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Rural seed sector development through participatory varietal selection

Synergies and trade-offs in seed provision services and market participation among household bean producers in Western Uganda

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Abstract

Purpose – This impact assessment provides empirical evidence from household producer surveys to test the assumptions surrounding the contribution of participatory varietal selection (PVS) activities on seed sector development. The purpose of this paper is to focus on household access and adoption of common bean varieties from seed provision services and local markets to determine if, and under what social conditions, PVS activities stimulated seed uptake and market participation.

Design/methodology/approach – The propensity score matching technique and simple regression analysis were used to estimate the impact and compare household performance across three farmer groups located in Hoima, Uganda.

Findings – PVS increased access to and adoption of improved varieties and supported additional intermediate development outcomes when farmer group characteristics were aligned with PVS efforts. Specifically, PVS was more likely to stimulate market purchases of newly introduced varieties in the farmer group located closest to markets. The project did not however, improve all the development objectives that were evaluated. PVS most critically, did not increase the probability that households received the specific varieties they desired.

Research limitations/implications – This study found that PVS can support the key pillars of seed sector development. In addition to increasing household access to new varieties, free seed dissemination promoted market participation and stimulated local seed market development.

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Originality/value – This study addressed the need to consider intermediate development outcomes in impact assessments of development interventions. The findings clarified the contribution of PVS in the context of broader development goals and identified farmer group dynamics associated with enhanced impacts among rural producers in Uganda.

Keywords Uganda, Participation, Adoption, Propensity score matching (PSM), Common bean, Intermediate development outcomes (IDOs)

Paper type Research paper

Introduction

Awareness that agricultural development initiatives could benefit from incorporating household producers into development activities increased rapidly toward the end of the twentieth century. Over the past two decades, development institutions identified impact assessments and participatory methodologies as two promising approaches from which to learn. Such strategies can address the needs and interests of household producers and ultimately shift development approaches toward a more client-oriented development paradigm. Scholars in the fields of sociology and political science (Amanor, 2011; Ampaire *et al.*, 2013), as well as psychology (Gibson, 2009), economics (Barrett and Dorosh, 1996) and plant breeding (Haussmann *et al.*, 2012) all supported the notion that household producer participation had great potential for enhancing the impact of development efforts. Consequently, major agricultural development institutions under the CGIAR Consortium systematically incorporated methods for accessing program impact and incorporating household producer feedback into their operational frameworks. Nevertheless, the majority of impact assessments, including those employed by CGIAR Research Programs, remained focused on ultimate outcomes like food security and poverty alleviation. These metrics did not reflect key features of the value chain that specific participatory research and development activities were designed to enhance, known as intermediate development outcomes. Consequently, empirical evidence surrounding the contribution that participatory activities can make in complex development agendas was lacking. Even fewer investigations were made into the factors that contribute to benefits associated with participatory activities. An understanding of these development dynamics can, however, be critical to ensure that development initiatives are effective. The present study addresses the need to incorporate intermediate development outcomes in impact assessments of participatory development activities, using a case study of participatory varietal section (PVS) trials that were conducted in Western Uganda.

Methodologies for PVS have commonly been designed to capture farmers' preferences surrounding new varieties developed by breeding programs, when the release of these products is imminent. Commonly, farmers evaluate varieties that have been grown on their own demonstration plots, under farmer management conditions (Asfaw *et al.*, 2012). Breeders are then expected to establish priorities for varietal release and seed dissemination based on feedback received from the farmers. PVS trials have become increasingly popular in the seed sector development efforts in the twenty-first century. In contrast to standard breeding approaches, breeders' selection decisions under participatory plant breeding (PPB) models are the result of PVS activities. PVS is believed to be particularly well suited for transferring the benefits of crop improvement from breeders to producers, in a context in which farmers' needs and the seed market are poorly understood. Some of the longstanding assumptions surrounding the benefits of PVS include that it increases information exchange and seed transfer between the formal seed sector, composed of breeders and seed companies, and the informal sector, dominated by household producers; improves household acceptability of newly developed varieties; creates avenues for seed diffusion and dissemination that are accessible to household producers; and encourages household experimentation with, and long-term adoption of new varieties that they would not otherwise access.

The present study evaluated the impact of PVS bean breeding activities within the Climate Change, Agriculture and Food Security (CCAFS) CGIAR program under the

Pan-Africa Bean Research Alliance – International Center for Tropical Agriculture (PABRA-CIAT). The analysis used indicators of intermediate development outcomes related to the adoption of improved common bean varieties and seed market participation among household bean producers in Western Uganda to test assumptions surrounding possible benefits associated with the PVS. The assessment specifically evaluated potential trade-offs between seed provision services and market participation, and identified farmer group conditions that supported the desired outcomes of PVS. The first section reviews the institutional environment in which these farmers operated. Subsequently, the second section introduces the theory of change that informed the impact assessment design and interpretation of the results of this study.

Institutional environment

Bean seed sector development in Uganda

Seed sector development efforts in Uganda during the 1970s were generally focused on the formal seed sector and relied heavily on government subsidy programs (Zerbe, 2001). By the 1980s, private sector development efforts were oriented around the explicit mandate to promote seed systems of high value vegetables. Up until this point, efforts to develop new varieties and seed supply chains had taken place without any apparent consideration of the needs or preferences of household producers. However, the public-private partnerships that emerged in the late 1990s shifted the focus of development efforts to crops that played a significant role in household production and consumption activities, including beans and other legumes (Mubangizi, *et al.*, 2012; Kansimme, 2014; van Mele *et al.*, 2011).

Joint public-private investment in the Ugandan bean seed subsector increased in concert with augmented bean production levels and contribution to gross domestic product (GDP). Uganda's total bean output and productively per hectare increased most rapidly between 1997 and 2002, when many of the first improved, disease-resistant varieties were introduced (Kalyebara, 2008; Sibiko, Owuor, Gido, Ayuya and Mwangi, 2013). Over the last decade, annual production of common bean in Uganda ranged from nearly half a million to nearly one million metric tons, making common bean among the top five crop contributors to GDP along with banana, cassava, sweet potato, and maize (FAO, 2015). FAO statistics show that common bean production for seed in particular steadily increased over time, reaching 12 percent of total production in 2011 and 6 percent of total production in 2012. This is likely an underestimate, since beans were seldom sold exclusively as seed and the majority of seed procurement transactions occurred through the informal sector and were not documented. For instance, in 2011 approximately 90 percent of common bean production occurred on household plots that ranged from 0.1 to 4 hectares (Trust, 2012). Market growth and increased opportunities for household producers to engage with the formal market provided an opportunity for household bean producers to focus production and market activities toward commercial, rather than subsistence, interests (Buruchara *et al.*, 2011; FAO, 2015). In light of these changes, common bean in Uganda shifted from being understood as a traditional subsistence crop to being perceived as a market-oriented crop.

