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Abstract

This study investigates the relationship between women's empowerment in agriculture, their nutritional status and those of their children. Growing empirical evidence suggests that a positive link exists, but that not all empowerment dimensions influence nutritional outcomes. Using 2010 to 2016 LSMS-ISA household survey data for Nigeria, specific evidence on this topic was provided.

Our findings show that no relationship exists between women who hold agricultural land and credit, and their energy calorie intake. Women's joint holding of land and other agricultural inputs positively influence their nutritional calorie intake. Children's anthropometry responds positively to women's empowerment indicators, although with a differential impact for boys and girls.

Women's access to agricultural inputs and land rights are necessary conditions for maximizing the potential benefit derived from the women-empowerment-nutrition link. Improvement in anthropometry scores of girls among empowered women should be considered a priority for intervention programmes.

Key Words: *Nutrition, Empowerment, Women, Children, Agriculture*

JEL Classification: *Q15, Q18*

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1. Introduction

Gender inequality with respect to assets ownership has received increasing attention in the literature in the last decade and a half. Doss et al. (2014) documented the significant gender asset gap in some parts of sub-Saharan Africa (SSA), Asia and South America. They found that the gender agricultural land gap is more pronounced in Ghana and Karnataka, India, compared to Ecuador. The latter has witnessed rapid urbanization and thus there are increasing preferences for other assets. The adoption of a legal regime of joint asset ownership by both genders has also reduced the gender asset gap in Ecuador.

It has been shown that the equitable allocation of resources to both men and women can increase smallholder productivity and reduce poverty incidences (FAO in IFPRI and ILRI, 2015). Many developing countries have recognized the importance of agriculture to their economies, particularly in terms of its foreign exchange earnings capacity and employment provision. In SSA and Asia (excluding Japan), women constitute 48.7% and 42%, respectively, of the agricultural labour force (USAID, 2016). However, they own only 15% and 11% of agricultural land, respectively. Specifically, in Ghana, men and women own 64% and 29% of agricultural land, respectively. In Ecuador women are more favoured, with 30% holding agricultural land while men hold 25% (Doss et al., 2014).

The impact of women's empowerment on nutrition has been demonstrated empirically. Women's empowerment is considered vital for improving nutritional outcomes (Bold et al., 2013). Kamiya (2011), Shroff et al. (2011), Bhagowalia et al. (2012), Arulampalam et al. (2012) and Alaofe et al. (2017) documented the positive impact of women's empowerment on nutrition.

Women's empowerment can take various forms, such as higher education attainment, participation in household decision making, ability to act independently, mobility, and asset holdings (Bold et al., 2013). In 2013, Alkire et al. (2013) developed the Women's Empowerment in Agriculture Index (WEAI), which uniquely measures different domains of women's empowerment, spanning decisions on agricultural production, access to and decision-making power over productive resources, control over use of income, leadership in the community, and time use. This index has largely put to rest the different conceptualization of women's empowerment in agriculture which dominates the literature.

However, the literature is mixed on the relative impact of women's empowerment dimensions on nutritional outcomes. This is largely attributed to the pathway through which the empowerment dimension affects nutrition. Malapit and Quisumbing

(2015) found that while expanding women's access to credit has a positive impact on their dietary diversity, it has no relationship with their body mass index (BMI). They argued that culture and country context play important roles when adopting specific interventions to improve nutrition. Doss (2005) noted that in Ghana, women's access to farmland significantly increased their budget share spent on food. Other studies that have documented varying effects of empowerment dimensions on different nutritional outcomes include Shroff et al. (2011), Bhagowalia et al. (2012), Sraboni et al. (2014) and Malapit et al. 2015.

In Nigeria, women's access to agricultural land is poor. The female agricultural land value as a proportion of total agricultural land value was only 10% in 2010. In addition, the share of agricultural land area that is owned by women was 15.8% in 2010.[1] Only 10% of women are agricultural landholders. As women largely dominate the agricultural sector in Nigeria, accounting for more than 60% of the work force,[2] it suggests that their disempowerment through lack of access to agricultural land may negatively affect their income generation, poverty status and nutrition. The Nigerian Land Use Act of 1977, which was supposed to give preference to agricultural land, is faulty in many respects. Oshio (1986) asserted that the Act did not make specific reference to the provision of land for agricultural purposes. Gray and Kevane (1999) also noted the declining accessibility of agricultural land to women due to an increase in land value in SSA.

