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

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Abstract

In Sub-Saharan Africa, high levels of youth un(der)employment and weak agricultural input supply chains have been widely documented. However, relatively few studies have tested the effectiveness of employment programs for rural youth. At the same time, adoption rates of improved agricultural technologies among smallholder farmers remain low due to various supply and demand side constraints. Our study seeks to provide insight on both fronts. We will also contribute to the understanding of grit and better business practices on the entrepreneurial success of rural youth. We accomplish this by conducting a randomized control trial where rural youth in Eastern Kenya were trained in business concepts and linked with agricultural input suppliers to become resellers of agricultural inputs to smallholder farmers.

Keywords: Rural youth, inputs, grit, supply chain, Kenya

JEL Codes: C13, D91, L26, O12

1. Introduction

Today, the youth population in low-income countries, most notably in Africa, continues to grow at a swift pace.[1] In fact, twenty percent of the world's rural youth live in Africa, with that number expected to reach 37 percent by mid-century (IFAD, 2019). The narrative surrounding rural youth employment in Sub-Saharan Africa (SSA) often asserts that there is a large youth unemployment crisis. However, the literature has mostly debunked this claim and identified youth underemployment as the more pressing issue[2] (Bezu & Holden, 2014; Chrisiaensen & Maertens, 2022; Fox et al., 2016; Mabiso & Benefica, 2019). With nearly 14 million young Africans, mostly from rural areas, entering the work force every year, the importance of this problem cannot be overstated (IFAD, 2019).

Another major challenge in SSA is reaching rural farmers on the last-mile of the agricultural input supply chain. Even after substantial public and private-sector investments to promote the use of modern agricultural inputs, many smallholder farmers in SSA 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 input supply chain must be a priority to improve modern input adoption.

With these considerations in mind, this article estimates the effects of a clustered randomized controlled trial (RCT) that employed rural youth as resellers of agricultural inputs (e.g., hermetic storage bags, low-cost grain moisture meters) to farmers. Our sample consisted of 398 youth who were members of 40 agricultural youth groups (20 treatment and 20 control) in the Eastern Kenyan counties of Machakos, Makueni, and Kitui. Treatment youth were linked with agricultural input suppliers (henceforth, agro-dealers) and trained in business concepts, post-harvest grain management and gender considerations.

The agro-dealers provided youth group members with support in the form of capital, equivalent to $25 worth of inputs on credit (e.g. 10 hermetic storage bags), while the youth put

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[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).

[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).

up $5 in collateral. The RCT enabled us to test the following hypotheses: i) participating in the intervention increases youth income on average, while considering potential crowding out of other income-generating activities at baseline; ii) The extent to which youth with higher levels of grit achieve higher levels of income through participating in the treatment. We also tested if the intervention affected the following intermediate outcomes: iii) if treatment youth employed better business practices due to the training and iv) if implementing better business practices led to higher sales values.

Our study contributes to three strands of literature in development economics. First, we contribute to the limited empirical literature concerning rural youth in SSA by testing the effectiveness of employing youth as resellers of agricultural inputs. Rural youth are often characterized as working in low-wage, informal employment activities such as farming and off-farm self-employment (Abay et al., 2021; Chrisiaensen & Maertens, 2022; Fox et al., 2016; Mabiso & Benefica, 2019, Yeboah & Jayne, 2018) and in some cases abandoning agriculture in search of employment in other sectors of the economy (Ahaibwe et al., 2013; Bezu & Holden, 2014). At baseline, our sample is in line with the former viewpoint with respondents reporting farming (for 260 youth) and off-farm self-employment (for 150 youth) as their most common income generating activities.

Underemployment is a prevalent issue for rural youth given the seasonal nature of agriculture. As such, farmers and agricultural laborers do not work full-time throughout the entire calendar year and commonly work less hours than people who work outside of agriculture when evaluating their time use (Chrisiaensen & Maertens, 2022; de Janvry & Sadoulet, 2020; Yeboah & Jayne, 2018). Abay et al. (2020) indicates that the probability of Africans taking part in no economic activity is largest for those in their 20s and often waiting until their 30s for employment opportunities to arise in non-farm wage and business activities. Taking these facts into account, one can see the need to smooth the labor calendar for rural youth outside of the peak labor demand periods of planting and harvesting. Encouraging youth to undertake entrepreneurial opportunities has been suggested to reduce rural youth underemployment by smoothing out their labor calendar (Ahaibwe et al., 2013; Bezu & Holden, 2014; IFAD, 2019).