However, household production surveys indicate that bean production levels in Uganda were consistently below yield potential in 2010 (Sibiko, Owuor, Gido, Ayuya and Mwangi, 2013). Varietal traits, seed quality and cost were all considered to be factors that explained low production levels. According to Janet Edeme, the Head of the Rural Economy Division of the African Union Commission, rural Uganda was not able to fully benefit from seed sector development efforts, due to weak seed production and distribution systems, inadequate supply of quality seeds, and lack of implementation of seed policies (Nakweya, 2014). Other studies suggest that untimely availability of seed and the high cost of improved seed compared to recycled seeds were main factors that limited household seed access and production (Sibiko, Ayuya, Gido and Mwangi, 2013). Compromised seed quality was also treated as a major production constraint. A cost-benefit analysis by Sperling (1992) found that the cost purchasing

improved and certified bean seed was two to four times that of the recycled seed. Thus, despite increase in yield, producers of low value crops like beans did not realize a greater return on investment for certified seed. Studies of household seed varietal portfolios confirmed predictions based on cost-benefit analyses, such that despite the positive effects of certified seed on production, most Ugandan household producers depended primarily on household-saved seed (Sibiko, Ayuya, Gido and Mwangi, 2013). Household surveys additionally found that improved seeds were unattainable for 75 percent of household producers in Uganda, primarily due to the large distances that separated villages and producers from seed suppliers (Kansimme, 2014). Together, this body of evidence suggested that household producers could benefit from enhanced development and dissemination of improved bean varieties. The present study presents an evaluation of one such effort led by the PABRA and CIAT. This effort used PVS to increase seed access and other intermediate development outcomes that support broader seed sector development goals.

PABRA-CIAT PPB

The PABRA was established as a consortium of African-owned regional bean networks by the CIAT in 1996 with the mandate that PABRA would find solutions to value chain inefficiencies in the bean subsector. Since its conception, PABRA-CIAT has implemented a wide range of participatory program activities for varietal development and seed dissemination in order to link household producers to breeders, improve varietal adoption and stimulate market participation. The Alliance historically focused on applying participatory varietal selection (PVS) to realize these objectives, and PABRA formally incorporated PVS as a core guiding principle of its breeding approach in the 1990s (Sperling *et al.*, 1993, 1996). In 2011, PABRA formally reaffirmed its commitment to PVS by incorporating the methodology into the Alliance's strategies for varietal development and distribution of improved bean varieties under the Bean Breeding for Africa Strategic Plan.

In 2003, PABRA was among the first actors to formally incorporate participatory approaches in varietal dissemination efforts, when the Alliance concluded that seed sector value chain constraints had led to limited seed supply and prohibitively high costs of quality seeds for household producers. PABRA worked to build new value chain linkages by prioritizing household producers and local markets over seed distribution avenues built off centralized National Agricultural Research Systems, government extension services, and formal seed suppliers. These new supply chain networks became PABRA's alternative strategy for delivery of improved bean varieties, known as the Wider Impact Programme (David and Sperling, 1999; Sperling *et al.*, 1996).

Monitoring and evaluation of PABRA activities under the Alliance's research for development framework found that PABRA's breeding and distribution strategies contributed to the release of 146 improved bean lines during 2003-2008 and an additional 67 varieties from 2009 to 2011 (Buruchara *et al.*, 2011; Sperling *et al.*, 1993; Sperling *et al.*, 1996). PABRA also estimated that their seed dissemination efforts from 2003 to 2008 delivered seed for improved bean varieties that were developed through PVS activities to 7.5 million households (or 35 million people) (Buruchara *et al.*, 2011). However, it is important to note that these estimates were based on varietal release information rather than empirical evidence of post-release adoption or other potential benefits of PVS, such as access to preferred varieties or larger quantities of seed. Furthermore, these reports did not consider consequences related to intermediate development outcomes that are critical to the seed sector, including availability of varieties supplied in markets and household market participation.

Household producers in Uganda

Household producers have dominated seed sector activities in Uganda, including common bean production, throughout the nations' recent history. In 2011, up to 90 percent of the

common bean grown in Uganda was produced on plots that were less than four hectares (Trust, 2012). The predominance of small-scale bean production was still evident in 2013, when 60 percent of farmers in northern and southern Uganda grew common beans on slightly less than 0.4 hectares (ISSD-Uganda, 2015). Consequently, factors related to household-level varietal adoption and market participation had major implications for seed sector development.

Household characteristics related to age, education, gender, and household assets have contributed to models of varietal adoption and market participation by household producers (Feder *et al.*, 1985; Genius *et al.*, 2006). These household-level characteristics were found to be particularly strong predictors of household-level adoption among subsistence or semi-commercial farm households operating in imperfect market environments (Barrett, 2008; Cadot *et al.*, 2006). For instance, Omamo (1998a) demonstrated that these household characteristics influenced households' transportation costs and the likelihood that households adopted commercial rather than subsistence crops.

Household transaction costs can vary across households as a function of access to public goods and services (e.g. extension service information) and integration into seed exchange networks (e.g. farmer groups), therefore resulting in different patterns of adoption (Omamo, 1998b; Renkow *et al.*, 2004). For instance, adoption patterns have been associated with household access to extension services (e.g. Conley and Udry, 2005; Hoang *et al.*, 2006; Munshi, 2004). Relatedly, diffusion of innovation theory, which was widely applied in efforts to understand adoption patterns during the Green Revolution, predicts that household adoption would increase with household involvement in agricultural extension programs (Kristjanson *et al.*, 2009). Thuo *et al.* (2014) found empirical support for this model among household producers in Kenya, such that households were more likely to acquire information about and adopt improved groundnut varieties if they had ties to external support services.

Adoption models shifted focus from household-level characteristics and extension services to the role of farmers' social networks at the beginning of the twenty-first century (Matuschke, 2008). Recent adoption models have demonstrated that farmers' social networks played a significant role in shaping patterns of seed sector development. For instance, an empirical study that used a binary choice model of adoption found that household farmer-group affiliation influenced household-level adoption of hybrid wheat varieties in India (Matuschke and Qaim, 2007). In a more complex investigation of household network factors, Bandiera and Rasul (2006) found evidence that adoption among sunflower producers in Mozambique increased as the number of households' network ties increased. Furthermore, Conley and Udry (2005) suggested that social networks are more likely to influence adoption when households within social networks have similar characteristics. Thus, social networks among household pineapple producers in Ghana were more likely to influence household decisions to adopt and apply pineapple fertilizer when households in the social network resembled each other.

