LASER PULSE

Long-term Assistance and SErvices for Research (LASER)
Partners for University-Led Solutions Engine (PULSE)

Building Sustainable Supply Chains: A Model of Youth Input Resellers in Kenya

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KALRO Kenya Agricultural & Livestock Research Organization

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ABOUT LASER PULSE
LASER (Long-term Assistance and SErvices for Research) PULSE (Partners for University-Led Solutions Engine) is a $70M program funded through USAID's Innovation, Technology, and Research Hub, that delivers research-driven solutions to field-sourced development challenges in USAID partner countries.

A consortium led by Purdue University, with core partners Catholic Relief Services, Indiana University, Makerere University, and the University of Notre Dame, implements the LASER PULSE program through a growing network of 3,000+ researchers and development practitioners in 74 countries.

LASER PULSE collaborates with USAID missions, bureaus, and independent offices, and other local stakeholders to identify research needs for critical development challenges, and funds and strengthens the capacity of researcher-practitioner teams to co-design solutions that translate into policy and practice.

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Executive Summary

Project Motivation & Purpose

A productive population is beneficial to economic growth, but a growing population that lacks educational and economic opportunities can be a major burden. This issue is particularly acute in Sub-Saharan Africa (SSA) with 20 percent of the world's rural youth living in Africa, and the share is expected to reach 37 percent by mid-century (IFAD, 2019). [1] The narrative surrounding rural youth employment in SSA often asserts that there is a large youth unemployment crisis. However, the literature has recently identified youth underemployment as the more pressing issue (Bezu & Holden, 2014; Christiaensen & Maertens, 2022; Fox et al., 2016).[2] Underemployment can be categorized as "not being able to work as many hours as desired, either in wage or self-employment" (Fox et al., 2016, p. i9).With nearly 14 million young Africans, mostly from rural areas, entering the workforce every year, the importance of this problem cannot be overstated.

At the same time, reaching rural farmers in remote rural areas is another major issue. In SSA, the public and private sectors have made substantial investments to promote the use of modern agricultural inputs in SSA. These investments were made to ease access to these inputs; however, many smallholder farmers still have difficulty accessing these inputs when and where they need them (Aggarwal et al., 2018; Minten et al., 2013; Sitko & Jayne, 2014). In rural Ethiopia, Minten et al. (2013) found that farmers who live 10 km from the closest fertilizer distribution center faced transaction and transportation costs as high as the costs needed to bring the fertilizer from the international port to the distribution center (about 1,000 km). They concluded that solving the "last-mile" of the input supply chain must be a priority to improve modern input adoption. With these considerations in mind, we evaluated an intervention that was intended to improve youth underemployment and input supply chain access for rural farmers.

Methodology

We evaluated the effects of a clustered randomized controlled trial (RCT) in Kenya during 2021 and 2022. The intervention employed rural youth as resellers of agricultural inputs that included hermetic (airtight) storage bags, low-cost grain moisture meters to farmers on the last mile of the supply chain. Our sample consisted of 397 youth who were members of 40 agricultural youth clubs (20 treatment clubs and 20 control clubs) in the Eastern Kenyan counties of Machakos, Makueni, and Kitui. Treatment youth were linked with agricultural input suppliers (agro-dealers) and trained in business concepts, post-harvest grain management and gender main-streaming in agriculture. While changing gender attitudes was not the main focus of our study, we trained the youth on gender main streaming to highlight the important role that women play in agricultural production in Kenya and how to market the inputs to women and men differently based on their respective roles in agricultural production. We also wanted to make sure that women had the same opportunity to be successful in our study as men. As such, we nearly attained gender parity with 202 males and 196 females taking part in our study.

The agro-dealers provided youth group members with support in the form of capital, equivalent to 2,500 KSH ($25) worth of inputs on credit (e.g., 10 hermetic storage bags). The $25 amount in capital was chosen as a modest amount to provide youth, and this decision was informed by discussions with our field partners at the Kenyan Agricultural and Livestock Research Organization (KALRO) and local agro-dealers. Our project team also provided each youth with two hygrometers, a low-cost grain moisture meter, to either sell to farmers or offer grain moisture testing services for a fee. Additionally, the youth were required to put up 500

[1] In the context of our study, youth are classified as individuals between the ages of 18 and 35 as defined in the 2019 Kenyan Youth Development Policy (Republic of Kenya, 2019).

KSH ($5) of their own money in collateral for the agro-dealer as a sign of their seriousness and commitment to the project.