Rural youth are known to lack the skills, knowledge, and access to resources or financial capital that are necessary to undertake productive investments that are critical to entrepreneurial success (Mabiso & Benefica, 2019). Our intervention counteracts this point by providing

treatment youth with start-up capital along with training in business concepts and post-harvest grain management. McKenzie (2021) finds that business training programs in developing countries have had mixed levels of success. On average they increased firm profits and sales by 5 to 10 percent.

However, these programs mostly focused on business that already existed while relatively few studies have evaluated the effect on start-ups. In Kenya, Bensch et al. (2021) study the impacts of a program designed to disseminate energy-access technologies on the last-mile of the supply chain. Rural individuals were able to start their own business and were provided with business and technical training. They find that the program had a substantial impact increasing individual monthly incomes by 15 percent. Moreover, microenterprises who implement better business practices such as record-keeping or financial planning enjoy larger profits and longer survival rates (McKenzie & Woodruff, 2017).

Second, we contribute to the understanding of grit on the entrepreneurial success of rural youth. This relationship is important to chronicle as economists are increasingly interested in studying psychological phenomena such as grit due to their implications on welfare and poverty outcomes (Laajaj & Macours, 2019; Lybbert & Wydick, 2018). Psychology literature defines grit as "perseverance and passion for long-term goals" (Duckworth et al, 2007, p. 1). Grit is measured on a scale by asking respondents questions about how different characteristics describe them. Several studies have constructed a grit scale as a measure of economic outcomes (see Alan et al., 2019; Alaoui & Fons-Rosen, 2021; Ricker-Gilbert et al., 2019; Wolfe & Patel, 2016). Each of these studies employed the "Short Grit Scale" (Grit-S) first developed by Duckworth and Quinn (2009). Grit-S is an eight-item scale split into two major factors: perseverance of effort and consistency of interest (passion).

However, a recent meta-analysis of the psychology literature regarding grit has called into question the validity of this instrument after showing measurement inconsistences among the two major factors as a weak predictor of performance (Crede et al., 2017). To overcome this measurement inconsistency, we are the first economic study to employ the Triarchal Model of Grit Scale (TMGS) as a measure for how grit will affect youth resellers' performance in the program. The TGMS was developed by Datu et al. (2017) for use in a country with a collectivist culture such as Kenya (see Background section for more discussion on the TMGS).

Third, we provide insight to the scalability potential of our novel approach to create market linkages on the "last-mile" of the agricultural input supply chain. Recent studies have documented the high cost of and lack of access to agricultural inputs in rural areas of SSA (Aggarwal et al., 2018; Minten et al., 2013). For example, Aggarwal et al. 2018 find that farmers incur travel costs of 6 percent ad-valorem for each additional kilometer of travel to the nearest agro-dealer in Tanzania. They estimate that if travel costs were reduced by half, then fertilizer adoption would double and subsequently increase local maize prices which would improve farmer welfare.

We calculated the intention-to-treat (ITT) and treatment on the treated (TOT) effects of the training and access to start-up capital on an individual youth's income. The ITT analyses gauge the intervention's average effect for the treatment group. The TOT analyses evaluate the local average treatment effects (LATE) of the intervention. This refers to the impacts on those who were induced by the intervention to participate in the training, take advantage of the credit access and start selling inputs.

To estimate the LATE, we linearly regress youth practicing better business practices against the random treatment assignment to obtain an estimate of the impact of complying with the treatment. Furthermore, the decision to implement better business practices is non-random. To capture the effect of this on the value of sales, we instrument treatment youth implementing better business practices to obtain an unbiased causal estimate. A heterogeneity analysis was also conducted to test whether individual youth with different characteristics may benefit differently from the intervention.

2. Background

2.1. 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. Unemployment and under-employment 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 (UNDP, 2013).

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.[3] Hicks et al. (2015) is the only such study that we are aware of that focused on youth in primarily rural areas in Kenya. In their intervention, youth were randomly given training vouchers to enroll in a vocational training program of their choice, but they found no significant effects on earnings or employment.

2.2. Grit in a Collectivist Context

Grit can act as a critical motivating factor for youth to engage in self-employment such as entrepreneurship (Wolfe & Patel, 2016). Despite this, Wolfe and Patel (2016) find low reliability in the comparison of their results across nine countries due to reasons such as varying cultural contexts. For example, grit (and the associated Grit-S) is a culturally varying construct that originated in a Western context. This is consistent with Laajaj and Macours (2019) who note that measures for noncognitive skills that originated in this context are increasingly becoming more common in developing country surveys, but often suffer from significant measurement error due to low reliability.