This growing body of evidence suggests that seed sector development efforts can be more effective when they accommodate households' regional- and community-level networks and organizational infrastructure, rather than operating independently and in parallel to these systems. Yet, few studies have investigated the relationship between regional- and community-level seed exchange networks and the impact of this interaction on seed sector intermediate development outcomes.

Organizational setting

The present impact assessment evaluated PVS trials that were implemented under the PABRA-CIAT Participatory Action Research (PAR) Program. The program was launched in 2012 as a component of the CGIAR CCAFS Program (Mukankusi *et al.*, 2014). Using PVS

methods, household producers from three farmer groups located in Kyabigambire sub-county of Hoima District evaluated 16 improved bean varieties based on performance and farmer acceptability. PVS activities were carried out over the course of two phases. Phase 1 took place during the first crop season of 2012 (March-July) and Phase 2 took place during the first and second seasons of 2013 (March-July and August-December).

Each farmer group hosted one PVS trial. CIAT, the National Agricultural Research Organization (NARO), and the National Crops Resources Research Institute (NaCRRI) each provided seeds for the trials and trained farmers in planting layout, crop management and record keeping techniques, in addition to designing PVS protocols. CIAT/NARO-NaCRRI also provided inputs that included rain gauges, paper bags, and plot labels. However, these resources were only available over the course of PVS trials and were not accessible for individual household use during or after implementation of the program. Farmer participants prepared land for the trials, planted experimental varieties, carried out crop management activities, kept daily records of all of their agronomic practices (e.g. weeding and roguing) and recorded performance of individual genotypes (e.g. germination date and days to 50 percent flowering). Farmers also conducted evaluations following the PVS protocol. Each farmer group gained access to small quantities (150 g) of each of the newly improved varieties at the end of each of the three seasons. The individual households could then adopt and multiply these varieties for future household bean production.

Theory of change: expected and unanticipated outcomes of PVS

The present study investigated the impact of PVS trials on adoption and market participation, in addition to considering possible trade-offs. Household participation in PVS was expected to increase adoption of CIAT-selected varieties under the program's theory of change. However, the theory of change did not explicitly consider consequences for market participation. Meanwhile, trade-offs between adoption of seed from seed provision services and market participation have been a common phenomenon among subsistence or semi-commercial farm households operating in imperfect market environments (Barrett, 2008).

Evidence of trade-offs between seed provision services and market participation suggest that participation in PVS would decrease the likelihood that households purchased seed from the market (Almekinders and Thiele, 2003; Amanor, 2011; Omamo, 1998b). For instance, Amanor (2011) described an inherent tension between participatory plant-breeding networks and commercial seed markets, based on the premise that households are less likely to depend on market-purchased seed when open access arrangements in PVS allow farmers to gain access to varieties for experimentation, multiplication, and distribution through farmer networks. Since seed provision services could offer an alternative to more costly market-purchased seed, this seed distribution method has been criticized for disincentivizing household seed production, compromising markets by transforming potential clients into beneficiaries, and limiting the negotiating power of producers (Omanga and Rossiter, 2004). Furthermore, the market can offer advantages over seed provision services, for instance surrounding seed quality and uniformity assurance, varietal options, and timely availability.

Sperling and Cooper (2003) argued that seed provision services and vibrant seed markets are both essential to achieving long-term seed sector development goals. For this reason, the authors emphasized the need for efforts to increase adoption of varieties through seed provision services and to promote market participation in tandem. The FAO and CIAT similarly recommended that improvements in seed access should be achieved by strengthening local markets and taking precautions to avoid undermining them (Omanga and Rossiter, 2004).

An alternative theory of change posits a synergistic interaction of seed provision services and seed market participation, similar to the dynamic that Sperling and Cooper (2003), the FAO, and CIAT described. Under this alternative theory of change, PVS

trials should stimulate market participation. Thus, household interest in and knowledge of new varieties should increase with involvement in plant breeding activities, thereby motivating households to access new varieties through the seed market. Furthermore, training in varietal evaluation methodologies that households received through PVS trials would provide households with the skills to evaluate and benefit from varieties from the market. The varieties that households received directly through PVS trials could also promote experimental market purchases by providing households with enough seed to insure households against unpredictable performance of market purchased varieties. This theory of change represents a best possible outcome, where technology adoption would reinforce market participation to compound the natural, one-off gains associated with each independently.

Methods

Household selection and surveys

The households surveyed in the present study included the complete sample of 72 program participants and 126 control households. The program participants represented different community-level seed exchange networks via their membership in one of three farmer groups. Each farmer group was associated with a different parish within Kyabigambire except for one parish that was not included in the program (Kisabagwa Parish). This made for a total of three farmer groups/parishes (Kyamaleera Handcraft Cooperatives/Kibugubya Parish, Kakindo Sustainable Cooperative/Bulindi Parish or Akumulikire Women Cooperative/Buraru Parish). Control households were randomly selected and blocked across the Kyabigambire parishes such that they occupied the same general locations and had substantial geographical overlap with program participants. Generally, participating households tended to cluster by household farmer group members.

Household demographics and management practices were surveyed during the season that directly followed implementation of the program in December 2013. Surveys examined household affiliation with PVS trials (regional-level seed exchange networks) and farmer group membership (community-level seed exchange networks), as well as household characteristics that could correlate with household transaction costs. Household characteristics included age, household size, and household member contribution to and consumption of household bean production. Additional characteristics included in the model reflected household labor capacity (Table I).

Quasi-experimental design

The indicators of intermediate development objectives included in the analysis reflected intended outcomes related to CIAT-selected variety adoption and unanticipated consequences related to market participation (Table II). The intended outcomes were increasingly specific to what Sperling and Cooper (2003) described as household seed security. Under their seed security framework, farmers have access to sufficient quantities of the seeds of their preferred varieties, with additional guarantees of adequate physical quality and availability at the time of planting (Sperling and Cooper, 2003). The development indicators were binary variables (yes or no), where households were asked if seed provision services satisfied household adoption and seed retention criteria and if they had engaged in specific market activities within the last three seasons.