The RCT enabled us to test whether providing rural youth with training, access to capital, and the opportunity to sell inputs enabled them to increase their income and monthly total expenditures in the months following the intervention. We also conducted an exploratory heterogeneity analysis to estimate the extent to which income and expenditures increased more for youth in the treatment group who had certain characteristics compared to other youth in the treatment group. Furthermore, we provided descriptive evidence about the success of our intervention to increase market access of post-harvest inputs to farmers on the last-mile of the supply chain.

Findings

Our results indicate that intervention helped generate significant income for youth in the treatment group at the top of the income distribution, above the 90th percentile, during the initial main selling period of February to April 2022. However, we found that the intervention did not significantly increase income for most of the youth in the treatment group in our study. For example, the median youth in the treatment group generated over 4,000 KSH ($40) in additional income over the selling period. This amount accounts for approximately 37 percent of the income over the main selling period for those at the 50th percentile of the income distribution. However, when we looked across the distribution of treated youth, those at the top of the income distribution (above the 90th percentile) who were randomly assigned to the treatment group increased their income by more than $280 over the period. This is equivalent to about 36 percent of their total income from all of their income generating activities over this period for those at the 90th percentile of the income distribution. Essentially, this means that the employment opportunity and training that we provided did little to increase their economic standing in the short-term.

Our descriptive statistics from the intervention show that we were successful in creating new market linkages between agro-dealers and smallholder farmers, suggesting that innovative network designs could help further extend agricultural technologies and ease market access issues. However, we also found that external factors such as drought, poor incentives for youth in the treatment group, and a lack of trust between the agro-dealers and youth groups greatly inhibited the success of our intervention.

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ACRONYMS

IHS	Inverse Hyperbolic Sine
KALRO	Kenyan Agricultural & Livestock Research Organization
RCT	Randomized Controlled Trial
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development

Background

Rural Youth Employment in Kenya

Kenya is largely a young and rural country with a median age of 20 years and roughly 70 percent of its 54 million people living in rural areas (Central Intelligence Agency, 2022; UNDP, 2013). Given the country's large rural population, agriculture unsurprisingly is one of the main pillars of the Kenyan economy, making up one-third of GDP and engaging nearly 75 percent of the population in some sort of agricultural activity (Central Intelligence Agency, 2022). However, accurate employment numbers can be notoriously difficult to locate. Due to this point, we decided to focus on youth employment here for a more general view of youth employment, Unemployment and underemployment could affect around 40 percent of the population while disproportionately impacting youth at much higher levels (Central Intelligence Agency, 2022; UNDP, 2013). For example, a 2013 report estimated that 80 percent of the 2.3 million unemployed Kenyans were between the ages of 15 and 34. Moreover, the total number of unemployed youths in rural areas is greater than that of those in urban areas (UNDP, 2013). Despite this fact, empirical studies that have evaluated employment programs targeting Kenyan youth have had an outsized urban focus.[2] Hicks et al. (2015) is the only such study that we are aware of that focused on youth in primarily rural areas in Kenya.

Post-Harvest Input Supply Chains in Kenya

Market access for agricultural inputs such as fertilizer and seed have improved in Kenya over the last few decades following reforms that increased market activity (Chamberlin & Jayne, 2013). However, several agricultural inputs still face persistent supply chain complications in the country. Hermetic storage bags are an example of an agricultural input whose widespread dissemination has been inhibited by supply chain issues. These bags are multi-layered storage bags that utilize an airtight seal to decrease post-harvest loss from pests and excess moisture levels in stored grain.[3] Baributsa and Njoroge (2020) highlighted that their high price (250 Kenyan Shillings or KSH), local unavailability, and lack of knowledge on how to use the hermetic technology inhibited smallholders from adopting it.

Another post-harvest input whose dissemination is inhibited by a limited supply chain is the hygrometer. The hygrometer is a low-cost grain moisture meter that is placed inside a small airtight bag with a sample to measure the relative humidity and temperature in the surrounding air. This allows the hygrometer to obtain an accurate grain moisture content reading within 10 to 20 minutes (Tubbs et al., 2017). Fuller & Ricker-Gilbert (2021) observed that maize traders were willing to pay $0.28 to measure the moisture level in their grain using a hygrometer to determine if their grain was safe for storage. Nonetheless, they note that moisture testing services or access to these kinds of technologies are often out of reach to those in rural, informal grain markets.

