Women's Empowerment and the Adoption of Improved Maize Varieties: Evidence from Ethiopia, Kenya, and Tanzania

Greg Seymour (g.seymour@cgiar.org)[†], Cheryl Doss[‡], Paswel Marenya[§], Ruth Meinzen-Dick[†], and Simone Passarelli[†]

[†]International Food Policy Research Institute (IFPRI) – CGIAR Research Program on Policies, Institutions, and Markets (PIM), [‡]Yale University, and [§]International Maize and Wheat Improvement Center (CIMMYT)

Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association
Annual Meeting, Boston, Massachusetts, July 31-August 2

Women's Empowerment and the Adoption of Improved Maize Varieties: Evidence from Ethiopia, Kenya, and Tanzania

Greg Seymour*, Cheryl Doss, Paswel Marenya, Ruth Meinzen-Dick, and Simone Passarelli

Preliminary, rough, and incomplete. Please do not cite or circulate without authors' permission.

ABSTRACT

Despite recent evidence that decisions about technology adoption often involve input from both men and women, the literature on technology adoption rarely considers gender and intrahousehold issues. In this paper, we use survey data from Ethiopia, Kenya, and Tanzania to investigate the influence of women's empowerment on the adoption of improved maize varieties (IMVs). While our results are mixed as to whether or not women's empowerment is positively correlated with higher rates of adoption, we find overwhelmingly that women's empowerment is positively correlated with greater participation by women in decisions about the adoption of IMVs, the acquisition of credit for the purchase of IMVs, and the acquisition of extension services related to IMVs.

* Greg Seymour is contact author. Email: g.seymour@cgiar.org. Address: 2033 K St. NW, Washington, DC 20006.
This research was generously funded by the Australian Center for International Agricultural Research and the International Maize and Wheat Improvement Center through the Adoption Pathways project, and by the CGIAR Research Program on Policies, Institutions, and Markets. We thank Solomon Alemu, Menale Kassie, Fulgence Mishili, Geoffrey Muricho, and Gideon Obare for their input and assistance on this project. All errors are our own.

1. Introduction

A growing body of evidence suggests that decisions about technology adoption often involve input from both men and women (e.g., Love et al. 2014; Marenya et al. 2015; Lambrecht et al. 2016). Yet, the literature on technology adoption, however, rarely considers gender and intrahousehold issues. All too often in this literature, gender analysis is equated with a comparison of male- and female-headed households. This approach, though understandable (if not completely justifiable) in cases where the researchers lack data from more than one household decisionmaker, fails to capture important aspects of intrahousehold dynamics, which may be instrumental in determining many outcomes of interest. Similarly, recent interest in household methodologies as means of promoting women's empowerment and, more broadly, greater intrahousehold cooperation (e.g., Bishop-Sambrook 2014), raises questions about how these outcomes might impact agricultural production and, in particular, the adoption of new technologies, such as improved seed varieties.

This paper addresses the gap in understanding the role of gender in technology adoption through a multi-layered analysis of the influence of women's empowerment on decisions about the adoption and usage of improved maize varieties (IMVs). Our analysis utilizes farm-level data from three countries in East Africa (Ethiopia, Kenya, and Tanzania) to estimate a double hurdle model (Cragg 1971) capturing the relationship between women's empowerment and whether or not an IMV is grown by a farm (first hurdle) and the proportion of a farm's maize growing area planted with an IMV (second hurdle). We also interrogate the channels through which women's empowerment might relate to these decisions. Specifically, we analyze whether women's empowerment is associated with women's joint participation in: (1) decisions about the adoption (or disadoption) of IMVs, (2) the acquisition of credit for the purchase of IMVs or other inputs, and (3) the acquisition of extension services related to IMVs. We derive our measures of women's empowerment from indicators based on the Women's Empowerment in Agriculture Index (WEAI) (Alkire et al. 2013).

The paper proceeds as follows. The next section reviews existing evidence on gender and technology adoption. Section three discusses our empirical model. Section four describes our data. Section five presents our results. Second six concludes the paper with a discussion of the broader implications of our results for agricultural policy.

2. Review of Existing Evidence

The Role of Women's Empowerment in Agricultural Technologies

The role of women's empowerment and its analysis has received a growing amount of attention in research, especially since the inclusion of the third Millennium Development Goal of promoting gender equality and empowering women. A commonly referenced definition of empowerment is Kabeer (1999), who describes empowerment as expanding people's ability to make strategic life choices, particularly in contexts in which this ability had been denied to them. This ability to exercise choice encompasses three dimensions, including resources, agency, and achievements. In agriculture, where women comprise approximately 46 percent of the labor force in Sub-Saharan Africa (Quisumbing et al. 2014), promoting gender equality in access to inputs could result in yield gains of an estimated 20-30 percent (FAO 2011). Thus, there is substantial interest in investigating how agricultural policies can promote more gender equitable outcomes, for both social and economic gains.

Researchers have used numerous different variables in trying to analyze empowerment, including household decisionmaking, education level, control over income and asset ownership. The Women's Empowerment in Agriculture Index (WEAI) was developed in order to measure the aspects of empowerment that related to agriculture, mostly to the dimension of agency (Alkire et al. 2013). The WEAI aims to measure 5 domains of empowerment in agriculture, including (1) decisions about agricultural production, (2) access to and decisionmaking power about productive resources, (3) control of use of income, (4) leadership in the community, and (5) time allocation.

Due to women's pronounced role in the process of agricultural development, there are a number of reasons to hypothesize why empowerment and technological innovation may be related. Namely, women who are empowered tend to be more educated and have a greater level of decisionmaking power within the household. Research has found that women are more likely than men to invest in goods that will benefit their children and households, especially health and education (Quisumbing and Hallman 2003; Quisumbing 2003; Quisumbing and Maluccio 2003; Skoufias 2005). Time use surveys have found that women are responsible for many of the time-consuming agricultural tasks, such as weeding, hoeing and transplanting, and therefore may benefit more greatly from agricultural technology adoption (Blackden and Wodon 2006).[1] In addition, households in which women are empowered may be more progressive in their beliefs, and perhaps more open to the idea of technological innovation. Thus, if women were more empowered, it could be expected that a household may face a higher propensity to adopt new agricultural technologies and approaches.

However, to our knowledge, few papers have examined the relationship between women's empowerment, agricultural extension and technology adoption specifically. The

[1] It should be noted, however, that technologies may not, in fact, always free women's labor time; in fact, Doss (2001) finds that technology introduction can often increase women's labor burden, for example due to increased quantity of harvest or heightened input requirements

existing literature on this topic and related research areas is discussed below.