The impact of the program on participating households was computed as the average treatment effect on the treated (ATT). ATT was simply the average difference between program participant households and control households, where program participant households were paired with their most similar control household. This calculation accounted for the typical empirical problem implicated in calculating impact, namely the absence the counter-factual scenario (i.e. how PVS participating households would have performed if they had not

Endogenous household variables	Participating households ($n = 72$) Mean (SD)	Control households ($n = 126$) Mean (SD)
Average age	24.57 (10.82)	26.08 (11.11)
Proportion of household members < 6	0.11 (0.13)	0.11 (0.15)
Proportion of household members > 60	0.05 (0.15)	0.07 (0.17)
Household size	5.71 (2.18)	5.87 (2.37)
Proportion of household members that eat household beans but do not contribute labor of financial support	0.23 (0.23)	0.18 (0.19)
Proportion of household members that eat, provide labor and financial support	0.37 (0.21)	0.35 (0.23)
Too weak to cultivate your fields	0.54 (0.50)	0.35 (0.48)
Had to cultivate your fields alone	0.58 (0.50)	0.30 (0.46)
Had the option of receiving extra help in the form of paid labor	0.28 (0.45)	0.57 (0.50)
Had the option of receiving extra help in the form of voluntary family members	0.50 (0.50)	0.56 (0.50)

Table I. Summary statistics of household characteristics

Outcomes/performance indicators	Participating households ($n = 72$) Mean (SD)	Control households ($n = 126$) Mean (SD)
Intended: household adoption		
Received subsidized or free seed	0.78 (0.42)	0.19 (0.39)
Chose the variety that you received	0.22 (0.42)	0.10 (0.29)
Chose the quantity you received	0.08 (0.28)	0.10 (0.29)
Received the seed in time to plant it	0.63 (0.49)	0.13 (0.33)
Able to multiply the seed	0.67 (0.47)	0.12 (0.33)
Unanticipated: market participation		
Bought seeds within the last three seasons	0.89 (0.32)	0.83 (0.37)
Bought a specific variety that you wanted	0.90 (0.30)	0.78 (0.42)
Bought a variety that you never grew before	0.57 (0.50)	0.26 (0.44)
Bought the seeds in a timely fashion	0.81 (0.40)	0.70 (0.46)
Received a loan from a friend of neighbor	0.22 (0.42)	0.19 (0.40)

Table II. Summary statistics of intermediate development objective indicators

participated in the program), and consequently the data concerning the counterfactual (Godtland *et al.*, 2004; Ravallion, 2001). In order to address this challenge, ATT was calculated using a reconstructed baseline derived from control household data. Each control household was paired with the most comparable participating household. With this pairing method, the performance of each control household was used to represent the performance of their most similar participating household assuming hypothetically that it had not participated.

The household pairing method considered two major sources of bias that can emerge when control houses are utilized in this manner. The first source of bias is related to diffusion or spillover effects across participating and control households. Since the control households were selected from the same Kyabigambire sub-county, it is likely that control and participating households interacted. A comparison of these two groups would likely underestimate the program impact if households interacted (whether impact is negative or positive). For instance, it is possible that some control households had indirect access to improved varieties through exchanges with program participant households. Thus, the impact assessment distinguished between households that accessed seed directly from the program and those that accessed seed indirectly from program participants in order to minimize this spillover bias.

The second source of bias considered in this evaluation was household selection on household characteristics that impacted the error terms of both the probability of household participation in the program and household impact indicators. This is a common consideration for impact assessments, since households that are assigned to programs or treatments are often not random because of either purposive program placement or self-selection into programs. Consequently, household characteristics can be strongly associated with Exposure X. These household characteristics operate as confounding variables C (household characteristics) associated with outcome Y (intended adoption and market participation) and Exposure X (program). Household characteristics, including household age demographics and household contribution to and consumption of bean production were all household characteristics that could distinguish control and program participant households and/or explain differences in performance indicators, even in the absence of the PVS.

The use of an ordinary least squares impact assessment approach in this case could produce biased over or underestimates of program impact. Therefore, this study utilized the propensity score matching (PSM) analytical approach, in order to account for confounding variables (C) associated with non-random household selection (Ali and Abdulai, 2009; Becerril and Abdulai, 2010). The analysis accounted for household selection bias based on household characteristics (C) that included household age structure, size, household member contributions to household bean consumption and production, and labor recruitment options (Table I). The ATT was therefore a calculation of the isolated effect of exposure to the Program (X) on household adoption and market participation (Y) because it controlled for any biased distribution of household characteristics (C).

Alternative approaches include the Heckman two-step test and instrumental variable (IV) methods. However, the Heckman two-step estimation can be limited in the robustness of the results because selection estimators are dependent on a strong assumption that the hidden variables are normally distributed (Ali and Abdulai, 2009). Alternatively, the IV method has the benefit of controlling for the error term by including IVs, or exogenous (unobserved) household variables that impact the probability of exposure to the program (X) without impacting performance indicators (Y) or endogenous household variables (C). However, a major limitation of the IV method is in the inability to identify and test assumptions that would validate the use of an IV. A suitable IV could not be identified for use in this analysis.

The final set of analyses only included program participant households to determine if the impact of the program varied across farmer groups (Kyamaleera Handcraft Group, Kakindo Sustainable Cooperative, and Akumulikire Women Group). The probit model for this analysis included each outcome variable within the theory of change and evaluated the outcome when farmer groups were treated as dummy variables in the regression model.

Analysis

All analyses were carried out using the MatchIt package in R- and the P-score package in STATA14 to verify models and estimations. PSM began with the estimation of a probit regression for each household variable (Table III). The probit regression estimates of household characteristics were then used to calculate the probability of participation in the program (i.e. propensity score) for each household based on their observed household characteristics.

The results from the probit estimation indicate that program participant households were younger and had more dependents based on the proportion of household members that ate household beans but did not personally contribute to household bean production. Household labor capacity was also more limited among program participant households based on the proportion of households that were too weak to cultivate their fields and had to cultivate their fields alone without extra help from paid labor.