Experimental Design & Data

Sampling Frame

In October 2021, we worked with KALRO and county government youth departments to obtain lists of agricultural youth groups in the Eastern Kenyan counties of Machakos, Makueni, and

[2] See Alvares de Azevedo et al. (2013), Honorati (2015), and Brudevold-Newman et al. (2017) for more information about employment programs that have targeted urban youth in Kenya.

[3] Six types of hermetic storage bags are currently available in Kenya: Purdue Improved Crop Storage Bags (PICS), AgroZ Storage Bags, ZeroFly Storage Bags, Elite Storage Bags, GrainPro Storage Bags (SuperGrainbags), and SaveGrain Bags (Baributsa & Njoroge, 2020; FarmBiz Africa, 2018).

Kitui. We then contacted groups by phone to introduce ourselves and give them background on our project. Among the groups that expressed an interest, we scheduled a meeting to formally introduce ourselves, further explain our project and gauge the group's interest in taking part in our study. These meetings took place between October and November 2021. After identifying 40 groups who were willing to participate, we randomized the groups into either the treatment or control arms of the study using excel. Each of these study arms consists of 20 youth groups. Youth groups were stratified at the sub-county level to make sure that an equal number of treatment and control groups were in each sub-county.

After assigning each group to either the treatment or control arm, we scheduled a follow up meeting with each group to select youth participants and conduct the baseline survey. These meetings took place in November and December 2021. For transparency, youth members from each group were randomly chosen to take part in the study by an open lottery. During the meeting, pieces of paper were randomly distributed using a bowl with numbers from one to the total number of members present who were between the ages of 18 and 35. Those who got numbers between 1 and 10 were selected to participate in the study. In total, this process gave us a total sample size of 397 youth in 40 youth groups across the three counties.

Intervention & Timeline

In Machakos, Makueni, and Kitui counties farmers can harvest two crops throughout the year due to the two rainy seasons. Planting for the main agricultural season takes place during October and November with harvest occurring in February and March. The second planting period occurs in May and June with harvest happening in July to September. As our intervention focused mainly on post-harvest inputs, we aimed to have youth start selling inputs in late February to April to coincide with the post-harvest period from the main agricultural season. We conducted our baseline survey in November/December 2021. This initial survey collected information on demographic characteristics, income-generating activities, expenditures, borrowing and savings history, prior business experience/knowledge, and psychometric measures. Enumerators were hired and trained to conduct interviews with the youth in person using the Survey Solutions program on a handheld tablet.

Following this survey, treatment youth were invited to a one-day training in their local area conducted by KALRO staff in December 2021 or January 2022. The training covered targeted modules on the following topics: business plan development, marketing, record keeping, sources of business finance, cash/credit management, post-harvest grain management and input use, and gender mainstreaming in agriculture. After the trainings were completed, each treatment youth group provided us with a list of agro-dealers in the area. The goal of this approach was to identify agro-dealers who the youth would be comfortable working with so that trust could be built between the youth groups and agro-dealers. We recruited agro-dealers to pair with each treatment youth group in January and February 2022. When the agro-dealers were recruited, we also conducted a short baseline survey with them to learn about their business background.

After each group had been paired with an agro-dealer, we distributed the initial set of inputs to treatment youth in late February/early March 2022. The agro-dealers agreed to provide inputs to the youth on credit. The youth then sold the inputs on a commission basis with the youth and agro-dealers each receiving a portion of the commission from the revenue generated from the youth's sales. The initial bundle of inputs that the youth received included 10 hermetic storage bags valued at approximately 2500 KSH ($25).[4] Each youth was also required to put up 500 KSH

[4] Youth in various treatment groups received different brands of hermetic bags as it would have been impossible to give each group the same brand due to local availability. Despite this fact, our LATE estimates should be unbiased, and the stable unit value treatment assumption should hold. The is because hermetic bags are all sold at the same price, 250 Kenyan Shillings and there is widespread

($5) in collateral for the agro-dealer.[5] The project also provided each youth with two hygrometers to provide grain moisture testing services or sell to farmers. A hygrometer is typically valued at 300 KSH ($3). The youth also received a one-time allotment of 1000 KSH ($10) to cover initial travel costs to allow them to transport and sell the inputs at various locations such as markets or directly to smallholders. After selling the initial bags, the youth could return to the agro-dealer to get more. We also encouraged agro-dealers to provide other inputs (e.g., fertilizer, field crop seed, etc.) for the youth to sell to diversify the products and give them other opportunities to generate income. However, this didn't happen as only three treatment youths reported selling inputs other than hermetic bags and the hygrometer.[6]

