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# The Impact of Strengthening Agricultural Extension Services

## Evidence from Ethiopia

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## Abstract

This paper evaluates the effect of the Rural Capacity Building Project, which aimed at promoting growth by strengthening the agricultural service systems in Ethiopia and by making them more responsive to smallholders' needs. The project intended to increase the outreach of agricultural extension services to help farmers become aware of and adopt economically viable and environmentally sustainable technologies and practices. The paper examines the impact of the Rural Capacity Building Project using panel data on 1,485 geographically dispersed households in project and control kebeles. The results show that the strengthening of extension services had a positive impact on economic participation in the household, land area cultivated, and adoption of marketable crops, suggesting that access to extension helped farmers switch to more commercial, market-oriented agriculture. In addition, and contrary to previous evidence from other countries, female-headed households seem to have benefited equally from the project. However, the project was not able to reduce the preexisting gender gap in agricultural outcomes.


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# The Impact of Strengthening Agricultural Extension Services: Evidence from Ethiopia

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## 1. Introduction

Agricultural extension services are designed to "extend" research-based knowledge to the rural sector to improve the lives of farmers, by increasing their yields and production (Davis, 2008). The services are based on the assumption that there are beneficial technologies that can improve farmers' welfare, but that farmers need to know about them and about their benefits to adopt them. Extension services are meant to overcome this information barrier that constrains technology adoption, which may be rooted in low expected profits and perceived high risks (Jack, 2013). As information is a public good, its provision is associated with market failures, which justify government intervention in the provision of the services (Maffioli *et al*, 2011; Anderson and Feder, 2007). Indeed, most countries of Sub-Saharan Africa have been providing various forms of extension services for the last four decades through public investment. However, there is a lack of rigorous evidence on the impact of these investments on their ultimate beneficiaries, farming households.

Weaknesses in public extension systems have been noted but the evidence remains insufficient to reach a conclusion on the viability of extension services, based on cost-benefit considerations (Rivera et al, 2001, Anderson and Feder; 2007). Rigorous evidence on the impact of extension service investments could potentially have important effects on policy maker's commitment to adequately support such endeavors. Evidence would help promote policies geared towards the types of services that are most efficient in reaching beneficiaries and increasing productivity and income. In this paper, we evaluate the impact of the Rural Capacity Building Project (RCBP), a public investment to strengthen the extension system in Ethiopia.

Agriculture accounts for 85 percent of employment and 46 percent of GDP in Ethiopia (World Bank & IFPRI, 2010) and is dominated by smallholder farming, which accounts for approximately 96 percent of the country's cultivated area (Taffesse et al, 2012). Although there has been growth in production since 2000, most of the growth has come from increases in the area cultivated rather than an intensification of production. Yields have thus remained low by international standards (Taffesse et al, 2012). In 2006, as part of an array of policies that focused on promoting agricultural growth, the government implemented the RCBP, with the objective of strengthening agricultural services and systems and making them more responsive to the needs of smallholder farmers.

One of the components of the RCBP focused on improving the effectiveness of agricultural extension services in the country and explicitly sought to increase female participation by mainstreaming gender in all aspects of the extension system. Participation of women in agriculture in Ethiopia is substantial, with estimates lying between 29 percent and 45.5 percent of agricultural labor, according to the source (FAO, 2011; Palacios-Lopez *et al,* 2017). The gender gap in access to extension services appears relatively low in a study using data collected in 2009 in four regions of Ethiopia (World Bank/IFPRI, 2010). Twenty percent of women report having been visited by an extension agent, against 27 percent of men. However, they may simply be reporting the fact that an agent visited the home, even if they did not directly address the female respondent. The gender gap becomes significant in access to technical advice through community meetings organized by extension officers. Only 11 percent of women used this service against 28 percent of men (World Bank/IFPRI, 2010). In the sample used in the present study, 68 percent of female-headed households reported having had any contact with an extension officer in the past 12 months.

This is 18 percentage points less than male-headed households. Given women's high participation in agriculture and low access to extension, improving their access to knowledge and information on agricultural technologies may lift one of the barriers to women's economic empowerment in Ethiopia.

Studies evaluating the impact of extension have usually involved estimating the rate of returns to extension in an agricultural production function. Returns are generally positive but vary widely across studies and contexts (Anderson & Feder, 2007; Birkhaeuser *et al.*, 1991; Evenson, 2001). Challenges in identifying a causal relationship between extension and productivity or income include endogeneity in program placement and participation, lack of baseline data, and the severity of measurement errors in key outcomes (Aker 2011; Davis, 2008). Longitudinal data with valid counterfactuals are rare and experimental evidence on the impact of intensified extension services is very scarce, especially in Sub-Saharan Africa.

Traditional models of agricultural extension were usually government-driven and involved extension agents visiting farmers to deliver knowledge and information. Owens *et al* (2003) use panel data from a sample of resettled households in Zimbabwe to measure the impact of farmer contact with agricultural extension services. Controlling for farmer's ability, they find that receiving one or two visits per year has a significant positive impact on crop production but the effect is highly variable across years. A similar approach is used to measure the impact of access to extension services in Côte d'Ivoire, showing positive impacts on yields for food crops, but not for cash crops (Romani, 2003).

One of the most widely used models is the Training and Visit system (T&V), which involves regular visits by extension agents to contact farmers who are expected to disseminate the information learned to other farmers in their community (Anderson *et al*, 2005). An early study of the impact of the Kenya T&V extension system found high returns to extension (Bidlinsh and Evenson, 1993). However, these results were controversial, as a later study that revisited some of the data issues could not establish a significant impact on farmer efficiency or farm productivity (Gautam and Anderson, 1999). Gautam (2000) argues that the system was not efficacious because its approach did not focus on farmer empowerment, and was too supply-driven. In another study in Ghana, farmers were randomly selected into early and late treatment groups, to benefit from a business and technical training and input provision program (Agyei-Holmes *et al,* 2011). The program did not show significant impacts on crop yields and incomes. However, the sample size may have been too small to detect an effect and the phased-in design did not allow for medium term measurement of impact.

To overcome weaknesses of traditional extension systems, both the content and the mode of diffusion of the information can be altered. Adopting more demand-driven and participatory approaches can help increase the relevance of the extension services to the needs of farmers, and thus promote adoption of technology. In Uganda, a public-private extension service delivery approach, in which farmer groups contracted service providers to deliver advisory services, was evaluated using post-program cross-sectional data (Benin *et al,* 2007). The study finds that the program promoted adoption and use of agricultural production technologies but no significant impact on yield growth. Pamuk *et al* (2014) investigate the impact of a decentralized approach to the promotion of agricultural innovation, based on local participatory innovation platforms, where

representatives of local stakeholders, such as farmers' associations, traders, researchers, extension workers, NGOs, and government policy makers, meet regularly to share views, identify problems and prioritize solutions. The program was rolled out in eight countries in Sub-Saharan Africa and within each country, program locations were randomly selected at the village or higher administrative level. The study finds evidence of adoption of crop management innovations but also considerable heterogeneity in the impact across research sites. Other higher-level outcomes such as yields or household welfare were not included in the study.