Explanatory variables	Participation in PAR Probit (SE)	Marginal effects (SE)
Average age	−0.05 (0.02)**	−0.01 (0.01)**
Proportion of household members < 6	−2.12 (1.00)**	−0.63 (0.31)**
Proportion of household members > 60	1.28 (1.04)	0.36 (0.32)
Household size	−0.03 (0.06)	−0.01 (0.02)
Proportion of household members that eat household beans but do not contribute labor of financial support	1.14 (0.55)**	0.34 (0.17)**
Proportion of household members that eat, provide labor and financial support	1.59 (0.71)**	0.47 (0.22)**
Too weak to cultivate your fields	0.71 (0.21)**	0.22 (0.07)**
Had to cultivate your fields alone	0.77 (0.22)**	0.24 (0.07)**
Had the option of receiving extra help from paid labor	−0.63 (0.21)**	−0.19 (0.07)**
Had the option of receiving extra help from voluntary family members	−0.19 (0.2)	−0.05 (0.06)
McFadden pseudo R^2	0.19	
Log pseudolikelihood	48.17	
Correctly classified observations	73%	
No. of observations	198	

Notes: Standard error is in ( ). *,**Significant at 10 and 5 percent levels, respectively

Table III.
Probability of household involvement in participatory varietal selection trials (probit)

The distribution of household propensity scores for program participant and control households showed sufficient common support for matching (Figure 1). Meanwhile, differences in the distributions of program participant and control households validated the use of the PSM technique to ensure comparability. In order to improve the robustness of the estimate, the matches were restricted to program participant and control households with common support in the distribution of their propensity scores. Therefore, the analysis only included participating and control households with the same propensity scores. Consequently, 28 control households were dropped from the original 126 households leaving 98 control households within the area of common support.

Household propensity scores were used to match the participating households with control households. From several matching techniques applicable to impact assessments, non-parametric kernel-based matching and nearest-neighbor matching were identified as ideal for this analysis given the small sample size (Heckman *et al.*, 1997, 1998). In contrast to other matching methods that select a subsample to further reduce the sample size,

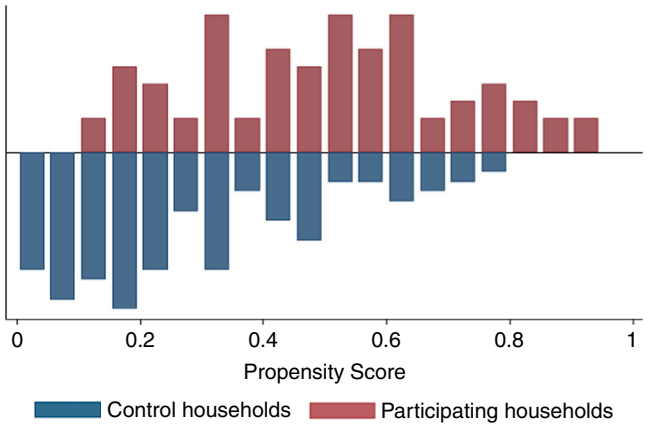

Figure 1.
Household propensity score distribution for participating and control households within an area of common support (0.102, 0.926) and the balancing property of propensity scores is satisfied

non-parametric kernel matching maintained the largest sample size possible. The non-parametric kernel regression matching method used the whole sample of control households to construct a weighted average match for each participating household within the area of common support. The nearest neighbor matching technique was also used to match each household to the household with the closest propensity so participating households were compared to control households that had the closest possible propensity scores.

Balancing tests were then conducted to determine if the matching techniques successfully constructed a comparison group of control households that resembled the group of program participant households and to verify the validity of these techniques. Propensity scores within program participant and control households satisfied the balancing property within propensity score blocks (Table AI). Mean equality tests, described by Abate *et al.* (2014), which compared simple means of household characteristics before and after matching, were also conducted as an additional method for evaluating balance (Abate *et al.*, 2014). The results indicated that the unmatched sample failed to satisfy the balancing property, and further validated the matching techniques (Table IV). Although the unmatched samples were comparable based on the number of household characteristics, the unmatched sample did not have comparable labor capacity based on the likelihood that the household was too weak to cultivate their fields, if they had to cultivate their fields alone, and if they had the option of hiring labor for extra support. There was, however, no statistical difference in observed characteristics between the two groups after matching.

Results and discussion

Intended impacts on adoption

The impact of (PVS trials on household bean producers in Hoima District of Western Uganda was assessed based on five indicators of intermediate development objectives: if the household received seed freely from the organization; if the household chose the variety that they received; if the household chose the quantity that they received; if the household received the seed in time to plant it; and if the household was able to multiply the seed. Average treatment effect estimates based on non-parametric kernel and nearest-neighbor matching methods both consistently showed that the program had positive and significant impacts on many, but not all, intended intermediate development outcomes (Table V). The impact estimates indicated that the program significantly increased the likelihood that households received improved varieties from an outside organization, increased the likelihood that a household received seed in time to plant it and finally, increased the proportion of households able to multiply new varieties that were obtained from an outside organization. However, the program did not significantly improve the likelihood that a household chose the type of variety that participants received. Furthermore, participation decreased the likelihood that households chose the quantity of seed they received through seed provision services.

Evidence from numerous studies suggests that seed stock sizes can be critical for ensuring that households are able to maintain a given variety over multiple seasons through multiplication and selection. For instance, Kouressy *et al.* (2008) argued that seed quantity was critical for households to adequately evaluate varietal performance and select well-adapted material, because seed stock sizes need to be large enough to produce variants for selection and ongoing adaptation. For instance, when population sizes of traditional sorghum varieties were large, farmers in Mali were able to shift to short cycle varieties when growing conditions required this trait (Kouressy *et al.*, 2008).

Evidence that the program decreased the likelihood that households chose the quantity of seed they received supports a common criticism of seed procurement services. This shortfall has been associated with seed provision services by various institutions that worked to increase seed access. For instance, gene banks and community seed banks were

Table IV. Balancing test of matched samples

Explanatory variables	Unmatched samples			Kernel-based matching			Nearest-neighbor matching		
	Participating households ($n = 72$)	Control households ($n = 126$)	Diff: p-value	Participating households ($n = 72$)	Control households ($n = 98$)	Diff: p-value	Participating households ($n = 72$)	Control households ($n = 98$)	Diff: p-value
Average age	24.57	26.08	0.354	24.67	24.60	0.967	24.57	24.35	0.89
Proportion of household members < 6	0.11	0.11	0.886	0.11	0.10	0.554	0.11	0.09	0.34
Proportion of household members > 60	0.05	0.07	0.507	0.05	0.05	0.977	0.05	0.06	0.71
Household size	5.71	5.87	0.646	5.71	5.70	0.977	5.71	5.56	0.66
Proportion of household members that eat household beans but do not contribute labor of financial support	0.23	0.18	0.135	0.22	0.21	0.749	0.23	0.19	0.31
Proportion of household members that eat, provide labor and financial support	0.37	0.35	0.511	0.37	0.34	0.449	0.37	0.34	0.41
Too weak to cultivate your fields	0.54	0.35	0.008	0.51	0.53	0.859	0.54	0.57	0.74
Had to cultivate your fields alone	0.54	0.35	0.000	0.56	0.59	0.713	0.58	0.58	1.00
Had the option of receiving extra help from paid labor	0.28	0.57	0.000	0.29	0.34	0.568	0.28	0.36	0.29
Had the option of receiving extra help from voluntary family members	0.50	0.56	0.391	0.53	0.53	0.853	0.50	0.43	0.41

