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Understanding Gender Differences in Agricultural Productivity in Uganda and Nigeria

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ABSTRACT

We investigate gender differences in agricultural productivity using data collected in 2005 from Nigeria and in 2003 from Uganda. Results indicate that lower productivity is persistent from female-owned plots and female-headed households, accounting for a range of socioeconomic variables, agricultural inputs, and crop choices using multivariate Tobit models. These results are robust to the inclusion of household-level unobservables. However, productivity differences depend on the type of gender indicator used, crop-specific samples, agroecological region, and inclusion of biophysical characteristics. More nuanced gender data collection and analysis in agricultural research spanning diverse regions are encouraged to identify interventions that will increase productivity and program effectiveness for male and female farmers.

Keywords: gender, agricultural productivity, Nigeria, Uganda

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1. INTRODUCTION

There is much interest in the sources and consequences of agricultural productivity differences between male and female farmers, particularly in Sub-Saharan Africa. Although it has often been argued that lower levels of physical and human capital among female farmers result in lower measured productivity or inability to respond to economic incentives, a review of studies undertaken in the late 1980s and early 1990s found that when differences in inputs are controlled for, no significant differences in technical efficiency of male and female farmers are observed (Quisumbing 1996). A number of new programmatic and funding initiatives targeting female farmers have centered on assumptions of potential farm and nonfarm gains by improving women's ability to access resources (Bill and Melinda Gates Foundation 2008; IFAD 2003; WB/FAO/IFAD 2009; World Food Programme 2009). However, many of the reviewed studies were flawed. Most studies did not investigate why inputs tended to be lower on female-managed plots, neglecting the endogeneity of input choice and the influence of intrahousehold allocation processes, many of which are culture and context specific, on the division of labor and of other resources on male- and female-managed plots. Most studies also focused on a single crop and typically used sex of the household head as the basis for stratifying sample observations. These methodological and data constraints oversimplify the diverse multi-crop farming systems in Sub-Saharan Africa and neglect the widespread phenomenon of crop cultivation by male and female individuals within the same household, whether practiced independently or jointly.[1] Later studies attempted to address some of these issues, but their conclusions are mixed; some showed lower productivity of female farmers whereas others show no significant differences.

This paper provides new estimates of gender differences in agricultural productivity using data collected by the International Food Policy Research Institute (IFPRI) in Uganda and Nigeria. We contribute to the literature by explicitly addressing the issue of crop choice, the sensitivity of productivity estimates to the choice of stratifying variable, and the possible heterogeneity of agricultural productivity differences within different agroecological zones and ethnic groups, controlling for household-level unobservables where possible. Knowing the source of these productivity differences is a key factor in identifying possible levers for policy intervention to improve the productivity of poor male and female farmers. Because estimates are likely to vary by cultural context and over time, we provide updated information for agricultural policy and targeting in both countries.

Data from Uganda were collected in 2003 at the plot level with the objective of linking natural resource management to poverty levels and household consumption. Data from Nigeria were collected in 2005 at the household level to evaluate the effects of the second round of *Fadama,* a national agricultural welfare program. We use multivariate tobit models to model productivity differences, controlling for socioeconomic indicators, agricultural inputs, crop choice, access to markets, and, in Uganda, biophysical plot characteristics. Findings from both countries indicate significantly lower productivity from plots owned or managed by females, and the results hold when accounting for background factors. However, findings vary across crops as well as by agroecological zone and inclusion of biophysical characteristics, suggesting that either cultural or regional gender differences or crop-specific comparative advantages affect productivity and gender. Findings from Uganda indicate that the type and specificity of gender indicator also matter, as results are diluted when household-level indicators rather than plot-specific crop ownership variables are used. In addition, results from the Uganda analysis suggest that, controlling for other factors, plot-level productivity is lowest among crops from mixed gender ownership, suggesting the presence of household bargaining difficulties between men, women, and children. However, when we control for household fixed effects, we find that productivity on female-owned plots is lower but that the mixed ownership indicator is no longer significant. This finding implies that the mixed ownership classification may capture the impact of unobserved household characteristics. We conclude with directions for further research and policy.

[1] It has been argued that static productivity analyses do not pay adequate attention to historical processes such as increased integration into the market economy and individualization of property rights (O'Laughlin 2007) as well as the extent to which colonial policies have influenced patterns of landownership, crop production, and specialization. This is an empirical study using cross-sectional data collected over one or two years; therefore, the time frame of our data does not allow us to analyze these long-run processes.

2. GENDER DIFFERENCES IN AGRICULTURAL PRODUCTIVITY: FRAMEWORKS, METHODS, AND EVIDENCE

The conventional method for measuring and modeling differences in technical efficiency between men and women in agricultural productivity is through the estimation of production functions that model the maximum output produced from the set of inputs given the technology available to the household (Battese 1992). The production of a farm manager i in household j is given by equation (1):

$$Y_{ij} = f(V_i, X_i, Z_j), \tag{1}$$

where Y_{ij} is the quantity produced, V_i is a vector of inputs used by farm manager i (including land, labor, capital, and extension advice), X_i is a vector of individual attributes, and Z_j is household and community-level variable(s). This approach typically is implemented by pooling observations of male and female farmers to estimate a productivity outcome (yield or value of production) and normally includes a gender indicator as one of the control variables in X_i. Alternatively, regressions may be estimated separately for subsamples of male and female farmers.

This production function approach focuses on technical efficiency, which assumes men and women produce the same output and use the same technology, rather than allocative efficiency, which takes into account the distribution of household-level inputs among household members. Attaining allocative efficiency implies no reallocation of inputs within the household, which would result in an increase in total output (yields). Resource allocations within the household may indicate asymmetrical distribution of productive inputs, rights, and responsibilities and, in fact, may be more appropriate for gender differences in comparison to total technical efficiency (Quisumbing 1996), as revealed in the study by Udry (1996) on Burkina Faso and other similar work. This latter approach is increasingly important to determine not just how productivity differs by gender but why productivity differs, and it may better inform policies to increase agricultural productivity and incomes within marginalized groups.

A number of possible factors may lead to agricultural productivity differences between men and women in the developing world.[2] First, assuming men and women have the same agricultural production function and use the same technique for the same crop, the quantity of inputs (e.g., fertilizer, seeds, or labor) applied by men and women may differ (see recent reviews of gender differences in nonland agricultural inputs by Peterman, Behrman, and Quisumbing 2010, and WB/FAO/IFAD 2009). Second, the quality of inputs may differ. Land quality may differ between men and women, including, but not limited to, soil quality, topography, and proximity to access points such as water sources, roads, and housing (factors that increase travel costs among other things) (Nkedi-Kizza et al. 2002; Tiruneh et al. 2001). Third, men and women may have different agricultural production functions, possibly because crop choice differs by gender, whether influenced by cultural norms (Doss 2002) or by other considerations such as the lack of resources to cultivate specific crops and the culturally appropriate division of labor.[3] For example, cultural norms in Ethiopia forbid women from using the plow because such work is perceived to be too physically strenuous (Frank 1999). Fourth, even if men and women have the same agricultural production function, shadow prices of inputs and credit may lead the women's production frontier to lie beneath the men's frontier, implying that women are less productive. In fact, in a review of empirical evidence and methodology in gender analysis of agricultural productivity, Quisumbing (1996) finds that the majority of studies conducted from the mid-1980s to 1990s show

[2] This paper focuses on the measurement of gender differences in agricultural productivity. Because rural households are engaged in a number of productive activities, including wage labor, off-farm employment, and nonagricultural self-employment, measures of agricultural productivity are only partial measures of the range of the household's productive activities.

[3] For example, in Ghana, women view maize production as a profitable, income-generating activity, yet they do not grow maize because they lack the capital to purchase the required inputs or to recruit wage labor to plow fields (WB/FAO/IFAD 2009). This is different from the first point, in which men and women may cultivate the same crop, but women apply lower levels of the same inputs.

female farmers are equally productive as male farmers once inputs and other background characteristics are controlled for.

The literature in the last 10-plus years has not provided definitive conclusions on productivity or sufficiently addressed data or methodological constraints. Perhaps the most influential papers on gender and agricultural productivity come from a four-year panel collected by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Burkina Faso. Enumerators visited sample households approximately every 10 days to collect farm operation and output information, resulting in a rich 4,655 plot-level dataset including 150 households in six villages.[4] Udry and colleagues (1995) use the ICRISAT data to estimate agricultural production functions for men and women in the same household who are farming the same crop within the same year and conclude that the value of household output can be increased by 10 to 15 percent by reallocating inputs (labor and manure) from men's plots to women's plots. Another analysis of the ICRISAT data concludes that output gains would be 5.89 percent, on average, if inputs were reallocated; however, the definition of men's plots in that analysis includes both those cultivated exclusively by men as well as household collective plots under the control of or owned by men with labor inputs from wives and children (Udry 1996).[5]

However, when Akresh (2005) attempts to replicate the results of Udry and colleagues using nationally representative data from Burkina Faso (2,406 households in 401 villages) collected by the World Bank between 1990 and 1991, he finds no evidence of Pareto inefficiency.[6] Akresh argues that allocative differences may be due to productivity shocks, transaction costs, and asymmetrical information involved in trading labor and resources between household members, and he cautions against making policy prescriptions from geographically restrictive data. Although Akresh uses similar household/year/crop fixed effects models, he is unable to control for additional plot-level characteristics such as soil type, topography, or distance from the family compound. Therefore, questions remain regarding observed productivity differentials and whether they result from methodology or reflect actual differentials.

Conclusions from recent published literature and from work in progress on gender differences in productivity are mixed.[7] A subset of these analyses examines the gender of the farmer, consistent with the analyses by Udry et al (1995) and Akresh (2005), and uses data exclusively from Sub-Saharan Africa. Goldstein and Udry (2008) find large differences in profits between plots controlled by men and those controlled by women in Ghana; however, this finding is completely explained by the duration of the fallow period. Quisumbing and colleagues (2001) find evidence of lower yields on female-owned parcels of cocoa in Ghana, although this result is only weakly significant (at the 10-percent level). Kinkingninhoun-Mêdagbé and colleagues (2008) find productivity differences between male and female farmers within a Benin semi-collective rice irrigation scheme, but the finding can be attributed to scheme membership and access to land and equipment. Oladeebo and Fajuyigbe (2007) find female rice farmers actually are more technologically efficient compared to male farmers in Osun State, Nigeria. In an evaluation of a nationwide cropping trial, Gilbert, Sakala, and Benson (2002) find no crop yield differences by gender of farmer in Malawi once socioeconomic and input differences are controlled for. Thus, although the majority of findings indicate the existence of productivity differences, further analysis indicates that access to inputs or specific constraints account for the differences.

[4] The data were collected from 1981 to 1985. In addition to information on operations, inputs, and outputs, the ICRISAT data include area of plot, location toposequence, and local name for soil type (categorized into one of 88 soil types). For more information on the ICRISAT data, see Udry (1996) or Udry et al. (1995).

[5] Alternatively, total household output could be increased by allocating land from women to men; however, this recommendation is less cited, presumably due to its unappealing equity implications.

[6] Akresh (2005) does find evidence of inefficiency when he limits the sample to "near- ICRISAT" provinces. These near-ICRISAT provinces, on average, contain households with larger plot sizes, greater wealth, higher percentage of cash crops, and higher than long-run provincial rainfall.

[7] Note that many of these studies do not focus on explaining gender differences explicitly; rather, they include gender as an explanatory variable or as an extension to the main analysis. Because the literature on gender differences in agriculture is much more vast than what is reviewed here and has already been summarized in reviews, and given the changes in technology, crop choice, and other inputs, we focus here on the literature published or available in the last 10 years.

Although additional research has contributed to the debate surrounding gender and agricultural productivity, most other studies use household headship as a gender indicator, again with mixed findings. Three studies in Ethiopia find female-headed households have persistently lower productivity measures compared to their male-headed counterparts (Bezabih and Holden 2006; Holden, Shiferaw, and Pender 2001; Tiruneh et al. 2001). However, Chavas, Petrie, and Roth (2005) and Thapa (2008) find no significant productivity differences by gender of household head in The Gambia and Nepal, respectively, after controlling for other inputs. Likewise, Horrell and Krishnan (2007) find that once inputs are controlled for, female-headed households in Zimbabwe are equally as productive as male-headed households, with the exception of cotton growers. However, with further disaggregation, they find differences in the sources of the disadvantages. De jure female-headed households (e.g., widows, separated or divorced women) are comparatively income-poor and thus are disadvantaged with regard to access to inputs, whereas de facto female-headed households (e.g., wives of male migrants who identify as household heads) have similar incomes as their male-headed counterparts but are asset-poor.[8] Thus, although studies examining household headship have contributed to the literature, their findings are mixed.