Another approach that attempts to overcome some weaknesses of traditional extension systems is Farmer Field Schools (FFS), where farmers attend weekly field school sessions throughout the season. Through observation and learning-by-doing, farmers are meant to internalize the advantages of improved technology and adopt new practices on their own fields (Waddington et. al, 2014). Davis et al. (2012) evaluate the impact of the scaling up of FFS in Kenya, Tanzania, and Uganda. Using matching estimators and a difference in differences approach, they find that productivity and income increase significantly in Kenya and Tanzania, but not in Uganda. One of the main limitations of that study is the lack of detailed baseline data on the outcomes of interest, relying on recall data instead, and non-random placement of FFS. Kondylis *et al* (2017) evaluate the impact of two different modalities of the T&V extension delivery system, using a randomized control trial methodology in Mozambique. They compare the traditional decentralized system in which extension agents train contact farmers (who are then supposed to train other farmers in their communities) to an alternative in which contact farmers receive an additional centralized 3-day training. They find that directly trained contact farmers are more likely to adopt techniques. However, these higher levels of adoption by contact farmers did not encourage higher diffusion to other farmers in the community.

Extension services are one of several possible sources of information about new technologies that farmers can use. Other strands of research have investigated how information can be passed on to farmers through alternative modes. For example, there is a growing body of literature that focuses on social learning, which describes how information spreads within one's network (see e.g.: Jack, 2013; Munshi, 2004; Conley and Udry, 2001; Bandiera and Rasul, 2006). Information can also be made cheaper to supply and acquire, for example through the use of new information and communication technologies, such as mobile-phone based service or internet kiosks (Aker, 2010; Cole & Fernando, 2012).

Among the literature on extension, two papers have analyzed the impact of extension services in Ethiopia. Dercon et al. (2010) use longitudinal household survey data from 1994 to 2004 to study the impact of public investments in road quality and extension services on the welfare of farmers. Using household fixed effects and an instrumental variable strategy, they find that receiving at least one extension visit during the last cropping season increased consumption growth by 7.1 percent. Krishnan and Patnam (2014) make use of later waves of the same survey to compare the role of extension services and peer learning on improved seeds and fertilizer adoption between 1999 and 2009. To identify the impacts of neighbors on adoption, they use farmers' spatial distribution within villages. They also control for unobserved heterogeneity in the placement of extension services and household characteristics by including household and village fixed effects. They find that extension services had a significant initial impact on adoption but that by 2009, adoption mainly takes place through social learning and extension services become irrelevant.

Reviews of the impact of extension services consistently conclude that female farmers are underserved: access to extension agents is significantly lower for women as compared to men. Ragasa (2014) reviews evidence from India and several countries in Sub-Saharan Africa and summarizes factors causing the gender gap in access to extension: extension agents primarily work with the main household decision maker, who is usually male; the perception that women's contribution to farming in the household is minimal; household responsibilities and mobility constraints that hinder women's participation in training activities; cultural factors that make interaction of female farmers with male extension agents difficult; and the like. As a result, women farmers receive mostly second-hand information from their husbands, and this information may not be attuned to their needs if their agricultural practices and crop choices are different from that of male farmers. In addition, women often lack the financial and material resources to translate theoretical knowledge into practice (O'Sullivan *et al,* 2014; Ragasa, 2014; Quisumbing & Pandolfelli, 2010). Decomposition analyses from agricultural surveys in Ethiopia and Uganda show that when women farmers do receive extension services, they benefit from them less than their male counterparts (O'Sullivan *et al,* 2014). More rigorous evidence is needed on specific interventions targeted at improving both access to and impact of extension for women farmers. A randomized control trial in Mozambique suggests that female farmers were more likely to learn about agricultural techniques in communities in which there was a second, female contact farmer, in addition to a male contact farmer (Kondylis *et al.* Mueller, 2014). Female messengers may not only improve communication to women, but also better meet their informational needs.

The remainder of this paper is organized as follows: Section 2 provides a more detailed description of the RCBP. Section 3 outlines our identification strategy and provides a description of the data used to implement the estimation. The results are presented in Section 4 and Section 5 concludes.

## 2. Rural Capacity Building Project

The Ethiopian extension system relies on a network of professionally trained extension workers, called Development Agents (DA), who are deployed in Farmer Training Centers (FTC). The objective of the Ethiopian government is to have one FTC in each kebele[1] in the country with three DAs per FTC, each specialized in a different topic: livestock, crops, or natural resources management. At the time of project preparation, at the end of 2006, only a small share of kebeles had a fully equipped and functional FTC and half of the DA target number had been reached.

The RCBP aimed at strengthening the agricultural extension service systems in Ethiopia to make them more responsive to the needs of farmers and enhance their capacity to become aware of, and adopt, economically viable and environmentally sustainable technologies and practices. Through these activities, the project hoped to raise households' income, productivity and adoption of new agricultural practices by smallholder farmers. The RCBP was implemented in 10 regions, 127 woredas, 635 kebeles and 2,500 FTCs in the country, beginning in 2007. The project sought to improve the effectiveness of the agricultural extension program as it scaled up, particularly with regard to its DAs' technical capacity and its ability to respond to the expressed needs of farmers

[1] Ethiopia is divided in *woreda,* or districts, which are composed of *kebeles.* A kebele is the smallest administrative division in Ethiopia, and is similar to a neighborhood, or a ward. There are about 8,000 kebeles in Ehiopia.

(especially market-oriented farmers), to enhance women's participation and gender equality mainstreaming in all aspects of the extension system, and to support the emergence of non-public sector agricultural services as an additional feature of extension services in Ethiopia. The RCBP supported capacity building at the woreda, regional, and federal levels of the agricultural extension system. DAs received training, exposure visits, and technical and managerial support. The project provided already built FTCs with basic materials and equipment, including furniture, means of transport, and demonstration sites. It also supported FTCs in the setup of management committees. Other activities covered by the RCBP included support for institutional innovation and M&E in Agricultural Advisory Services, and research-extension-farmer linkages.

The RCBP was based on the assumption that by providing assistance and training to farmers they would be able to enhance their farming methods, which would in turn increase their productivity and improve their welfare. Below we analyze the impact of the project to see if the evidence supports this theory of change.

The selection of kebeles receiving RCBP was a two-stage process: selection of the woredas was done by regional authorities and the selection of five kebeles per woreda was done at the woreda level. The Ministry of Agriculture selected the participating treatment woredas based on specific criteria that included: completed FTC building and assignment of three qualified DAs; access to basic infrastructure, such as water and access roads; agro-ecology representation; commitment to focusing programmatic activities toward the needs of women farmers; and farming systems representation (e.g. rainfed subsistence farming in food insecure and high potential areas, commercial oriented farming, irrigation based farming, pastoralism, etc.). Thus, in order to create a comparison group for our analysis within agro-climatic zones, control woredas were purposively selected for inclusion in our survey based on proximity to the treatment woreda, to ensure the most similar agro ecology/farming system.

## 3. Data and empirical strategy

### 3.1. Data

To estimate the impact of RCBP, we use a panel data set collected among farming households in both project and non-project kebeles. The sample includes 1,485 households spread across four major regions, Amhara, Oromia, Southern Nations, Nationalities and People's Region (SNNPR), and Benishangul-Gumuz (BSG). Table 1 depicts the breakdown of households by region. Overall, our sample covers 82 kebeles in 23 woredas.

The first round of data collection (Round 1) was conducted between December 2009 and January 2010 among 1,609 households. About two years later, from March to April 2012, an effort was made to re-interview (Round 2) all households in order to create a panel data set. For 1,485 households, this strategy proved successful.[2]

As indicated above, round 1 of data collection occurred in 2009-2010 which was 2 years after the RCBP officially started, in 2007. Project implementation proceeded slowly, however, and at the

[2] This implies an attrition rate of 8%, based on a sample of 1,609 surveyed initially.

time of the initial survey in 2009, many regions and kebeles had only recently received the RCBP treatment. At the time of this survey most of the equipment for the FTCs as well as other necessary inputs for the program had been procured, though much of it had not yet been delivered to the end users. However, there is evidence suggesting that the treatment group had already received substantially higher exposure to extension services than the control areas. We therefore conduct the analysis without baseline data.