Although the nutritional outcomes of women and children are improving in Nigeria, they still fall below acceptable international standards. In 2011, about 49% of women of reproductive age (15–49) were anaemic (Development Initiatives, 2015; WDI, 2016). In 2016, Nigeria had the fourth largest number of anaemic women (age 15–49 years), accounting for 50% of the women population (Development Initiatives, 2017).

In addition, the prevalence of overweight for women was 40% in 2014.[3] 31.5% of children under five years of age were underweight in 2016. The prevalence of stunting was 33% in 2015 (NBS, 2015) and 43.6% in 2016 (UNICEF/WHO/World Bank, 2019). Disaggregated results from across the states of the country show that nutritional status is worse in some states as stunting is above 40%. Furthermore, the incidence of Vitamin A deficiency in Children aged 6–59 months was 42% in 2013.

It has been argued that women are primary caregivers for themselves and their children, and are also responsible for their health and nutrition (Smith et al., 2003). It is therefore important to examine how women's nutritional status can be improved through empowerment. The statistics presented earlier show that greater efforts are required if Nigeria is to achieve Goal 2 of the Sustainable Development Goals (SDGs), which aims to achieve food security and improved nutrition, and promote sustainable agriculture by 2030. The goal specifically targets the nutritional status of women and children.

As reiterated in Nigeria's "National Strategic Plan of Action for Nutrition (2014–2019)", malnutrition and nutrition-related diseases are persistent public health challenges and are of significant importance to the country. According to the plan, it was expected that by 2018, wasting among children would be reduced to less than 10%, stunting among under-fives would reduce by 20%, and anaemia among women would drop by half. However, it is worth noting that the planned interventions were not premised on empirical evidence. The literature has shown that nutritional improvement responds differently to varying dimensions of women's empowerment. It is therefore important for policy interventions meant to empower women and improve their nutrition to be based on an understanding of which specific domains of empowerment matter for nutritional outcomes (Malapit and Quisumbing, 2015).

Smith et al. (2003), one of the relevant works on empowerment in Nigeria, adopted women's decision-making power relative to men and societal gender equality as dimensions of women's empowerment status. The study did not control for a potential endogeneity effect of women's relative power relative to men variable, which could result in inconsistent estimates if an ordinary least squares technique is used. Similarly, the study's findings are from almost three decades ago (it used 1990 Demographic and Health Survey data). It should be noted that a series of efforts to improve women's empowerment and nutritional status have taken place in the intervening years. Consequently, the findings of that study may no longer be relevant for policy guidance.

This study fills these gaps by examining the impact of women's empowerment through agricultural land holding on maternal and child nutrition. In doing so, we adopted the Living Standards Measurement Study -Integrated Survey on Agriculture (LSMS-ISA) for 2010/2011, 2012/2013 and 2015/2016, as well as the World Health Organization's (WHO) data on children of 0–59 month in our estimation. This will provide an unbiased basis for comparison with related studies.[4]

This study also adds to the limited literature on the topic in Nigeria and provides guidance to policy makers for addressing the challenges of nutritional deficiencies. The findings of this study would ensure that specific interventions aimed at empowering women and improving their nutritional outcomes are well targeted, thus reducing policy mismatch. Two research questions inform from this study:

i) Does women's holding of agricultural land affect their nutritional outcomes and that of their children?

ii) What other dimensions of women's empowerment in agriculture matter for positive nutritional status?

The rest of the paper is structured as follows: Section 2 discusses women's empowerment in agriculture in Nigeria and Africa. The model and data are described in Section 3, the results of the analysis are presented and discussed in Section 4, and Section 5 concludes with policy recommendations.

2. Women's empowerment in agriculture

Agriculture plays a vibrant role in SSA due to its large employment generation capacity and linkage with other sectors. Women are increasingly constituting a larger fraction of workers in the agriculture sector, largely due to the migration of men to cities. In SSA, women account for 48.7% of the agricultural labour force (USAID, 2016), while in Nigeria it is about 60%. However, they own less than 20% of agricultural land (USAID, 2016, http://www.fao.org/gender-landrights-database).