Gender in the Technology Adoption Literature

An extensive body of literature has examined the determinants of and constraints to adopting new agricultural technologies (e.g., Feder et al. 1985; Sunding and Zilberman 2001; Guerin and Guerin 1994; Knowler and Bradshaw 2007; Feder and Umali 1993). The constraints identified to technology adoption are most commonly found to be lack of credit, limited access to information and inputs, inadequate infrastructure, risk aversion, social networks and social learning behaviors. However, the majority of early papers exploring characteristics of technology adopters do not address gender directly, with the exception of several that include a variable for whether households were male or female-headed to look at whether men or women adopted certain technologies. By focusing on only the distinction of male- or female-headed households, the behaviors of women within male-headed households are missed (Doss and Morris 2001). Furthermore, the substantially smaller percentage of female-headed households in developing countries often results in statistically insignificant results when examining outcomes for this group (Quisumbing et al. 2014).

The focus on these types of limited gender analyses are often due to a reliance on survey data that are not sex-disaggregated. In these questionnaires, the respondent is commonly the primary decisionmaker or head of the household, generally a man. However, as Doss (2015) emphasizes, in many countries, male and female farmers cultivate plots separately or jointly, and make both independent and collective decisions regarding which crops and technologies to utilize in production (Doss 2015). Several studies have found that there is no difference in men and women's rates of adoption of agricultural technologies when controlling for other factors, such as access to complementary inputs (Chirwa 2005; Doss and Morris 2001). Yet as Doss argues, “it is rare that all else is equal,” meaning that in reality, men and women do not have equal access to the levels of inputs for which the models control, such as fertilizer, seed, credit, land, capital and extension services. Thus, it is important to consider the differential levels of these constraints in actuality when considering policies to promote technology adoption.

In addition, gender dimensions run much more deeply than whether a man and/or woman are making a decision. Rather, gender has a profound influence on the factors found to determine technology adoption—including social networks, asset ownership, access to extension, access to credit, and land holdings. Moreover, when considering the constraints to adoption at play, gender must be observed within the context of intersectionality of other characteristics, such as race, economic status, ethnic group and religion—all of which may contribute to differential societal status, behaviors and perceptions. Therefore, analysis that seeks to understand the determinants of agricultural technology adoption should not only incorporate gender-disaggregated data to understand men and women’s perspectives, but they should also understand the additional socioeconomic factors and qualities, which often have a gender dimension, that influence a households’ level of innovation.

Determinants of Technology Adoption

A substantial number of papers have sought to explain the determinants of technology adoption, which can be summarized by three frequently used paradigms used in the literature (Uaiene et al. 2009); the innovation-diffusion model, and adoption perception and economic constraints models. The first paradigm, described by Feder and Slader (1984), describes how farmers with larger amounts of capital (including human capital, land and information) will adopt technologies first, and more farmers will adopt once the technologies are more diffuse and thus the search costs lower (Feder and Slade 1984). The adoption perception model takes the approach that a farmer's adoption behavior depends mainly on how the benefits and attributes of a technology are perceived by a farmer (Kivlin and Fliegel 1967). Lastly, the economic constraint model argues that resource endowments are the principal constraint to adoption in the short-run, and that inflexibility of inputs such as land, labor and credit largely influence adoption decisions. A wealth of literature has tested variations of these models and combinations of them, finding that the use of all three improves explanatory power relative to only one paradigm (Uaiene et al. 2009), suggesting that elements of all three paradigms of technology diffusion, farmer perceptions and access to inputs play a role in determining adoption behaviors.

Uaiene et al. (2009) look at characteristics of adopters of agricultural technologies in Mozambique, finding that households with higher education, male household heads, access to credit, access to extension services, membership to an agricultural association and outgrower schemes are all associated with higher rates of adoption of new technologies. Although in this paper, only the gender of the household head was included in analysis due to the lack of intrahousehold data, making it impossible to determine how gender influences technology adoption in households with more than one decisionmaker.

One of the most pertinent papers in the literature utilizing sex-disaggregated data to understand technology adoption is research from Doss and Morris (2001), which examines the differential rates of technology adoption in improved maize varieties and chemical fertilizers in Ghana. Their model uses the gender of the farmer, rather than the gender of the household head, in examining the factors that influence improved maize and chemical fertilizer adoption. Findings demonstrate that lower adoption by women compared to men could largely be explained by differential access to complementary inputs, including land, labor and extension services. These results suggest that men and women's use of technology in agriculture is not due to differences in propensity to innovate, but to the differential access to the goods and services that make technologies accessible, usable and profitable. Nonetheless, women farmers are less likely than men to adopt agricultural technologies such as improved crop varieties and agricultural management practices (Doss 2001). Therefore, equal access to the resources that create enabling environments for technology adoption could serve to help equalize conditions for men and women in agricultural innovation.

Gender and Access to Extension Services

As Doss and Morris (2001) highlight, the adoption of agricultural technologies is linked to access to complementary inputs. There remains a large gap between men and women's access to these inputs, one of which is extension services. A number of studies and reviews have examined differences in men and women's access to extension, though many only compare male and female-headed households in their gender analysis. A joint World Bank and IFPRI study (2010) interviewed both spouses when present, and examined access to extension services in Ethiopia, India and Ghana. The researchers found the most pronounced gender gap in Ghana for female-headed households, where 12 percent of the male-headed households and less than two percent of female spouses in male-headed households received an extension visit, and only two percent of female-headed households received a visit. Women's extension access was highest in Ethiopia, where 20 percent of women and 27 percent of men received agricultural extension visits. Access to livestock services was found to be higher for women in India compared to men, likely because women are often the caretakers for animals.

Another comparative piece by Davis et al. (2012) found that men and women partake equally in Farmer Field Schools (FFS) in Kenya and Tanzania, though women in Uganda are less likely to participate. The analysis also incorporated elements of technology adoption, finding that women benefit more than men from these services. Peterman et al. (2014) reviewed 17 studies that address gender differences in access to human resources, including extension services. Except for the cases specified in Davis et al. 2012 and the case of higher livestock services for women in World Bank/IFPRI (2010), Peterman et al. find lower levels of access for women compared to men in all other studies reviewed.

Very few studies, other than examples mentioned (e.g. Doss and Morris, 2001) make an empirical linkage between gender, extension and technology adoption. Rather, the focus is either on the piece of agricultural extension, or technology adoption. As the World Bank/IFPRI (2010) study finds, access to extension is a key determinant of the adoption of new technologies. Their analysis of Ghana data found that meeting with an extension agent to be the greatest predictor of the adoption of an agricultural technology, with the likelihood of adopting new technologies approximately 18 percent greater for those who met with an extension agent. It should be noted that access to extension services does not consider the quality of those services, the gender sensitivity of the information, the material covered in these visits, or the promotion of new technologies in the visit.

One recent publication that does successfully make these linkages is a paper by Lambrecht et al. (2016) which explores the role of gender in the receipt of agricultural extension visits. Using data from the Democratic Republic of the Congo, the authors look at the relationship between female participation in extension visits and the adoption of three agricultural technologies: improved legume varieties, row planting and mineral fertilizer. Their findings suggest that joint male and female participation in extension visits results in the highest rates of technology adoption, compared to male- or female- only visits. They also find that female participation is not conducive to promoting adoption of capital-intensive technologies, but it is for labor-intensive technologies and traditionally female-dominated crops. This may be due to the fact that men often dominate the decisionmaking space of capital-intensive purchases, whereas women are responsible for manual tasks such as weeding and planting.