Kenya is a country with a collectivist culture meaning individuals have an interdependent concept of self [4] (Ma & Schoeneman, 1997). This fact has economic implications for productivity and performance since social factors such as relatedness to parents, friends and peers are linked to higher levels of passion and perseverance for long-term goals in an interdependent context (Datu, 2017). Datu et al. (2017) developed the TMGS to better assess grit in a collectivist setting by adding a third factor, "adaptability to situations", to the two other factors included in Grit-S. [5, 6] Additionally, Datu et al. (2017, 2018) find that the TMGS is a psychometrically sound and valid measure in a collectivist setting among Filipino high school students.

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[3] 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.
[4] Personal identities in this context are characterized in terms of relationships to others (Ma & Schoeneman, 1997).
[5] Datu (2018) points out that "adaptability to situations" is justified as a factor of grit because individuals in interdependent settings tend to exhibit different behaviors based on what actions are required in specific situations.
[6] The TMGS is made up of ten items scored on a 5-point Likert-type scale. See Appendix A1 for the complete scale.

2.3.Agricultural 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 market liberalization (Chamberlin & Jayne, 2013). However, several agricultural inputs still face persistent supply chain complications in the country. Despite being available for many years in Kenya, hermetic storage bags are example of an agricultural input whose widespread dissemination has been inhibited by supply chain issues. These bags are generally multi-layered storage bags that utilize an airtight seal to decrease post-harvest loss from pests and excess moisture levels in stored grain.[7]

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 hermitic technology inhibited smallholders from adopting it. 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, a low-cost moisture meter, 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.

3. Experimental Design & Data

3.1. Sampling Frame

In October 2021, we worked with the Kenya Agricultural and Livestock Research Organization (KALRO) and county government youth departments to obtain lists of agricultural youth groups in the Eastern Kenyan counties of Machakos, Makueni, and Kitui. We then contacted groups by phone to introduce ourselves and give them background on our project. If groups were interested in the project, we scheduled a meeting with each group to formally introduce ourselves, further explain our project and gauge the group's interest in taking part in our study.[8] 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.

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[7] 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).

[8] We are aware that this sampling method could raise external validity issues about our results since group identification is endogenous on a group's decision to participate in our study. However, this kind of identification is necessary to build trust between the youth groups and agro-dealers. Additionally, this sampling method appears to have led to no selection bias since our balance checks show that our randomization was successful.

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 open lottery. Pieces of paper were distributed in a bowl with numbers from one to the total number of members present who were between the ages of 18 and 35. Those whose got pieces with the numbers from 1 to 10 were selected to participate in the study. In total, this process gave us a total sample size of 398 youth in 40 youth groups across the three counties.

3.2. Intervention & Timeline

In Machakos, Makueni, and Kitui counties farmers are able two harvest two crops throughout the year due to the two rainy seasons. Planting for the 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, our aim was 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 interview the youth in person with 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.

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). Each youth was also required to put up 500 KSH ($5) in collateral for the agro-dealer.[9] 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 ($6). 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. However, these additional inputs varied between youth groups as it depended on what products the agro-dealers stocked.

After the selling period ended in April, the follow-up survey was conducted in late April/early May 2022. This survey recorded information about treatment youth's performance selling inputs, better business practices, income-generating activities, expenditures, and recent borrowing and savings activities. The data used in our analysis comes from both the baseline and follow-up surveys.

3.3. Power Calculations

We ran a small pilot that included 10 youth resellers and one agro-dealer during the post-harvest season of July to September 2021 that follows the short growing season. Using the yearly baseline revenue mean of 13,400 KSH from the pilot, we assumed an increase of 5 percent of baseline revenue as a result of the training.[10] This would be in line with the average increase in sales from business training interventions as discussed in McKenzie (2021). We based our standard deviation assumptions based off the standard deviation of 0.05 for sales in McKezie and

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[9] 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.

[10] These power calculations were initially conducted when we thought our main outcome variable would be revenue. We later changed course and adopted income as our main outcome variable because it is a more realistic measure of economic well-being by considering costs. However, our pilot data did not include detailed information on costs to income generating activities and did not allow us to factor in costs in these power calculations.