The questionnaire administered covered a wide range of topics including household demographics, asset ownership, agricultural production and practices as well as markers for the interaction between the household and agricultural extension agents. The main survey respondent was the household head. The access to agricultural extensions services module, however, was administered to two respondents separately: the household head and his or her spouse. If the household head had no spouse or if the spouse was unavailable for the interview, the main farming household member other than the head or spouse was interviewed.[3]

Table 2 presents summary statistics by treatment status during the first round of data collection. The sample is balanced at Round 1 on sociodemographic characteristics that, by nature, are relatively stable over time. The average size of households is a little over six members, and around one-quarter of households are headed by a woman.

### 3.2. Identification strategy

We estimate the impact of RCBP at two points in time, first in 2009-2010, at the beginning of roll-out (Round 1), then in 2012, when follow-up data was collected (Round 2).

We estimate the following equation:

$$Y_{ijt} = \delta Round2 + \beta_1 Z_j Round1 + \beta_2 Z_j Round2 + \gamma Region_j + \alpha X_{it} + \varepsilon_{ijt}$$

Where $Y_{ijt}$ denotes the outcome of interest of household i, residing in kebele j, at time t. Let $Z_j$ be an indicator variable that captures the treatment status which equals one if kebele j in which household i resides received the RCBP and zero otherwise. Let $Round_t$ be an indicator variable of the round of data collection, equal to 1 at Round 1, for t=1, and equal to 1 at Round 2, for t=2. $\delta$ controls for time effects and $\gamma$ for regional effects, with $Region_j$ a set of indicator variables of the region in which the household is located. Finally we control for household contemporaneous sociodemographic characteristics by including the following vector of variables $X_{it}$: sex of household head, presence of a female spouse of the head, household size, number of men in the household, number of elderly in the household (> 50 years old), number of adults (25-49), number of adolescents (16-24), number of children (6-15), dependency ratio (number of children under 7/household size), number of literate household members, number of students in household, number of rooms in the dwelling, roof material is iron sheets.

In this paper, we capture the intention-to-treat (ITT) estimator of the RCBP project. As treatment compliance is unobservable in this context, the ITT estimates the impact of RCBP based on assignment to treatment, that is, living in treated kebeles. The $\beta_1$and $\beta_2$ coefficients are the ITT

[3] A detailed definition of all the outcomes presented is included in the annex (Table 7).

estimators of the impact of RCBP on treated households, at Round 1 and Round 2 respectively.

Assessing the impact of any intervention requires making an inference about the outcomes that would have been observed for program participants (treatment) had they not participated, i.e. the counterfactual. We hypothesize that before program roll-out, treatment and control households were identical in time-invariant observable and unobservable characteristics. Results from descriptive statistics confirm that socio-demographic characteristics, which are generally stable over time, were balanced at Round 1 between treatment and control. In other words, to identify the impact of RCBP, we assume that in the absence of RCBP, the outcomes of treated households would have been the same as that of control households. If the project areas were selected for their agricultural growth potential over time in ways that are not captured by observable characteristics, then this selection – rather than the activities of the project – could be driving the results.

## 4. Results

### 4.1. Main impacts

Table 3 presents the ITT estimates of the impact of the RCBP on economic and agricultural outcomes of interest. Each row shows results of a regression for a different dependent variable. Column (1) shows the Round 1 mean of the control households and Column (2) shows the number of observations. Column (3) shows the coefficient of the time indicator and controls for the general trend between Round 1 and Round 2. Column (4) shows the ITT impact of RCBP at Round 1, and Column (5) shows the ITT coefficient at Round 2. All standard errors are clustered at the kebele level and all regressions control for regions and contemporaneous household sociodemographic characteristics.

Looking at Panel A of Table 3, our estimates suggest that in the earlier stages of the program (at Round 1) the number of household members working on the household farm decreased in RCBP households, and that agricultural sales increased. At Round 2, the RCBP had a positive and significant impact on the number of people contributing to income in the household and the total plot area owned or used by the household. Taken together, the ITT estimates suggest that the RCBP program had a significant impact on the economic participation of household members. The increase in the number of people contributing to household income was higher by 0.36 members in RCBP households at Round 2, and that difference is statistically significant. In terms of farm labor, there was an overall decline in household farm labor for all (treatment and control) households during the evaluation period. However, in RCBP areas, household farm labor was significantly lower at Round 1, but the overall decrease was mitigated in Round 2.

Panel B shows results on agricultural outcomes and high-value farming. Overall productivity, defined as the value of output per hectare, did not increase as a result of RCBP, regardless of the round. However, the farming and selling of marketable crops increased significantly. Farmers are adopting more marketable crops and are less likely to use intercropping. The evidence is consistent with RCBP helping farmers switch to more commercial, market-oriented agriculture. The labor patterns we observe in Panel A could also be consistent with this. Given that more market-oriented agriculture requires more work off farm (in terms of marketing, but also potentially in areas such

as processing), the significant increase we see in the number of people contributing to income but not necessarily working on the farm could be laying the groundwork for the crop switching.

Land area, irrigation and tree farming increased significantly at Round 2 in RCBP areas. In fact, the general negative trend observed in the control group for these outcomes was potentially mitigated by the program. It appears the training provided by extension agents could have encouraged farmers to devote more resources to agriculture, by investing in land, better technology and marketable crops with a longer maturation period.

In Panel C of Table 3 we assess the impact of RCBP on access and satisfaction with extension services. Results show that at Round 1, treatment households had significantly more regular contact with extension services. Regular contact with extension services is defined as at least monthly visits to give advice. These visits can be to the field, dwelling, or in another location. This confirms the hypothesis that at the time of the first round of data collection, increased services had already started being provided in RCBP areas. While satisfaction with extension services, measured as the respondent reporting that the advice given by the DA was very useful, was significantly higher at Round 1, it was significantly lower at Round 2 in RCBP areas. The negative coefficients in Round 2 offset the general increase in satisfaction and exposure to extension services that is indicated by the positive coefficients of the time variable.

These results suggest that that there was a "surge" in extension services in RCBP areas at Round 1. The effect of being exposed to extension are already visible at that time, as shown by the adoption of marketable crops and new agricultural technologies (see Figure 1). At Round 2 however, households in RCBP are more likely to report an increase in having received advice from NGOs than from an extension agent. It is possible that after initially getting a set of useful information from extension agents, households graduated to other sources of information as extension agents could not keep pace.

### 4.2. Impact of RCBP by gender of the household head

One of the original goals behind collecting the data for this impact evaluation was to look at the gender-differentiated impacts of expanding extension. Hence, the overall sample surveyed was larger than it would have been if we were simply looking for average impact. In addition, as indicated above, we asked more than one individual in the household about farming outcomes. To start our examination of how the effects might be different by gender, we turn to the effects on male versus female headed households since, in Ethiopia, the farm manager is often equated with being the head of the household. To do this, we estimate the following equation:

$$Y_{ijt} = \delta Round2 + \beta_1 Z_j Round1 + \theta_1 F_i Z_j Round1 + \beta_2 Z_j Round2 + \theta_2 F_i Z_j Round2 + \gamma Region_j + \alpha X_{it} + \varepsilon_{ijt}$$

Where $F_i$ is a female headship indicator, equal to 1 if the head of household i is a woman, and the other variables are as defined above.