As can be intuited from this discussion, much of the inconclusiveness comes from methodological challenges inherent in collecting and analyzing data on gender productivity differences. In addition, many of the surveyed studies are based on data with relatively small sample sizes (up to 150 households) and thus are further limited in their methodological approaches.[9] The use of female headship as an indicator of the gender of the farmer or plot manager in the African setting is complicated by the complex familial structure of households, including monogamous, polygamous, and skipped-generation households. These underlying cultural and household structural considerations often are not noted or collected in agricultural economic surveys. These limitations are the topic of an active debate regarding the validity and generalizability of overly simplistic, geographically narrow, time-specific studies focusing on gender and agriculture (Kevane and Gray 1999; O'Laughlin 2007; Whitehead and Kabeer 2001). Furthermore, the inconclusiveness of gender research due to either methodological or data limitations obscures the policy and programmatic recommendations that emerge from gender productivity analysis and do not enable us to ascertain whether gender matters in producing evidence-based agricultural policy.

[8] As mentioned, a household may be de facto female-headed during a limited period while a spouse is working away from home or is ill and may be more likely to be receiving remittances from internal or international migrants. This type of female headship is differentiated from de jure headship, which usually occurs upon divorce, separation, or widowhood. Distinctions between types of female-headed households are discussed in Quisumbing et al. (2001) and literature surveying these differences is reviewed in Fafchamps and Quisumbing (2008).

[9] However, it should be noted the sample sizes in several gray literature publications are small: Tiruneh et al. (2001) have sample sizes of N = 100 and N =77 on male- and female-headed household regressions, respectively, so the results should be interpreted with caution. In addition, sample sizes in several published literature are small: Kinkingninhoun-Mêdagbé et al. (2008) report N = 45; Oladeebo and Fajuyigbe (2007), N = 100; and Chavas, Petrie, and Roth (2005), N = 115.

3. DATA AND SETTINGS

The agricultural sector remains a significant component of both Uganda and Nigeria's economies, employing upward of 80 and 70 percent of the respective Ugandan and Nigerian labor forces (CIA 2009a, 2009b). Both countries have experienced increasing urban–rural tensions as urban areas move toward service and manufacturing while rural areas continue to be dominated by small-scale subsistence farming.[10] The two countries have noted differences in dominant exports and staple crops. Nigeria's primary nonpetroleum exports are agricultural products, such as cocoa and rubber. In northern Nigeria, staple crops are millet, cowpeas, and guinea corn. In the central region, staple crops are yams, sorghum, millet, cassava, cowpeas, and corn. In the south, staple crops are yams, cassava, and cocoyams (Metz 1991). In Uganda, coffee is the primary export of large-scale farmers; however, most small-scale farmers grow tubers and *matooke* (plantains) for consumption and maize, grains, groundnuts, and beans for consumption and sale (CIA 2009a, 2009b; Kasente et al. 2001).

Nigeria is Africa's most populous nation (estimated 149 million in 2009) and has a significantly larger population and land mass compared to Uganda (estimated population is 32.4 million in 2009) (CIA 2009a, 2009b). Nigeria is noted for its enormous ethnic, religious, and cultural diversity, boasting more than 250 different ethnic groups and large Muslim and Christian populations with a sizeable Animist minority. The three largest ethnic groups in Nigeria are the Igbo (predominantly Christian, located in the south and southeast), the Yoruba (Muslim and Christian, located in the west and southwest), and the Hausa-Fulani (Muslim, located in the north). Uganda is known for its complicated clan structure, which encompasses about 11 ethnic groups (none of which holds a majority) and a predominantly Christian population with a sizable Muslim minority. Scholars of both countries concur that women play essential roles in planting, farming, harvesting, processing, and preparing agricultural products (Ajani 2008; Kasente et al. 2001; Tripp 2004). In Nigeria, the role women play in agriculture is determined largely by geographic region, culture, and religion. Gender-differentiated cropping patterns often persist among certain groups, such as the Igbo and Yoruba. For example, yams, the "prestige" crop, are regarded by agriculturalists as a male crop, whereas "ephemeral" crops, such as cassavas, melons, beans, maize, and cocoyams, are regarded as female crops (Achebe and Teboh 2007; Ajani 2008; Ezumah and Di Domenico 1995). In the northern part of the country, among the pastoralist *Hausa-Fulani*, women play a notable role in the production and marketing of dairy products, such as milk and butter, but typically men formally own cattle (Boserup 1970; Waters-Bayer and Bayer 1994). In Uganda, gender-differentiated agricultural-related tasks also are observed. According to Kasente and colleagues (2001), within Ugandan households, men focus on land clearing and marketing, whereas women are largely responsible for weeding, postharvest processing, and food preparation, although some flexibility exists within household allocation of tasks. Household crops (such as plantains and tubers) typically are considered female crops, whereas cash crops typically are considered male crops.

Despite national attempts at land reform in both countries (see the Land Use Act of 1978 [Nigeria 1978] and the Land Act 1998 [Uganda 1998]), indigenous and customary land inheritance systems driven by patriarchal norms persist, and women's claims to land are made primarily through husbands or male kin (Aluko and Amidu 2006). According to the 2004 Nigerian Living Standards Survey, 72 percent of male-headed households own land with deeds compared to only 49 percent of female-headed households (Ojowu, Bulus, and Omonona 2008). Women in Nigeria are limited in their autonomy and rights within marriage and divorce following the *Sharia* and Islamic family laws, which include maintenance of property and custody of children, although these views are slowly being challenged and changed (Oba 2002; Rehman 2007). Perhaps reflecting this discrimination in multiple realms and both institutional and cultural challenges faced by women, Nigeria ranks 138 out of 156 countries included in the Gender-related Human Development Index (UNDP 2008). Ugandan women also face inequity within marriage, divorce, and widowhood, although some advances have been made in the last five years, partly as a result

[10] The rate of urbanization in both countries is about the same; however, a much larger percentage of the Nigerian population currently lives in urban areas (48 percent vs. 13 percent of Ugandans) (CIA 2009a, 2009b).

of strong women's coalitions and activist groups (Kafumbe 2009). Similar to Nigeria, Uganda ranks low (131 out of 156) on the UNDP (2008) Gender-related Human Development Index, reflecting the multisectoral discrimination faced by women.

Fadama II Data (2005)

The data used in this study, the *Fadama II* data, were collected in 2005 by IFPRI as part of an evaluation of the second phase of the World Bank–sponsored National *Fadama* Development Project.[11] *Fadama* is the largest agricultural development project in Nigeria and is focused on community-driven development. The project included a range of development services, such as cost-sharing infrastructure investments, capacity building, projects in crop improvement, livestock, agroforestry, fishing, and postharvest services, and varied according to a local development plan (Nkonya et al. 2008b). *Fadama II* was conducted in 10 selected local government areas in 12 states, encompassing all three major agroecological zones. It is scheduled to run for six years between 2004 and 2010.[12] The *Fadama II* survey sample includes project beneficiaries, other respondents living in project areas (but not direct recipients), and comparable respondents living in different communities within the same states. Approximately 25 households were randomly selected per *Fadama* community association, stratified on state and gender of the respondent, resulting in a sample of 3,750 households. In addition to the detailed agricultural questionnaire, the *Fadama II* data included information on education, household composition, household assets and expenditures, as well as a community-level questionnaire that collected structured and semistructured information on infrastructure, resources, and conflict in the community. For more detailed information on the *Fadama II* project, sample selection, and midterm results, see Nkonya et al. (2008b). It is important to note that the data are not nationally representative or population representative within the 12 *Fadama* states and instead represent program areas within each state (see Figure A.1 in the Appendix for a map of *Fadama II* participating states).

Natural Resource Management Linkage Study (2003)

The National Resource Management (NRM) data were collected by IFPRI and collaborators (World Bank, the National Agricultural Research Organization, Makerere University, and the Norwegian Trust Fund) in order to explore linkages between natural resources and poverty levels. The NRM survey included an extensive agricultural module administered at the plot level containing questions on ownership and usage rights, investments, crop and input choice, land and soil characteristics, livestock, and agricultural knowledge (Nkonya et al. 2008a). In addition, the survey collected information on household demographics, education and health, assets, expenditures, and labor force participation. The sample was drawn from 123 communities in the 565 enumeration areas surveyed in the Uganda National Household Survey 2002/2003 conducted by the Uganda Bureau of Statistics (2003).[13] The NRM data cover eight districts (Arua, Iganga, Kabale, Kapchorwa, Lira, Masaka, Mbarara, and Soroti) selected for natural resource and poverty levels, resulting in a total sample of 3,625 plots distributed in 851 households. Because the NRM data are statistically representative of the selected eight districts, survey weights are used in all analyses. However, not all plots per household were surveyed if they were remotely located or were in different geographic areas. Figure A.2 in the Appendix shows locations of communities included in the sample. For more detailed information on project background or sample selection, see Nkonya et al. (2008a).

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[11] *Fadama* in the Hausa language means a low-lying flood plain. *Fadamas* typically are covered with shallow groundwater during the rainy season and retain moisture during the dry season, so they have high potential for economic development and agricultural productivity.

[12] These are the humid forest (Lagos, Ogun, and Imo), moist savannah (Adamawa, Federal Capital Territory, Oyo, and Taraba), and dry savannah (Bauchi, Gombe, Kaduna, Kebbi, and Niger). However, based on the initial success of the project, the third phase *(Fadama III)* was rolled out to all 37 states in 2009.

[13] The Uganda National Household Survey sampling used two-staged probability proportional to size method stratified by location (urban, rural) in the first stage to draw a sample of enumeration areas and stratified by employment status in the second stage to ensure an adequate percentage of households with at least one unemployed person and sufficient population engaged in informal sector activities. For more details on the sample selection, see Uganda Bureau of Statistics (2003).

4. METHODS AND FRAMEWORK

Empirical Model

Although we strive to conduct parallel analysis between Nigeria and Uganda, where richer indicators are available, we use more specific measures and do not dilute the information available for either country. Typically, empirical studies estimating male–female productivity differences use the Cobb-Douglas production function, estimated by taking logarithms on both sides, as in equation (2):

$$\ln Y_i = \alpha_0 + \alpha_1 \ln L_i + \alpha_2 \ln T_i + \beta \ln E_i + \gamma\, EXT_i + \delta\, Gender_i + \varepsilon, \quad (2)$$

where Y_i is the i^{th} farm manager's output, L_i is labor input (hired or family), T_i is a vector of land, capital, and other conventional inputs, E_i is educational attainment or an indicator variable for the level of schooling (of the farm manager, household head, or members of the household), EXT_i is an index of extension services, $Gender_i$ is a dummy variable for the sex or gender of the farm manager or household head, and ε is the error term.[14] Note that in the analysis that follows, we do not explicitly model a true production function, which has intensive data requirements focusing on modeling of all production factors; rather, we are concerned with the coefficient on gender while controlling for access to other inputs.