Women are disadvantaged in the distribution of agricultural inputs, especially land. Discussions on the gender gap in land ownership and women's inadequate access to rural land dominates the literature (Namubiru-Mwaura, 2014). In Zambia, farms held by female-headed households are 0.6 hectares smaller than those held by male-headed households (Jayne et al., 2009). The landholding bias against women persists amid the limitless benefits derivable from women's control of agricultural land. Allendorf (2007) showed that children of women who own land in Nepal are significantly less likely to be severely underweight. Poor access to land and insecure land rights is also linked to rural poverty (Cotula et al., 2006).

Weak secure land rights constitute a major limiting factor to women's agricultural land access in Africa (Cotula et al., 2006). Insecure land rights prevent farmers from investing resources in soil quality, which could boost productivity (Faure, 1995). Africa is still immersed in bureaucratic bottlenecks in land registration and title (Deininger, 2003). Only 10% of rural land in Africa is registered (Byamugisha, 2013).

The plight of women to own land for agricultural purposes is worsened by existing formal land tenure and customary practices in rural areas. Although most land legislation across Africa specifies equal gender rights and prohibit gender discrimination, they are often not implemented in rural areas (Cotula et al., 2006). Customary norms and religion prevail in rural areas[5] and are more important in determining women's land rights (Namubiru-Mwuara, 2014). The extensive application of customary law in rural areas of Africa prevents women from exercising their land rights due to cultural attitudes and customs (Cotula et al., 2006).

Generally, women do not hold any right to land in an African setting. In a patrilineal society, land is allocated to male family heads and transferred via lineage (Lastarria-Cornhiel, 1997). Women only have secondary rights to land, which is derived from their association with male land holders such as husbands (Cotula et al., 2006). Although according to matrilineal practice women are entitled to land through their mother's lineage, often the land is placed in the custodianship of a male family member, who allocates the land (Cotula et al., 2006).

It is worth noting that customary practices regarding land holding are changing gradually to favour women (Lastarria-Cornhiel, 1997). The increased commercialization of agriculture, migration, population pressure on land and urbanization has made the transition to individualized ownership of land a more prominent issue. In Nigeria, female children in the Wudili district of Kano have had their inheritance rights to land recognized by their brothers and the community (Ross, 1987). Men do not see women's land holding as a threat, as women stay in purdah and cannot cultivate the land themselves but do so through male family members (Ross, 1987).

Nevertheless, the growing individualization of land ownership suggests that poor women in rural areas may not possess the financial resources to acquire land. Affluent women who can afford land reside mainly in urban areas. Despite these hindrances, women are making strides in land acquisition through the negotiation of land rights (Freudenberger, 1993), collective land purchase, joint titling and support from international organizations to obtain land collectively (Cotula et al., 2006). Women in rural areas have also been able to secure land titles and gain access to high-priced agricultural land through group ownership (ACORD, 2011). Legislation in countries such as Brazil, Ethiopia and South Africa favours equal land rights for both sexes and joint titling (Cotula et al., 2006; Namubira-Mwaura, 2014). Joint land titling among spouses secures the land for women and ensures that they are not dispossessed of their land during divorce or abandonment by their husbands (ICRW, 2005). Their decision-making power concerning activities on the farm is also enhanced (ICRW, 2005).

In Nigeria, women in rural areas are also deprived equal access to agriculture empowerment tools such as land and credit. Cotula et al. (2006) noted that complementary factors such as access to credit, markets and inputs are equally important in supporting players in the agricultural sector. Equal access to productive resources is crucial as it will increase women yields on their farms by 20% to 30% (FAO, 2011). This could further raise agricultural output in developing countries by 2.5% to 4%. Women in Nigeria owned only 10% of agricultural land in 2010 (USAID, 2016).

Land holding in the agricultural rural sector in Nigeria is mainly communal, family-owned and governed by customary land tenure (Ike, 1984). Under this arrangement, the family, clan, village or community owns land. Each member of the family or community is entitled to a portion of the land for subsistence farming (Famoriyo, 1979; Ike, 1984), and the family land cannot be alienated without the consent of family members (Famoriyo, 1979). In this land-sharing arrangement, women are often disadvantaged, as customary practices and cultural barriers often prevent them from inheriting or owning land (AfDB, 2015). The patrilineal system of land inheritance dominates most parts of Nigeria, and women's rights to the use of land only derives from their husband or a male relative (Soetan, 1999).

The Nigerian tenure system, as instituted in the Land Use Act of 1978, does not explicitly state that women have equal rights to land, in the same way as men. It vests the control and management of all land within urban areas with the state governor (Section 2a). Rural land is under the control of the local government administrator (Section 2b). Regardless of Section (2b), the governor has overall power to grant statutory rights of occupancy on any land, in both urban and rural areas. Nwabueze (2009) asserted that the Nigeria Land Use Act of 1978 has failed to achieve its goal of equitable land redistribution, as land is still unaffordable to low-income earners.