After the selling period ended in April, the midline survey was conducted in late April/early May 2022. This survey recorded information about treatment youth's performance selling inputs, income-generating activities, expenditures, and recent borrowing and savings activities. During the midline survey, we also conducted a follow-up survey with the agro-dealers that asked about their experience and satisfaction working with the project. The youth and agro-dealers also agreed that if a youth hadn't sold all of the initial bags that they received by the end of the selling period that they would return the remaining, unsold bags to the agro-dealer. Our project team also agreed that if a youth failed to return the bags that the agro-dealer would be compensated by the project to make up for the loss. In addition, if a youth wanted to return the bags to the agro-dealer at any point, the agro-dealers agreed to return the youth's 500 KSH in collateral. If the agro-dealer failed to do this, our project team agreed to reimburse the youth as such. After the initial selling period, our KALRO colleagues followed-up with the agro-dealers and youth groups to facilitate the returning of the bags and/or the corresponding collateral.

Baseline Randomization Balance Check

In an RCT, it is important to have balance among observable characteristics at baseline to be able to discern if the differences in outcome variables post-treatment are attributable to the treatment itself. In other words, this balance will help us to discern if the employment opportunity was successful at generating extra income and expenditures as well as if they were in better economic standing compared to the control group. As such, Table 1 below reports the pre-treatment balance of our randomization. Column 1 presents the number of observations while columns 2 and 3 represent the mean for each variable listed for the control and treatment groups. Column 4 shows the difference between the means for the control and treatment group for each variable. Additionally, column 5 displays the p-value for each variable to show if the two means for each variable are statistically different from the other. The treatment and control groups were not different from each other based on the baseline observed variables.

The first variable listed is the baseline value of yearly total income from the year before (December 2020 to November 2021). The second variable is the inverse hyperbolic sine (IHS) transformation of yearly total income. We use this transformation because it allows us to account for the negative and zero income values in our data (Bellemare & Wichman, 2019). The third variable is the yearly income dummy variable that is equal to one if a respondent had a positive total income over the course of the baseline year. Another main outcome variable was total expenditure for the month prior to the baseline survey being conducted. The mean of

awareness in Kenya of the value of hermetic storage regardless of the brand. As such, each youth should be able to have the same potential outcome regardless of the bag they sold.

[5] Five of the treatment groups received capital equivalent to $12.50 and put up $2.50 in collateral. This was done because they anticipated a poor harvest in their areas and weren't initially confident, they would be able to sell the 10 hermetic bags.

[6] These two youths each only sold 1 unit of fertilizer or livestock feed at the midline survey. As such, the income from these inputs will have negligible effects on our outcomes and are included in the econometric analysis.

the variable in KSH is statistically different between treatment and control groups, with a p-value of 0.06. However, the IHS transformed value of expenditures was balanced between the two groups. Despite success with our randomization, there were two other variables that are unbalanced at baseline: 1) the number of years that a youth has been a member of their youth group (p-value = 0.045); 2) =1 if a youth has participated in another agricultural development project in the past two years (p-value = 0.052). We controlled for these unbalanced covariates by including them in the RHS of our econometric model.

Table 1: Baseline Descriptive Statistics

		Mean			
	N	Treatment	Control	Difference	P-Value
Outcome Variables					
Yearly Income (KSH)	397	126,238	149,131	-22893	0.495
Yearly IHS Income	397	11.106	10.94	0.17	0.57
Yearly Income Dummy	397	0.96	0.955	0.01	0.796
Prior Monthly Expenditures (KSH)	397	21,056	16,046	5,010	0.06
Prior Monthly IHS Expenditures	397	10.062	9.875	0.19	0.13
Control Variables					
Business Knowledge Score	397	3.055	2.924	0.13	0.388
Grit Score	397	41.05	41.252	-0.20	0.618
Age	397	27.498	27.854	-0.36	0.46
No. of Years as a Group Member	397	2.19	2.643	-0.45	0.045
Highest Level of Education Completed	396	5	5.187	-0.19	0.31
=1 if female	397	0.512	0.47	0.04	0.395
=1 if HH Head	397	0.252	0.212	0.04	0.356
=1 if in another club	397	0.487	0.49	0.00	0.961
=1 if affected by Covid	397	0.699	0.637	0.06	0.19
=1 if participated in another ag dev project	397	0.291	0.384	-0.09	0.052
=1 if prior business training	397	0.322	0.313	0.01	0.857
=1 if own a business	397	0.377	0.339	0.04	0.425

Notes: Columns 1 reports the number of observations for each variable while columns 2 and 3 show the mean of each variable for the control group and treatment groups. Column 4 reports the difference between the control and treatment means for each variable with column 5 reporting the corresponding p-value. For context, 100 KSH is approximately equal to $1.