Puerto (2021). They ran an RCT with 3,357 firms in 157 rural markets in Kenya where firms were randomly assigned to receive business training. Knowing that we most likely wouldn't be able to achieve nearly as large of a sample size given financial resources and time constraints, we assume a standard deviation of 0.15 for revenue. This higher value is warranted given that a smaller sample size will have higher levels of variability in the main outcome variable.

We concluded that we could detect a reasonable MDE between 800 to 1300 KSH with a sample size in the range of 250 to 350 youth participants. This was determined assuming different scenarios with intra-cluster correlation coefficients of 0.01, 0.04, 0.07, and 0.1. These scenarios gave us a cohen's d value of 6 to 10 percent. These calculations were also done assuming 0.05 significance level, 0.8 statistical power, and a cluster size of 10 youth (per youth group). To account for expected early attrition, we determined that our ideal sample size would be to oversample and recruit 400 youth to take part in the intervention. This attrition is important to note as rural youth can be a transient group that may relocate in search of economic opportunities (Bezu & Holden, 2014; Mabiso & Benefica, 2019). This number was also comparable to the size of the treatment and control groups in other youth employment studies conducted in Kenya (see Alvares de Azevedo et al., 2013; Hicks et al., 2015; Honorati, 2015; Brudevold-Newman et al., 2017).

3.4. Baseline Randomization Balance Checks

Table 1 below reports the pre-treatment balance of our randomization. Columns 1 and 2 present the number of observations and mean for each variable listed for the control group. Columns 3 and 4 report the same except for the treatment group. On the whole, our randomization method appears to have been successful. The first variable listed is the baseline value of our main outcome variable, monthly average income. For this variable, we use inverse hyperbolic sine (IHS) transformation because it allows us to account for the negative and zero income values in our data (Bellemare & Wichman, 2019).

Despite this randomization success, there are two variables that are unbalanced at baseline. The number of years that a youth has been a member of their youth group appears to be significantly different (p-value = 0.044) between the treatment and control arms at the 5 percent significance level. Additionally, the indicator for if a youth has participated in another agricultural development project in the past two years appears to marginally different (p-value =

0.061) at the 10 percent significance level. We will control for these unbalanced variables in our econometric model.

3.5. Attrition

We recognized that it will be a challenge to keep the youth participants engaged throughout the project and to track their activities while getting them to complete survey interviews. This was important to reduce attrition and minimize any bias that it may cause. To accomplish this, we made the decision to oversample the control and treatment sample-size based on our power calculations and the observed fact that rural youth can be a transient group that may relocate in search of economic opportunities (Bezu & Holden, 2014; Mabiso & Benefica, 2019).

Table 1
Baseline Descriptive Statistics

Variables	Control		Treatment			
	N	Mean	N	Mean	Difference	p-value
	(1)	(2)	(3)	(4)	(5)	(6)
IHS Monthly Average Income	198	7.057	200	6.833	0.225	0.608
Age	198	27.854	200	27.52	0.334	0.488
No. of Years as Group Member	198	2.643	200	2.189	0.454	0.044
=1 if married	198	0.591	200	0.56	0.031	0.534
=1 if children	198	0.651	200	0.64	0.011	0.811
Level of Education Completed	198	5.187	199	5.01	0.177	0.336
=1 if affected by Covid	198	0.637	200	0.7	-0.064	0.178
=1 if another ag development project	198	0.384	200	0.295	0.089	0.061
=1 if prior business training	198	0.313	200	0.32	-0.007	0.884
=1 if own a business	198	0.339	200	0.38	-0.042	0.388
Business Knowledge Score	198	2.924	200	3.065	-0.141	0.353

Notes: Columns 1 and 2 report the number of observations and mean of each variable for the control group while columns 3 and 4 report the same for the treatment group. Column 5 reports the difference between the control and treatment means for each variable with column 6 reports the corresponding p-value. See Appendix A2 for the list of questions used to calculate the business knowledge score.

4. Empirical Model

4.1. Null Hypotheses

Our econometric analysis will test the following null hypotheses:

1. Providing rural youth with training and access to capital will not increase a youth's monthly income on average and not lead to a crowding out of other baseline income sources.

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2. Treatment youth with higher levels of grit will not achieve higher levels of monthly income compared to those with lower levels.

3. Providing business training will not cause youth to implement better business practices.

4. Implementing better business practices will not lead to a larger value of sales for treatment youth.

4.2. Dependent Variables

The main outcome variable used in our analysis is monthly income for the months of February, March, and April. We chose the monthly income for these months as these were the months that covered the main post-harvest selling period. 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).[11] If they selected working on any activity within these months, we subtracted their average monthly cost from their average monthly revenue from each activity. We then aggregated their total income for the three months and divided that number by three to arrive at their average monthly income for the three-month period.