Chigbu et al. (2019) noted that women in Nigeria who directly derive land use rights from their husbands or relations only use the land for farming and as directed by their husbands or true owners of the land. The authors emphasized the heterogeneous differences among women in their quest for land access and tenure security. They also noted that homogenizing their land needs may lead to an overgeneralization in land policy and programmes.

It should be noted that land ownership backed by law or customs empowers women in making decision on how the land is used. Thus, a woman may have access to land without having a legal right to it and this often limits her ability to plant crops of her choice (Namubiru-Mwaura, 2014).

Although land legislation and policies such as spousal joint land titling are not common in Nigeria, efforts are being made by the government to amend the Land Tenure Act of 1978 to be gender-sensitive in land provision. Group land ownership by women's associations are also becoming a popular way of acquiring land for rural women. One key programme that has impacted positively on women in agriculture is African Women in Agricultural Research and Development (AWARD).[6] Since inception, about 493 women scientists have benefitted from AWARD fellowships, which are aimed at promoting agricultural innovation (AWARD, 2018). The Nigerian arm of the AWARD is NiWARD, and it serves as a platform for fellows to improve the wellbeing of smallholder women farmers through scientific research outcomes.

3. Methodology

Data

Data from the 2010/2011, 2012/2013 and 2015/16 Living Standards Measurement Study-Integrated Survey on Agriculture (LSMS-ISA) for Nigeria was used for analysis in this study. This survey provides information on the same respondents over time. The longitudinal characteristics of the data enabled us to monitor changes in the nutritional pattern of households over time. The panel survey is nationally representative and consists of 5,000 randomly selected households.

Attrition rates in the surveys are low, representing 4.9% and 8.4% in Waves 2 (2012/2013) and 3 (2015/2016), respectively, since the baseline survey in 2010/2011 (NBS, 2016). The enumeration areas were distributed across the six geopolitical zones of the country. The survey is divided into agricultural, household and community sections. We restricted our samples to households engaged in agriculture in rural and urban areas.

The WEAI developed by Alkire et al. (2013) has become an acceptable measure of women's empowerment in the literature. A uniform measure of empowerment enables comparison of findings among studies. The LSMS-ISA does not explicitly provide information on all five domains of women's empowerment (production, resources, income, leadership and time) required for the computation of WEAI. The absence of all five indicators making up the aggregate WEAI precludes the use of WEAI as an aggregate empowerment measure in this study. Nevertheless, in the same spirit as the WEAI, the indicators of women's empowerment that captures control over resources within the agricultural sector (access to land holding and decisions about credit) are used in the study. Detailed information on food consumption in the survey allows for the computation of calorie availability for women. Information on the weight, height/length and age of children is also available to compute anthropometry scores for children below 59 months of age.

Wave 1 (2010/2011), Wave 2 (2012/2013) and Wave 3(2015/2016) of the ISA-LSMS data contain 4,997, 4746, and 4,611 households, respectively. As our study focussed on women's empowerment in agriculture, our sample was restricted to households whose occupation is agriculture and has at least one woman in the household within the reproductive age of 15–49 years. Therefore, we included women who are heads of single-headed female households and those in households headed by either a male or female. The study leveraged on the longitudinal nature of the data to track women in agriculture who are within the age range of 15–49 years across the three waves. Our final estimation sample consists of 1,238 women aged 15–49 years.

It is important to address the problem of seasonality in household surveys. Harttgen and Klansen (2012) and Sraboni et al. (2014) noted that seasonality could lead to over or under-estimation of food consumed in a single-round household survey. The household survey used in our study is a double-round survey conducted during post-planting and post-harvesting periods (one-year period). In addition, we adjusted for a potential seasonality effect using the average data on food consumption in both post-planting and post-harvest periods. Data on food consumption in the ISA-LSMS are provided on a 7-day recall and at the household level. In order to obtain food consumed by women in the household on a 24-hour recall, we divided total household consumption by 7 days and by the household size.