Dependent Variables

We have five main outcome variables: total income during the initial main selling period (February to April 2022), a dummy for positive income over the main selling period, a dummy if total income increased over the main selling period compared to the same time frame at baseline, total IHS expenditures for the month prior to the midline survey, and a dummy equal to one if the expenditures increased from the total expenditures from the month before the baseline survey. We chose to only include the months between February and April in our main selling period income variable as these were the months that covered the main post-harvest selling period. We excluded December 2021 and January 2022 from the main selling period income variable. We included our dummy variables to verify our results from the econometric specifications where the IHS-transformed income variables are the outcome.

We asked respondents which months they worked on 10 different types of income-generating activities (11 if treatment youth complied with the treatment and sold inputs).[7] If they selected working on any activity within these months, we subtracted their average costs from their average revenue from each activity. We then aggregated their total income for the months in which respondents indicated that they had financial transactions (received revenue and incurred costs) for each income variable. The total expenditure variable was calculated as an aggregation of six different forms of expenditures from the month before both surveys. The different types of expenditure are as follows: household contribution/personal, savings allocation, children's education, healthcare, investment, and family support. We use IHS transformed forms of each outcome variable in our analysis as described below. We chose income and expenditures as our main outcome variables because they were tangible and measurable outcomes to measure for rural youth in our study area. Focusing on these outcomes enabled us to see how our intervention impacted the daily life of youth and whether the intervention increased income and expenditures.

Results

Post-Treatment Outcome Descriptive Statistics

Table 2 reports the means for the control and treatment groups, their differences, and corresponding p-values for each post-treatment outcome variable. The differences in each of the main selling period income variables were significant. Additionally, the difference in midline expenditures were significant between the treatment and control groups, with corresponding p value of 0.044.

As discussed in the next subsection, the descriptive statistics from the intervention show that youth in the treatment group only generated a little over 200 KSH. Essentially, this means that the employment opportunity and training that we provided did little to increase their economic standing in the short-term. This little amount of additional income would seem to suggest that the intervention wouldn't have a statistically significant difference between the treatment and control groups. To explore this, we looked at the impacts the random treatment assignment had for those at different percentiles in the income distribution. We did this because looking only at average outcomes can mask substantial differences in impacts in variables such as income and expenditures that are heavily affected by outliers. We show these results in the Impacts from Treatment Assignment sub-section. To deal with the potential impacts of outliers on income, we drop the bottom two and top two percent percentiles of the untransformed Main Selling Period Income variable and then IHS-transform the new variable in our main analysis. The untransformed Main Selling Period in Table 2 does

[7] The baseline and midline surveys asked respondents about the following income generating activities: farming, salaried and/or contracted employment, off-farm self-employment, casual agricultural and non-agricultural laborer, rented out land, housekeeping, school stipend, gift/donations, and interest earned.

not include dropped observations, but the Main Selling Period IHS variable in the same table does include dropped observations.

Tables 3 shows both the untransformed and IHS-transformed descriptive statistics for each income source for the main selling period. The disaggregated sources of income seem to further indicate that the persisting significance in our main selling period income variable is being driven by an observed difference in farming income in both the non- and IHS-transformed variables. This implies that the youth took the knowledge and skills that they gained from the training and applied them to their already existing income-generating activities such as farming. Farming income was also the most commonly reported income source in each of the three surveys that we conducted.

Table 2: Post-Treatment Outcome Descriptive Statistics

		Mean			
	N	Treatment	Control	Difference	P-Value
Main Selling Period Income (Feb. to Apr. 2022)					
Main Selling Period Income (KSH)	383	42,804	27,853	14,951	0.052
Main Selling Period IHS Income	373	9.46	8.767	0.693	0.058
Main Selling Period Positive Income Dummy	383	0.938	0.832	0.106	0.001
Main Selling Period Increased Income Dummy	383	0.596	0.479	0.117	0.022
Midline Expenditures (Month before Midline Survey)					
Midline Prior Monthly Expenditures	383	19,741	15,798	3,943	0.044
Midline Prior Monthly IHS Expenditures	383	10.099	9.893	0.206	0.127
Midline Prior Monthly Increased Expenditures Dummy	383	0.549	0.5	0.49	0.336

Notes: Column 1 displays the number of observations for each variable while columns 2 and 3 show the means for each variable between the control and treatment groups. Columns 4 and 5 report the difference between the two means and the corresponding p-value. For context, 100 KSH is approximately equal to $1.