3. Methodology

One of the challenges associated with estimating the influence of women's empowerment on IMV production is that we only observe the intensity of IMV adoption for those farms that adopt an IMV, and not all farms choose to do so. One possible approach to address this selection issue would be to estimate a Heckman model (Heckman 1979). The Heckman model, however, is designed for truncation that emerges from unobserved values, such as in the case of wage rate models where the sample includes unemployed persons. Given that our data was purposively sampled to be representative of maize-growing regions within the sample countries, it is safe to assume that the vast majority of farmers in these regions are aware of several different IMVs. In this context, the decision not to adopt an IMV likely reflects an optimal choice made by farmers based on prevailing market and agronomic conditions, rather than as a missing value.

A Tobit model (Tobin 1958) is another possible approach to model farmers' IMV decision. However, the Tobit might be too restrictive, in that it would require that the decision to adopt an IMV and the amount of IMV to plant be determined by the same process. Cragg's (1971) double-hurdle model is more flexible than the Tobit model because it allows for the possibility that factors influencing IMV adoption and factors influencing quantity of IMV planted may be different or that the same factors may impact each decision differently. The double-hurdle model fits our problem because we are uncertain of how women's empowerment might influence these two decisions.

The second part of our analysis interrogates the channels through which women's empowerment might impact decisions about IMV production. In particular, we focus on understanding the factors determining women's joint participation in three aspects of IMV production: (1) decisions about the adoption (or disadoption) of IMVs, (2) the acquisition of credit for the purchase of IMVs or other inputs, and (3) the acquisition of extension services related to IMVs. We focus on joint participation, rather than sole participation, based largely on the fact that sole participation by women within our data on these three aspects of IMV production is rare. Therefore, we model women's joint participation as a binary outcome, and estimate the model using probit regression. Throughout our analysis, the unit of analysis is the household (or farm).

4. Data

The data used in this analysis come from surveys carried out in Ethiopia, Kenya, and Tanzania as part of the Adoption Pathways (AP) project during 2013.[2] In Ethiopia, data were collected during for approximately 900 households from nine districts in the following regions: Benishangul-Gumuz, Oromia and Southern Nations Nationalities and Peoples' Region (SNNP). In Kenya, data were collected for approximately 540 household from two counties in western Kenya (Siaya and Bungoma) and three counties in eastern Kenya (Embu, Tharaka Nithi and Meru). In Tanzania, data were collected for approximately 550 households in two districts in northern Tanzania (Karatu and Mbulu) and three districts in eastern Tanzania (Mvomero, Kilosa, and Gairo). In each of the countries, the surveys followed a multistage sampling procedure designed to be representative of the major maize–legume farming systems within the country and

[2] The Adoption Pathways project, formally titled "Identifying socioeconomic constraints to and incentives for faster technology adoption: Pathways to sustainable intensification in Eastern and Southern Africa," was funded by the Australian International Food Security Center (AIFSC) and Australian Centre for International Agricultural Research (ACIAR). The project was led by the International Maize and Wheat Improvement Center (CIMMYT) and operated in Ethiopia, Kenya, Tanzania, Malawi, and Mozambique.

combined include data on 1,990 households.[3] However, missing variables limit the number of households eligible for our sample. This is particularly a problem among women in Kenya and Tanzania, for whom data is often missing on one or more of the questions we use to measure women's empowerment. Given the way in which our empowerment indicators are calculated (discussed in greater detail below), this requires that they be dropped from the sample.[4] After accounting for this, the resulting sample includes data on 1,358 households (899 from Ethiopia, 226 from Kenya, and 354 from Tanzania).

Descriptive statistics for all variables used in our analysis are presented in Table 1. Roughly 33 percent of households in the sample grow an IMV. According to respondents' self-reports ("In your household, who makes the decision on which improved maize varieties to use and dis-adopt?"), both spouses have a say in decisions about adoption in 55 percent of households. Considerably fewer households report joint participation by both spouses in the acquisition of credit and extension services related to IMV (based on the questions: "In your household, who mostly acquires credit (cash or in kind) services for purchase of maize seeds both improved and local varieties and other inputs (fertilizer, herbicides)" and "In your household, who mostly acquires extension services related to new maize varieties?").

The indicators of women's empowerment used in our analysis are based on the WEAI. The WEAI is a survey-based index that uses individual-level data collected from the primary male and female decision-makers within the same households to measure respondents' empowerment in their roles and engagement based on ten indicators across five domains (production, resources, income, leadership, and time allocation) within the agriculture sector

[3] For details on the survey and sampling design see Teklewold et al. (2013) for Ethiopia, Kassie et al. (2014b) for Kenya, Kassie et al. (2014a) for Tanzania.

[4] The calculation of a woman's empowerment score requires data in each of the eight component indicators. A missing value in a single one of these indicators resulted in the respondent being dropped from the sample.

(Alkire et al., 2013). It is comprised of two sub-indices—the Five Domains of Empowerment index (5DE) and the Gender Parity Index (GPI)—which measure empowerment, respectively, in terms of a woman's individual achievements and her achievements relative to those of her spouse.

As part of the Adoption Pathways surveys, data was collected on eight of the ten WEAI indicators (Seymour and Komatsu 2015). Following same underlying methodology utilized in the WEAI, we construct an index of empowerment for each woman by taking the weighted sum of her achievement across these eight indicators (referred to henceforth as a woman's empowerment score).[5] According to this index, women in the sample achieve adequacy in 84.2 percent of the (weighted) indicators.[6] We also measure a woman's relative achievement of empowerment based on a comparison of both spouses' empowerment scores. This indicator, referred to as the empowerment gap, takes a value of zero if a woman's empowerment score is greater than or equal to that of her spouse; otherwise, it equals the difference between her empowerment score and that of her spouse. Thus, higher values reflect greater gender inequality within the household. According to this indicator, men achieve a roughly 10 percent higher level of empowerment than women in the sample. A key innovation of the WEAI is that it can be decomposed and used as a diagnostic tool to assess the contribution of each domain or indicator to the overall level of disempowerment (or empowerment) within a group. We take advantage of this feature and decompose a woman's empowerment score into four principal indicators: (1) the number of group she belongs to, (2) the proportion of decision she solely or joint participates in over assets, (3) the proportion of decision she solely or joint participates in over the use of

[5] For details on the Alkire-Foster methodology see Alkire and Foster (2011).
[6] Adequacy is based on the same cut-offs utilized in the WEAI. See Alkire et al. (2013) and Seymour and Komatsu (2015) for details.

income, and (4) the proportion of decision she solely or joint participates in over food and cash crop farming (excluding decisions about the types of seeds to buy) and livestock raising.

