline impact)	95.949 (45.911)**	261.758 (293.639)
Spillover * Endline2	20.609 (46.007)	455.670 (223.973)**
Spillover * Endline 1	87.170 (44.395)*	560.719 (264.420)**
Spillover (Midline impact)	44.124 (40.752)	-193.682 (225.114)
Endline 2 dummy	-126.844 (28.319)***	-909.130 (132.484)***
Endline 1 dummy	-53.407 (29.205)*	-364.268 (189.113)*
Baseline value of Y	0.092 (0.009)***	0.015 (0.006)**
Constant	312.820 (28.535)***	2,467.302 (163.363)***
Observations	12,715	12,715
R-squared	0.064	0.022
Training = GS (Midline)	0.707	0.852
Training = GS (Endline 1)	0.604	0.272
Training = GS (Endline 2)	0.398	0.633
Control mean (Midline)	423	2554
Control mean (Endline 1)	436	2488
Control mean (Endline 2)	385	2094

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A6: Endline2, endline and midline impacts on banana marketing

	Sold banana on contract	Amount of banana sold (kg)	Revenue from banana sales (Ksh)	Log of Revenue from banana sales (Ksh)
Training * Endline2	0.074 (0.021)***	316.650 (48.001)***	6,057.321 (778.711)***	1.388 (0.243)***
Training * Endline 1	0.022 (0.008)***	101.992 (44.431)**	1,804.807 (684.492)***	0.270 (0.237)
Training (Midline impact)	-0.009 (0.005)*	59.943 (40.245)	840.130 (577.694)	0.165 (0.234)
Goal setting * Endline2	0.066 (0.018)***	266.396 (40.738)***	5,113.677 (664.206)***	1.145 (0.231)***
Goal setting * Endline 1	0.022 (0.008)***	113.273 (42.806)***	2,237.183 (695.090)***	0.373 (0.242)
Goal setting (Midline impact)	-0.006 (0.005)	78.493 (39.206)**	1,059.611 (573.616)*	0.300 (0.234)
Spillover * Endline2	0.020 (0.007)***	19.908 (37.372)	427.334 (606.940)	0.105 (0.230)
Spillover * Endline1	0.010 (0.005)*	68.804 (38.728)*	1,106.732 (600.193)*	0.119 (0.231)
Spillover (Midline impact)	-0.008 (0.004)*	30.108 (33.037)	548.465 (499.336)	0.172 (0.233)
Endline2 dummy	-0.008 (0.004)*	-98.619 (23.690)***	-709.085 (377.139)*	0.551 (0.165)***
Endline1 dummy	-0.009 (0.005)**	-20.188 (27.010)	172.967 (424.072)	0.684 (0.194)***
Baseline value of Y	0.038 (0.032)	0.108 (0.010)***	0.158 (0.014)***	0.117 (0.013)***
Constant	0.011 (0.004)***	234.166 (23.731)***	3,582.301 (352.492)***	5.818 (0.202)***
Observations	12,715	12,715	12,715	12,715
R-squared	0.026	0.076	0.093	0.101
Training = GS (Midline)	0.468	0.486	0.581	0.268
Training = GS (Endline 1)	0.996	0.738	0.400	0.434
Training = GS (Endline 2)	0.545	0.216	0.153	0.084
Control mean (Midline)	.007	326	4877	6.64
Control mean (Endline 1)	.008	363	6071	7.46
Control mean (Endline 2)	.028	324	6052	7.62

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A7: Endline2, endline and midline impacts on household income and expenditure