In estimating equation (2) to model agricultural productivity, special consideration must be given to the distribution of the outcome measure. Although productivity is a positive continuous indicator, we observe a mass point at zero productivity, which may occur for a number of different reasons. For example, a plot could have been cultivated but crops lost due to adverse weather shocks, pests, or other natural disasters. Alternatively, the area could have been left fallow to improve soil fertility or to serve as pasture or grazing land, or the area could have been abandoned due to poor crop expectations, high input costs, or inability to farm because of limited resources. Finally, due to the timing of survey visits and fluctuations in the time of harvesting, a certain crop (or portion of a crop) produced may not have been harvested yet, resulting in low or zero productivity measurements. Therefore, we do not observe the potential productivity for all plots that report zero productivity. Given these factors, the following tobit model (Tobin 1958) may be the most appropriate estimation procedure, given the left censoring of the dependent variable at zero:

$$\ln Y_i^* = Gender_i + \boldsymbol{X}_i\boldsymbol{\beta} + \eta_i, \quad (3)$$

$$\ln Y_i = 0 \text{ if } \ln Y_i^* \leq 0, \quad (3a)$$

$$\ln Y_i = \ln Y_i^* \text{ if } \ln Y_i^* > 0,\ i = 1, \ldots, N \text{ and } \eta_i \sim N(0, \sigma^2),\ iid, \quad (3b)$$

where Y_i is an indicator of output (productivity), *Gender* is the gender indicator, $\boldsymbol{X}$ is a set of control variables, N is the number of observations, and η_i is the error term that is assumed to be independent and identically distributed with zero mean and fixed variance. The set of equations (3) through (3b) indicates the expected value of productivity given the observable characteristics (including a gender indicator) is a function of the probability of Y_i being nonzero (or uncensored) and the expectation of Y_i given positive productivity. To further account for the possibility that the decision to leave land fallow is responsible for the reporting of zero productivity, we include an indicator for fallow plot as part of the vector of control variables. Although leaving land fallow can be considered a decision variable, in the short-run context in which we estimate productivity differences we assume that this decision has been previously made and is

[14] If all other inputs are measured correctly, the gender dummy captures the sex of the farm manager and is an indicator of biological differences. However, if the other inputs are incorrectly measured or some variables are omitted, the gender dummy is appropriately called a "gender" and not a "sex" dummy variable because it will capture socially determined allocations of inputs between men and women.

exogenous to current production decisions.[15] Survey weights are applied in all descriptive and regression analyses in Uganda (note, however, that results do not change significantly without weighting). We run the same specification using the full sample as well as by major primary crop and agroecological region. For Uganda, we also explore the robustness of our findings to the inclusion of household fixed effects using Honoré's fixed effects tobit estimator (Honoré 1992).

Measurement of Key Variables

Productivity

Following Owens, Hoddinott, and Kinsey (2003), our multi-crop productivity outcome is a measure of value of crop yield per area unit. In Nigeria, productivity is measured by multiplying the quantity of each crop produced per hectare (in kilograms) by the average annual state-level price and then aggregating across crops. In Uganda, total value of crop production is measured by multiplying the quantity of crops produced per acre (in kilograms) by the village-level price, aggregating over crops and two previous planting seasons. In both countries, the productivity value is transformed into thousands of logged Nigerian naira (₦) and thousands of logged Ugandan shillings (USh) for the purpose of analysis. The value of crop production in these settings is a more appropriate measure than the crop yield because the majority of plots were planted with more than one crop, and area estimates for each crop are difficult to calculate. Using actual yield measures per crop when intercropping is practiced would be misleading because individual crop yields will be artificially low. Of note, although we are able to control for general seasonal-specific price effects by using average prices at the village or state level, we are not able to explore or control for gender or other related price discriminations due to market access or asymmetrical information.[16] We omit plots reporting productivity greater than ₦200 million per hectare in Nigeria and greater than USh20 million per acre in Uganda.[17]

Gender

In Nigeria, the sex of the household head is used as an indicator of female-owned plot production because gender-disaggregated information on control or ownership of plots was not collected at the plot level. For Uganda, we have information at the plot level. For each plot, the question was asked, "Who claims ownership of crops on this plot?" The coding of the question gives categories of ownership but does not specify an individual per se (response categories include household head, spouse, female children, male children, children, whole family, relative, and other responses). By matching these categories to the household roster, in most cases the gender of the owner can be attributed to either male or female, whereas in other cases (whole family or relative), the gender is ambiguous. We code this ambiguous category as "mixed gender," possibly owing to multiple cultivators on a single plot. Therefore, in the Ugandan analysis we include indicators of female crop ownership and mixed crop ownership and

[15] In Uganda, there is an option to code the primary crop in the most recent crop season as "fallow" or "pasture." However, in Nigeria, if no crop was observed, the indicator was simply left missing; therefore, we cannot attribute it specifically to fallow because the indicator could be missing for a variety of reasons. However, because this option refers only to the primary crop, there exists the possibility of positive productivity due to "secondary crops." In Uganda, where the primary crop and secondary crop are missing in the first crop season, the crop choice variable is replaced by the second crop season.

[16] A limitation of our productivity outcome is the use of village- or state-level prices instead of own prices obtained per crop. This means our crop value is not the actual market value obtained but rather is a proxy measure of produced value. This is important for our analysis if we believe that the market value will differ by gender of the household head or farmer. However, even if we had own prices, there likely would be a large number of missing price values in cases where an output was used for home consumption or had not yet been sold and thus would be proxied at a higher level.

[17] This results in dropping one observation in Nigeria and one observation in Uganda.

compare them to the omitted comparison group of male crop ownership. If no crop ownership was reported because the plot was commercially owned, this observation was dropped from the analysis.[18]

Control Variables

The vector ***X*** of control variables is divided into four groups: (1) socioeconomic characteristics, (2) agricultural inputs, (3) crop indicators, and (4) community-level controls. Socioeconomic characteristics include age and education indicators for household head and household size. Agricultural inputs include measures of land, irrigation, fertilizer and seeds, extension services, and labor inputs.[19] Because input use may be endogenous, we use measures that rely on prices, wages, or community-level, non–self-clustered indicators. In addition, we use previous year (or season) indicators for inputs where possible. For Uganda we include tenure security variables in accordance with the recognized tenure categories in the 1998 Ugandan Land Acts (Republic of Uganda 1998). Tenure categories represent variations in farmers' ability to secure, lease, sell, make improvements upon, or sublet land and are listed in order of tenure security: proportion of land under freehold, customary, or *mailo* tenure (see Table A.1 in the Appendix for further description of tenure categories). For Nigeria we include participation indicators for the *Fadama II* program. Crop indicators are dummy variables of primary crop and secondary crop (in certain specifications) grown, aggregated at either the household level (for Nigeria) or the plot level (Uganda). Community-level indicators include distances to markets and roads and agroecological zone indicators. Finally, for certain specifications for Uganda, we include biophysical indicators of stock of macronutrients in the soil (nitrogen [N], phosphorus [P], and potassium [K]) and natural resource capital (topsoil depth and average slop of plot; see Nkonya et al. [2008b] for the explanation of pathways between biophysical characteristics and productivity and detailed soil fertility results). The construction and definition of all control variables for both countries are described in detail in Appendix Table A.1.

[18] This resulted in the dropping of approximately 5.3 percent of observations. We experiment with including this group and controlling for missing multivariate models; however, doing so does not change the magnitude or relationship of the main results, so we exclude it for simplicity of presentation. Note that this distinction is different from productivity missing or zero reports, which are included in the sample.

[19] Note that we drop irrigation and fertilizer indicators in Uganda because less than 2 percent of our sample reports each.

5. RESULTS

Descriptive Differences in Gender and Productivity

Table 1 gives the breakdown of primary crops grown by 3,706 households in the full Nigerian sample and stratified by gender of the household head. Approximately 29.8 percent (or 1,105 households) are headed by females. The most commonly grown crops in the sample are maize (14 percent), rice (8 percent), and cassava, cowpea, tomato, leafy green vegetables, and other vegetables (all between 3 and 4 percent). There are significant differences in crop choice. Female-headed households are significantly more likely to grow leafy green vegetables and are significantly less likely to grow nearly all other main crops except cassava and yams. Of the included crops, past research indicates rice, tomatoes, and yams are traditionally sold for cash (Nweke 1996). Table 2 gives the breakdown of primary crops grown in 2,700 plots in the full Ugandan sample, stratified by the sex of the crop owner. Using sample weights, approximately 18.7 percent of the plots are female-owned crops, 53.3 percent of the plots are male-owned crops, and 26.1 percent of the plots are mixed ownership crops. The most commonly grown crops across Ugandan plots are banana (15 percent), beans and peas (13 percent), and maize, cassava, sweet potato and sorghum (all 6 to 8 percent). Male-owned plots are significantly more likely to be planted with banana, maize, and coffee, whereas female-owned plots are significantly more likely to be planted with sweet potato, sorghum, beans, and peas compared to other plots. Past research indicates maize can be either a cash crop or a subsistence crop, whereas tobacco traditionally is regarded as a cash crop (Nweke 1996).

Table 1. Gender indicators and crop choice in Nigeria

Primary crop choice (=1)	Full sample (SD) N = 3,706	Female mean (SD) N = 1,105	Male mean (SD) N = 2,601
Maize	0.14	0.11**	0.15**
	[0.35]	[0.31]	[0.36]
Rice	0.08	0.06**	0.10**
	[0.28]	[0.24]	[0.29]
Cowpea	0.04	0.02**	0.05**
	[0.19]	[0.12]	[0.21]
Cassava	0.04	0.04	0.04
	[0.19]	[0.20]	[0.19]
Tomato	0.03	0.01**	0.04**
	[0.18]	[0.07]	[0.20]
Leafy green vegetable	0.03	0.05*	0.03*
	[0.18]	[0.21]	[0.17]
Other vegetable	0.03	0.01**	0.03**
	[0.16]	[0.12]	[0.18]
Yam	0.02	0.02	0.02
	[0.15]	[0.15]	[0.15]
Sugarcane	0.02	0.01**	0.03**
	[0.15]	[0.08]	[0.17]
Peppers	0.02	0.00**	0.02**
	[0.12]	[0.06]	[0.14]
Fallow, missing or no crop	0.54	0.67**	0.48**
	[0.50]	[0.47]	[0.50]

Source: 2005 *Fadama II* evaluation data.
Notes: Sample is stratified on gender of household head. Primary 10 crops presented. For list of all crop indicators, see Appendix Table A.1. Mean values reported with standard deviations are in brackets. * indicates significant mean differences at the 5 percent level; ** significant at the 1 percent level.

Table 2. Gender indicators and crop choice in Uganda

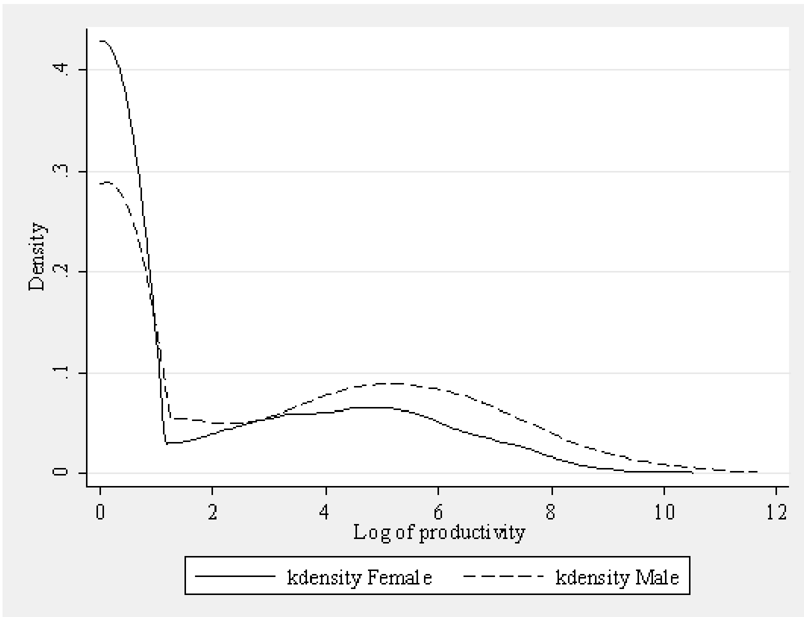
Primary crop choice (=1)	Full sample (SE) N = 2,700	Female mean (SE) N = 565	Mixed mean (SE) N = 830	Male mean (SE) N = 1,305
Banana	0.15	0.12*	0.13*	0.18*
	[0.01]	[0.02]	[0.02]	[0.01]
Beans and peas	0.13	0.16*	0.14*	0.11*
	[0.01]	[0.02]	[0.01]	[0.01]
Maize	0.08	0.06*	0.06*	0.09*
	[0.01]	[0.01]	[0.01]	[0.01]
Sweet potato	0.08	0.09**	0.10**	0.06**
	[0.01]	[0.01]	[0.01]	[0.01]
Cassava	0.07	0.07	0.07	0.08
	[0.01]	[0.01]	[0.01]	[0.01]
Sorghum	0.06	0.10**	0.07**	0.04**
	[0.01]	[0.02]	[0.01]	[0.01]
Groundnut	0.04	0.05	0.03	0.03
	[0.01]	[0.01]	[0.01]	[0.01]
Coffee	0.03	0.02**	0.02**	0.04**
	[0.00]	[0.01]	[0.01]	[0.01]
Millet	0.02	0.02	0.02	0.02
	[0.00]	[0.01]	[0.01]	[0.00]
Other vegetable	0.02	0.02*	0.01*	0.02*
	[0.00]	[0.01]	[0.00]	[0.00]
Fallow or pasture	0.21	0.20	0.20	0.23
	[0.00]	[0.01]	[0.01]	[0.02]

Source: 2003 Natural Resource Management survey data.
Notes: Sample is stratified on plot-level crop ownership indicators. Primary 10 crops presented. For list of all crop indicators, see Appendix Table A.1. Weighted mean values reported with linearized standard errors are in brackets. * indicates significant mean differences at the 5 percent level; ** significant at the 1 percent level.