	Participating households ($n = 72$) Mean (SD)	Control households ($n = 98$) Mean (SD)	Naïve (t-test)	ATT kernel	ATT nearest neighbor
Intended: household adoption					
Received subsidized or free seed	0.78 (0.42)	0.19 (0.39)	9.86 [0.06]**	0.52 [0.08]**	0.57 [0.10]**
Chose the variety that you received	0.22 (0.42)	0.10 (0.29)	2.49 [0.05]**	0.08 [0.07]	0.13 [0.07]
Chose the quantity you received	0.08 (0.28)	0.10 (0.29)	0.28 [0.04]	−0.05 [0.06]	−0.01 [0.06]
Received the seed in time to plant it	0.63 (0.49)	0.13 (0.33)	8.50 [0.06]**	0.45 [0.08]**	0.50 [0.09]**
Have been able to multiply the seed	0.67 (0.47)	0.12 (0.33)	9.60 [0.06]**	0.50 [0.08]**	0.53 [0.10]**
Unanticipated: market participation					
Bought seeds within the last three seasons	0.89 (0.32)	0.83 (0.37)	1.06 [0.05]	0.10 [0.07]	0.21 [0.11]*
Bought a specific variety that you wanted	0.90 (0.30)	0.78 (0.42)	2.23 [0.06]**	0.13 [0.06]*	0.07 [0.09]
Bought a variety that you never grew before	0.57 (0.50)	0.26 (0.44)	4.50 [0.07]**	0.29 [0.08]**	0.29 [0.12]**
Bought the seeds in a timely fashion	0.81 (0.40)	0.70 (0.46)	1.76 [0.07]*	0.13 [0.08]	0.15 [0.11]
Received a loan from a friend of neighbor	0.22 (0.42)	0.19 (0.40)	0.05 [0.06]	0.07 [0.07]	0.01 [0.09]

Notes: Standard deviation is in ( ), standard error is in [ ]. *,**Significant at 10 and 5 percent levels, respectively

Table V.
Impact of participatory varietal selection trials on adoption practices and market participation among bean producers in Uganda

often not equipped to provide sufficient quantities of seeds for direct sowing by farmers, or population sizes sufficient for selection among variants that are adapted to environmental conditions and management practices (Iriate *et al.*, 2000). This evidence also corroborates other studies that support the argument in favor of improving market access over seed dissemination through organizations. For instance, Omanga and Rossiter (2004) made this argument based on empirical evidence that farmers were less likely to choose the type and amount of crops they wanted if they accessed seed through an outside organization compared to accessing seed through local markets.

Unanticipated impacts on market participation

Purchasing seed from the market was common among both program participant and control households. Household members indicated that they tended to purchase seeds to supplement seed stock during the lean period of the growing season, before the next seasons' harvest. The household surveys further confirmed that a substantial portion of the program participant and control households bought seeds from the market within the last three seasons (89 and 83 percent, respectively).

The two matching techniques resulted in inconsistent significance estimates for program impact on two market-related outcomes, namely the likelihood that households bought seeds within the last three seasons and the likelihood that households bought a specific variety they wanted. However, both estimates indicated that the program had a positive impact on these market behaviors. Treatment effect estimates based on nearest-neighbor matching techniques found that the program significantly increased the likelihood that households purchased seed from the market, although the significance level was marginal

and the non-parametric kernel-based matching estimate was not significant. Participation in the program was associated with a slight, but not significant, increase in the proportion of households that bought a specific variety that they wanted from the market, from 78 to 90 percent. One potential explanation for this minor increase is that the knowledge gained from access to new varieties through the program contributed to the farmers' ability to identify the varieties they wanted. The significance of all other estimates was consistent across both matching techniques.

The participation in the program significantly increased the likelihood that households bought a variety from the market that they had not grown previously. The seed from PVS trials found in program participant household seed stocks might have contributed to the household's willingness to experiment if it provided excess seed, and if households treated that seed as insurance against losses from experimenting with unfamiliar, market-purchased seed. Finally, the program did not significantly impact the proportion of households that received loans from friends or neighbors.

Impact heterogeneity

The PSM impact estimates assumed homogeneous impact across all three farmer groups. However, the impact could vary across farmer groups. Naïve comparisons, based on simple *t*-tests, compared each farmer group to control households. Regression analysis was additionally used to identify the farmer group or groups that were positively affected by the program and to test the robustness of the naïve comparisons. This analytical approach was chosen for comparisons across farmer groups because farmer group sizes were too small to pair program participant and control households in the PSM analysis.

Regression analysis was performed with farmer groups only, and used farmer group affiliation as a dummy variable. Regressions assessed the marginal effect of participation in the two cooperatives (out of the three total cooperatives) on the ten outcome indicators. Participation in the two cooperatives was captured on the basis of the two dummy variables and the coefficients and significance of these two dummies were interpreted against the third dummy, which was omitted from the model. For instance, if the two dummies included in the model were negative and significant, then the third one (the excluded farmer group) was positive and significant.

Farmer group descriptive statistics and regression analysis indicated that adoption-related outcomes varied across farmer groups. Specifically, the regression model that excluded Kyamleera Handcraft Group produced a significant negative effect on the probability that the household received seed in time to plant it (Table AII). These results demonstrate that Kyamaleera Handcraft Group was the only farmer group that was more likely to receive seed in time to plant it due to group members' participation in PVS trials.

Naïve comparisons indicated that the Akumulikire Women Cooperative and Kakindo Sustainable Group were significantly more likely to choose the variety that they received compared to control households, while the proportion of Kyamaleera Handcraft Group members that was able to choose the variety they received was not significantly higher than control households. Regression analysis also showed that membership in Kyamaleera Handcraft Group was negatively associated with the likelihood that households chose the varieties that group members received. Evidence that the ability to choose varieties varied across farmer groups suggests that this seed management strategy was less prevalent among Kyamaleera Handcraft Group members because of community-level dynamics rather than the program overall. This explanation is consistent with the farmer group-mediated method, under which seed from the program was distributed after PVS trials.