	Total income	Income from non-banana crops	Per capita monthly expenditure
Training * Endline 2	8,642.379 (6,715.622)	5,748.058 (6,130.881)	98.663 (226.372)
Training * Endline 1	15,573.194 (6,711.518)**	6,628.634 (4,972.674)	-213.081 (219.487)
Training (Midline impact)	-13,884.298 (5,989.541)**	-12,823.765 (6,285.743)**	171.551 (179.680)
Goal setting * Endline 2	7,015.806 (7,158.734)	4,408.718 (6,326.521)	53.263 (225.567)
Goal setting * Endline 1	11,448.200 (6,929.609)	5,080.271 (4,403.855)	-100.317 (231.739)
Goal setting (Midline impact)	-16,347.028 (6,423.542)**	-12,093.620 (6,320.712)*	-68.688 (195.275)
Spillover * Endline2	-2,572.468 (6,548.368)	-1,649.171 (5,590.777)	-359.296 (225.404)
Spillover * Endline 1	4,330.748 (5,490.352)	405.924 (4,060.599)	-259.618 (227.005)
Spillover (Midline impact)	-7,484.568 (6,089.385)	-4,475.788 (6,815.956)	285.340 (192.544)
Endline 2 dummy	-2,220.125 (4,240.764)	-238.962 (3,068.504)	-297.464 (165.002)*
Endline 1 dummy	-581.724 (5,121.948)	-7,131.973 (5,005.320)	-174.949 (138.493)
Baseline value of Y	0.222 (0.017)***	0.379 (0.026)***	
Constant	110,386.363 (4,854.695)***	41,363.825 (5,629.218)***	3,850.292 (134.031)***
Observations	12,715	12,715	12,715
R-squared	0.036	0.092	0.008
Training = GS (Midline)	0.561	0.772	0.0950
Training = GS (Endline 1)	0.400	0.585	0.445
Training = GS (Endline 2)	0.782	0.697	0.779
Control mean (Midline)	114879	45946	3965
Control mean (Endline 1)	118309	47617	3528
Control mean (Endline 2)	115455	39243	3690

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A8: Impact heterogeneity of banana cultivation by access to land and gender

	Cultivated banana	Cultivated modern variety	Used Tissue culture banana	Land used for banana	Money spent on banana
Training (Endline2)	0.190 (0.045)***	0.289 (0.052)***	0.352 (0.073)***	0.106 (0.025)***	189.397 (116.574)
Goal setting (Endline2)	0.149 (0.050)***	0.186 (0.064)***	0.179 (0.082)**	0.074 (0.014)***	67.852 (70.062)
Training (Endline2) * Male	0.073 (0.048)	0.115 (0.062)*	0.000 (0.082)	0.000 (0.026)	-128.706 (116.411)
Goal setting (Endline2) * Male	0.089 (0.055)	0.204 (0.074)***	0.154 (0.085)*	0.024 (0.021)	116.293 (105.755)
Training (Endline2) * Large land	0.036 (0.070)	-0.033 (0.107)	-0.057 (0.117)	0.000 (0.040)	325.707 (310.393)
Goal setting (Endline2) * Large land	0.066 (0.075)	0.197 (0.081)**	0.161 (0.111)	0.023 (0.032)	148.498 (121.367)
Training (Endline2) * Male * Large land	-0.149 (0.084)*	-0.113 (0.124)	0.065 (0.124)	0.004 (0.043)	-87.016 (315.452)
Goal setting (Endline2) * Male * Large land	-0.101 (0.088)	-0.285 (0.102)***	-0.157 (0.128)	0.026 (0.037)	14.466 (147.778)
Male respondent	-0.087 (0.040)**	-0.136 (0.047)***	-0.074 (0.036)**	-0.005 (0.008)	32.566 (55.712)
Large land	-0.041 (0.064)	-0.073 (0.059)	-0.048 (0.057)	0.070 (0.015)***	82.649 (57.005)
Male * Large land	0.106 (0.075)	0.198 (0.078)**	0.101 (0.060)*	-0.001 (0.016)	-19.353 (78.349)
Baseline value of Y	0.033 (0.032)			-0.013 (0.006)**	0.015 (0.013)
Constant	0.752 (0.049)***	0.624 (0.038)***	0.265 (0.042)***	0.107 (0.007)***	123.772 (31.613)***
Observations	2,729	2,729	2,729	2,729	2,729
R-squared	0.096	0.144	0.124	0.135	0.039

Note: Large land is household with above median land sizes. Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A9: Impact heterogeneity of banana cultivation by baseline access to loan