5. Results

The first part of our analysis focuses on understanding the influence of women's empowerment on farmers' adoption of IMVs. To this end, we estimate a series of double-hurdle models using pooled data from all three countries in our sample. The second part of analysis interrogates the channels through which women's empowerment might relate to these decisions. Specifically, we analyze whether woman's empowerment is associated with women's joint participation in: (1) decisions about the adoption (or disadoption) of IMVs, (2) the acquisition of credit for the purchase of IMVs or other inputs, and (3) the acquisition of extension services related to IMVs. Throughout our analysis, we measure women's empowerment using each of three approaches outlined in the previous section. Furthermore, all of our regressions include the following set of control variables: age and education for the primary male and female decision-makers within the household,

Pooled Regressions

Table 2 shows the results of the double-hurdle models. We find no evidence of a significant relationship between women's empowerment and the adoption of an IMV. We do, however, find some evidence that women's empowerment is positively associated the share of maize area planted with IMV. Namely, we find evidence of a statistically significant (at the 10 percent level) positive association between a woman's empowerment score and the share of maize area planted with IMV. We also find evidence of positive association between the share of maize area planted with IMV and two of the component indicators of empowerment that we analyze: the number of groups a woman belongs to and the proportion of decisions she solely or jointly participates in about the use of income.

Table 3 shows the results of the probit models. The results overwhelmingly indicate that women's empowerment is positively associated with greater participation by women in all three aspects of IMV production that we investigate (decisions about the adoption of IMVs, the acquisition of credit for the purchase of IMVs or other inputs, and the acquisition of extension services related to IMVs). In terms of the individual indicators of empowerment, we find that two most important factors for this are: decision-making over assets and decision-making over production; though the latter is not statistically significantly related to the acquisition of extension services related to IMVs.

Country-Specific Regressions

As a robustness check to the findings of our pooled analysis, we re-estimate each of our models separately for each country represented in our sample. These results are presented in Table 4–Table 6 (double-hurdle models) and Table 7–Table 9 (probit models). In general, we find far fewer statistically significant results than we do when pooling the data, which may be understandable given the steep decrease in sample size (especially for Kenya and Tanzania). Nonetheless, we are able to replicate several of our prior results using the (relatively) larger Ethiopian sample, in particular that women's empowerment is positively associated with greater participation by women in all three aspects of IMV production that we investigate (decisions about the adoption of IMVs, the acquisition of credit for the purchase of IMVs or other inputs, and the acquisition of extension services related to IMVs) and that the most important factor in this relationship is a woman's participation in decision-making over assets. The latter findings is echoed in the Tanzanian sample (for all three IMV-related activities) as well.

6. Conclusions

In this paper, we sought to addresses a gap in understanding about the role of gender in technology adoption through an analysis of the influence of women's empowerment on decisions about the adoption and usage of improved maize varieties (IMVs) in three East African countries (Ethiopia, Kenya, and Tanzania). While we find only mixed evidence as to the influence of women's empowerment on whether a farm grows an IMV and the share of maize area planted with IMV, we find overwhelmingly that women's empowerment is positively associated with greater participation by women in three aspects of IMV production: (1) decisions about the adoption (or disadoption) of IMVs, (2) the acquisition of credit for the purchase of IMVs or other inputs, and (3) the acquisition of extension services related to IMVs.

In other words, our results strongly suggest that women's empowerment increases women's participation in the process of IMV adoption—though whether or not this translates into higher rates of adoption is still unclear. Nonetheless, coupled with other recent evidence showing that women's preferences matter in decisions about the adoption of IMV (e.g., Love et al. 2014; Marenya et al. 2015; Lambrecht et al. 2016), these results have strong implications for the targeting of agricultural extension services and the dissemination of information about new technologies, in general. If women are involved in decisions about technology adoption (as our evidence shows to be the case), then programs aimed at promoting technology adoption should target both men and women. Doing otherwise (targeting only men) risks forgoing potential gains by leaving a significant portion of the principal decision-makers without the necessary inputs for making informed decisions.

A few caveats, however, should be borne in mind when considering our results. First, the relationships uncovered by our results should be regarded as correlational, rather than as causal, given that the data we analyze are cross-sectional. Second, the extent to which our results are generalizable outside of our sample is unclear, given that (1) we are unable to completely replicate our pooled results at the country-level and (2) the data are not designed to be nationally representative.

References

Alkire, Sabina, and James Foster. 2011. "Counting and Multidimensional Poverty Measurement." *Journal of Public Economics* 95 (7-8): 476–87.

Alkire, Sabina, Ruth Meinzen-Dick, Amber Peterman, Agnes R. Quisumbing, Greg Seymour, and Ana Vaz. 2013. "The Women's Empowerment in Agriculture Index." *World Development* 52: 71–91.

Blackden, Mark C., and Quentin Wodon, eds. 2006. *Gender, Time Use, and Poverty in Sub-Saharan Africa*. Washington, DC: The World Bank. doi:10.1596/978-0-8213-6561-8.

Chirwa, Ephraim W. 2005. "Adoption of Fertiliser and Hybrid Seeds by Smallholder Maize Farmers in Southern Malawi." *Development Southern Africa* 22 (1): 1–12. doi:10.1080/03768350500044065.

Cragg, John G. 1971. "Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable." *Econometrica* 39 (5): 829–44.

Davis, K., E. Nkonya, E. Kato, D.A. Mekonnen, M. Odendo, R. Miiro, and J. Nkuba. 2012. "Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa." *World Development* 40 (2): 402–13. doi:10.1016/j.worlddev.2011.05.019.

Doss, Cheryl R. 2001. "Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience." *World Development* 29 (12): 2075–92. doi:10.1016/S0305-750X(01)00088-2.

———. 2015. "Women and Agricultural Productivity: What Does the Evidence Tell Us?" Economic Growth Center Discussion Paper No. 1051. Yale University, New Haven, CT. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2682663.

Doss, Cheryl R., and Michael L. Morris. 2001. "How Does Gender Affect the Adoption of Agricultural Innovations? The Case of Improved Maize Technology in Ghana." *Agricultural Economics* 25 (1): 27–39. doi:10.1016/S0169-5150(00)00096-7.

FAO. 2011. *The State of Food and Agriculture. Women in Agriculture: Closing the Gap for Development*. Rome, Italy: Food and Agriculture Organization of the United Nations. doi:ISSN 0081-4539.

Feder, Gershon, Richard E. Just, and David Zilberman. 1985. *Adoption of Agricultural Innovations in Developing Countries: A Survey*. *Economic Development and Cultural Change*. Vol. 33. doi:10.1086/451461.

Feder, Gershon, and Roger Slade. 1984. "The Acquisition of Information and the Adoption of New Technology." *American Journal of Agricultural Economics* 66 (3): 312–20. doi:10.1177/017084068800900203.