Note that both Tables 1 and 2 include the number of plots classified as primarily fallow in both countries. In Nigeria, 54 percent of all plots are fallow or are missing crop indicators, and a significantly larger percentage of female-headed households fall into this category compared to male-headed households. In contrast, in Uganda, 21 percent of all plots are classified as fallow; however, no significant differences by plot ownership are seen.

Figures 1 and 2 display kernel density plots showing cumulative differences in the logged value of productivity by gender in Nigeria and Uganda, respectively. Each density line charts the probability distribution (or proportion of cases at a certain point) of the productivity indicator across the range of logged productivity values. In Nigeria, the mean value of crop production is ₦554.68 in the full sample, and, as can be seen from the higher dashed line representing the male density, this value is significantly higher (at the 1-percent level) among the male-headed households (mean ₦714.72) compared to female-headed households, represented by the solid line (mean ₦177.93). In Uganda, the mean value of crop production is USh330.94 in the full sample, USh257.88 in the female-owned sample, USh276.97 in the mixed-ownership sample, and USh388.08 in the male-owned sample, and these differences are significantly different at the 5-percent level. These differences are reflected in the density plots shown in Figure 2, where the dashed line representing male density outcomes is higher than the solid line representing female ownership plots and the dotted line representing mixed ownership plots. Note, however, that because the kernel densities are plotted using log transformed values, they also reflect a large portion of the sample reporting zero productivity (mass point at zero), which is another important source of gender differences. Among the approximately 49 percent of the Nigerian sample reporting no output, female-headed households make up 38.4 percent of the sample (vs. 21.4 percent of the nonzero sample). Among the approximately 21.3 percent of the Ugandan sample reporting no output, 17.9 percent are female-owned plots, 37.6 percent are mixed-ownership plots, and 44.4 percent are male-owned plots.

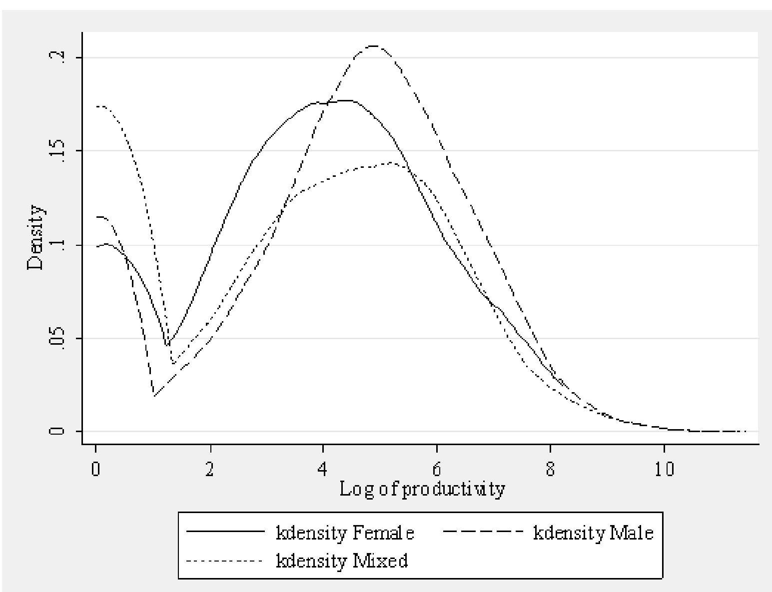
Figure 1. Kernel density of productivity, by gender, Nigeria



Source: 2005 *Fadama II* evaluation data.

Note: N = 3,706 households.

Figure 2. Kernel density of productivity, by gender, Uganda



Source: 2003 Natural Resource Management survey data;

Note: N = 2,700 plots.

Tobit Results among Full and Crop-Specific Regressions

Tables 3 and 4 give the core results from tobit regressions in Nigeria and Uganda, respectively. Each column represents a separate regression. From left to right, we first present the full sample, followed by crop-specific regressions and then the full sample excluding fallow plots. Although not reported, all regressions include agroecological zone indicators and primary crop indicators in the case of the full sample regressions. Descriptive statistics including mean values and standard deviations for all control variables are included by gender in Appendix Tables A.2 and A.3. Sample sizes are reported at the top of the column, and pseudo R-squared values are reported at the bottom of each column. For both countries, when we consider households and individuals farming any type of crop, female-headed households and female farmers are significantly associated with lower output value when controlling for access to other inputs. Including biophysical characteristics of the plot in Uganda (last column) further increases this disadvantage, indicating that women are allocated farmland that is comparatively resource-poor. However, we find that the persistent disadvantage varies by crop. For example, in Uganda the negative association is driven by farmers growing sweet potatoes or sorghum as their primary crop, whereas in Nigeria it is driven by households growing tomatoes as their primary crop. Furthermore, decisions to leave land fallow may play an important role in explaining the gender divide, as the significance of the gender indicator is attenuated when fallow plots are excluded in Nigeria and the magnitude and significance level drops in Uganda (although it is still significant at the 10-percent level). These main results are robust to a number of checks, including controlling for secondary crop indicators and use of quantity produced (in kilograms) of each crop as an outcome instead of value of crop produced in Nigeria. In the next section we explore several other robustness checks to assess if these core results hold across geographic variation and choice of gender indicator. Finally, of note, in Uganda, where we include a category of mixed crop ownership, we find that these plots are associated with coefficients representing the lowest comparative productivity outcomes (in the full sample, the sample excluding fallow plots, and the crop-specific samples of beans and peas and of sweet potato). We will return to this finding in the discussion section.

Regional-Specific Results

Table 5 gives a summary of key gender coefficients for Nigeria (panel A) and Uganda (panel B) stratified by agroecological zone. All other aspects of the estimation equation are maintained, including primary crop-fixed effects to control for the variability of crop choice across regions. Similar to primary crop-specific regressions, gender indicators vary, based on the regional area of analysis. In Nigeria, female-headed households are associated with significantly lower productivity in the moist and dry savannah areas; however, no significant productivity differences are seen between male and female households in the humid forest zone. In Uganda, female and mixed crop ownerships are associated with significantly lower productivity in the southwest highlands. Implications of the sensitivity of our results based on geographic location are discussed in the next section.

Gender Indicator Robustness Checks

Because we are specifically interested in the interactions between gender and productivity, we conduct several robustness checks, using four different forms of the gender indicator on the Uganda data, where such sensitivity analysis is possible because gender indicators were gathered at different levels of aggregation. Summaries of results for each gender indicator are reported in Table 6.

Table 3. Tobit productivity results for full sample and by major crop, Nigeria

Variable (N)	Full N = 3,706	Maize N = 497	Rice N = 326	Cassava N = 138	Tomato N = 129	Leafy green vegetables N = 128	Cowpea N = 123	Excluding fallow N = 1,723
Female-headed households (=1)	-0.321***	-0.252	-0.031	-0.493	-2.083**	-0.340	-0.062	-0.237
	(0.116)	(0.202)	(0.294)	(0.570)	(0.987)	(0.392)	(0.302)	(0.169)
Age head (years)	0.012	-0.0990*	-0.006	0.152	0.057	0.113	-0.156	0.018
	(0.021)	(0.054)	(0.052)	(0.191)	(0.093)	(0.075)	(0.107)	(0.033)
Age of head squared $(years)^2$	0.000	0.001**	0.000	-0.001	0.000	-0.001	0.002	0.000
	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)
Head primary schooling (=1)	0.328***	0.534**	-0.358	0.358	-0.461	0.554	0.073	0.551***
	(0.125)	(0.250)	(0.299)	(0.714)	(0.482)	(0.462)	(0.374)	(0.165)
Head secondary schooling (=1)	0.128	0.171	0.182	-0.363	-0.101	0.522	0.011	0.285
	(0.148)	(0.286)	(0.301)	(0.859)	(1.048)	(0.538)	(0.353)	(0.214)
Head postsecondary schooling (=1)	-0.046	-0.014	-0.369	-0.080	1.348**	0.952	0.246	0.171
	(0.162)	(0.293)	(0.323)	(0.819)	(0.521)	(0.752)	(0.462)	(0.225)
Log household size (ln)	0.108	0.639***	0.581**	0.693	-0.622	-0.196	0.411*	0.266*
	(0.093)	(0.226)	(0.253)	(0.486)	(0.450)	(0.494)	(0.217)	(0.148)
Log rainfed land area (ln acres)	0.080	0.347**	0.229	-0.403	0.144	-0.053	0.736***	0.246**
	(0.054)	(0.154)	(0.285)	(0.311)	(0.287)	(0.327)	(0.110)	(0.114)
Log of irrigated land area (ln acres)	0.242**	0.166	0.279	1.408**	0.365	0.009	0.218	0.229
	(0.106)	(0.317)	(0.252)	(0.649)	(0.401)	(0.421)	(0.286)	(0.200)
NSC log NPK fertilizer (ln *naira*/bag)	-0.003**	-0.006	-0.006*	-0.005	0.002	-0.004	-0.004	-0.003
	(0.001)	(0.005)	(0.003)	(0.004)	(0.006)	(0.003)	(0.003)	(0.002)
NSC log Urea fertilizer (ln *naira*/bag)	0.000	0.002	0.002	0.007**	-0.001	0.002	0.002	0.000
	(0.001)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.001)
NSC log SSP fertilizer (ln *naira*/bag)	0.003	0.007*	0.002	0.090***	0.000	-0.003	0.012***	0.003
	(0.002)	(0.004)	(0.003)	(0.028)	(0.005)	(0.003)	(0.002)	(0.003)
NSC log price of seeds (ln *naira*/kg)	-0.000**	-0.001***	-0.000***	-0.001	0.017***	-0.002	0.00728*	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.003)	(0.004)	(0.000)
NSC extension (contact = 1)	-0.098	-1.769*	-0.144	4.681*	-6.740***	0.285	1.560	-1.397*
	(0.615)	(1.024)	(0.887)	(2.485)	(2.550)	(2.184)	(0.972)	(0.784)
NSC log wage (*naira*/day)	0.591***	-0.012	0.487	3.713**	2.108**	-0.184	-2.114***	0.644
	(0.192)	(0.614)	(0.556)	(1.501)	(0.858)	(1.076)	(0.515)	(0.401)

Table 3. Continued

Variable (N)	Full N = 3,706	Maize N = 497	Rice N = 326	Cassava N = 138	Tomato N = 129	Leafy green vegetables N = 128	Cowpea N = 123	Excluding fallow N = 1,723
Log distance to nearest road (km)	-0.123***	-0.278**	-0.137	-0.028	-0.364***	0.012	-0.070	-0.266***
	(0.047)	(0.131)	(0.146)	(0.226)	(0.125)	(0.257)	(0.073)	(0.082)
Log distance to nearest town (km)	-0.003	-0.048	0.038	-0.244	-0.044	0.298	0.331***	0.016
	(0.060)	(0.226)	(0.150)	(0.242)	(0.136)	(0.331)	(0.119)	(0.115)
Fadama II program indicators	x	x	x	x	x	x	x	x
Agroecological zone indicators	x	x	x	x	x	x	x	x
Primary crop indicators	x							x
Pseudo R squared	0.23	0.06	0.06	0.06	0.18	0.04	0.20	0.05

Source: 2005 *Fadama II* evaluation data.
Notes: For construction of control variables, see Appendix Table A.1; for descriptive statistics of control variables, see Appendix Table A.2; all coefficients are reported as average partial effects from corresponding tobit models and standard errors clustered at the local government area are reported in parentheses. NSC stands for non-self clustered means at the village level; NPK stands for nitrogen, phosphorus, and potassium; SSP stands for single super phosphate synthesized from rock phosphate and sulphuric acid. * indicates significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 4. Tobit productivity results for full sample and by major crop, Uganda