	Cultivated banana	Cultivated modern variety	Used Tissue culture banana	Land used for banana	Money spent on banana
Training (Endline2)	0.236 (0.037)***	0.331 (0.038)***	0.363 (0.050)***	0.113 (0.017)***	267.140 (104.258)**
Goal setting (Endline2)	0.216 (0.037)***	0.333 (0.033)***	0.315 (0.047)***	0.110 (0.016)***	219.148 (65.096)***
Training (Endline2) * Loan	-0.121 (0.070)*	-0.110 (0.085)	-0.122 (0.114)	-0.021 (0.034)	-137.749 (114.534)
Goal setting (Endline2) * Loan	-0.025 (0.050)	-0.030 (0.060)	-0.038 (0.081)	0.040 (0.033)	50.103 (154.082)
Loan	0.066 (0.046)	0.027 (0.044)	-0.004 (0.041)	0.010 (0.013)	-19.025 (55.719)
Baseline value of Y	0.032 (0.030)			0.004 (0.007)	0.025 (0.013)*
Constant	0.696 (0.049)***	0.554 (0.029)***	0.224 (0.028)***	0.127 (0.010)***	171.263 (35.871)***
Observations	2,729	2,729	2,729	2,729	2,729
R-squared	0.092	0.132	0.120	0.094	0.020

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A10: Impact heterogeneity of banana cultivation by baseline access to irrigation

	Cultivated banana	Cultivated modern variety	Used Tissue culture banana	Land used for banana	Money spent on banana
Training (Endline2)	0.215 (0.035)***	0.287 (0.044)***	0.306 (0.052)***	0.079 (0.015)***	128.760 (60.404)**
Goal setting (Endline2)	0.213 (0.035)***	0.317 (0.035)***	0.274 (0.052)***	0.092 (0.015)***	133.009 (50.330)***
Training (Endline2) * Irrigation	0.005 (0.043)	0.081 (0.048)*	0.104 (0.072)	0.085 (0.025)***	312.049 (220.772)
Goal setting (Endline2) * Irrigation	-0.018 (0.042)	0.028 (0.042)	0.088 (0.074)	0.056 (0.027)**	223.751 (127.948)*
Irrigation	0.045 (0.039)	0.032 (0.034)	0.092 (0.034)***	0.033 (0.012)***	183.673 (58.318)***
Baseline value of Y	0.034 (0.031)			0.004 (0.006)	0.021 (0.013)
Constant	0.693 (0.045)***	0.549 (0.029)***	0.200 (0.028)***	0.120 (0.008)***	124.166 (27.528)***
Observations	2,729	2,729	2,729	2,729	2,729
R-squared	0.093	0.137	0.139	0.138	0.054

Note: Robust standard errors clustered at village level in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Appendix B: Survey instruments

For the three rounds of surveys, we used similar questionnaires. New questions were added to our baseline instrument when conducting the midline and endline 1 surveys. The endline 2 survey was significantly shorter in scope and focused on the key outcome areas. We are attaching the file containing the endline 1 questionnaire.

Questionnaire.doc

Appendix C: Pre-analysis plan

Our pre-analysis plan was prepared in October 2017 before we launched our midline survey. The file is attached here. The trial has also been registered at American Economic Association RCT registry (#AEARCTR-0002579).

Pre-analysis
Plan_oct_2017.docx

Appendix D: Sample size and power calculations

Following is the power calculation narrative we used at stage of our study design.

"The power calculations of our evaluation will largely follow Spybrook et al (2011). We will adopt a two-stage sampling process. In the first stage, clusters (i.e., villages where farmer groups are located) will be randomly selected in treatment and control groups. In the second stage, households (i.e., farmers) from within these clusters will be selected. As noted above, there will be 20% to 100% of the farmers per FO who will take part in the training. Given there are, on average, 30 farmers in one farmer organization (FO), 16 farmers will on average be provided with training in the treatment clusters. The size of each cluster will be 16 (i.e., 16 households, on average, in each village). Since there will be at least six farmers from each FO in the 60 treatment villages who will receive training, and 30 villages in comparison group, there will be 90 villages

Apart from the above information, we also need estimates of the standardized effect size and intra-class correlation. We will use the effect size of 0.3 SD in our power calculations. The effect size of 0.3 SD was chosen by taking into account impact sizes on programs that can be compared with this. For example, if we consider graduation programs targeting ultra-poor farmers, one can argue that we are underestimating the effect size. On the other hand, microfinance programs show lower impact of the program.10 However, as mentioned above, we believe this intervention to have higher take-up so larger impact.