Table 5 shows the coefficients of the impact of RCBP at each round and of the impact at each round interacted with the female headship indicator. We see that while the positive impact of the program on the number of individuals who contribute to income is lower in female-headed households, this difference is not statistically significant. Additionally, there is no significant

statistical difference in the impact of the number of people who work on the farm. The coefficient for the interaction term of treatment and female-headed household is also not statistically significant (and small) for farming and sales of marketable crops. This suggests that the main impacts of the program, adoption of marketable crop farming and increased labor force participation, benefitted male and female-headed households equally. Likewise, we find no difference in access to extension for female heads of households.

It is possible that, as extension is often geared towards or available to household heads only, the equal impact of RCBP on extension access for both female and male-headed households is actually driven by household headship and not gender. To verify that, we make use of the information on access and satisfaction with extension services which was collected for two individuals in each household: the household head and his or her spouse. If the household head had no spouse or if the spouse was unavailable for the interview, the main farming household member other than the head or spouse was interviewed. Including the data on the secondary respondent, we check whether the gender disaggregated results hold when looking at the sample in three different ways. First, we run the regression including all respondents, with gender interactions. This estimation compares the impact of RCBP on access to extension services on all men in the sample compared to all women, regardless of the headship status. Second, we run the regression on the women-only sample, adding interactions for headship. This model compared female household heads to other sample women who are secondary respondents, that is, wives of household heads in the majority of cases. Third, we run the regression on the sample of secondary respondents only, with gender interactions. In all three cases, there are no significant differences in the effect of RCBP on access to extension services between men and women, and household heads and non-heads (results not shown but are available on request).

There are a few remaining differences in impacts between female and male-headed households. As indicated by Panel B of Table 5, the number of crops grown by female-headed households increased significantly more than in male-headed households at Round 2. Female-headed households cultivate on average of 3.7 crops initially, against 4.7 for male-headed households (Table 4). As women are shifting to more commercial agriculture are the same rate as men, this significant coefficient may simply reflect the addition of one crop to their portfolio, starting from a lower baseline situation. Indeed, the fact that they do not experience the decline in intercropping (significant at 10 percent) at Round 1 that male headed households do is also indicative of this diversification.

The negative coefficient of irrigation for female-headed households at Round 2 means that the total effect of RCBP on female-headed household's irrigation was not significantly different from zero, and irrigation increased only in male-headed households. This may reflect a wealth effect, as irrigation represents a large investment and female-headed households have lower initial levels of wealth overall. If RCBP helped households make larger investments on their land, such as irrigation, as suggested above, this positive effect did not reach female-headed households. We will return to potential wealth effects in the next section.

We examine whether differences in fertility or tenure of plots could be driving the investment effect of RCBP. Looking at the simple differences in reported fertility of plots between control female and male-headed households at Round 1, we see no significant differences, ruling out the

explanation of soil fertility driving investments on the land such as irrigation (Table 4). In addition, the share of plots owned (including owned but rented out, shared out or gifted out) by female-headed households is higher than that of male-headed households, which would exclude land tenure differences driving differences in irrigation investments (Table 4).

It is important to note that although many of the impacts of RCBP are not statistically different between male- and female-headed households, RCBP did not help close the gender gap. As shown in Table 4, female-headed households are initially worse off in all dimensions: wealth and consumption, labor and capital endowment, access to extension services and farming advice in general, and farming practices. The project thus succeeded to some extent at benefitting women farmers as much as their male counterparts, but in both treatment and control areas, female-headed households were still worse off in these dimensions after RCBP.

### 4.3. Heterogeneity analysis by initial level of wealth

As mentioned in the gender-disaggregated analysis, some of the differences in effects of RCBP across sex may in fact by reflecting a wealth effect. We hypothesize that initially wealthier households may be more able to fully reap the benefits of the knowledge acquired from the extension agents. Below we analyze whether there is heterogeneity in treatment effect along the initial level of wealth. The higher wealth interaction term is equal to one if initially the total value of assets owned by the household was above the sample median. Assets include an extensive list of durable goods and equipment owned by the household and excludes land, house, and livestock.

Table 6 shows that there is no difference in impact on marketable crop adoption and access to extension services for initially wealthier households. At Round 1, the impact of RCBP on labor force participation in wealthier households is significantly negative as compared to less wealthy farmers, but this effect disappears at Round 2. RCBP has a strong positive impact on the likelihood of using irrigation for wealthier households in both rounds. At Round 1, RCBP significantly increases the number of crops with improved seeds for these households. For initially poorer households, the coefficient on the value of livestock is now positive and significant, while it is negative, but non-significant for wealthier households. This suggests the project encouraged investments, with wealthier households being able to invest in the land, by expanding irrigation use and higher quality crop farming, while poorer households invested in cheaper or more liquid assets, such as livestock. This pattern seems in turn to have an effect on higher-level outcomes measuring household welfare. Panel A of Table 6 suggests that initially wealthier households benefitted from RCBP significantly more than poorer households, in terms of non-food consumption and level of assets (the latter significant at 10 percent).

In terms of access to extension services, Panel C of Table 6 suggests that at Round 2, wealthier households in RCBP areas were significantly more likely to receive advice from peers than wealthier control households. We interpret this finding as a sign that wealthier households have larger or better quality networks that they can turn to for advice and useful information on agricultural technology, once they have exhausted the knowledge that the public extension system could provide.

## 5. Conclusion

We use a panel data set collected among farming households in Ethiopia between 2009 and 2012 to evaluate the impact of the Rural Capacity Building Project, which aimed at increasing farmer productivity and technology adoption by strengthening the agricultural extension system. Round 1 of data collection occurred from December 2009 to January 2010, that is, 2 years after the RCBP officially started, in 2007. Project implementation proceeded slowly, however, and at the time of the initial survey in 2009, many regions and kebeles had only recently received the RCBP. At the time of this survey most of the equipment for the FTCs as well as other necessary inputs for the program had been procured, though it is unclear as to how much training exactly the treatment group had had access to already. About two years later, from March to April 2012, an effort was made to re-interview (Round 2) all Round 1 households in order to create a panel data set. In accordance with the program roll-out, it seems that at Round 1, households in RCBP areas had already been exposed to extension services. Given this evidence, we conducted the analysis with no baseline data.

The results support the hypothesis of a "surge" in extension services happening around the first round of data collection. Treatment households have more regular contact with extension officers and higher satisfaction with extension services. At Round 2, treatment households report lower satisfaction with extension services and seem to be favoring information sources outside of the government system. The effects of the increase in access to extension services at Round 1 are visible at both Round 1 and Round 2. Firstly, the evidence points to a positive impact of RCBP on economic participation in the household, land area cultivated and adoption of marketable crops, suggesting that access to extension helped farmers switch to more commercial, market-oriented agriculture. Secondly, female-headed households seem to have benefited equally from RCBP. However, as their initial levels of wealth, agricultural outcomes and access to extension were lower, the project did not contribute to reducing the gender gap.