Table 3: Main Selling Period (Feb. to Apr. 2022) Income Sources

		Mean			
	N	Treatment	Control	Difference	P-Value
Non-Transformed Income Sources (KSH)					
Farming Income	383	4,277	2,463	1,814	0.022
Salaried/Contracted Income	383	8,588	5,211	3,377	0.416
Off-Farm Self-Employment Income	383	25,741	17,680	8,061	0.222
Casual Agricultural Laborer Income	383	1,059	986	73	0.89
Casual Non-Agricultural Laborer Income	383	1,838	662	1,176	0.057
Rented Out Land Income	383	26	26	0	0.989
Housekeeping Income	383	462	409	52	0.829
School Stipend Income	383	0	0	0	.
Gifts/Donations Income	383	360	477	-116	0.459
Interest Earned Income	383	608	203	405	0.094
IHS-Transformed Income Sources					
Farming Income	383	3.926	3.05	0.876	0.077
Salaried/Contracted Income	383	1.544	2.027	-0.483	0.239
Off-Farm Self-Employment Income	383	4.628	3.845	0.783	0.154
Casual Agricultural Laborer Income	383	1.346	1.82	-0.474	0.171
Casual Non-Agricultural Laborer Income	383	1.01	0.745	0.265	0.354
Rented Out Land Income	383	0.048	0.128	-0.08	0.359
Housekeeping Income	383	0.627	0.61	0.017	0.942
School Stipend Income	383	0	0	0	.
Gifts/Donations Income	383	0.933	0.677	0.256	0.314
Interest Earned Income	383	0.523	0.363	0.16	0.405

Notes: Column 1 displays the number of observations for each variable while columns 2 and 3 show the means for each variable between the control and treatment groups. Columns 4 and 5 report the difference between the two means and the corresponding p-value. For context, 100 KSH is approximately equal to $1.

Intervention Outcomes

Table 4 reports the descriptive statistics for the main outcomes from selling inputs. On average, the intervention only increased incomes by a small amount, just over 200 KSH ($2). Even though hermetic bags were the most common input sold, they generated little income for each youth reseller. This was because after selling a bag for 250 KSH the youth received a small margin, between 20 to 40 KSH, and paid the rest back to the agro-dealer.

Offering moisture testing services appeared to be the activity that led to the largest increase in income on average at about 198 KSH ($1.98). However, drastically fewer youth offered moisture testing services than the number that sold hermetic bags at. This is most likely due to the fact that you have to calibrate the hygrometer before using and then wait 10 to 20 minutes for the result. Additionally, even fewer hygrometers were sold even after training the youth on how to use them. Most smallholder farmers will not possess knowledge on how to use the hygrometer which would require the youth to teach them how before selling. Without proper training and knowledge, there is little incentive for a farmer to adopt new and foreign technology.

We also surveyed the youth on their biggest obstacles to selling. The most common answer both times was the poor harvest in their local area which would explain why overall sales were low due to low demand for post-harvest inputs. The second most reported barrier were transportation issues or long distances to sell inputs. This was further explained as the three most listed places where the youth sold inputs were as follows: directly to farmers in their households, at local markets, and out of the youths' own household. Farmers preferring other products (e.g., fertilizer, seed, etc.) than what the youth were selling was also the third most common barrier.

Despite generating low levels of income for treatment youth, our intervention did prove successful in providing smallholders easier access to agricultural inputs. Table 5 is based on youth observations of the number of farmers that said it was their first time either adopting a new input or accessing moisture testing services. Over 100 farmers said it was their first time adopting a hermetic storage bag or having their grain moisture levels tested to see if it was safe for consumption. Moreover, only 8 farmers reported adopting a hygrometer for the first time which was most likely due to the technical knowledge needed to operate the device as previously mentioned.

A similar pattern occurred for the number of total customers who bought the inputs or service offered and for the total number of inputs sold/moisture tests conducted. For hermetic storage bags, there were a total of 311 customers and 509 bags sold. 118 people were customers for moisture testing with 129 moisture tests being conducted in total while these numbers were much lower for hygrometers sold at 8 for both outcomes. As Fuller and Ricker-Gilbert (2021) point out, people in rural grain markets often lack access to these types of services/technologies and given the success of the service in our study, a similar network type approach of rural service providers could increase awareness of food safety issues and access to these types of services. An obstacle to implementing such an approach would be that the incentives would need to be lucrative enough for the service providers, but in our study the profit margins were simply too low.