Feder, Gershon, and Dina L. Umali. 1993. "The Adoption of Agricultural Innovations: A Review." *Technological Forecasting and Social Change* 43: 215–39.

Guerin, L.J., and T.F. Guerin. 1994. "Constraints to the Adoption of Innovations in Agricultural Research and Environmental Management: A Review." *Animal Production Science* 34 (4):

549–71.

Heckman, James J. 1979. “Sample Selection Bias as a Specification Error.” *Econometrica* 47 (1): 153–61. doi:10.2307/1912352.

Kabeer, Naila. 1999. “Resources, Agency, Achievements: Reflections on the Measurement of Women’s Empowerment.” *Development and Change* 30 (3): 435–64. doi:10.1111/1467-7660.00125.

Kassie, Menale, Moti Jaleta, and Alessandra Mattei. 2014. “Evaluating the Impact of Improved Maize Varieties on Food Security in Rural Tanzania: Evidence from a Continuous Treatment Approach.” *Food Security* 6 (2): 217–30. doi:10.1007/s12571-014-0332-x.

Kassie, Menale, Simon Wagura Ndiritu, and Jesper Stage. 2014. “What Determines Gender Inequality in Household Food Security in Kenya? Application of Exogenous Switching Treatment Regression.” *World Development* 56 (April): 153–71. doi:10.1016/j.worlddev.2013.10.025.

Kivlin, Joseph E., and Frederick C. Fliegel. 1967. “Differential Perceptions of Innovations and Rate of Adoption.” *Rural Sociology* 32: 78–91.

Knowler, Duncan, and Ben Bradshaw. 2007. “Farmers’ Adoption of Conservation Agriculture: A Review and Synthesis of Recent Research.” *Food Policy* 32 (1): 25–48. doi:10.1016/j.foodpol.2006.01.003.

Lambrecht, Isabel, Bernard Vanlauwe, and Miet Maertens. 2016. “Agricultural Extension in Eastern Democratic Republic of Congo: Does Gender Matter?” *European Review of Agricultural Economics*, 1–33. doi:10.1093/erae/jbv039.

Love, Abby, Nicholas Magnan, and Gregory J. Colson. 2014. “Male and Female Risk Preferences and Maize Technology Adoption in Kenya.” Selected Paper Prepared for Presentation at the Agricultural & Applied Economics Association’s 2014 AAEA Annual Meeting. Minneapolis, MN, July 27-29. doi:10.1017/CBO9781107415324.004.

Marenya, Paswel, Menale Kassie, and Emilio Tostao. 2015. “Fertilizer Use on Individually and Jointly Managed Crop Plots in Mozambique.” *Journal of Gender, Agriculture and Food Security* 1 (2): 62–83.

Peterman, Amber, Julia A. Behrman, and Agnes R. Quisumbing. 2014. “A Review of Empirical Evidence on Gender Differences in Nonland Agricultural Inputs, Technology, and Services in Developing Countries.” In *Gender in Agriculture and Food Security: Closing the Knowledge Gap*, edited by Agnes R Quisumbing, Ruth Meinzen-Dick, Terri L Raney, Andre Croppenstedt, Julia A Behrman, and Amber Peterman, 145–86. Food and Agriculture Organization of the United Nations.

Quisumbing, Agnes R., ed. 2003. *Household Decisions, Gender, and Development: A Synthesis of Recent Research*. Washington, DC: International Food Policy Research Institute.

Quisumbing, Agnes R., and Kelly Hallman. 2003. “Marriage in Transition: Evidence on Age, Education, and Assets from Six Developing Countries.” 183. Policy Research Divison Working Paper 183. Population Council.

Quisumbing, Agnes R., and John A. Maluccio. 2003. "Resources at Marriage and Intrahousehold Allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa." *Oxford Bulletin of Economics and Statistics* 65 (3): 283–327.

Quisumbing, Agnes R., Amber Peterman, Julia A. Behrman, André Croppenstedt, Terri L. Raney, and Ruth Meinzen-Dick, eds. 2014. *Gender in Agriculture: Closing the Knowledge Gap*. FAO; Springer.

Seymour, Greg, and Hitomi Komatsu. 2015. "Women's Empowerment in Agriculture: Evidence from the Adoption Pathways Surveys in Ethiopia, Kenya, and Tanzania." Adoption Pathways Discussion Paper. International Maize and Wheat Improvement Center (CIMMYT).

Skoufias, Emmanuel. 2005. "PROGRESA and Its Impacts on the Welfare of Rural Households in Mexico." Research Report 139. Internatioal Food Policy Research Institute, Washington, DC. https://books.google.com/books?hl=en&lr=&id=PHfZ8rmuUSkC&pgis=1.

Sunding, David, and David Zilberman. 2001. "The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector." In *Handbook of Agricultural Economics*, 1:207–61. Handbook of Agricultural Economics. Elsevier. doi:10.1016/S1574-0072(01)10007-1.

Teklewold, Hailemariam, Menale Kassie, Bekele A. Shiferaw, and Gunnar Köhlin. 2013. "Cropping System Diversification, Conservation Tillage and Modern Seed Adoption in Ethiopia: Impacts on Household Income, Agrochemical Use and Demand for Labor." *Ecological Economics* 93 (September): 85–93. doi:10.1016/j.ecolecon.2013.05.002.

Tobin, James. 1958. "Estimation of Relationships for Limited Dependent Variables." *Econometrica* 26 (1): 24–36.

Uaiene, R.N., C. Arndt, and W.A. Masters. 2009. "Determinants of Agricultural Technology Adoption in Mozambique." National Directorate of Studies and Policy Analysis Discussion Papers No. 67E. Ministry of Planning and Development, Republic of Mozambique.

World Bank, and IFPRI. 2010. *Gender and Governance in Rural Services: Insights from India, Ghana, and Ethiopia*. Washington, DC: The World Bank. doi:10.1596/978-0-8213-7658-4.

Table 1. Descriptive Statistics

	Ethiopia	Kenya	Tanzania	Total
Household grows an IMV	0.301	0.273	0.659	0.330
Joint decision-making over adoption of IMV	0.561	0.592	0.457	0.555
Joint access to credit for purchase of IMV seeds	0.250	0.359	0.309	0.268
Joint access to extension services about IMV	0.231	0.427	0.296	0.259
Woman's empowerment score	0.847	0.883	0.742	0.842
Empowerment gap	0.101	0.052	0.147	0.099
Group membership	2.151	1.932	0.901	2.013
Decision-making over assets	0.650	0.602	0.519	0.633
Decision-making over income	0.689	0.686	0.755	0.695
Decision-making over production	0.763	0.887	0.757	0.777
Woman's age	35.69	44.34	39.99	37.07
Man's age	43.83	52.10	46.51	45.02
Woman's education (years)	1.206	7.553	5.593	2.328
Man's education (years)	3.225	8.466	6.173	4.091
Government extension services	0.972	0.893	0.160	0.890
Other extension services	0.526	0.291	0.123	0.463
Share of fertile land	0.494	0.247	0.548	0.471
Share of flat land	0.646	0.420	0.556	0.612
Area of owned land (ha)	1.438	0.737	1.563	1.369
N	899	226	354	1,358

Source: Authors' calculations based on AP data from Ethiopia, Kenya, and Tanzania.