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**Table 1: Sample by location and treatment status**

| Region | Woreda | Observations |
|---|---|---|
| **Amhara** | | |
| *Control* | Debay Tilatgin | 150 |
| | Chilga | 126 |
| | Tech Gayint | 112 |
| *Treatment* | Fagita Lekomma | 59 |
| | Dejen | 42 |
| | Dembia | 60 |
| | Minjar | 21 |
| | Meket | 59 |
| | Dewa Chifa | 55 |
| | Mekdela | 90 |
| **Benshangul Gumuz** | | |
| *Control* | Homosha | 83 |
| *Treatment* | Menge | 64 |
| | Bello Jiganfoy | 88 |
| **Oromia** | | |
| *Control* | Boset | 117 |
| *Treatment* | Kuni | 26 |
| | Adama | 82 |
| | Booke | 18 |
| **SNNP** | | |
| *Control* | Dalocha | 84 |
| *Treatment* | Geze Gofa | 21 |
| | Yem Special | 21 |
| | Darra | 21 |
| | Offa | 65 |
| | Soro | 21 |

**Table 2: Household Level Descriptive Statistics by Treatment Status, Round 1**

| | Control Mean | Treatment - Control | N |
|---|---|---|---|
| Male household head (=1) | .741 | .017 | 1,485 |
| | [.438] | (.021) | |
| Presence of a female spouse of the household head (=1) | .723 | .007 | 1,485 |
| | [.448] | (.021) | |
| Household size | 6.19 | .020 | 1,485 |
| | [2.45] | (.178) | |
| Number of men in the household | 3.11 | .041 | 1,485 |
| | [1.69] | (.108) | |
| Number of elderly (> 50 years old) | .501 | -.012 | 1,485 |
| | [.678] | (.051) | |
| Number of adults (aged 25-49) | 1.46 | -.004 | 1,485 |
| | [.901] | (.050) | |
| Number of adolescents (aged 16-24) | 1.23 | -.064 | 1,485 |
| | [1.14] | (.080) | |
| Number of children (aged 6-15) | 2.07 | .059 | 1,485 |
| Dependency ratio (number of children under 7/household size) | .175 | .009 | 1,485 |
| | [.169] | (.016) | |
| Number of literate household members | 2.85 | .043 | 1,485 |
| | [2.04] | (.169) | |
| Number of students in the household | 2.37 | .098 | 1,485 |
| | [1.81] | (.145) | |
| Number of rooms in the dwelling | 2.07 | .045 | 1,473 |
| | [1.04] | (.133) | |
| Roof material is iron sheets (=1) | .560 | -.028 | 1,478 |
| | [.497] | (.065) | |

Notes: Standard deviations in brackets. Standard errors of the difference between Treatment and Control in parentheses. * indicates significance at 10% level, ** at 5% level, *** at 1% level.

**Table 3: Impact of RCBP**

| Panel A: Household Income, Assets, and Consumption | | | | | |
|---|---|---|---|---|---|
| | Round 1 | | Impact estimates | | |
| | Control mean | Obs. | Round 2 | Round 1 x RCBP | Round 2 x RCBP |
| Food consumption from market purchases (birr) | 71.6 | 2,847 | 64.4*** | 4.78 | -14.6 |
| | [90.7] | | (8.51) | (8.47) | (11.0) |
| Total value of assets (birr) | 966 | 2,847 | 979*** | 140 | 338 |
| | [1,321] | | (153) | (136) | (250) |
| Non-food consumption (birr) | 3,209 | 2,750 | 2,210*** | 161 | 242 |
| | [2,921] | | (307) | (281) | (459) |
| Nb of household members who contribute to income | 2.22 | 2,847 | .307* | -.015 | .360** |
| | [1.49] | | (.155) | (.127) | (.166) |
| Nb of household members who work on household farm | 4.10 | 2,847 | -.558*** | -.386*** | .105 |
| | [2.28] | | (.121) | (.111) | (.094) |
| Total plot area (ha) | 2.20 | 2,847 | -.663* | -.133 | .382** |
| | [4.35] | | (.334) | (.340) | (.167) |
| Livestock ownership (=1) | .958 | 2,834 | -.032** | -.015 | -.021 |
| | [.200] | | (.014) | (.015) | (.019) |
| Total value of livestock owned (birr) | 7,718 | 2,834 | 24,430*** | 721 | 4,213 |
| | [9,012] | | (3,401) | (1,304) | (5,258) |
| Total agricultural sales (birr) | 3,961 | 2,847 | -173 | 880 | 944 |
| | [6,031] | | (423) | (581) | (587) |

| Panel B: Agricultural outcomes and high-value farming | | | | | |
|---|---|---|---|---|---|
| | Round 1 | | Impact estimates | | |
| | Control mean | Obs. | Round 2 | Round 1 x RCBP | Round 2 x RCBP |
| Productivity (harvest value/ha, birr) | 5,466 | 2,811 | 2,778*** | -345 | -11.6 |
| | [4,920] | | (401) | (453) | (783) |
| Tried new agricultural activities in the past year (=1, head) | .473 | 2,513 | .033 | .058 | -.008 |
| | [.500] | | (.041) | (.041) | (.038) |
| Intercropping (=1) | .237 | 2,801 | -.057 | -.086** | -.059* |
| | [.425] | | (.041) | (.035) | (.032) |
| Irrigation (=1) | .146 | 2,803 | -.087*** | .031 | .046* |
| | [.354] | | (.023) | (.039) | (.026) |
| Crops with improved seeds (number of crops) | .823 | 2,806 | .007 | .078 | -.070 |
| | [1.26] | | (.084) | (.105) | (.100) |

| | | | | | |
|---|---|---|---|---|---|
| Crops with purchased seeds (number of crops) | 1.50 | 2,806 | -.383*** | -.269** | -.221* |
| | [1.55] | | (.090) | (.121) | (.112) |
| Fertilizer or pesticides (=1) | .865 | 2,783 | -.037 | -.002 | .007 |
| | [.342] | | (.024) | (.017) | (.032) |
| Number of crops grown by the household | 4.45 | 2,806 | -.951*** | -.053 | -.013 |
| | [1.95] | | (.133) | (.237) | (.183) |
| Marketable crop farming (=1) | .225 | 2,806 | -.143*** | .097** | .186*** |
| | [.418] | | (.027) | (.039) | (.038) |
| Marketable crop selling (=1) | .131 | 2,795 | -.057** | .106*** | .203*** |
| | [.338] | | (.028) | (.036) | (.039) |
| Tree farming (=1) | .171 | 2,801 | -.113*** | .015 | .044* |
| | [.377] | | (.026) | (.037) | (.024) |

**Panel C: Access to extension services**

| | Round 1 | | Impact estimates | | |
|---|---|---|---|---|---|
| | Control mean | Obs. | Round 2 | Round 1 x RCBP | Round 2 x RCBP |
| Contact with extension officer for advice or information (=1, head) | .821 | 2,435 | .184*** | .014 | .002 |
| | [.384] | | (.027) | (.032) | (.014) |
| Contact with extension officer was regular (=1, head) | .458 | 2,237 | .504*** | .076* | -.014 |
| | [.499] | | (.030) | (.042) | (.017) |
| Rated DA advice very useful (=1, head) | .568 | 1,819 | .085* | .153*** | -.084* |
| | [.496] | | (.045) | (.047) | (.044) |
| Received advice from peer (=1, head) | .656 | 2,522 | -.134** | -.003 | .058 |
| | [.475] | | (.056) | (.039) | (.045) |
| Received advice from contact farmers (=1, head) | .339 | 2,422 | .081* | .111** | .021 |
| | [.474] | | (.045) | (.047) | (.047) |
| Received advice from extension officers (=1, head) | .837 | 2,586 | .123*** | .003 | -.016 |
| | [.370] | | (.025) | (.031) | (.023) |
| Received advice from an NGO (=1, head) | .068 | 2,519 | -.032** | -.025 | .038* |
| | [.252] | | (.013) | (.016) | (.019) |

Notes: Standard errors in parentheses, clustered at the kebele level. * indicates significance at 10% level, ** at 5% level, *** at 1% level. Each row shows the coefficients of the regression of the outcomes in the left-hand side column on a time indicator (Round 2), and the interaction of the time indicators and the treatment variable (Round 1 x RCBP, Round 2 x RCBP). All regressions control for region and the following contemporaneous household variables: sex of household head, presence of a female spouse of the head, household size, number of men in the household, number of elderly in the household, number of adults, number of adolescents, number of children, dependency ratio, number of literate household members, number of students in household, number of rooms in the dwelling, roof material is iron sheets. Outcomes shown in Panel C and "Tried new agricultural activities in the past year" are individual respondent level variables, with only household heads included in the sample.