Based on our experiences, another major challenge could potentially be the ability of all parties to work together. During the midline survey, we also surveyed all 17 agro-dealers in our study about their experiences with the project. Nine of them expressed high satisfaction, while seven of them had low levels of satisfaction and one reported very low levels. The major challenges that the agro-dealers mentioned about working with the youth are as follows: they often failed to pay the agro-dealer in a timely manner, the youth were not always honest, and poor communication between the agro-dealer and the youth. Despite this, 11 of the agro-dealers said they would continue working with the youth in the future. Given these facts, building trust, and having proper communication are major factors that would be necessary to any future project that wanted to involve multiple parties to extend agricultural technologies such as ours.

Table 4: Intervention Descriptive Statistics for Treatment Group

Variables	N	Mean	Std. Dev.	Min	Max
Total Revenue from Intervention (KSH	120	1,202	1,086	220	7,800
Total Income from Intervention (KSH)	120	212	322	0	2,860
Hermetic Storage Bags					
Total Sales Value (KSH)	120	1,060	935	220	7,500
Income (KSH)	120	120	113	0	900
Number Sold	120	4	4	1	30
Number of Customers	120	3	2	1	11
Moisture Testing					
Income (KSH)	37	198	470	0	2,800
Number of Tests Conducted	37	4	6	1	28
Number of Customers	37	3	5	1	28
Hygrometers					
Income (KSH)	8	300	27	250	350
Number Sold	8	1	0	1	1
Number of Customers	8	1	0	1	1

Notes: Column 1 reports the number of observations of each variable while columns 2 and 3 show the mean and standard deviation. Columns 4 and 5 report the minimum and maximum values. For context, 100 KSH is approximately equal to $1.
(1) The main selling period refers to the time period between February and April 2022.
(2) Total revenue includes the sales value from selling hermetic storage bags and revenue from moisture testing and selling hygrometers.
(3) Income from selling hermetic storage bags is equal to total sales value minus the amount paid back to the agro-dealer.
(4) The income from moisture testing and selling hygrometers is simply equal to the revenue generated from each activity since the youth didn't have to pay anything back to the agro-dealer for either activity.

Table 5: Total Number of New Adopters, Customers, and Inputs Sold

Input/Service Offered	No. of New Adopters	No. of Customers	No. of Inputs Sold/Tests Conducted
Hermetic Storage Bags	103	311	509
Moisture Testing	129	118	162
Hygrometers	8	8	8

Impacts from Treatment Assignment

We focus our main analysis on the time period of the main selling period (Feb. to Apr. 2022) as it is the period where we are most likely to observe an impact from the observation. Table 6 reports the impact estimates at different percentiles along the income distribution from the treatment assignment. These estimates include all observations and do not drop any outliers in the data. The estimates are measured in Kenyan Shillings. Across the income distribution, we find a limited impact on income for the majority of youth during the main selling period. However, the significant difference between the treatment and control groups shown in Table 2 is most-likely being driven by large impacts for those treatment youth at the top of our income distribution, above the 90th percentile, as shown in Table 6. In column (5), the random treatment assignment generated over 28,000 KSH in income for those at the 90th percentile of the income distribution. These results exhibit that the intervention disproportionally benefitted people at the top of the income distribution while marginally increasing the income over the selling period for the vast majority of youth.

Table 7 presents the average impact estimates during the main selling period. After dropping outlier observations in the data and IHS-transforming the main selling period income variable, we see in column (1) that the treatment assignment had a marginally significant and positive effect on income. As shown in Table 6, this effect is most-likely being driven by those at the top of the income distribution. To back-up our results, we employed dummy variables equal to one if a youth had positive income during the main selling period and if their income increased over this period compared to the same period at during the year before the baseline survey. Columns (2) and (3) provide supportive evidence that the random treatment assingment had a significant effect on income in the short-term. Treatment youth were more likely to have positive and increased income compared to the control group. Column (4) shows that the treatment assignment increased expenditures during the month before the midline survey by 16.9 percent but this effect was not significant. We also find that the expenditures marginally increased expendititures compared to the month before the baseline survey in a statistically insignificant manner.