Variable (N)	Full N = 2,700	Banana N = 393	Beans and peas N = 345	Maize N = 212	Sweet potato N = 204	Cassava N = 197	Sorghum N = 195	Excluding fallow N = 2,134	Including biophysical N = 2,180
Crop ownership female (=1)	-0.269**	0.226	0.066	-0.060	-0.798*	-0.273	-0.930**	-0.216*	-0.332**
	(0.119)	(0.277)	(0.351)	(0.415)	(0.411)	(0.389)	(0.365)	(0.130)	(0.157)
Crop ownership mixed (=1)	-0.292*	0.211	-0.824**	-0.655	-0.981***	-0.662	-0.378	-0.410**	-0.202
	(0.166)	(0.343)	(0.400)	(0.428)	(0.351)	(0.586)	(0.438)	(0.199)	(0.166)
Age head (years)	0.017	0.064	0.062	-0.128	-0.127**	0.037	-0.093	0.020	0.040
	(0.029)	(0.052)	(0.069)	(0.103)	(0.062)	(0.087)	(0.079)	(0.032)	(0.028)
Age of head squared $(\text{years})^2$	0.000	-0.001	-0.001	0.001	0.00134**	0.000	0.001	0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Head primary schooling (=1)	0.170	0.149	0.536*	0.005	0.971***	-0.640	-0.109	0.158	0.226
	(0.181)	(0.332)	(0.292)	(0.380)	(0.345)	(0.418)	(0.418)	(0.194)	(0.172)
Head secondary schooling (=1)	0.137	0.542	0.403	0.218	0.431	-0.414	-1.130**	0.143	0.250
	(0.264)	(0.388)	(0.532)	(0.524)	(0.499)	(0.667)	(0.539)	(0.297)	(0.237)
Head postsecondary schooling (=1)	0.164	0.256	-0.024	-1.362**	-0.169	0.892	-0.304	0.099	0.267
	(0.366)	(0.576)	(0.753)	(0.641)	(0.864)	(0.753)	(1.086)	(0.378)	(0.357)
Log household size (ln)	-0.225	-0.256	-0.453	1.049**	-0.225	-0.216	0.274	-0.232	-0.309*
	(0.138)	(0.234)	(0.278)	(0.480)	(0.310)	(0.422)	(0.343)	(0.154)	(0.156)
Log rainfed land area (ln acres)	0.070	0.215*	0.111	0.094	-0.545*	0.189	0.181	0.095	0.063
	(0.053)	(0.123)	(0.156)	(0.175)	(0.288)	(0.225)	(0.220)	(0.060)	(0.061)
NSC log seed price (ln shilling/kg)	-0.374***	-0.398	-0.461**	-0.148	0.024	-0.882***	-0.185	-0.367***	-0.351**
	(0.084)	(0.241)	(0.180)	(0.126)	(0.178)	(0.244)	(0.218)	(0.078)	(0.138)
NSC extension (contact =1)	1.462**	0.541	2.362**	2.990***	-1.681	2.947**	3.680**	1.414**	1.239
	(0.706)	(1.423)	(0.936)	(1.136)	(1.735)	(1.388)	(1.699)	(0.702)	(0.823)
Proportion land free/leasehold (%)	0.009	0.166	-0.334	3.549***	5.770*	-1.437**	4.583***	0.931	-0.190
	(0.690)	(0.923)	(0.841)	(0.757)	(3.454)	(0.675)	(1.352)	(0.685)	(0.721)
Proportion land *mailo* (%)	-0.197	-0.328	-0.326	2.626***	6.348*	-0.378	1.999	0.755	-0.345
	(0.646)	(0.890)	(0.468)	(0.650)	(3.751)	(0.629)	(1.602)	(0.671)	(0.686)

Table 4. Continued

Variable (N)	Full	Banana	Beans and peas	Maize	Sweet potato	Cassava	Sorghum	Excluding fallow	Including biophysical
	N = 2,700	N = 393	N = 345	N = 212	N = 204	N = 197	N = 195	N = 2,134	N = 2,180
Proportion land customary (%)	-0.085	0.229	0.193	2.923***	6.135	0.000	0.000	0.959	-0.167
	(0.637)	(0.920)	(0.642)	(0.715)	(3.773)	(0.000)	(0.000)	(0.680)	(0.702)
Log community wage (shillings/day)	0.115	0.090	-1.652***	-0.123	0.893	0.727	2.264**	0.062	0.150
	(0.290)	(0.707)	(0.558)	(0.524)	(0.665)	(0.719)	(1.126)	(0.271)	(0.317)
Log distance to nearest market (km)	0.245*	-0.035	0.293	0.270	0.822***	0.542	-0.445	0.278*	0.240
	(0.139)	(0.260)	(0.304)	(0.306)	(0.280)	(0.434)	(0.345)	(0.150)	(0.145)
Log distance to nearest road (km)	-0.054	0.015	0.036	-0.320	-0.537*	0.300	0.343	-0.046	-0.040
	(0.102)	(0.210)	(0.191)	(0.245)	(0.293)	(0.421)	(0.302)	(0.107)	(0.115)
Agroecological zone indicators	x	x	x	x	x	x	x	x	x
Primary crop indicators	x							x	x
Pseudo R squared	0.04	0.03	0.05	0.07	0.06	0.06	0.04	0.03	0.03

Source: 2003 NRM survey.
Notes: For construction of control variables, see Appendix Table A.1; for descriptive statistics of control variables, see Appendix Table A.3; all coefficients are reported as average partial effects from corresponding tobit models, using survey weights and standard errors clustered at the community level reported in parentheses. NSC stands for non-self clustered means at the village level; NPK stands for nitrogen, phosphorus, and potassium; SSP stands for single super phosphate synthesized from rock phosphate and sulphuric acid. * indicates significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 5. Summary of coefficients on gender indicators from productivity tobit models, by agroecological zone, Nigeria and Uganda

Gender coefficient	Humid forest	Moist savannah	Dry savannah			
Panel A: Nigeria (N)	**N = 922**	**N = 990**	**N = 1,794**			
Female household head (=1)	-0.022	-0.464**	-0.494**			
	(0.078)	(0.190)	(0.217)			
Pseudo R squared	0.31	0.17	0.24			
	NW farmlands	**N Moist farmlands**	**Mt. Elgon farmlands**	**SW grass farmlands**	**Lake Victoria and Mbale**	**SW highlands**
Panel B: Uganda(N)	**N = 345**	**N = 559**	**N = 110**	**N = 373**	**N = 640**	**N = 672**
Crop ownership female (=1)	-0.036	0.241	-0.462	0.029	-0.119	-0.874***
	(0.311)	(0.389)	(0.552)	(0.344)	(0.201)	(0.231)
Crop ownership mixed (=1)	-0.875	-0.514	0.000	-0.061	-0.274	-0.569*
	(0.920)	(0.311)	(0.000)	(0.402)	(0.266)	(0.295)
Pseudo R squared	0.02	0.02	0.07	0.07	0.02	0.02

Source: 2005 *Fadama II* Evaluation and 2003 NRM survey.
Notes: For construction of control variables, see Appendix Table A.1; for descriptive statistics of control variables, see Appendix Tables A.2 and A.3. All coefficients are reported as average partial effects from corresponding tobit models (survey weights applied in Uganda). Standard errors are reported in parentheses and clustered at the local government levels and community levels in Nigeria and Uganda, respectively. * Significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 6. Summary of coefficients on gender indicator robustness checks in Uganda using tobit productivity model (full sample in Table 4)

Gender variation	Sample size (N)	Coefficient (SE)
Excluding mixed ownership category:		
Crop ownership female (=1)	2,700	-0.166 (0.129)
Aggregating gender at the household level:		
Female-headed household (=1)	2,700	0.117 (0.139)
Gender as a household-level continuous variable:		
Proportion of land female owned/managed (%)	2,700	0.025 (0.154)
Excluding polygamous households:		
Crop ownership female (=1)	2,260	-0.203 (0.125)
Crop ownership mixed (=1)		-0.050 (0.137)

Source: 2003 NRM survey.
Notes: For construction of control variables, see Appendix Table A.1; for descriptive statistics of control variables, see Appendix Table A.3. All coefficients are reported as average partial effects from corresponding tobit models using survey weights. Standard errors are reported in parentheses and clustered at the community level.

The first variation excludes the mixed crop ownership category to proxy a situation where data are not collected to allow a joint gender or group ownership category. All other aspects of the estimation, including control variables, remain identical to the main analysis. The second variation tests an indicator for female-headed households to simulate results if gender indicators are collected only at the household level (as in Nigeria). The third variation is also at the household level, but the gender indicator is a continuous variable measuring the proportion of land that is female-owned and managed. We also consider the implications of diverse household structure by rerunning the main analysis excluding polygamous households (16 percent of the sample) but using the same crop ownership variables (female and mixed) as in the main analysis. Results show that none of the gender indicators across regressions are significant, and gender differences are lost when indicators are aggregated to a higher level (household) or when specific household structures are disregarded. This suggests that gender differences in agricultural productivity may not be revealed at higher levels of aggregation that do not correspond to the basic decisionmaking unit in specific farming systems.

Household Fixed Effects Robustness Checks

It could be argued that the reported results reflect selection bias due to unobservables such as unobserved plot characteristics, unobserved inputs (for example, skills and ability), or other unobserved household-level factors. For Uganda, we are able to control for a range of plot characteristics using detailed biophysical indicators data. Without panel data, we cannot control for unobserved skill and ability of the plot manager, but because households may farm more than one plot devoted to the same crop in a single season, we can control for household-level unobservables using a fixed effects estimator. We use Honoré's (1992) tobit with fixed effects estimator to estimate the same regressions as above, noting that variables that do not vary within a household will be dropped from the estimation. In addition, households that do not cultivate more than one plot will be dropped from the estimation, but this does not constitute a source of selection bias because selection into the sample is accounted for by the fixed effect. This least-absolute deviations estimator is preferred to a tobit with dummy variables.[20]

Table 7 gives a summary of the coefficients on the female ownership and the mixed ownership indicators for different specifications from the tobit with fixed effects regressions.[21] When household-level unobservables are controlled for, the female ownership indicator remains significant and negative for all crops. This result is robust to the inclusion of biophysical characteristics and to the exclusion of fallow plots. The female ownership dummy is insignificant for bananas, but is negative and significant for beans. However, the loss of significance of the mixed ownership dummy indicates that the previous negative and significant result is not robust to controls for unobservable household characteristics. This implies that the previous result for mixed ownership may reflect unobserved household-level variables that may drive the phenomenon of mixed ownership. For example, extended families may be more likely to report mixed ownership, or families that have bargaining difficulties or intra-familial conflict may be more likely to report mixed ownership. This phenomenon could also reflect enumerator error (for example, certain enumerators did not probe the ownership or management of specific plots).

Table 7. Summary of selected coefficients on gender indicators for tobit fixed effects estimates in Uganda

	All crops			**Banana**	**Beans**	**Maize**
	Basic model, all plots	**Including biophysical controls**	**Excluding fallow plots**	**Basic model**	**Basic model**	**Basic model**
Crop ownership female (=1)	-0.911** (0.373)	-0.918** (0.395)	-0.791** (0.392)	0.184 (0.380)	-3.697*** (1.110)	-0.170 n.c.
Crop ownership mixed (=1)	-0.318 (0.343)	-0.431 (0.356)	-0.477 (0.354)	1.858 (1.985)	0.504 (0.762)	-0.718 (0.720)
Number of plots	2,700	2,180	2,134	393	345	212
Number of households	763	594	755	287	263	182
Minimum number of plots per household	2	2	2	2	2	2
Maximum number of plots per household	18	18	16	7	8	4

Source: 2003 NRM survey.
Notes: For construction of control variables, see Appendix Table A.1; for descriptive statistics of control variables, see Appendix Table A.3. All coefficients are from fixed effects tobit models using the Pantob stata ado program developed by Honoré (1992). Standard errors are reported in parentheses and clustered at the community level; n.c. = not computed. * Indicates significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

[20] This estimator is preferred because it is both consistent and asymptotically normal under suitable regularity conditions and assumes neither a particular parametric form nor homoskedasticity.

[21] Note that although we attempt to replicate all regressions in Table 7, among the crop-specific regressions, only those of banana, beans, and maize have sample sizes large enough to support this estimation. In addition, we report coefficients instead of average partial effects because, as Honoré (2008) explains, computing marginal effects depends on the unobserved fixed effects, which the Honoré estimator strips away. Although it is computationally possible to recover marginal effects, they would not be comparable to those in a tobit model, so we do not compute them.