The likelihood that households bought a variety that they never grew before also varied across farmer groups. The regression model that excluded Kakindo Sustainable Group produced a significant negative marginal effect on the proportion of households that bought

a specific variety that they never grew before. This model, together with the descriptive statistics, suggests that the Program had the greatest impact on experimental purchases in the market within the Kakindo Sustainable Group (Table AIV). Kakindo Sustainable Group members might be most likely to respond to seed provision services by increasing market participation this way because its member households traveled the shortest travel distance to markets of all farmer group households.

Informal household interviews identified group characteristics that may have contributed to the differences in seed procurement behaviors across farmer groups. Kyamaleera Handcraft Group might have been uniquely well suited to receive seed in a timely fashion, since group characteristics like reliable cell phone reception and the location of households close to the main road supported household member capacity to communicate efficiently. Alternatively, Akumulikire Women Cooperative might have been less likely to receive seed in time to plant it because Akumulikire Women Group households are more isolated. Akumulikire Women Group households were located along a hill slope far from the main road, where cell phone reception was very limited.

Kakindo Sustainable Cooperative members might have been more likely to experiment with new varieties from the market because Kakinodo households sourced their seed from markets that were the closest to their households, in comparison to the other two farmer groups. Akumulikire households might have been less likely to increase experimental market purchases because the average distance to markets where Akumulikire households bought their seeds was slightly further (6.1 miles $\pm$ 6.4) than that of Kyamaleera Handcraft Group seed sources (5.4 $\pm$ 5.2) and Kakindo (5.3 $\pm$ 8.4). These farmer group characteristics suggest that each farmer group had a unique advantage over the other farmer groups, where Kyamaleera Handcraft Group had the capacity to communicate most efficiently, and Kakindo Sustainable Group members enjoyed the shortest travel distance to markets.

Conclusions

This impact assessment identified the strengths and weaknesses of a targeted seed sector development activity under the PABRA-CIAT PAR Program, in which households in Western Uganda evaluated common bean varieties in PVS trials. The goal of this initiative was "increase the resilience of bean farming systems in the face of climate change related stress" (Mukankusi *et al.*, 2014). PVS trials had to achieve multiple levels of impact to effectively contribute to this broad seed sector development agenda. The present study evaluated intermediate development objectives that reflected the program theory of change in order to determine if the trials achieved these multiple levels of impact. PVS activities increased many adoption-related objectives that the program was designed to accomplish and encouraged market participation by program participants.

One particular concern of development agencies that have provided services to communities with poorly understood or limited market participation has been the possibility that free seed provision services could compromise market participation. Prior to the present study, very little was understood about the seed procurement methods that were used by the household producers who participated in the PVS trials. Therefore, efforts to promote the seed sector in Western Uganda required a careful assessment of the relationship between the roles of seed provision services, and market participation among these household producers. Contrary to a common perception that free seed provision would discourage recipients to participate in the market, the present study found that seed provision services through PABRA-CIAT complemented, rather than compromised seed market participation. Household producers were particularly more likely to experiment with new varieties through market purchases. Evidence that households with increased access to improved varieties not only increased adoption but also market purchases demonstrates that seed provision services can operate to promote market-based strategies for ensuring household seed supply.

In addition to evidence that PVS increased market participation, the present study also found that the program impact varied across community-level seed exchange networks (i.e. farmer groups). PVS was more likely to result in desirable outcomes when households were relatively easy to communicate with, as well as located close to main roads and markets. For instance, the members of the Kakindo Sustainable Cooperative group were more likely than members of other farmer groups to increase market purchases in response to participation in the Program. Meanwhile, Kakindo Sustainable Cooperative households tended to travel the shortest distance to purchase seed from markets. Together, these results suggest that the average distance that households travel to the market can be an important factor to consider when designing seed provision programs or identifying farmer group program partners. This finding suggests that local seed market growth and adoption of newly developed varieties are likely to occur in tandem if PVS activities include farmer groups that are located close to markets. Programs could alternatively prioritize activities that link households to markets when seed sector development is targeted at communities that are not close to markets.

The evidence of market participation among households in this study might reflect the market dynamics that were assumed under the market-led paradigm of agricultural development from the 1980s (Reardon and Timmer, 2006). Under this model, markets provided households with opportunities to benefit from trade, households engaged in favorable market transactions, and consequently households increased income and demand for goods to further stimulate market growth (Boughton *et al.*, 2007). The present study did not provide evidence of specific benefits associated with household market behavior. However, it did suggest that market participation contributed to diversifying household seed stocks. The participation in the PVS trials had an impact on a particular type of household market purchasing behavior wherein households selected varieties from the market that they had not grown previously. This evidence suggests that households were more likely to take risks in the market when they received free seed through PABRA-CIAT PVS trials. Household interviews would be needed to further elucidate the rationale underlying market participation responses to PVS. Further studies could investigate the consequences of these experimental purchases to determine if experimental market purchases increased the likelihood that households benefit from experimental purchases. For example, households might be more likely to rotate in new varieties, experience decreased overall susceptibility to biotic stresses (pests, disease), or obtain hearty varieties and seeds that overcome abiotic (drought, saline soil) stresses. They might also be more likely to obtain new or recently developed bio-fortified varieties and increase dietary diversity and nutrition.

The present evaluation also identified shortfalls of the program and brought into question assumptions about the unique benefits of PVS methodology. For instance, Witcombe (2014) lauded PVS as a method for improving farmer acceptability of new varieties, based on the premise that it provides an effective mechanism for breeders to identify traits that the producers desire. However, the present study did not find evidence that PABRA-CIAT was able to apply knowledge gained about household varietal preferences from PVS evaluations to inform seed dissemination following varietal trials. Specifically, the program did not significantly improve the likelihood that households received the varieties they desired.

The participatory breeding approach also had potential to improve seed access through the direct links that PVS created between the formal seed sector and program participants. However, PVS actually decreased the likelihood that households chose the quantity of seed they received. This shortfall of the Program reinforced a common criticism of seed procurement services, which argues in favor of improving market access rather than seed dissemination through organizations. These findings indicate that seed sector

development efforts by PABRA-CIAT, among other institutions that work to increase seed access, are likely to benefit from establishing internal capacity for seed multiplication or partnerships so these efforts can ensure that households receive sufficient quantities of seed through seed provision services. Such an agenda could improve the producers' ability to retain and benefit from new varieties after early stage adoption. Nonetheless, evidence that the program increased household market participation suggests that the program might have indirectly increased household capacity to obtain a desired type and amount of seed. In this way, the PABRA-CIAT Program provides an excellent case study for methods that promote seed markets and seed provision services in tandem. Longitudinal studies focused on retention and turnover of market purchased and organization-sourced seed could elucidate the long-term impacts of these programs, as well as the relative significance of early stages of varietal adoption.