**Table 4: Round 1 outcomes by gender of household head, control group**

| | Male headed households | Female headed households | Difference | N |
|---|---|---|---|---|
| Food consumption from market purchases (birr) | 77.5 | 54.8 | 22.6*** | 672 |
| Total value of assets (birr) | 1,107 | 562 | 545*** | 672 |
| Non-food consumption (birr) | 3,557 | 2,214 | 1,342*** | 672 |
| Nb of household members who contribute to income | 2.37 | 1.77 | .603*** | 672 |
| Nb of household members who work on household farm | 4.37 | 3.32 | 1.05*** | 672 |
| Total plot area (ha) | 2.32 | 1.86 | .460*** | 672 |
| Livestock ownership (=1) | .980 | .895 | .085** | 669 |
| Total value of livestock owned (birr) | 8,965 | 4,117 | 4,848*** | 669 |
| Total agricultural sales (birr) | 4,536 | 2,312 | 2,224*** | 672 |
| Productivity (harvest value/ha, birr) | 5,955 | 4,069 | 1,886*** | 668 |
| Tried new agricultural activities in the past year (=1) | .540 | .280 | .259*** | 653 |
| Intercropping (=1) | .256 | .181 | .075** | 667 |
| Irrigation (=1) | .163 | .099 | .064** | 670 |
| Crops with improved seeds (number of crops) | .888 | .636 | .252** | 671 |
| Crops with purchased seeds (number of crops) | 1.58 | 1.26 | .320*** | 671 |
| Fertilizer or pesticides (=1) | .873 | .841 | .032 | 667 |
| Number of crops grown by the household | 4.70 | 3.72 | .984*** | 671 |
| Marketable crop farming (=1) | .249 | .156 | .093** | 671 |
| Marketable crop selling (=1) | .149 | .077 | .072** | 664 |
| Tree farming (=1) | .185 | .133 | .052 | 671 |
| Share of plots owned | .411 | .418 | -.007 | 670 |
| Share of plots fertile | .848 | .971 | -.123*** | 672 |
| Contact with extension officer for advice or information (=1) | .869 | .684 | .185*** | 653 |
| Contact with extension officer was regular (=1) | .502 | .333 | .169*** | 642 |
| Rated DA advice very useful (=1) | .596 | .437 | .160** | 403 |
| Received advice from peer (=1) | .684 | .578 | .106** | 654 |
| Received advice from contact farmers (=1) | .380 | .225 | .155*** | 652 |
| Received advice from extension officers (=1) | .890 | .688 | .202*** | 655 |
| Received advice from an NGO (=1) | .071 | .058 | .014 | 649 |

Notes: * indicates significance at 10% level, ** at 5% level, *** at 1% level. Table shows means at Round 1 of data collection for the control group only.

**Table 5: Gender differentiated impact of RCBP**

| Panel A: Household Income, Assets, and Consumption | | | | |
|---|---|---|---|---|
| | Round 1 x RCBP | Round 1 x RCBP x Female head | Round 2 x RCBP | Round 2 x RCBP x Female head |
| Food consumption from market purchases (birr) | .059 | 19.5* | -20.1* | 23.3 |
| | (9.29) | (10.5) | (11.2) | (15.5) |
| Total value of assets (birr) | 243 | -403** | 341 | -27.4 |
| | (162) | (199) | (275) | (234) |
| Non-food consumption (birr) | 150 | 62.0 | 97.1 | 628 |
| | (292) | (306) | (531) | (593) |
| Nb of household members who contribute to income | .006 | -.085 | .381* | -.088 |
| | (.152) | (.167) | (.192) | (.191) |
| Nb of household members who work on household farm | -.393*** | .026 | .123 | -.076 |
| | (.133) | (.172) | (.103) | (.142) |
| Total plot area (ha) | -.102 | -.124 | .360** | .095 |
| | (.359) | (.227) | (.173) | (.255) |
| Livestock ownership (=1) | -.010 | -.020 | -.023 | .008 |
| | (.012) | (.045) | (.021) | (.048) |
| Total value of livestock owned (birr) | 1,410 | -1,929 | 5,482 | -5,860 |
| | (1,332) | (1,485) | (6,205) | (6,483) |
| Total agricultural sales (birr) | 1,011 | -522 | 954 | -52.9 |
| | (692) | (773) | (684) | (791) |
| **Panel B: Agricultural outcomes and high-value farming** | | | | |
| | Round 1 x RCBP | Round 1 x RCBP x Female head | Round 2 x RCBP | Round 2 x RCBP x Female head |
| Productivity (harvest value/ha) | 253 | -249 | 1,710 | -1,850 |
| | (820) | (903) | (1,570) | (1,684) |
| Tried new agricultural activities in the past year (=1, head) | .069 | -.046 | -.021 | .053 |
| | (.044) | (.064) | (.042) | (.066) |
| Intercropping (=1) | -.110*** | .094* | -.044 | -.067 |
| | (.038) | (.049) | (.035) | (.044) |
| Irrigation (=1) | .038 | -.032 | .060** | -.066* |
| | (.043) | (.038) | (.027) | (.035) |
| Crops with improved seeds (number of crops) | .146 | -.276* | -.091 | .091 |
| | (.123) | (.164) | (.104) | (.156) |

| | | | | |
|---|---|---|---|---|
| Crops with purchased seeds (number of crops) | -.237* | -.133 | -.279** | .261 |
| | (.136) | (.144) | (.111) | (.159) |
| Fertilizer or pesticides (=1) | -.007 | .023 | .019 | -.052 |
| | (.018) | (.036) | (.031) | (.046) |
| Number of crops grown by the household | -.075 | .077 | -.152 | .622** |
| | (.251) | (.269) | (.182) | (.259) |
| Marketable crop farming (=1) | .102** | -.022 | .178*** | .036 |
| | (.042) | (.054) | (.040) | (.049) |
| Marketable crop selling (=1) | .111*** | -.022 | .201*** | .007 |
| | (.037) | (.040) | (.040) | (.045) |
| Tree farming (=1) | .021 | -.028 | .034 | .043 |
| | (.041) | (.058) | (.024) | (.039) |
| **Panel C: Access to extension services** | | | | |
| | Round 1 x RCBP | Round 1 x RCBP x Female head | Round 2 x RCBP | Round 2 x RCBP x Female head |
| Contact with extension officer for advice or information (=1, head) | -.005 | .074 | .005 | -.009 |
| | (.030) | (.057) | (.016) | (.012) |
| Contact with extension officer was regular (=1, head) | .057 | .072 | -.014 | .005 |
| | (.045) | (.066) | (.018) | (.030) |
| Rated DA advice very useful (=1, head) | .131*** | .121 | -.063 | -.094 |
| | (.048) | (.093) | (.047) | (.076) |
| Received advice from peer (=1, head) | -.026 | .094 | .057 | .004 |
| | (.042) | (.060) | (.050) | (.072) |
| Received advice from contact farmers (=1, head) | .116** | -.020 | .010 | .041 |
| | (.050) | (.058) | (.051) | (.071) |
| Received advice from extension officers (=1, head) | -.017 | .078 | -.005 | -.039 |
| | (.027) | (.055) | (.019) | (.049) |
| Received advice from an NGO (=1, head) | -.018 | -.029 | .042** | -.018 |
| | (.018) | (.026) | (.020) | (.032) |