6. EXPLORING HETEROGENEITY ACROSS HEADSHIP DEFINITIONS AND AGROECOLOGICAL ZONES

A key contribution of this analysis is the demonstration that the variability of results depends on the choice and implementation of gender indicators. Although female-headed households may be easily identifiable and headship is the most routinely collected gender indicator, the concept of household head may be less concrete and more fluid than many researchers conceptualize, encompassing typologies ranging from de jure and de facto to skipped-generation female-headed households (Finley 2007; Fuwa 2000). Of interest, Doss (2002) noted that approximately 14 percent (616 out of 4,552) of women in the third Ghanaian Living Standards Survey reported being *both* married *and* the head of the household. Doss speculates this result may demonstrate the more fluid use of the term "household head" or may hint at the number of women in polygamous marriages who have husbands residing elsewhere. In an analysis using Living Standard Measurement Surveys from 11 Latin and South American countries, Deere, Alvarado, and Twyman (2009) find that using household head instead of individual ownership overestimates the mean gender–wealth gap because women in male-headed households often own assets jointly with spouses. Beyond gendered discussions of headship indicators, further disaggregation at the plot level between female- and male-managed or ownership of crops is important. Doss and Morris (2001) find that female Ghanaian maize farmers in female-headed households have different (lower) adoption rates of agricultural technology (modern seed varieties and fertilizer) than do female farmers residing in male-headed households. They find that, consistent with other research, the sex of the household head is not a clear-cut indicator of who owns crops or makes decisions. Bourdillon and colleagues (2002) find that even in female-headed households of rural Zimbabwe, men (for example, adult sons) are expected to make agricultural decisions. Consistent with these phenomena, in the Ugandan data used in this analysis, 12.4 percent of the plot ownership among female-headed households is identified as male-owned and 13.7 percent is identified as mixed gender-owned. As our results show, using a gender indicator aggregated at the household-head level may dilute gender differences in productivity at the plot level and thus may miss important constraints that women plot owners face even within male-headed households. This is not an isolated example. In the often-cited Burkina Faso ICRISAT sample, on average, there are 1.8 wives per household head (Udry 1996), and the high prevalence of polygyny may have important implications for agricultural productivity analysis. Jacoby's (1995) study of the "economics of polygyny" in Côte d'Ivoire finds, conditional on wealth, that men with more productive farms have more wives, and demand for additional wives is higher in regions where food crops are relatively more important than cash crops. In our robustness checks, we find indications that important differences in agricultural productivity may be driven by the sample of polygamous households; however, we are unable to explore the underlying factors driving these differences. In this context, intrahousehold bargaining, not only between men and women but across generations with adolescents and children, may influence productivity outcomes, an issue that has been largely ignored by the intrahousehold literature.

Another interesting feature of this study is the diversity of agroecological zones under investigation. As previously noted, some of the most cited works on gender and agricultural productivity differences are within a fairly limited geographic sample. For example, Udry and colleagues (1995) draw their sample from 150 households in six villages in Burkina Faso, and Goldstein and Udry (2008) examine 60 married couples in four village clusters in eastern Ghana. Clearly this limited regional scope has implications for the generalizability of results. Other studies that disaggregate by geographic zone also find that estimates change, often significantly between regions (Somda et al. 2002). Beyond indicating that regional differences matter, a number of interesting trends emerge from our analysis. Both in Uganda and Nigeria, we find female-headed households are associated with lower productivity in the dry savannah area. This may occur because the dry savannah ecology burdens women and girls with additional time-consuming activities that reduce the time spent on farming activities. For example, Appiah, Demery, and Karyea-Adjei (2000) find that women and girls in the savannah area of Ghana spend considerably more time fetching firewood and water on a daily basis than is required in other agroecological zones in the country.[22] Analysis by agroecological zone in Sudan finds that production costs are much higher in savannah zones than in equatorial forest zones (Kebbeh, Haefele, and Fagade 2003). The authors partially attribute this finding to the greater needs for fertilizers and herbicides and the higher costs of irrigation in the dry area. In this case, women, who often have less access to important assets, are at a further disadvantage (Peterman, Behrman, and Quisumbing 2010). Uganda has a diverse representation of agroecological zones, spanning zones characterized by dry unimodal rainfall and low agricultural productivity (north and northeastern regions) to those with bimodal rainfall and high agricultural productivity (highlands and Lake Victoria region in the south). This arrangement makes Uganda a good "case study" in which to test a range of diverse ecological characteristics faced by farmers in many Sub-Saharan countries (Nkonya et al. 2008a) for a mapping of agroecological zones and a summary of regions/countries in Sub-Saharan Africa with similar characteristics.

In addition to trends within agroecological zones, religious and cultural norms may vary by region. For example, scholars note the relatively recent emergence of Islamic *Sharia* law throughout states in northern Nigeria and the accompanying adoption of the *hijab* and a more rigid male "public"–female "private" dichotomy (Ludwig 2008; Mahdi 2009). Given the geographic overlap between these northern states and the agroecological zones in Nigeria where we find lower female productivity, it is worth exploring the impact of an Islamic revival on women and farming. These issues are intertwined with access to inputs such as land and legal provisions surrounding women's property rights. Unfortunately, due to data constraints, we are unable to explore these issues in greater depth using the Nigerian data. However, a larger body of research has begun to acknowledge the critical importance of cultural interactions inherent in the linkages between gender and agriculture (Cotula 2006).

[22] On average, women and girls spend 48 minutes per day collecting water in the savannah region compared to 28 minutes per day in forest areas and 13 minutes per day in coastal areas (Appiah, Demery, and Karyea-Adjei 2000).

7. CONCLUSIONS AND RESEARCH IMPLICATIONS

Although attention to gender analysis in agricultural research has increased substantially in the past decade, the need for continued and more robust treatment of gender persists. This effort necessitates not only learning and redefining how gender can be incorporated and analyzed within agricultural economics, but also more nuanced and specific data collection efforts. Our study, using relatively recent large sample size datasets in Nigeria and Uganda, offers several insights for future research on gender gaps in agricultural productivity. First, using Ugandan data, we show that a range of household-level gender indicators obscure and underestimate gender differences in productivity. Therefore, particular attention should be paid to the level of aggregation of gender indicators in agricultural research, and sensitivity analysis should be conducted, where possible, to provide more robust and credible results. This necessitates attention to gender issues at the onset of survey design rather than ex post analysis using available indicators, such as household headship, routinely collected in agricultural surveys. Second, we find that, even when household-level unobservables are controlled for, female-owned plots have the lowest productivity, controlling for other inputs in Uganda. This finding suggests that attention to issues of gender differences in control of resources and intrahousehold bargaining should be components of research and program implementation. Third, we find results vary substantially by region, primary crop choice, and inclusion or measurement of fallow plots in both countries. Therefore, we recommend that gender be integrated in agricultural programs and research within the context of both regional ecological and biophysical needs but also in the context of regional cultural differences. For example, if women are culturally proscribed to cultivate low-return crops, then significant returns to crop diversification by women may ensue. This paper clearly adds to evidence warning against extrapolation of policy findings from region- and crop-specific studies that intensively examine dynamics within a scheme or localized program. In terms of policy implications, this result means that governments and other donor organizations should consider carefully the geographic targeting of data collection and evaluations to maximize the validity of recommendations according to country ecology and crop diversity. As programs seek to improve agricultural productivity, rural livelihoods, and food security, attention to gender as a cross-cutting dimension is a potential avenue to increased success in accomplishing these goals.

APPENDIX: SUPPLEMENTARY TABLES AND FIGURES

Table A.1. Definitions of inputs for Nigeria and Uganda (2005 *Fadama II* and 2003 NRM survey data)

Variable	Nigeria	Notes	Uganda	Notes
Socioeconomic	Age	Age of household head (years)	Age	Age of household head in years
indicators		Age of household head squared (years)^2		Age of household head squared (years)^2
	Education	Head of household has partial or completed primary schooling (=1)	Education[a]	Head of household has partial or completed primary schooling (=1)
		Head of household has partial or completed secondary schooling (=1)		Head of household has partial or completed secondary schooling (=1)
		Head of household has postsecondary education (=1)		Head of household has postsecondary education (=1)
	HH size	Log of household size (ln)	HH size	Log of household size (ln)
Agricultural inputs	Land	Log of rainfed land area (ln acres)	Land	Log of total land area from gps readings (ln meters)
	Irrigation	Log of irrigated land area (ln acres)	Irrigation	Omitted due to low prevalence of irrigation (< 2 percent)
	Fertilizer and seeds	NSC mean of previous year (2004-05) price of NPK fertilizer (*naira*/bag)	Fertilizer and seeds	Omitted due to low prevalence of fertilizer use (< 2 percent)
		NSC mean of previous year (2004-05) price of Urea fertilizer (*naira*/bag)		—
		NSC mean of previous year (2004-05) price of SSP fertilizer (*naira*/bag)		—
		NSC mean of previous year (2004-05) price of seeds (*naira*/kg)		NSC mean of first season (2002) seed price (1,000s shilling/kg)
	Extension	NSC access to agricultural extension (contact = 1)	Extension	NSC access to agricultural extension (contact = 1)
	Labor	NSC log mean previous year (2004-05) household-level agricultural wage (per day in *naira*)	Labor	Log community mean wage (per day in shillings)
	Land tenure	—	Land tenure[b]	Proportion land freehold or leasehold (%)
		—		Proportion land customary (%)
		—		Proportion land *mailo* (%)
Access to markets	Distances	Log of distance to nearest road (km)	Distances	Log of distance to nearest all season road (km)
		Log of distance to nearest town (km)		Log of distance to nearest market (km)
Agroecological	Omitted (dry savannah)	Humid forest (=1)	Omitted (Lake Victoria crescent and Mbale)	Northwestern farmlands (=1)
zones		Moist savannah (=1)		Northern moist farmlands (=1)
				Mt. Elgon farmlands (=1)
				Southwestern grass-farmlands (=1)
				Southwestern highlands (=1)

Table A.1. Continued

Variable	Nigeria	Notes	Uganda	Notes
Crops	Primary and secondary indicators	Banana, cassava, cowpea, other fruit, leafy green vegetable, other vegetable, maize, pepper, pumpkin, rice, soybean, sugarcane, sweet potato, tomato, yam/cocoyam (omitted are missing/fallow=1)	Primary and secondary indicators	Beans/peas, groundnut, maize, millet, cassava, potato, sorghum, sweet potato, coffee, other vegetable, banana, other crop (omitted are fallow/pasture=1)
Other indicators	Omitted (non-*fadama* participants in non-*fadama* areas)	*Fadama* participant (=1)	Biophysical indicators	Log nitrogen stock in top 20 cm soil (N, ln kg/ha)
		Non-*fadama* participant in *Fadama* area (=1)		Log phosphorus stock in top 20 cm soil (P, ln kg/ha)
				Log potassium stock in top 20 cm soil (K, ln kg/ha)
				Log average slope (ln %)
				Log topsoil depth (ln cm)

Notes: Nigeria sample size is 3,706 households; Uganda sample size is 2,700 plots. NSC stands for Non-self clustered means at the village level; NPK stands for nitrogen, phosphorus, and potassium; urea or carbaminde is a naturally occurring high nitrogen compound; SSP stands for single super phosphate synthesized from rock phosphate and sulphuric acid; HH stands for household.

[a] Unfortunately, education levels were not collected for all members, and thus we cannot use the female/spouse education level.

[b] These categories represent the four tenure systems recognized by the Land Act of 1998 (Uganda 1998). Under customary tenure, an individual, family, or traditional institution may occupy land and share or use the land for the good of the community. In addition, a certificate of ownership may be obtained by the District Land Board, which allows leasing, mortgaging, selling, subletting, or bequeathing. Freehold and leasehold tenures are legal occupation or contract tenure, which include improvements on the land. *Mailo* is a tenure system evolving from the original land titling from the colonial government in the 1900s, and operates similar to a freehold system, with certain restrictions between owners and tenants. See Uganda (1998) for details.