Sales values for were calculated as an aggregation of the value of sales for each type of input sold. To measure better business practices, we adapted a list of 11 questions to measure better practices from the one used in McKenzie and Woodruff (2017); see Appendix A3 for the full list of questions. A respondent's answer to each question is assigned a one or zero with one meaning they are currently implementing the associated business practice. As you will see below, the vector denoting this variable represents the aggregate number of business practices being employed with a maximum possible score of 11 and minimum of 0. The income questions were asked in both surveys while the value of sales and better business practices questions were only asked at the follow-up survey.

4.3. Impacts of the treatment assignment

The focus of our analysis is on the impact of the treatments, training, and initial capital on the monthly income of the youth. We start by estimating the intention-to-treat (ITT) effect of being assigned to each treatment group for individual *i* who assigned to youth group *j* as follows:

$$Y_{ij} = \beta_1 + \beta_2 T_{ij} + \beta_3 G_{ij} + \beta_4 X_{ij} + \beta_5 Y_{ijbaseline} + \beta_6 Group_j + \varepsilon_{ij} \tag{1}$$

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[11] The baseline and follow-up survey 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.

where Y_{ij} denotes post-treatment monthly income. T_{ij} is a binary variable equal to one if an individual was assigned to the treatment group and zero otherwise. Vector G_{ij} in the above equation represents the measure of grit as a proxy for ability on the outcome variables. Grit was only measured at baseline as we view it as an inherent trait and constant throughout the intervention

X_{ij} denotes the vector that includes characteristics of the youth that are unbalanced between the treatment and control groups at baseline. We also include baseline monthly income to gather its effect on post-treatment monthly income with β_5 as the corresponding parameter. The youth group fixed effect is denoted by $Group_j$ while β_6 is the parameter to estimate. The error term is denoted by ε_{ij}. Since the intervention was randomized at the youth group level, we cluster standard errors at the same level (Athey & Imbens, 2017). We use Equation (1) to test the first hypothesis.

To test the second hypothesis, we estimate the following model to quantify how grit interacts with the treatment and their associated impact on youth monthly income:

$$Y_{ij} = \varphi_1 + \varphi_2 T_{ij} + \varphi_3 G_{ij} + \varphi_4 T_{ij} * G_{ij} + \varphi_5 X_{ij} + \varphi_6 Y_{ijbaseline} + \varphi_7 Group_j + u_{ij} \qquad (2)$$

where outcome variable Y_{ij} is the same as in Equation (1). Additionally, the covariates T_{ij}, G_{ij}, X_{ij}, $Y_{ijbaseline}$, and $Group_j$ are denoted the same as in Equation (1) while the error term is captured by u_{ij}. The parameter φ_4 tests if youth with higher grit levels who participate in the treatment gain more from it compared to those with lower levels of grit. We expect that φ_5 will both be greater than zero.

4.4. Impacts of actually complying with the treatment assignment

We estimate the effect of actually taking part in the training provided to treatment youth and subsequently selling the inputs (TOT estimates). TOT quantifies the effect of the intervention on youth who were induced by randomization to attend the training and sell inputs. These estimates also include who, regardless of treatment assignment, would not have complied with the treatment. To quantify the effect of compliance, we estimate equation (3) below:

$$B_{ij} = \gamma_1 + \gamma_2 T_{ij} + \gamma_3 G_{ij} + \gamma_4 X_{ij} + \gamma_5 Group_j + e_{ij} \tag{3}$$

where the outcome variable B_{ij} denotes better business practices currently being implemented for youth i assigned to youth group j. The other covariates are the same as in equation (1) except for e_{ij} representing the error term. The model in equation (3) is used to test hypothesis 3.

It is important to note that the decision to implement better business practices is non-random. To capture the effect of this on the value of sales, the following model utilizes the two-stage instrumental variable method:

$$B = \rho_1 + \rho_2 T_{ij} + \rho_3 G_{ij} + \rho_4 X_{ij} + \rho_5 Group_j + \eta_{ij} \tag{4}$$

$$V_{ij} = \alpha_1 + \alpha_2 \hat{B}_{ij} + \alpha_3 T_{ij} + \alpha_4 G_{ij} + \alpha_5 X_{ij} + \alpha_6 Group_j + \omega_{ij} \tag{5}$$

where B in equation (4) denotes once again denotes better business practices and the explanatory variables are the same as in equation (3) with η_{ij} representing the error term. In equation (5) $\hat{B}_{ij}$ is predicted by using T_{ij} in equation (4) as an exogenous variable. The outcome variable V_{ij} represents a respondent's total value of sales for each type of input sold. In equation (5) the error term is given as ω_{ij} and the other covariates are the same as previously stated. Standard errors are clustered at the youth group level to reflect the level of random assignment. The model in Equation (5) is used to test the fourth hypothesis.