Model

This study models the relationship between nutritional outcomes in women and children, and women's empowerment in agriculture using a panel regression model specified in Equations 1, 2 and 3. A fixed effect model was adopted to model the relationship among the variables. Our preference for a fixed effect rather than a random effect model is to enable us to control for unobserved heterogeneity such as food preferences among women respondents, which could influence their nutritional status. A Hausman test (shown in Table 2) was conducted, which favoured the use of a fixed effect estimation model.

An instrumental variable (IV) fixed effect regression method is adopted due to the potential endogeneity of the empowerment variable adopted in this study. This measurement error is widely documented in the women's empowerment nutrition literature (Sraboni et al. 2014; Malapit et al. 2015; Malapit and Quisumbing, 2015). This may bias the coefficient of empowerment variable, leading to inconsistent estimates. To circumvent this problem, we used instruments to eliminate the empowerment variable of potential simultaneity bias. The equation of the model is a two-step model specified below, which controls for the potential endogeneity of the women's empowerment indicator in the model. We specify an IV model shown in Equation 1:

$$X_{it} = B_1 Y_{it} + B_2 Z_{it} + \delta_i + \varepsilon_{it} \quad (1)$$

X_{it} is women's empowerment as measured by asset ownership (agricultural land holding), and access to or decision about credit. Agricultural land holding is represented by a dummy (=1, if woman is aged 15–49, and owns or manages land, and 0 otherwise). This measure of empowerment has been identified as a major empowerment instrument for SSA women (Soetan, 1999; Doss, 2005). The binary variable decision over credit also assumes a value of 1 if a woman is in a household that has an agricultural loan, and zero otherwise.

Y_{it} is a vector of individual and household characteristics that may affect nutritional outcomes. These include: age of woman (in years); literate (whether woman can read and write in any language); household size; logarithm of plot size (measure of wealth); geopolitical zone of woman; urban; plot acquisition type (outright purchase, or OP; rented for cash or in-kind, or RC; used free of charge, or FOC; and distributed by community or family, or DBCF); minimum dietary diversity of women (MDD-W),[7] gender of household head, consumer price index (CPI),[8] food security condition of households as measured by Fsec1 (days the household relied on less preferred food), Fsec2 (days they reduced the number of meals), Fsec3 (days they limited portion size at meal times), and Fsec4 (days the household had no food in the house). These definitions capture mild and severe food insecurity. Table A3 provides a detailed description of the variables.

Z_{it} represents the set of instruments. They are, age difference between primary male and female decision makers, and proportion of male children in total number of children. The instruments are assumed to be strongly correlated with the empowerment variable, but uncorrelated with the error term, except indirectly through the dependent variable. Some of these instruments largely draw from the related literature on empowerment (Sraboni et al., 2014; Malapit et al., 2015).

Equations 2 and 3 represent the second stage regression for mother and child nutritional outcomes, respectively.

$$N_{it}^{w} = B_3 X_{it} + B_4 Y_{it} + B_5 L\mathrm{sec}urity_{it} * X_{it} + B_6 farminputs_{it} * X_{it} + \alpha_i + u_{it} \quad (2)$$

$$N_{it}^{c} = B_7 X_{it} + B_8 Y_{it} + \beta_9 boy_{it} + B_{10} boy_{it} * X_{it} + \alpha_i + u_{it} \quad (3)$$

here N_{it}^{w} and N_{it}^{c} represent the nutritional outcomes of women and children. For women, it is measured by calorie availability. This indicator measures the energy intake by women of reproductive age (15–49) based on a 24-hour recall. The ISA-LSMS provides information on food groups consumed from different sources, their quantity, and units of measurement. We define calorie availability as a continuous variable.

The ISA-LSMS standard conversion table was used to convert food quantity consumed into standard measures (in our case gram). We followed the method used by Moltedo et al. (2014) by converting food consumed by women into equivalent calories. This is a two-step method which involves first converting a food group into a standard measure (grams) and then multiplying that by quantity consumed. The second step involves converting food into kilocalories (kcal). We used equivalent calories for food as provided by the FAO (2012) in its food composition table for West Africa. The calories are then multiplied by food grams to give calories consumed by the household. We aggregated calories across all food groups consumed by the household and then divided by 100 to arrive at kilocalories per 100 grams (kcal/100 gram). To calculate what is consumed by women in households, we divided the aggregate calories by household size and then by seven days to arrive at the calories available to a woman in a household in a 24-hour recall period.