We use statistics from the Kenyan Integrated Household Budget Survey 2005 to assume intra-cluster correlation in our study sites in Kenya. The within-village correlation of key outcome variables (such as total per-capita expenditure (PCE), PCE on food and total income) range from 0.15 to 0.22. Thus, considering intra-class correlation coefficients up to 0.20 seems reasonable.

The power computations based on the above inputs are calculated for our study. In general, we want to strive for a power value of 0.80 or higher which will be achievable by 89 villages. The power of the study will thus be at least 0.8. The power will be increased if the program impact is estimated to be more than 0.3 or the intra-class correlation is less than 0.2. Also note that the cluster level covariates are not taken into account; incorporating these covariates is a strategy for increasing the precision of the estimate and power (Spybrook et al, 2011)."[11]

An important change between this power calculation and actual implementation took place after the baseline survey. Our proposed sampling was intended to distinguish between farmers who are FO members and non-members. The purpose was to measure spillover between the FO members who participate in training and non-members who do

[11] Attrition was not explicitly discussed in the original power calculations, partly because the change in power as a result of change in number of observations within clusters had minimal effect. For example, as mentioned in original power calculations, reducing the number of households in our study from 30 to 20 from each cluster reduced the power from 0.84 to 0.82. Since the attrition was relatively modest in our study, we do not feel attrition rate has serious implications on our study.

not participate. However, during our baseline we discovered that the implementation partner did not have the FOs established yet, and all our sample households were eligible for their intervention. This enabled us to randomize within village without making any distinction between FO member and non-members. The critical advantage for this adjustment of our evaluation design has been ensuring comparability between the treatment and control farmers in the treatment villages to have a proper spillover sample.

Appendix E: Implementation monitoring

We deployed 2 field supervisors and a research associate to conduct compliance monitoring during implementation. Summary of their weekly reports are attached here.

Compliance tracking.zip

Appendix F: Qualitative assessment

We conducted a qualitative assessment before the endline survey. This report was done by our research team with support from an expert in qualitative methods.