4.5. Heterogenous impacts

To analyze if youth with certain characteristics benefit differently from the intervention, we estimate the following model:

$$Y_{ij} = \delta_1 + \delta_2 T_{ij} * Z_{ij} + \delta_3 G_{ij} * Z_{ij} + +\delta_4 T_{ij} + \delta_5 G_{ij} + \delta_6 Z_{ij} + \delta_7 X_{ij} + \delta_8 X_{ij} * Z_{ij} +$$

$$\delta_9 Y_{ijbaseline} + \delta_{10} Y_{ijbaseline} * Z_{ij} + \delta_{11} Group_j + d_{ij} \tag{6}$$

Where Y_{ij}, T_{ij}, G_{ij}, X_{ij}, $Y_{ijbaseline}$ and $Group_j$ are as described in Equation 1. The error term is denoted by d_{ij}. Z_{ij} is a variable that changes for each iteration and is made up of a youth's individual characteristics. Standard errors are clustered at the youth group level. The coefficient

parameters $\widehat{\delta_2}$ and $\widehat{\delta_3}$ are indicators of whether the impacts of the treatment assignment differ by each characteristic Z.

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Appendix A1: The Triarchal Model of Grit Scale

Number	Item
Perseverance of Effort	
1	I am hard worker.
2	I finish whatever I begin.
3	I am diligent.
Consistency of Interests (Passion)	
4	New ideas and projects sometimes distract me from previous ones.
5	I have been obsessed with a certain idea or project for a short time but later lost interest.
6	I often set a goal but later choose to pursue a different one.
Adaptability to Situations	
7	I appreciate new opportunities that come into my life.
8	Changing plans or strategies is important to achieve my long-term goals in life.
9	Changes in life motivate me to work harder.
10	I am able to cope with changing circumstances in life.

*Each item is scored as follows:

1. Not like me at all.
2. Not much like me.
3. Somewhat like me.
4. Mostly like me.
5. Very much like me.

Note: Statements with negative connotations are scored in reverse. (e.g., more points if given statement describes the person.)

Appendix A2: Business Knowledge Questions

Number	Question
1	Who is an entrepreneur? a. person who makes loans to other businesses b. A person who starts their own business c. A person who works for another business d. A person who goes to college
2	What is the result of the difference between revenue and costs? a. Total Budget b. Daily Costs c. Profit d. Income
3	How is revenue calculated? a. Price x Quantity Sold b. Price + Quantity Sold c. Quantity Sold - Cost d. Price - Cost
4	If you want to borrow money, who can you ask? a. A bank b. Village Savings and Loan Association c. Family member d. All of the above
5	When asking for a loan, the borrower must consider which of these characteristics? a. The source of the loan b. Amount of the loan c. Repayment schedule d. All of the above
6	The additional cost of a loan beyond the principal is affected by which of the following? a. Interest rates b. Loan duration c. What type of business you are starting d. Both Interest Rates and Loan Duration
7	Personal expenses should be included in your businesses record keeping. a. Yes b. No

Note: The business knowledge score was calculated as the sum of the questions a respondent got correct.

Appendix A3: Better Business Practice Questions

Number	Question
Marketing	
1	Have you asked your customers whether there are any other products they would like you to sell? If yes, please specify which products:
2	Have you asked your associated agro-dealer which products are selling well?
3	Have you attracted customers with a special offer?
4	While selling inputs, did you advertise in any form?
Costing and Record Keeping	
5	Did/Do you keep written business records?
6	Did/Do you record every purchase and sale that you make?
7	Did/Do you use your records regularly to know whether sales of a particular product are increasing or decreasing?
8	Did/Do you know which goods you make the most profit per item selling? If yes, please specify which products:
Financial Planning	
9	Did you have a sales target set for the input selling period? If yes, please specify the value of the sales target in shillings:
10	Did/Do you compare your sales achieved to your sales target regularly?
11	Did/Do you have a budget of the likely cost that your business will have to face during the input selling period?