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Further reading

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(The Appendix follows overleaf.)

Appendix

Table AI. Propensity score blocks for participating and control households

Inferior bound of the propensity score block	Participating households	Control households	Total
0.10	7	28	35
0.2	16	34	50
0.4	25	22	47
0.6	17	14	31
0.8	7	0	7
Total	72	98	170

Notes: Observations are reduced to areas of common support. The table presents the optimal number of blocks (five) where the mean propensity score is equal for participating and control households where the balancing property of the propensity score is satisfied

Table AII. Probit model showing marginal effect of membership in Kakindo Sustainable Group and Akumulikire Women Group (excluding Kyamaleera Handcraft Group)

	Dummy/Kakindo Sustainable Group			Dummy/Akumulikire Women Group				
	Mfx	SE	*p*-value	Mfx	SE	*p*-value	No. of observations	R^2
Intended: adoption								
Received subsidized or free seed	−0.997	2.808	0.723	−0.992	4.835	0.837	71	0.258
Chose the variety that you received	0.998	1.584	0.529	0.993	4.694	0.833	71	0.216
Chose the quantity you received	0.000	0.000	1	0.000	0.000	0.999	71	0.302
Received the seed in time to plant it	−0.672	0.152	0.000**	−0.630	0.147	0.000**	71	0.208
Have been able to multiply the seed	−0.999	0.742	0.178	−0.997	1.952	0.610	71	0.296
Unanticipated: market participation								
Bought seeds within the last three seasons	0.025	0.077	0.744	0.053	0.075	0.485	71	0.009
Bought a specific variety that you wanted	−0.086	−0.128	0.528	−0.128	0.117	0.275	71	0.036
Bought a specific variety that you never grew before	0.519	0.101	0.000**	0.352	0.126	0.005*	71	0.175
Bought the seeds in a timely fashion	−0.508	0.180	0.005*	−0.190	0.165	0.249	71	0.166
Received a loan from a friend of neighbor								

Notes: Kakindo and Akumulikire dummy variables had significant negative marginal effects on the probability that the household received seed in time to plant. *,**Significant at 10 and 5 percent levels, respectively

	Dummy/Kyamaleera Handcraft Group			Dummy/Kakindo Sustainable Group				
	Mfx	SE	*p*-value	Mfx	SE	*p*-value	No. of observations	R^2
Adoption								
Received subsidized or free seed	0.342	0.074	0.000**	0.001	0.795	0.999	71	0.258
Chose the variety that you received	−0.359	0.073	0.000**	−0.001	0.475	0.999	71	0.216
Chose the quantity you received	−0.001	1.296	0.999	−0.001	0.608	0.999	71	0.302
Received the seed in time to plant it	0.483	0.089	0.000**	−0.026	0.123	0.833	71	0.208
Have been able to multiply the seed	0.523	0.077	0.000**	0.001	0.958	0.999	71	0.296
Unanticipated: market participation								
Bought seeds within the last three seasons	−0.061	0.010	0.542	−0.031	0.103	0.766	71	0.010
Bought a specific variety that you wanted	0.094	0.065	0.147	0.034	0.065	0.600	71	0.036
Bought a specific variety that you never grew before	−0.373	0.135	0.006*	0.268	0.143	0.060	71	0.175
Bought the seeds in a timely fashion	0.147	0.099	0.136	−0.244	0.133	0.067	71	0.166

Notes: The Akumulikire dummy variable did not have a consistent significant marginal effect on any intermediate development indicators. *,**Significant at 10 and 5 percent levels, respectively

Table AIII. Probit model showing marginal effect of membership in Kyamaleera Handcraft Group and Kakindo Sustainable Group (excluding Akumulikire Women Group)

	Dummy/Kyamaleera Handcraft Group			Dummy/Akumulikire Women Group				
	Mfx	SE	*p*-value	Mfx	SE	*p*-value	No. of observations	R^2
Adoption								
Received subsidized or free seed	0.240	0.075	0.001*	−0.002	1.304	0.999	71	0.258
Chose the variety that you received	−0.306	0.075	0.000**	0.001	0.602	0.999	71	0.216
Chose the quantity you received	0.000	0.001	1.000	0.222	0.307	0.999	71	0.302
Received the seed in time to plant it	0.500	0.091	0.000**	0.026	0.119	0.830	71	0.208
Have been able to multiply the seed	0.441	0.080	0.000**	−0.002	1.325	0.999	71	0.296
Unanticipated: market participation								
Bought seeds within the last three seasons	−0.028	0.093	0.766	0.028	0.087	0.746	71	0.010
Bought a specific variety that you wanted	0.065	0.080	0.412	−0.038	0.082	0.642	71	0.036
Bought a specific variety that you never grew before	−0.599	0.124	0.000**	−0.289	0.169	0.087	71	0.175
Bought the seeds in a timely fashion	0.286	0.079	0.000**	0.177	0.083	0.032	71	0.166

Notes: The Kakindo Sustainable Group dummy variable had a significant negative marginal effect on the proportion of households that bought a specific variety that they never grew before. *,**Significant at 10 and 5 percent levels, respectively

Table AIV. Probit model showing marginal effect of membership in Kyamaleera Handcraft Group and Akumulikire Women Group (excluding Kakindo Sustainable Group)

About the authors

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Gian Nicola Francesconi holds a PhD in Development Economics from the Wageningen University (NL) and an MSc in Agribusiness from the Scuola Superiore S'Anna (IT). He lived and worked in Africa for 13 years: Ethiopia (four years), Senegal (seven years) and Uganda (two years). He has also work experience in Ghana, Mauritania, Burkina Faso, Malawi, Tanzania, Rwanda and Madagascar. His work focuses on research (impact evaluations and organizational diagnostics), capacity building and PPP development in support of agricultural cooperatives and farmer organizations. He worked mostly for the CGIAR (ILRI, IFPRI and CIAT) and collaborated with several universities and research centers (Missouri, Wageningen and Humboldt Universities, etc.), international organizations (UN, World Bank, WFP, FAO, etc.), NGOs (NCBA-CLUSA, ACDI-VOCA, etc.), social enterprises and multinational companies. Since September 2016, he relocated to the Netherlands to start working as a "Senior Technical Adviser on Cooperative Agribusiness Development" for CTA, which is the center for agricultural cooperation of the EU and ACP countries. In his current position, Dr Francesconi is responsible for leading and developing the EDC project (Enhancing Development through Cooperatives: www.edc.cta.int) financed by OCDC, USAID, OXFAM, Ford Foundation, CIAT and CTA.

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