Table A.2. Descriptive statistics for control variables in Nigeria

	Full sample		Female-headed		Male-headed	
	N = 3,706		N = 1,105		N = 2,601	
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Socioeconomic indicators						
Female-headed household (=1)	0.30	[0.46]	1.00	[0.00]	0.00	[0.00]
Age head (years)	43.0	[12.3]	42.4	[11.9]	43.6	[12.4]
Age of head squared (years)^2	2,023	[1,140]	1,939	[1,060]	2,059	[1,171]
Head no formal schooling (=1)	0.420	[0.49]	0.44	[0.50]	0.411	[0.49]
Head primary schooling (=1)	0.23	[0.42]	0.23	[0.42]	0.225	[0.42]
Head secondary schooling (=1)	0.20	[0.40]	0.17	[0.38]	0.215	[0.41]
Head postsecondary schooling (=1)	0.15	[0.36]	0.15	[0.36]	0.149	[0.36]
Log household size (ln members)	2.28	[0.56]	2.20	[0.51]	2.31	[0.58]
Agricultural inputs						
Log rainfed land area (ln acres)	0.84	[1.17]	0.54	[1.03]	0.970	[1.21]
Log of irrigated land area (ln acres)	0.26	[0.62]	0.15	[0.47]	0.304	[0.67]
NSC NPK fertilizer (*naira*/bag)	115	[95.7]	108	[91.8]	118	[97.3]
NSC Urea fertilizer (*naira*/bag)	139	[131]	121	[107]	147	[139]
NSC SSP fertilizer (*naira*/bag)	80.6	[64.4]	80.9	[60.7]	80.5	[66.0]
NSC price of seeds (*naira*/kg)	217	[331]	203	[275]	224	[352]
NSC extension (contact =1)	0.15	[0.20]	0.16	[0.21]	0.146	[0.200]
NSC log wage (ln *naira*/day)	5.28	[0.56]	5.35	[0.54]	5.25	[0.57]
Access to markets						
Log distance to nearest road (km)	1.79	[1.37]	1.82	[1.40]	1.78	[1.36]
Log distance to nearest town (km)	1.88	[1.06]	1.84	[1.04]	1.90	[1.07]
Agroecological zones						
Humid forest (=1)	0.25	[0.43]	0.32	[0.47]	0.22	[0.41]
Moist savannah (=1)	0.27	[0.44]	0.29	[0.46]	0.26	[0.44]
Dry savannah (=1)	0.48	[0.50]	0.39	[0.49]	0.53	[0.50]
Fadama II program indicators						
Fadama (=1)	0.35	[0.48]	0.44	[0.50]	0.30	[0.46]
Non-*fadama* in *Fadama* area (=1)	0.33	[0.47]	0.29	[0.45]	0.34	[0.48]
Non-*fadama* in non-*Fadama* area (=1)	0.33	[0.47]	0.27	[0.44]	0.35	[0.48]

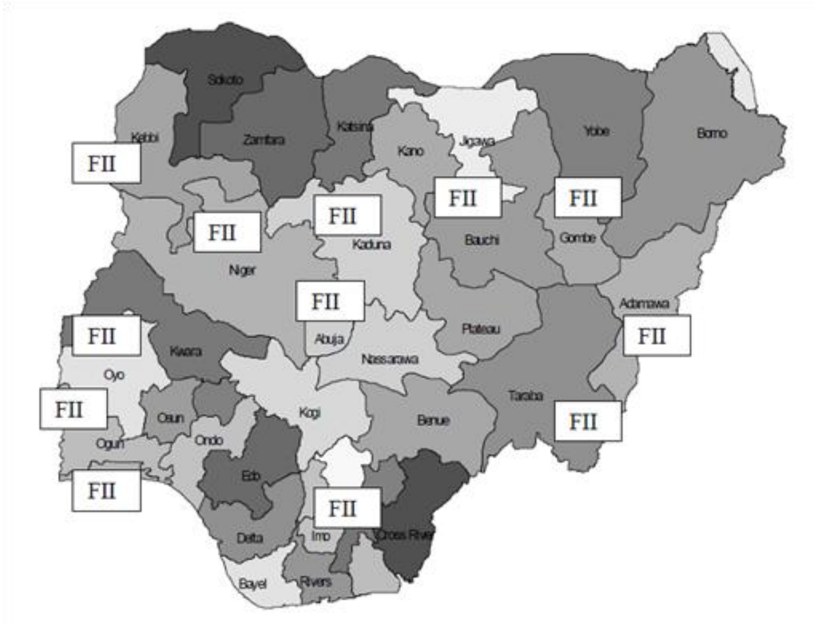
Source: 2005 *Fadama II* Evaluation.
Notes: Mean and SD are reported in brackets. NSC stands for non-self clustered means at the village level; NPK stands for nitrogen, phosphorus, and potassium; SSP stands for single super phosphate synthesized from rock phosphate and sulphuric acid.

Table A.3. Descriptive statistics for control variables in Uganda

	Full sample		Female owned		Mixed owned		Male owned	
	N = 2,700		N = 565		N = 830		N = 1,305	
Variables	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Socioeconomic indicators								
Crop ownership female (=1)	0.20	[0.02]	1.00	[0.00]	0.00	[0.00]	0.00	[0.00]
Crop ownership mixed (=1)	0.28	[0.02]	0.00	[0.00]	1.00	[0.00]	0.00	[0.00]
Crop ownership male (=1)	0.52	[0.02]	0.00	[0.00]	0.00	[0.00]	1.00	[0.00]
Age head (years)	42.0	[0.58]	45.0	[1.27]	40.4	[0.99]	41.5	[0.74]
Age of head squared $(years)^2$	1,937	[54.0]	2,222	[126]	1,811	[88.5]	1,895	[68.0]
Head no formal schooling (=1)	0.33	[0.02]	0.46	[0.04]	0.25	[0.03]	0.31	[0.03]
Head primary schooling (=1)	0.45	[0.02]	0.36	[0.04]	0.48	[0.04]	0.46	[0.03]
Head secondary schooling (=1)	0.14	[0.02]	0.11	[0.03]	0.17	[0.03]	0.14	[0.03]
Head postsecondary schooling (=1)	0.09	[0.01]	0.07	[0.03]	0.10	[0.02]	0.08	[0.02]
Log household size (ln members)	1.59	[0.02]	1.50	[0.05]	1.67	[0.03]	1.59	[0.03]
Agricultural inputs								
Log total land area (ln meters)	-0.49	[0.05]	-0.84	[0.07]	-0.47	[0.07]	-0.37	[0.07]
NSC seed price (1,000s of shilling/kg)	1.03	[0.11]	0.98	[0.11]	0.96	[0.14]	1.10	[0.12]
NSC extension (contact=1)	0.24	[0.01]	0.24	[0.02]	0.21	[0.02]	0.26	[0.02]
Proportion land freehold (%)	0.39	[0.02]	0.45	[0.04]	0.48	[0.04]	0.31	[0.03]
Proportion land *mailo* (%)	0.13	[0.02]	0.14	[0.03]	0.07	[0.02]	0.16	[0.04]
Proportion land customary (%)	0.48	[0.02]	0.40	[0.04]	0.45	[0.04]	0.52	[0.03]
Log community wage (shillings/day)	7.21	[0.04]	7.16	[0.05]	7.06	[0.04]	7.31	[0.06]
Access to markets								
Log distance to nearest road (km)	0.91	[0.05]	0.91	[0.08]	0.94	[0.08]	0.89	[0.05]
Log distance to market (km)	1.22	[0.04]	1.32	[0.08]	1.36	[0.06]	1.10	[0.05]
Agroecological zones								
Northwestern farmlands (=1)	0.16	[0.01]	0.18	[0.03]	0.01	[0.01]	0.24	[0.02]
Northern moist farmlands (=1)	0.18	[0.01]	0.12	[0.03]	0.32	[0.03]	0.13	[0.02]
Mt. Elgon farmlands (=1)	0.02	[0.00]	0.02	[0.01]	0.00	[0.00]	0.03	[0.01]
Southwestern grass-farmlands (=1)	0.15	[0.01]	0.13	[0.03]	0.16	[0.03]	0.16	[0.02]
Southwestern highlands (=1)	0.28	[0.03]	0.24	[0.04]	0.18	[0.02]	0.36	[0.04]
Lake Victoria crescent and Mbale (=1)	0.20	[0.02]	0.31	[0.04]	0.34	[0.03]	0.09	[0.01]
Biophysical indicators	N = 2,180		N = 458		N = 577		N = 1,145	
Log N stock (ln kg/ha)	8.03	[0.03]	8.09	[0.06]	8.18	[0.05]	7.94	[0.04]
Log P stock (ln kg/ha)	7.30	[0.03]	7.39	[0.06]	7.38	[0.07]	7.23	[0.07]
Log K Stock (ln kg/ha)	8.69	[0.06]	8.86	[0.10]	8.91	[0.09]	8.91	[0.09]
Log of average slope (ln %)	0.88	[0.03]	0.93	[0.05]	0.85	[0.06]	0.85	[0.06]
Log of topsoil depth (ln cm)	3.26	[0.02]	3.24	[0.03]	3.23	[0.03]	3.23	[0.03]

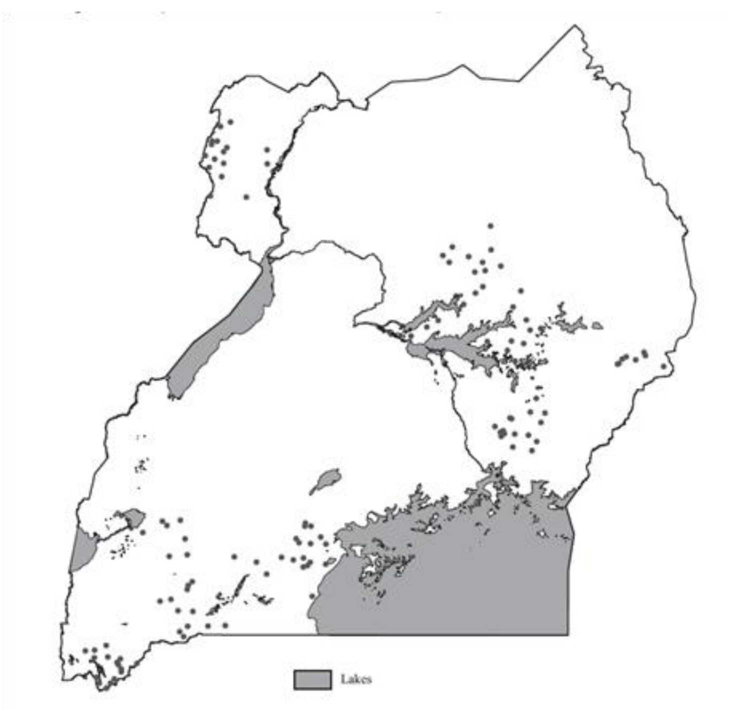
Source: 2003 NRM survey.
Notes: Weighted means and linearized standard errors are reported in brackets. NSC stands for non-self clustered means at the village level; NPK stands for nitrogen, phosphorus, and potassium; SSP stands for single super phosphate synthesized from rock phosphate and sulphuric acid.

Figure A.1. Map of *Fadama II* participating states in Nigeria



Source: Nkonya et al. 2008b.

Figure A.2. Map of communities sampled in 2003 Ugandan NRM survey



Source: Nkonya et al. 2008a.

REFERENCES

Achebe, N., and B. Teboh. 2007. Dialoging women. In *Africa after gender?*, eds. C. Cole, T. Manuh, and S. Miescher. Bloomington, Ind., U.S.A.: Indiana University Press.

Ajani, O. I. Y. 2008. *Gender dimensions of agriculture, poverty, nutrition, and food security in Nigeria.* IFPRI Nigeria Strategy Support Program Brief 5. Washington, D.C.: International Food Policy Research Institute.

Akresh, R. 2005. *Understanding Pareto inefficient intrahousehold allocations.* Working Paper. Department of Economics. Urbana-Champaign, Ill., U.S.A.: University of Illinois at Urbana-Champaign.

Aluko, B., and A. R. Amidu. 2006. Women and land rights reforms in Nigeria. Paper presented at the Promoting Land Administration and Good Governance 5th FIG Regional Conference, March 8–11, Accra, Ghana. <http://www.fig.net/pub/accra/papers/ts09/ts09_04_aluko_amidu.pdf>. Accessed September 22, 2009.

Appiah, K., L. Demery, and S. G. Karyea-Adjei. 2000. Poverty in a changing environment. In *Economic reforms in Ghana: The miracle and the mirage*, eds. E. Aryeetey, J. Harrigan, and M. Nissanke. Amhara, Ethiopia, and Trenton, NJ, U.S.A.: African World Press.

Battese, G. E. 1992. Frontier production functions and technical efficiency: A survey of empirical applications in agricultural economics. *Agricultural Economics* 7 (3 & 4): 185–208.