Notes: Standard errors in parentheses, clustered at the kebele level. * indicates significance at 10% level, ** at 5% level, *** at 1% level. Each row shows the coefficients of the regression of the outcomes in the left-hand side column on interactions of treatment and time (Round 1 x RCBP, Round 2 x RCBP), and the interaction of the time indicator, treatment variable and sex of the household head (Round 1 x RCBP x Female head, Round 2 x RCBP x Female head). All regressions control for region, time period, and the following contemporaneous household variables: presence of a female spouse of the head, household size, number of men in the household, number of elderly in the household, number of adults, number of adolescents, number of children, dependency ratio, number of literate household members, number of students in household, number of rooms in the dwelling, roof material is iron sheets. Outcomes shown in Panel C and "Tried new agricultural activities in the past year" are individual respondent level variables, with only household heads included in the sample.

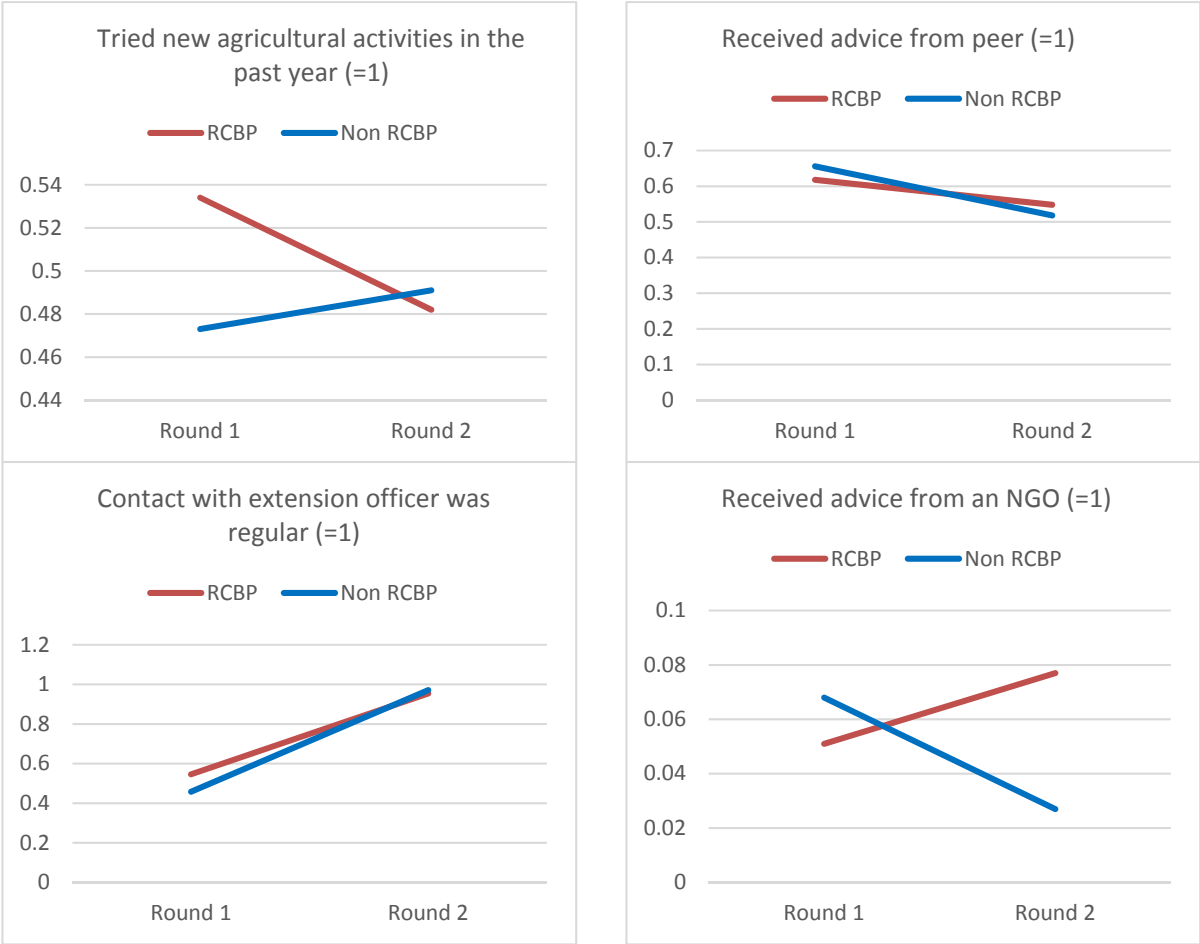
**Table 6: Heterogeneity analysis by level of initial assets**

| Panel A: Household Income, Assets, and Consumption | | | | |
|---|---|---|---|---|
| | Round 1 x RCBP | Round 1 x RCBP x High initial assets | Round 2 x RCBP | Round 2 x RCBP x High initial assets |
| Food consumption from market purchases (birr) | -1.61 | 12.5 | -18.5 | 8.58 |
| | (9.70) | (10.8) | (13.0) | (15.9) |
| Total value of assets (birr) | -56.9 | 382* | 13.1 | 692* |
| | (108) | (202) | (188) | (350) |
| Non-food consumption (birr) | 3.74 | 307 | -328 | 1,233** |
| | (255) | (373) | (364) | (596) |
| Nb of household members who contribute to income | .121 | -.268* | .238 | .243 |
| | (.151) | (.153) | (.183) | (.226) |
| Nb of household members who work on household farm | -.171 | -.431** | .099 | .015 |
| | (.113) | (.193) | (.105) | (.141) |
| Total plot area (ha) | .164 | -.604 | .366** | .056 |
| | (.138) | (.524) | (.147) | (.223) |
| Livestock ownership (=1) | -.019 | .007 | -.027 | .013 |
| | (.027) | (.029) | (.029) | (.036) |
| Total value of livestock owned (birr) | 553 | 449 | 6,277** | -4,106 |
| | (1,417) | (1,354) | (2,565) | (8,327) |
| Total agricultural sales (birr) | 295 | 1,129 | 670 | 637 |
| | (425) | (896) | (629) | (807) |
| **Panel B: Agricultural outcomes and high-value farming** | | | | |
| | Round 1 x RCBP | Round 1 x RCBP x High initial assets | Round 2 x RCBP | Round 2 x RCBP x High initial assets |
| Productivity (harvest value/ha) | -253 | -204 | 378 | -740 |
| | (459) | (611) | (777) | (1,133) |
| Tried new agricultural activities in the past year (=1, head) | .084 | -.051 | -.006 | -.002 |
| | (.056) | (.068) | (.055) | (.065) |
| Intercropping (=1) | -.129*** | .085 | -.074* | .030 |
| | (.045) | (.052) | (.041) | (.052) |
| Irrigation (=1) | -.017 | .095** | -.010 | .112*** |
| | (.037) | (.047) | (.022) | (.041) |
| Crops with improved seeds (number of crops) | -.106 | .361** | -.026 | -.070 |
| | (.092) | (.174) | (.101) | (.153) |