The ISA-LSMS only provides information on food consumption at the household level. Information on women's consumption was not available. In circumventing this challenge, calorie availability for women was arrived at using calorie availability for the household divided by the household size (per capita calorie). The justification for this is that household consumption reflects women's consumption patterns in the household. Often, all dwellers in a household consume the same food. In addition, questions on food consumption in the survey were directed at the most senior female or person most knowledgeable about food consumption. X_{it} and Y_{it} are as defined in Equation 1.

The measure of women's nutritional outcome (calorie availability) in our study is dependent on farm yield and quantity consumed. Farm yield and investment on land quality are influenced by factors such as availability and use of farm inputs, and land rights (Faure, 1995; FAO, 2011, Cotula et al., 2006). Therefore, we interacted the women's land access variable with the use of farm technology, land rights, use of herbicides, quality of soil, and type of seedling used in planting. This is represented by $L\sec urity_{it} * X_{it}$ and $farm\,inputs_{it} * X_{it}$ in Equation 2. This enabled us to examine the joint impact of farm inputs and land security, and women's access to land on nutritional outcomes. α_i (i=1.....n) is the unknown intercept for each individual and U_{it} is the error term.

Anthropometry scores for children of 0–59 months were used as a measure of child nutritional outcomes. Child anthropometry scores (height-for-age, or HAZ; weight-for-height, or WHZ; and weight-for-age, or WAZ) for under-five children were adopted. The z-scores or anthropometry scores were computed using the WHO Anthro software developed by the World Health Organization (WHO, 2010).[9] A child is categorized as stunted, wasted, and underweight if the HAZ, WHZ and WAZ measurements, respectively, are two or more standard deviations below the median reference group.

In the equation for children, Y_{it} includes additional control variables such as water source (dummy=1 for safe water source, 0 otherwise), child's age, boy is 1 and 0 otherwise, child's health status (if the child visited a clinic in the past four weeks), number of meals eaten by children, dummy=1 for children who are 0–2 years of age, and 0 for children who are above 2–5 years old, and other explanatory variables as defined earlier. The interaction of the empowerment variable with 'boy' in equation 3 is to test whether women's empowerment has a differential impact for boys and girls independently. The variable boy takes on the value of 1 for boys and 0 for girls.

4. Results and analysis

The estimated result of the impact of women's access to land on their energy calorie intake is presented in Table 1. The second-stage regression of the IV technique is presented in the first column of Table 1.[10] The endogeneity of the women's empowerment variable is well documented in the literature. Failure to exclude this endogenous variable would result in inconsistent estimates. To avoid this pitfall, a pre-estimation test was carried out to establish if the women's empowerment variable (women's access to land) is truly endogenous in our model.

The result of the endogeneity test presented in the lower panel of Table 1 fails to reject the null hypothesis of exogeneity at a p-value of 0.4275. The Hausman test of exogeneity also did not reject the null hypothesis of consistent estimates from fixed effects. Other IV diagnostics as shown by the Cragg-Donald and Kleibergen-Paap tests were also unsatisfactorily. The F-statistic of 1.185 in the Cragg-Donald test fails to exceed the critical values at 10%–25%, suggesting that the instruments are weak. The non-validity of the instruments may be attributed largely to the exogenous nature of the empowerment variable in the model. Sraboni et al. (2014) also failed to reject the exogeneity of the gender parity gap as an empowerment variable for women.

As a result, the fixed effect result, as shown in columns 2–4 of Table 1, are taken as valid for our sample. The Hausman test presented in Table 2, for choosing between the fixed and random effect models, is statistically significant, implying that the null hypothesis of the random effect model can be rejected. The null hypothesis is that the conditional mean of the disturbances given the regressors is zero (Baltagi et al. 2003).

The fixed effect estimation result presented in column 2 of Table 1 has an overall good fit as indicated by the statistical significance of the F-statistic. The coefficients of the variables have the expected signs, except for women's access to land, which is not statistically significant. The coefficient of women's access to land suggests that women's land holding has no relationship with the amount of calories they consume. This result contrast with Sraboni et al. (2014) who found a positive association between women's empowerment and per capita calorie availability. Berti et al. (2003) also showed that women's empowerment in the form of capital investment had a huge positive impact on their nutrition. Another study that found a significant positive impact of women's access to land on their nutrition is Doss (2005).