Table 2. Double-Hurdle Models of Factors Influencing Adoption of Improved Maize Varieties (pooled regressions)

Hurdle 1: Probability of adopting IMV	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Woman's empowerment score	0.283	0.246				
Empowerment gap			-0.003	0.302		
Group membership					0.061	0.040
Decision-making over assets					-0.027	0.168
Decision-making over income					0.156	0.157
Decision-making over production					-0.049	0.149
Woman's age	-0.033*	0.019	-0.023	0.031	-0.035*	0.019
Man's age	0.015	0.016	-0.011	0.028	0.016	0.016
Woman's education (in years)	0.011	0.017	-0.001	0.020	0.009	0.017
Man's education (in years)	0.031**	0.013	0.038**	0.016	0.031**	0.013
Government extension services	0.287**	0.135	0.301*	0.171	0.277**	0.136
Other extension services	-0.004	0.093	0.038	0.101	-0.013	0.093
Share of fertile land	0.308***	0.097	0.313***	0.111	0.309***	0.097
Share of flat land	0.304***	0.099	0.295**	0.117	0.293***	0.099
(log) Area of owned land (ha)	0.477***	0.117	0.505***	0.133	0.470***	0.117
Country/district dummies	Yes		Yes		Yes	
Hurdle 2: Share of maize area planted with IMV						
Woman's empowerment score	0.067*	0.036				
Empowerment gap			-0.054	0.042		
Group membership					0.019***	0.006
Decision-making over assets					0.031	0.023
Decision-making over income					0.051**	0.023
Decision-making over production					-0.021	0.021
Woman's age	-0.007**	0.003	-0.007	0.004	-0.008***	0.003
Man's age	0.002	0.002	0.002	0.004	0.003	0.002
Woman's education (in years)	0.001	0.002	-0.000	0.003	0.000	0.002
Man's education (in years)	0.006***	0.002	0.007**	0.003	0.006***	0.002
Government extension services	0.016	0.026	-0.003	0.032	0.013	0.025
Other extension services	-0.003	0.012	0.004	0.014	-0.005	0.012
Share of fertile land	0.034**	0.017	0.023	0.021	0.033*	0.017
Share of flat land	0.036*	0.019	0.025	0.022	0.033*	0.018
(log) Area of owned land (ha)	-0.008	0.024	-0.026	0.030	-0.012	0.024
Country/district dummies	Yes		Yes		Yes	
Observations	1,358		1,076		1,358	

Source: Authors' calculations based on AP data from Ethiopia, Kenya, and Tanzania.
Notes: Coefficients displayed are the conditional average partial effects (APEs). Dual-adult households only.
* $p<0.10$ ** $p<0.05$, and *** $p<0.01$

Table 3. Probit Models of Factors Influencing Joint Decision-Making and Participation in IMV Production (pooled regressions)

	Joint decision-making over adoption/dis-adoption of improved maize varieties			Joint access to credit for purchase of maize seeds			Joint access to extension services about improved maize varieties		
Woman's empowerment score	0.345***			0.440***			0.217***		
	(0.094)			(0.093)			(0.084)		
Empowerment gap		-0.397***			-0.475***			-0.230**	
		(0.110)			(0.111)			(0.099)	
Group membership			0.008			-0.006			-0.004
			(0.012)			(0.011)			(0.012)
Decision-making over assets			0.518***			0.280***			0.230***
			(0.069)			(0.058)			(0.056)
Decision-making over income			-0.111*			-0.065			-0.037
			(0.059)			(0.053)			(0.055)
Decision-making over production			0.207***			0.181***			0.058
			(0.056)			(0.051)			(0.052)
Woman's age	-0.014***	-0.004	-0.015***	-0.009***	-0.006**	-0.010***	-0.009***	-0.006**	-0.009***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Man's age	0.013***	0.004	0.014***	0.007***	0.004*	0.007***	0.007***	0.004**	0.007***
	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Woman's education (years)	0.014**	0.012	0.012*	-0.000	-0.002	0.000	0.010*	0.009	0.010**
	(0.007)	(0.008)	(0.007)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)
Man's education (years)	-0.007	-0.000	-0.006	-0.001	0.004	0.000	-0.007*	-0.002	-0.007
	(0.005)	(0.006)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
(log) Area of owned land	0.006	0.004	0.019	-0.002	-0.001	0.021	0.004	-0.000	0.015
	(0.041)	(0.046)	(0.040)	(0.036)	(0.040)	(0.035)	(0.036)	(0.040)	(0.035)
Country/district dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.104	0.050	0.143	0.116	0.095	0.125	0.139	0.128	0.147
Observations	1,058	899	1,058	1,058	899	1,058	1,058	899	1,058

Source: Authors' calculations based on AP data from Ethiopia, Kenya, and Tanzania.

Notes: Coefficients displayed are the conditional average marginal effects (AMEs). Robust standard errors in parentheses. Dual-adult households only. * p<0.10 ** p<0.05, and *** p<0.01

Table 4. Double-Hurdle Models of Factors Influencing Adoption of Improved Maize Varieties (country-specific regressions), Ethiopia

Hurdle 1: Probability of adopting IMV	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Woman's empowerment score	0.382	0.349				
Empowerment gap			0.026	0.383		
Group membership					0.070	0.049
Decision-making over assets					-0.230	0.346
Decision-making over income					-0.033	0.221
Decision-making over production					0.205	0.216
Woman's age	-0.062	0.039	-0.041	0.052	-0.066*	0.040
Man's age	0.006	0.025	-0.036	0.039	0.006	0.025
Woman's education (in years)	-0.004	0.029	0.003	0.030	-0.009	0.029
Man's education (in years)	0.034*	0.019	0.021	0.021	0.034*	0.019
Government extension services	0.324	0.275	0.263	0.326	0.276	0.277
Other extension services	-0.104	0.116	-0.104	0.121	-0.104	0.118
Share of fertile land	0.151	0.141	0.143	0.146	0.154	0.142
Share of flat land	0.524***	0.164	0.509***	0.171	0.509***	0.164
(log) Area of owned land (ha)	0.542***	0.159	0.558***	0.165	0.525***	0.159
District dummies	Yes		Yes		Yes	
Hurdle 2: Share of maize area planted with IMV						
Woman's empowerment score	0.062	0.053				
Empowerment gap			-0.036	0.055		
Group membership					0.021***	0.007
Decision-making over assets					0.079*	0.046
Decision-making over income					0.051	0.034
Decision-making over production					-0.017	0.035
Woman's age	-0.002	0.007	-0.000	0.008	-0.004	0.007
Man's age	0.001	0.004	-0.001	0.005	0.002	0.004
Woman's education (in years)	0.003	0.004	0.004	0.004	0.003	0.004
Man's education (in years)	0.005	0.003	0.003	0.003	0.005	0.003
Government extension services	0.054	0.060	0.041	0.064	0.037	0.059
Other extension services	-0.003	0.016	-0.003	0.017	-0.006	0.016
Share of fertile land	0.004	0.020	0.002	0.021	0.001	0.020
Share of flat land	0.037	0.032	0.023	0.033	0.032	0.031
(log) Area of owned land (ha)	-0.024	0.032	-0.031	0.035	-0.028	0.031
District dummies	Yes		Yes		Yes	
Observations	778		715		778	