Table 6: Main Selling Period Income Distribution Impacts

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Main Selling Period Income (KSH)				
	Perecentile = 10%	Perecentile = 25%	Perecentile = 50%	Perecentile = 75%	Perecentile = 90%
Treatment	169	1,036	4,657	9,843	28,639**
	(1,287)	(1,501)	(3,408)	(6,226)	(11,470)
Constant	-170	368	17,363**	25,099	41,309**
	(2,208)	(1,437)	(7,833)	(18,466)	(18,703)
Baseline Dependent Variable Included	Yes	Yes	Yes	Yes	Yes
Sub-County Fixed Effects Included	Yes	Yes	Yes	Yes	Yes
Baseline Control Variables Included	Yes	Yes	Yes	Yes	Yes
Observations	383	383	383	383	383
R-squared	0.059	0.082	0.109	0.102	0.091

Notes: This table shows percentile regressions for the variable Main Selling Period Income and reports values in Kenyan Shillings (KSH). Standard errors are clustered at the youth group level and reported in parentheses (Parente & Silva, 2016). *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 7: Main Selling Period Average Treatment Impacts

VARIABLES	(1) Main Selling Period IHS Income	(2) Main Selling Period Positive Income Dummy	(3) Main Selling Period Increased Income Dummy	(4) Midline Prior Monthly IHS Expenditures	(5) Midline Prior Monthly Increased Expenditures Dummy
Treatment	0.803*	0.108***	0.121***	0.169	0.041
	(0.399)	(0.032)	(0.037)	(0.134)	(0.051)
Constant	7.219***	0.729***	0.392***	6.559***	0.439***
	(0.682)	(0.050)	(0.037)	(1.015)	(0.070)
Baseline Dependent Variable Included	Yes	Yes	-	Yes	-
Sub-County Fixed Effects Included	Yes	Yes	Yes	Yes	Yes
Baseline Control Variables Included	Yes	Yes	Yes	Yes	Yes
Observations	368	383	383	383	383
R-squared	0.047	0.077	0.054	0.117	0.052

Notes: The above table reports the Main Selling Period ITT Estimates. Standard errors are clustered at the youth group level and reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Conclusions

The random treatment assignment generated a large amount of income for those at the top of the income distribution but failed to generate the same benefits for the majority of youth. This significance was most likely driven by farming income (shown in Table 3), meaning that the knowledge and skills gained from the training were likely put to use on already existing ventures such as farming rather than selling inputs. Farming was also the most commonly reported income generating activity in our sample. We also found no significant effect of our intervention on prior monthly expenditures or increased expenditures from the month before the baseline survey. On average, youth only generated 212 KSH ($2.12) in income from selling inputs. • In total the 200 youth who participated in the treatment successfully sold over 500 hermetic storage bags to over 300 customers. More than 100 of these customers adopted the technology for the first time. Over 100 grain moisture tests were conducted for more than 100 customers, most of whom reported it was the first time that they had had access to this type of service. The youth were only able to sell 8 hygrometers to just as many customers. This small amount is most likely due to the fact that the hygrometer requires training to properly use. This barrier to adoption may have inhibited farmers from buying the device from the youth. The youth also cited poor harvests in their area, transportation issues, and farmers preferring other products as barriers to selling inputs. The prolonged drought in the horn of Africa exacerbated this, surely leading to lower demand for post-harvest technologies. Additionally, nine of the 17 agro-dealers expressed high satisfaction, while seven of them had low levels of satisfaction and one reported very low levels. The agro-dealers mentioned that working youth was difficult because they often failed to pay the agro-dealer in a timely manner, the youth were not always honest, and poor communication between the two parties. Despite this, 11 of the agro-dealers said they would continue working with the youth in the future.

Recommendations

Our intervention successfully trained 400 rural youth in Eastern Kenya and linked them to agro-dealers. This created easier market access to post-harvest inputs for smallholder farmers as shown by the quantities sold and the number of new adopters. However, an obstacle to implementing such an approach would be that the incentives would need to be lucrative enough for the service providers. In our study, the profit margins were simply too low. Since the intervention failed to generate economic benefits for the majority of youth, we recommend that our intervention should not be scaled up in our study area. It is possible that this type of intervention could be scaled-up in an area less prone to drought with consistently high yields for smallholder farmers. These types of agricultural conditions could potentially generate higher demand for post-harvest inputs and increased economic opportunities for rural youth. Furthermore, the youth enjoyed the training that the project offered, but they needed more bundled products to sell for higher profit margins to make a successful business across seasons. Information Communication Technology (e.g., apps or a website) could be used to link young people to more potential customers for input to increase sales. Building trust, and having proper communication are major factors that would be necessary to any future project that wanted to involve multiple parties to extend agricultural technologies such as ours.

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