| | | | | |
|---|---|---|---|---|
| Crops with purchased seeds (number of crops) | -.390*** | .233 | -.255** | .088 |
| | (.132) | (.185) | (.126) | (.153) |
| Fertilizer or pesticides (=1) | -.019 | .035 | .013 | -.008 |
| | (.021) | (.024) | (.041) | (.043) |
| Number of crops grown by the household | .117 | -.353 | .211 | -.419** |
| | (.230) | (.239) | (.204) | (.209) |
| Marketable crop farming (=1) | .122** | -.050 | .195*** | -.016 |
| | (.048) | (.046) | (.051) | (.054) |
| Marketable crop selling (=1) | .112*** | -.013 | .191*** | .025 |
| | (.042) | (.042) | (.053) | (.050) |
| Tree farming (=1) | .044 | -.060 | .053* | -.016 |
| | (.043) | (.046) | (.032) | (.037) |
| **Panel C: Access to extension services** | | | | |
| | Round 1 x RCBP | Round 1 x RCBP x High initial assets | Round 2 x RCBP | Round 2 x RCBP x High initial assets |
| Contact with extension officer for advice or information (=1, head) | .025 | -.021 | -.0003 | .003 |
| | (.046) | (.048) | (.015) | (.015) |
| Contact with extension officer was regular (=1, head) | .103** | -.055 | .001 | -.031 |
| | (.049) | (.059) | (.023) | (.030) |
| Rated DA advice very useful (=1, head) | .184*** | -.062 | -.030 | -.102 |
| | (.064) | (.072) | (.055) | (.065) |
| Received advice from peer (=1, head) | .053 | -.111* | -.004 | .123* |
| | (.051) | (.061) | (.050) | (.069) |
| Received advice from contact farmers (=1, head) | .130** | -.037 | .015 | .009 |
| | (.055) | (.056) | (.057) | (.069) |
| Received advice from extension officers (=1, head) | -.00004 | .006 | -.030 | .028 |
| | (.044) | (.047) | (.034) | (.035) |
| Received advice from an NGO (=1, head) | -.029 | .008 | .039* | -.002 |
| | (.019) | (.029) | (.020) | (.030) |

Notes: Standard errors in parentheses, clustered at the kebele level. * indicates significance at 10% level, ** at 5% level, *** at 1% level. Each row shows the coefficients of the regression of the outcomes in the left-hand side column on interactions of treatment and time (Round 1 x RCBP, Round 2 x RCBP), and the interaction of the time indicator, treatment variable and high initial level of assets (Round 1 x RCBP x High initial assets, Round 2 x RCBP x High initial assets). All regressions control for region, time period, and the following contemporaneous household variables: presence of a female spouse of the head, household size, number of men in the household, number of elderly in the household, number of adults, number of adolescents, number of children, dependency ratio, number of literate household members, number of students in household, number of rooms in the dwelling, roof material is iron sheets. Outcomes shown in Panel C and "Tried new agricultural activities in the past year" are individual respondent level variables, with only household heads included in the sample.

**Figure 1: Round 1 and 2 means in the RCBP and non-RCBP kebeles**




Note: Means are calculated over the entire sample of respondents to the extension module, which was administered to the household head and another household member of the opposite sex (the spouse in male-headed households, another male in farmer in female-headed households).

## Annex

**Table 7: Definition of outcomes of interest**

| Variable name | Definition |
|---|---|
| *Food consumption from market purchases (birr)* | Total value of food consumed from market purchases during the previous last week in birr. Winsorized at 1%. |
| *Total value of assets (birr)* | Total value of all household assets excluding land, house and livestock in birr. Winsorized at 1%. |
| *Non-food consumption (birr)* | Total value of non-food items purchased in the past 12 months in birr, items with monthly recall are annualized. Winsorized at 1%. |
| *Nb of household members who contribute to income* | Number of people who contribute to income in the household |
| *Nb of household members who work on household farm* | Number of people who work on household farm activities |
| *Total plot area (ha)* | Total size of all plots owned or used by household in hectares (including rented/shared/gifted out and forest/pasture/homestead) |
| *Livestock ownership (=1)* | = 1 if household owns livestock |
| *Total value of livestock owned (birr)* | Total value of livestock owned in the past 12 months. Poultry purchase recall period is 3 months and annualized. Winsorized by 1 %. |
| *Total agricultural sales (birr)* | Total value of agricultural sales: crops sold last during the last cropping season, and livestock and animal by-product sold in the last 12 months.Winsorized at 1%. |
| *Productivity (harvest value/ha, birr)* | Total value of all crops harvested, using regional median price in birr, divided by total area cultivated in hectare. Winsorized at 1%. |
| *Tried new agricultural activities in the past year (=1)* | = 1 if respondent tried any new agricultural activities in the past year. |
| *Intercropping (=1)* | = 1 if household intercrops on at least one plot. |
| *Irrigation (=1)* | = 1 if household used irrigation on at least one plot. |
| *Crops with improved seeds (number of crops)* | Number of crops for which improved seeds were used. |
| *Crops with purchased seeds (number of crops)* | Number of crops for which seeds/seedlings were purchased. |
| *Fertilizer or pesticides (=1)* | = 1 if household used natural fertilizer, chemical fertilizer, pesticides, herbicides, or fungicides. |
| *Number of crops grown by the household* | Total number of crops grown by the household. |
| *Marketable crop farming (=1)* | = 1 if household grows at least one marketable crop, defined as high value crops that are primarily cultivated to sell on the market: coffee, mango, avocado, banana, guava, casmir, sesame, peanuts, clove, ginger, tobacco, khat, dinbilal, watermelon, eucalyptus, pineapple, orange, papaya, garlic, lemon, sunflower, cumin, cauliflower, rapeseed, cucumber, apple, and spices. |

| | |
|---|---|
| *Marketable crop selling (=1)* | = 1 if household sold at least one marketable crop. |
| *Tree farming (=1)* | = 1 if household grows at least one marketable tree: mango, avocado, banana, guava, eucalyptus, orange, papaya, lemon, apple, gishta |
| *Share of plots owned* | Share of all plots cultivated that are owned, rented out, or shared out by the household. |
| *Share of plots fertile* | Share of all plots cultivated on which soil is reported as fertile. |
| *Contact with extension officer for advice or information (=1)* | = 1 if the respondent had contact with a DA or a WOARD officer for advice or information since the last harvest, whether in the field, at the dwelling, or another location, = 0 if no contact |
| *Contact with extension officer was regular (=1)* | = 1 if contact with the DA or a WOARD officer was monthly or more frequent, = 0 if less frequent or no contact. |
| *Rated DA advice very useful (=1)* | = 1 if, conditional on having had contact with the DA, the respondent rated DA's advice very useful, = 0 if rated advice useful or not useful. |
| *Received advice from peer (=1)* | = 1 if received advice from a household member, friend or neighbor, on vegetable garden, crops, livestock, natural resource management in the last 12 months. |
| *Received advice from contact farmers (=1)* | = 1 if received advice from a model farmer, follower farmer, or farmer group in the last 12 months (same topics as above). |
| *Received advice from extension officers (=1)* | = 1 if received advice from a DA, a Farmer Training Center officer, or a WOARD officer in the last 12 months (same topics as above). |