Source: Authors' calculations based on AP data from Ethiopia.
Notes: Coefficients displayed are the conditional average partial effects (APEs). Dual-adult households only.
* p<0.10 ** p<0.05, and *** p<0.01

Table 5. Double-Hurdle Models of Factors Influencing Adoption of Improved Maize Varieties (country-specific regressions), Kenya

Hurdle 1: Probability of adopting IMV	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Woman's empowerment score	-1.081	0.836				
Empowerment gap			2.423**	1.223		
Group membership					0.038	0.099
Decision-making over assets					0.006	0.397
Decision-making over income					0.438	0.522
Decision-making over production					-0.711*	0.397
Woman's age	0.031	0.049	0.042	0.095	0.029	0.050
Man's age	-0.036	0.034	-0.110	0.099	-0.027	0.035
Woman's education (in years)	0.034	0.036	-0.001	0.047	0.026	0.037
Man's education (in years)	0.008	0.035	0.054	0.046	0.004	0.035
Government extension services	-0.196	0.248	-0.088	0.337	-0.248	0.249
Other extension services	0.019	0.227	0.445	0.286	0.015	0.230
Share of fertile land	0.112	0.278	-0.040	0.336	0.133	0.280
Share of flat land	0.274	0.217	0.472*	0.275	0.246	0.220
(log) Area of owned land (ha)	0.671*	0.366	0.808*	0.478	0.634*	0.369
District dummies	Yes		Yes		Yes	
Hurdle 2: Share of maize area planted with IMV						
Woman's empowerment score	0.025	0.189				
Empowerment gap			-0.342	0.273		
Group membership					0.000	0.017
Decision-making over assets					0.012	0.066
Decision-making over income					0.080	0.105
Decision-making over production					-0.020	0.122
Woman's age	0.001	0.009	-0.026	0.017	-0.002	0.009
Man's age	-0.004	0.008	0.028	0.020	-0.000	0.007
Woman's education (in years)	-0.003	0.008	-0.009	0.010	-0.005	0.008
Man's education (in years)	0.009	0.007	0.020*	0.011	0.008	0.007
Government extension services	-0.086*	0.046	-0.063	0.050	-0.071	0.049
Other extension services	-0.034	0.038	-0.048	0.061	-0.037	0.039
Share of fertile land	-0.008	0.042	-0.024	0.050	-0.012	0.043
Share of flat land	0.031	0.047	-0.012	0.060	0.014	0.045
(log) Area of owned land (ha)	-0.078	0.097	-0.190*	0.103	-0.109	0.104
District dummies	Yes		Yes		Yes	
Observations	226		150		226	

Source: Authors' calculations based on AP data from Kenya.
Notes: Coefficients displayed are the conditional average partial effects (APEs). Dual-adult households only.
* p<0.10 ** p<0.05, and *** p<0.01

Table 6. Double-Hurdle Models of Factors Influencing Adoption of Improved Maize Varieties (country-specific regressions), Tanzania

Hurdle 1: Probability of adopting IMV	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Woman's empowerment score	0.403	0.406				
Empowerment gap			-0.362	0.606		
Group membership					0.056	0.105
Decision-making over assets					0.109	0.239
Decision-making over income					0.293	0.278
Decision-making over production					-0.198	0.265
Woman's age	-0.041	0.032	-0.008	0.053	-0.040	0.032
Man's age	0.066**	0.029	0.044	0.054	0.066**	0.029
Woman's education (in years)	0.011	0.027	-0.049	0.040	0.011	0.027
Man's education (in years)	0.047*	0.025	0.061	0.038	0.046*	0.025
Government extension services	0.682***	0.228	0.806***	0.312	0.719***	0.229
Other extension services	0.367	0.274	0.899**	0.389	0.382	0.274
Share of fertile land	0.622***	0.168	0.885***	0.234	0.642***	0.169
Share of flat land	0.112	0.165	-0.158	0.235	0.106	0.166
(log) Area of owned land (ha)	0.330	0.214	0.489*	0.289	0.330	0.215
District dummies	Yes		Yes		Yes	
Hurdle 2: Share of maize area planted with IMV						
Woman's empowerment score	-0.017	0.040				
Empowerment gap			-0.050	0.058		
Group membership					-0.007	0.008
Decision-making over assets					0.010	0.018
Decision-making over income					-0.008	0.024
Decision-making over production					0.006	0.022
Woman's age	-0.003	0.003	-0.004	0.004	-0.003	0.003
Man's age	-0.000	0.004	0.004	0.006	-0.000	0.004
Woman's education (in years)	-0.001	0.002	-0.004	0.004	-0.001	0.002
Man's education (in years)	-0.000	0.003	0.001	0.004	0.000	0.003
Government extension services	-0.033	0.036	-0.033	0.034	-0.032	0.038
Other extension services	-0.013	0.024	0.015	0.037	-0.013	0.024
Share of fertile land	0.007	0.033	0.029	0.037	0.008	0.034
Share of flat land	-0.004	0.014	-0.000	0.020	-0.003	0.014
(log) Area of owned land (ha)	-0.037*	0.021	-0.045*	0.027	-0.034	0.021
District dummies	Yes		Yes		Yes	
Observations	354		211		354	

Source: Authors' calculations based on AP data from Tanzania.
Notes: Coefficients displayed are the conditional average partial effects (APEs). Dual-adult households only.
* p<0.10 ** p<0.05, and *** p<0.01

Table 7. Probit Models of Factors Influencing Joint Decision-Making and Participation in IMV Production (country-specific regression), Ethiopia