Bezabih, M., and S. Holden. 2006. Tenure insecurity, transaction costs in the land lease market and their implications for gendered productivity differentials. Invited paper presentation at the International Association of Agricultural Economists Conference, August 12–18, Gold Coast, Australia.

Bill and Melinda Gates Foundation. 2008. Gender impact strategy for agricultural development. <http://www.gatesfoundation.org/learning/Documents/gender-impact-strategy.pdf>. Accessed September 29, 2009.

Boserup, E. 1970. *Woman's role in economic development.* New York: St Martin's Press.

Bourdillon, M., P. Hebinck, J. Hoddinott, B. Kinsey, J. Marondo, N. Mudege, and T. Owens. 2002. Assessing the impact of HYV maize in resettlement areas of Zimbabwe. Summary Report. International Food Policy Research Institute, Washington, D.C.

Chavas, J.-P., R. Petrie, and M. Roth. 2005. Farm household production efficiency: Evidence from the Gambia. *American Journal of Agricultural Economics* 87 (1): 160–179.

CIA (Central Intelligence Agency of the United States). 2009a. *The World Factbook. Nigeria*. <https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html>. Accessed August 18, 2009.

________. 2009b. *The World Factbook. Uganda*. <https://www.cia.gov/library/publications/the-world-factbook/geos/ug.html#>. Accessed August 10, 2009.

Cotula, L. 2006. *Gender and law: Women's rights in agriculture.* Legislative Study 76, Rev 1. Rome: Food and Agriculture Organization of the United Nations.

Deere, C. D., G. E. Alvarado, and J, Twyman. 2009. *Poverty, headship and gender inequality in asset ownership in Latin America.* Working Paper. Center for Latin American Studies Gainesville, Fla., U.S.A.: University of Florida.

Doss, C. R. 2002. Mens crops? Womens crops? The gender patterns of cropping in Ghana. *World Development* 30 (11): 1987–2000.

Doss, C. R., and M. 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.

Ezumah, N., and C. Di Domenico. 1995. Enhancing the role of women in crop production: A case study of Igbo women in Nigeria. *World Development* 23 (10): 1731–1744.

Fafchamps, M., and A. R. Quisumbing. 2008. Household formation and marriage markets in rural areas. In *Handbook of development economics,* vol. 4, eds. T. P. Schultz and J. A. Strauss. Amsterdam: North-Holland.

Finley, A. P. 2007. The graying of Mexico and its impact on female-headed households. Theoretical and methodological considerations. *Latin American Research Review* 42 (3): 183–204.

Frank, E. 1999. Gender, agricultural development and food security in Amhara, Ethiopia: The contested identity of women farmers in Ethiopia. U.S. AID Contract 663-0510-3-60031. <http://pdf.dec.org/pdf_docs/Pnacg552.pdf>. Accessed September 14, 2009.

Fuwa, N. 2000. The poverty and heterogeneity among female-headed households revisited: The case of Panama. *World Development* 28 (8): 1515–1542.

Gilbert, R. A., W. D. Sakala, and T. D. Benson. 2002. Gender analysis of a nationwide cropping system trial survey in Malawi. *African Studies Quarterly* 6 (1). <http://web.africa.ufl.edu/asq/v6/v6i1a9.htm>. Accessed September 29, 2009.

Goldstein, M., and C. Udry. 2008. The profits of power: Land rights and agricultural investment in Ghana. *Journal of Political Economy* 116 (6): 981–1022.

Holden, S., B. Shiferaw, and J. Pender. 2001. Market imperfections and land productivity in the Ethiopian highlands. *Journal of Agricultural Economics* 52 (3): 53–70.

Honoré, B. E. 1992. Trimmed LAD and least squares estimation of truncated and censored regression models with fixed effects. *Econometrica* 60 (3): 533–565.

________. 2008. On marginal effects in semiparametric censored regression models. Working paper. <http://ssrn.com/abstract=1394384>. Accessed September 29, 2009.

Horrell, S., and P. Krishnan. 2007. Poverty and productivity in female-headed households in Zimbabwe. *Journal of Development Studies* 43 (8): 1351–1380.

IFAD (International Fund for Agricultural Development). 2003. *Mainstreaming a gender perspective in IFAD's operations: Plan of action 2003–2006.* Rome.

Jacoby, H. 1995. The economics of polygyny in sub-Saharan Africa: Female productivity and the demand for wives in Côte d'Ivoire. *Journal of Political Economy* 103 (5): 938–971.

Kafumbe, A. 2009. Women's rights to property in marriage, divorce and widowhood in Uganda: The problematic aspects. *Human Rights Review.* <http://www.springerlink.com/content/wg52008384pg1r05/>. Accessed September 29, 2009.

Kasente, D., M. Lockwood, J. Vivian, and A. Whitehead. 2001. Gender and the expansion of nontraditional agricultural exports in Uganda. In *Shifting burdens: Gender and agrarian change under neo-liberalism,* ed. S. Razavai. Bloomfield, Conn., U.S.A.: Kumarian Press Inc.

Kebbeh, M., S. Haefele, and S. O. Fagade. 2003. Challenges and opportunities for improving irrigated rice productivity in Nigeria. Working paper from the West Africa Rice Development Association (WARDA). <http://www.usaid.gov/ng/downloads/markets/irrigated_rice_study_report.pdf>. Accessed September 22, 2009.

Kevane, M., and L. C. Gray. 1999. A woman's field is made at night: Gendered land rights and norms in Burkina Faso. *Feminist Economics* 5 (3): 1–26.

Kinkingninhoun-Mêdagbé, F. M., A. Diagne, F. Simtowe, A. R. Agboh-Noameshie, and P. Y. Adegbola. 2008. Gender discrimination and its impact on income, productivity and technical efficiency: evidence from Benin. *Agriculture and human values* 2 (1): 57-69.

Ludwig, F. 2008. Christian–Muslim relations in northern Nigeria since the introduction of Shari'ah in 1999. *Journal of the American Academy of Religion* 76 (3): 602–637.

Mahdi, H. 2009. *The hijab in Nigeria, the women's body and the feminist private/public discourse*. Institute for the Study of Islamic Thought in Africa (ISITA) Working Paper 09-003. <http://www.bcics.northwestern.edu/documents/workingpapers/ISITA_09-003_Mahdi.pdf>. Accessed September 29, 2009.

Metz, H. C., ed. 1991. *Nigeria: A country study*. <http://countrystudies.us/nigeria/58.htm>. Accessed September 14, 2009.

Nigeria. 1978. *Land Use Act 1978*. Laws of the Federation of Nigeria 1990. <http://www.nigeria-law.org/Land%20Use%20Act.htm>. Accessed September 29, 2009.

Nkedi-Kizza, P., J. Aniku, K. Awuma, and C. H. Gladwin. 2002. Gender and soil fertility in Uganda: A comparison of soil fertility indicators for women and men's agricultural plots. *African Studies Quarterly* 6 (1). <http://www.africa.ufl.edu/asq/v6/v6i1a2.htm>. Accessed August 6, 2009.

Nkonya, E., J. Pender, K. C. Kaizzi, E. Kato, S. Mugarura, H. Ssali, and J. Muwonge. 2008a. *Linkages between land management, land degradation, and poverty in Sub-Saharan Africa: The case of Uganda*. Research Report 159. Washington, D.C.: International Food Policy Research Institute.

Nkonya, E., D. Phillip, M. Tewodaj, J. Pender, M. K. Yahaya, G. Adebowale, T. Arokoyo, and E. Kato. 2008b. *From the ground up: Impacts of a pro-poor community-driven development project in Nigeria.* IFPRI Discussion Paper 00756. Environment and Production Technology Division (EPTD) and Development Strategy and Governance Division (DSG). Washington, D.C.: International Food Policy Research Institute.

Nweke, F. 1996. *Cassava: A cash crop in Africa.* Ibadan, Nigeria: Cosca.

Oba, A. A. 2002. Islamic law as customary law: The changing perspective in Nigeria. *International and Comparative Law Quarterly* 51 (4): 817–850.

Ojowu, O., H. Bulus, and B. Omonona. 2008. *Nigeria poverty assessment.* Working Paper. National Bureau of Statistics, Nigeria. <http://www.pak-nigeria.org/pdfs/24_Nigeria_Poverty_Assessment_2007_Table_of_Contents_Executi.pdf>. Accessed September 29, 2009.

Oladeebo, J. O., and A. A. Fajuyigbe. 2007. Technical efficiency of men and women upland rice farmers in Osun state, Nigeria. *Journal of Human Ecology* 22 (2): 93–100.

O'Laughlin, B. 2007. A bigger piece of a very small pie: Intrahousehold resource allocation and poverty reduction in Africa. *Development and Change* 38 (1): 21–44.

Owens, T., J. Hoddinott, and B. Kinsey. 2003. The impact of agricultural extension on farm production in resettlement areas of Zimbabwe. *Economic Development and Cultural Change* 51 (2): 337–357.

Peterman, A., J. Behrman, and A. R. Quisumbing. 2010. *A review of empirical evidence on gender differences in nonland agricultural inputs, technology, and services in developing countries.* IFPRI Discussion Paper 00975. Poverty, Health, and Nutrition Division (PHND). Washington, D.C.: International Food Policy Research Institute.

Quisumbing, A. R. 1996. Male-female differences in agricultural productivity: Methodological issues and empirical evidence. *World Development* 24 (10): 1579–1595.

Quisumbing, A. R., E. Payongayong, J. B. Aidoo, and K. Osuka. 2001. Women's land rights in the transition to individualized ownership: Implications for tree-resource management in western Ghana. *Economic Development and Cultural Change* 50 (1): 157–181.

Rehman, J. 2007. The sharia, Islamic family laws and international human rights law: Examining the theory and practice of polygamy and talaq. *International Journal of Law, Policy and the Family* 21: 108–127.

Somda, J., A. J. Nianogo, S. Nassa, and S. Sanou. 2002. Soil fertility management and socio-economic factors in crop-livestock systems in Burkina Faso: A case study of composting technology. *Ecological Economics* 43 (2): 175–183.

Thapa, S. 2008. *Gender differentials in agricultural productivity: Evidence from Nepalese household data.* Working Paper. Trento, Italy: University of Trento.

Tiruneh, A., T. Tesfaye, W. Mwangi, and H. Verkuijl. 2001. *Gender differentials in agricultural production and decision-making among smallholders in Ada, Lume, and Gimbichu Woredas of the Central Highlands of Ethiopia.* Mexico, D.F.: International Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Agricultural Research Organization (EARO).

Tobin, J. 1958. Estimation of relationships for limited dependent variables. *Econometrica* 26 (1): 24–36.

Tripp, A. M. 2004. Women's movements, customary law and land rights in Africa: The case of Uganda. *African Studies Quarterly* 7(4). <http://www.africa.ufl.edu/asq/v7/v7i4a1.htm>. Accessed August 10, 2009.

Udry, C. 1996. Gender, agricultural production, and the theory of the household. *Journal of Political Economy* 104 (5): 1010–1046.

Udry, C., J. Hoddinott, H. Alderman, and L. Haddad. 1995. Gender differentials in farm productivity: Implications for household efficiency and agricultural policy. *Food Policy* 20 (5): 407–423.

Uganda (Republic of). 1998. *Land Act 1998*. Kampala, Uganda: Government Printer.

Uganda Bureau of Statistics. 2003. Uganda national household survey 2002/2003: Report on the socio-economic survey. <http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/unhs%20200203%20report.PDF>. Accessed July 17, 2009.

UNDP (United Nations Development Programme). 2008. *2007/8 Human development report*. <http://hdr.undp.org/en/media/HDR_20072008_EN_Complete.pdf>. Accessed September 22, 2009.

Waters-Bayer, A., and W. Bayer. 1994. *Planning with pastoralists: PRA and more a review of methods focused on Africa.* Working Paper from Deutsche Gesellschaft für Technische Zusammenarbeit. Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit.

WB/FAO/IFAD (World Bank/Food and Agriculture Organization of the United Nations/International Fund for Agricultural Development). 2009. *Gender and agriculture: Sourcebook*. Washington, D.C.

Whitehead, A., and N. Kabeer. 2001. *Living with uncertainty: Gender, livelihoods, and pro-poor growth in rural sub-Saharan Africa.* IDS Working Paper 134. Brighton, U.K.: Institute of Development Studies, University of Sussex.

World Food Programme. 2009. WFP gender policy: Corporate action plan (2010–2011). <http://home.wfp.org/stellent/groups/public/documents/resources/wfp205173.pdf>. Accessed September 29, 2009.

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