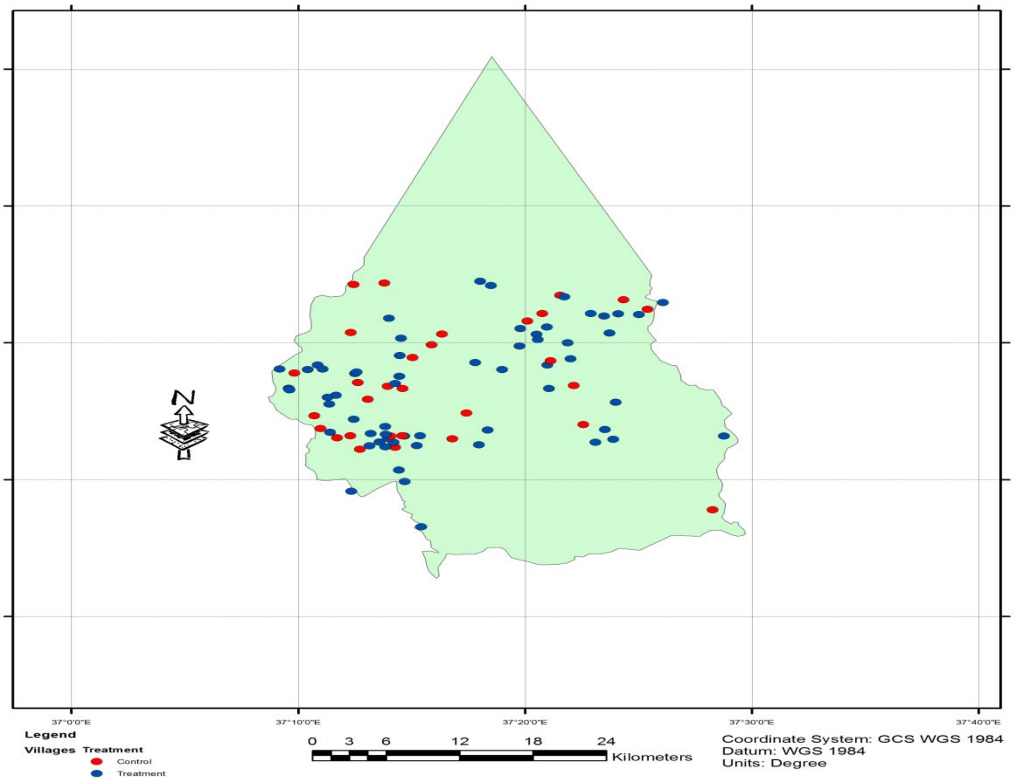
Qualitative Assessment Report.dc

Appendix G: Midline impact paper

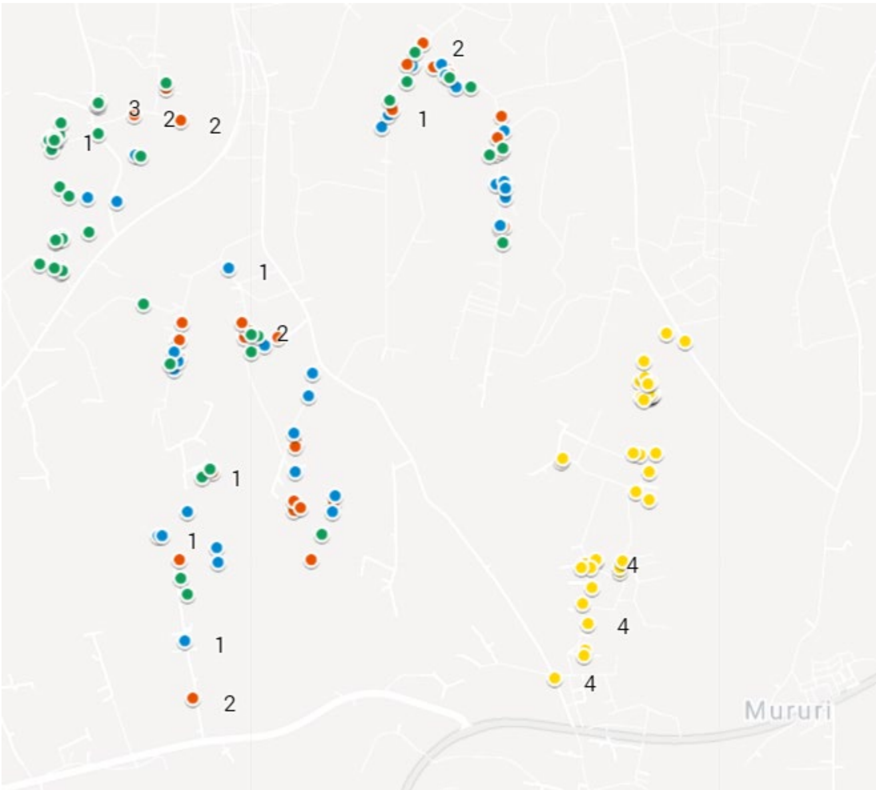
The paper from the panel data after the midline survey is attached here

Midline Paper_20180319.docx

Appendix H: Map of study location



Zoomed image of four neighbouring villages



1=training only, 2=Training + goal setting, 3=Spillover, 4=Control

Appendix I: Cost data for the programme implementation

Intervention Costs.pdf

Appendix J: .do files.

For results at endline 1

Do files.zip

For results at endline 2

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In Kenya, the government and development partners have tried to increase banana cultivation by smallholder farmers to improve productivity and food security. One project, implemented by the East Africa Market Development Associates (EAMDA) targeted about 11,000 farmers in Kirinyaga county. The authors of this study used a randomized controlled trial (RCT) to measure the impacts of information-sharing and a goal-setting intervention on farmers' adoption of tissue culture banana (TCB), banana productivity and household income.

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