	Joint decision-making over adoption/dis-adoption of improved maize varieties			Joint access to credit for purchase of maize seeds			Joint access to extension services about improved maize varieties		
Woman's empowerment score	0.348***			0.459***			0.210**		
	(0.112)			(0.102)			(0.094)		
Empowerment gap		-0.405***			-0.510***			-0.246**	
		(0.125)			(0.116)			(0.110)	
Group membership			0.012			-0.001			0.004
			(0.014)			(0.012)			(0.012)
Decision-making over assets			0.793***			0.370***			0.283***
			(0.096)			(0.080)			(0.085)
Decision-making over income			-0.225***			-0.086			-0.049
			(0.067)			(0.063)			(0.069)
Decision-making over production			0.307***			0.214***			0.088
			(0.065)			(0.064)			(0.068)
Woman's age	-0.015***	-0.003	-0.016***	-0.009***	-0.005	-0.009***	-0.007***	-0.004	-0.007***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Man's age	0.013***	0.004	0.015***	0.007***	0.004	0.008***	0.006***	0.004	0.007***
	(0.002)	(0.003)	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)
Woman's education (years)	0.012	0.014	0.008	-0.002	-0.001	-0.001	0.014**	0.015**	0.014**
	(0.009)	(0.009)	(0.008)	(0.007)	(0.008)	(0.007)	(0.006)	(0.007)	(0.006)
Man's education (years)	-0.006	-0.003	-0.005	0.003	0.007	0.004	-0.004	-0.002	-0.003
	(0.006)	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
(log) Area of owned land	0.007	0.007	0.025	-0.017	-0.005	0.007	0.011	0.016	0.023
	(0.048)	(0.052)	(0.045)	(0.040)	(0.043)	(0.040)	(0.039)	(0.042)	(0.039)
Country/district dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.088	0.041	0.151	0.115	0.096	0.126	0.144	0.127	0.154
Observations	778	715	778	778	715	778	778	715	778

Source: Authors' calculations based on AP data from Ethiopia.

Notes: Coefficients displayed are the conditional average marginal effects (AMEs). Robust standard errors in parentheses. Dual-adult households only. * p<0.10 ** p<0.05, and *** p<0.01

Table 8. Probit Models of Factors Influencing Joint Decision-Making and Participation in IMV Production (country-specific regression), Kenya

	Joint decision-making over adoption/dis-adoption of improved maize varieties			Joint access to credit for purchase of maize seeds			Joint access to extension services about improved maize varieties		
Woman's empowerment score	0.380			0.472			0.098		
	(0.292)			(0.333)			(0.269)		
Empowerment gap		-0.023			-0.236			0.332	
		(0.391)			(0.380)			(0.351)	
Group membership			-0.013			-0.038			-0.024
			(0.034)			(0.033)			(0.033)
Decision-making over assets			0.278*			-0.062			-0.023
			(0.150)			(0.134)			(0.148)
Decision-making over income			0.365*			0.226			-0.032
			(0.204)			(0.202)			(0.183)
Decision-making over production			-0.010			0.023			-0.004
			(0.155)			(0.153)			(0.143)
Woman's age	-0.008*	0.009	-0.010**	-0.007*	0.002	-0.006	-0.011***	0.001	-0.010**
	(0.004)	(0.010)	(0.004)	(0.004)	(0.009)	(0.004)	(0.004)	(0.009)	(0.004)
Man's age	0.009***	-0.007	0.010***	0.001	-0.012	-0.000	0.003	-0.012	0.003
	(0.003)	(0.010)	(0.003)	(0.002)	(0.009)	(0.002)	(0.003)	(0.009)	(0.003)
Woman's education (years)	0.016	0.017	0.016	-0.016	-0.016	-0.015	-0.006	-0.007	-0.004
	(0.014)	(0.020)	(0.014)	(0.013)	(0.018)	(0.013)	(0.013)	(0.018)	(0.014)
Man's education (years)	-0.013	-0.005	-0.018	-0.002	-0.003	0.002	-0.028**	-0.032*	-0.026*
	(0.014)	(0.017)	(0.014)	(0.013)	(0.018)	(0.013)	(0.013)	(0.018)	(0.013)
(log) Area of owned land	0.013	-0.074	0.016	-0.026	-0.116	-0.034	0.010	-0.021	0.016
	(0.149)	(0.196)	(0.145)	(0.128)	(0.176)	(0.124)	(0.133)	(0.175)	(0.130)
Country/district dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.151	0.076	0.182	0.165	0.119	0.164	0.157	0.146	0.159
Observations	153	103	153	153	103	153	153	103	153

Source: Authors' calculations based on AP data from Kenya.

Notes: Coefficients displayed are the conditional average marginal effects (AMEs). Robust standard errors in parentheses. Dual-adult households only. * p<0.10 ** p<0.05, and *** p<0.01

Table 9. Probit Models of Factors Influencing Joint Decision-Making and Participation in IMV Production (country-specific regression), Tanzania

	Joint decision-making over adoption/dis-adoption of improved maize varieties			Joint access to credit for purchase of maize seeds			Joint access to extension services about improved maize varieties		
Woman's empowerment score	0.328***			0.344			0.418**		
	(0.218)			(0.248)			(0.208)		
Empowerment gap		-0.580**			-0.431			-0.812**	
		(0.295)			(0.396)			(0.371)	
Group membership			0.006			0.042			-0.019
			(0.051)			(0.044)			(0.049)
Decision-making over assets			0.241**			0.342***			0.385***
			(0.116)			(0.099)			(0.101)
Decision-making over income			0.014			-0.137			-0.001
			(0.129)			(0.123)			(0.114)
Decision-making over production			0.103			0.154			-0.009
			(0.111)			(0.102)			(0.096)
Woman's age	-0.016***	-0.017**	-0.016***	-0.016***	-0.021**	-0.017***	-0.013***	-0.020***	-0.012***
	(0.005)	(0.008)	(0.004)	(0.005)	(0.008)	(0.004)	(0.005)	(0.007)	(0.004)
Man's age	0.016***	0.013*	0.016***	0.014***	0.013*	0.014***	0.016***	0.019***	0.016***
	(0.003)	(0.007)	(0.003)	(0.004)	(0.008)	(0.004)	(0.003)	(0.007)	(0.004)
Woman's education (years)	0.021	-0.003	0.019	0.020	0.011	0.019	0.023	0.008	0.016
	(0.016)	(0.021)	(0.016)	(0.014)	(0.020)	(0.014)	(0.015)	(0.021)	(0.014)
Man's education (years)	-0.011	0.024	-0.007	-0.034***	-0.020	-0.032**	-0.018	0.017	-0.012
	(0.014)	(0.021)	(0.015)	(0.013)	(0.019)	(0.014)	(0.012)	(0.020)	(0.013)
(log) Area of owned land	-0.020	-0.000	-0.002	0.071	0.135	0.082	-0.070	-0.079	-0.048
	(0.103)	(0.128)	(0.106)	(0.094)	(0.121)	(0.086)	(0.093)	(0.114)	(0.091)
Country/district dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.139	0.214	0.162	0.172	0.168	0.238	0.183	0.279	0.235
Observations	127	81	127	127	81	127	127	81	127

Source: Authors' calculations based on AP data from Tanzania.

Notes: Coefficients displayed are the conditional average marginal effects (AMEs). Robust standard errors in parentheses. Dual-adult households only. * p<0.10 ** p<0.05, and *** p<0.01