Table 1: Women's calorie intake and access to land (empowerment)

Variable	IV fixed effect		Fixed effect (within estimator)	
Dependent variable: log women calorie availability	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
	(1)	**(2)**	**(3)**	**(4)**
Access to land	1.4127	-0.0854	-0.1012	-0.0936
	(2.4881)	(0.0654)	(0.0778)	(0.0749)
Technology			-0.0441*	
			(0.0238)	
Herbicide				0.0525*
				(0.0246)
Access to land × technology			0.0830***	
			(0.0120)	
Access to land × herbicide				0.0148***
				(0.0047)
Household head is female	-0.2912***	-0.3305***	-0.3360***	-0.3290***
	(0.0770)	(0.0381)	(0.0381)	(0.0382)
Household size	-0.1028***	-0.1087***	-0.1085***	-0.1089***
	(0.0133)	(0.0083)	(0.0092)	(0.0083)
Age of women (years)	-0.0120***	-0.0118***	-0.0116***	-0.0118***
	(0.0032)	(0.0031)	(0.0031)	(0.0031)
Woman is literate	0.0067	0.0222	0.0261	0.0215
	(0.0377)	(0.0248)	(0.0250)	(0.0248)
Fsec1	-0.0128	-0.0155**	-0.0154**	-0.0154**
	(0.0095)	(0.0077)	(0.0077)	(0.0076)
Fsec2	0.0126	0.0153	0.0157	0.0150
	(0.0150)	(0.0116)	(0.0116)	(0.0116)
Fsec3	-0.0648***	-0.0533***	-0.0552***	-0.0524***
	(0.0234)	(0.0116)	(0.0117)	(0.0116)
Fsec4	0.0610	0.0429*	0.0406*	0.0426*
	(0.0398)	(0.0232)	(0.0234)	(0.0232)
Rented for cash	-0.0905	-0.0918	-0.0878	-0.0959
	(0.0734)	(0.0695)	(0.0697)	(0.0694)
Free of charge	-0.2237***	-0.2393***	-0.2343***	-0.2381***
	(0.0469)	(0.0336)	(0.0341)	(0.0337)
Distributed by community	-0.0483	-0.0584**	-0.0533*	-0.0581**
	(0.0363)	(0.0271)	(0.0271)	(0.0272)
Married (polygamous)	0.0963**	0.1072***	0.1026***	0.1081***
	(0.0397)	(0.0363)	(0.0363)	(0.0366)

continued next page

Table 1 Continued

Variable	IV fixed effect		Fixed effect (within estimator)	
Dependent variable: log women calorie availability	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
	(1)	**(2)**	**(3)**	**(4)**
Div/Sep/Wid.	-1.2951	-0.0890	-0.0895	-0.0854
	(2.009)	(0.1210)	(0.1218)	(0.1204)
Never married	-0.1194	-0.1125	-0.1141	-0.1085
	(0.1109)	(0.1039)	(0.1032)	(0.1032)
Log plot size	-0.0084	-0.0055	-0.0062	-0.0054
	(0.0133)	(0.0112)	(0.0113)	(0.0112)
Log CPI	-0.5541**	-0.6861***	-0.6974***	-0.6987***
	(0.2357)	(0.0879)	(0.0887)	(0.0883)
MDD-W	0.0595***	0.0596***	0.0592***	0.0589***
	(0.0096)	(0.0090)	(0.0091)	(0.0091)
Observations	3616	3616	3,588	3,612
F-statistic	24.37	30.80	26.52	27.81
Prob>F	0.0000	0.0000	0.0000	0.0000
Cragg-Donald F-statistic	1.185			
Kleibergen-Paap F-statistic	0.626			
Endogeneity test:				
Chi^2 P-value	0.4275			
Hausman test of exogeneity				
Null: fixed effect (within estimator) estimates are consistent				
$Chi^2(18)$	0.42			
P-value	1.0000			

Robust standard errors are in parentheses. *** significant at 1%, ** at 5% and * at 10%.

Table 2: Hausman test: Selection between fixed effects and random effects

Null: Difference in coefficients between fixed effects and random effects not systematic	
$Chi^2(18)$	168.27
P-value	0.0000

Although our findings appear counterintuitive, it reinforces some studies that have found that access to land without corresponding use of farm inputs may reduce expected farm yields (Cotula et al., 2006). Faure (1995) pointed out that disputes over agricultural land or insecure land rights may prevent investment in the quality of the soil, which could further reduce farm yields. The AfDB (2015) showed that in Nigeria, the cassava yield on a woman's farm is about one-quarter less than a man's due to the constraint of quality inputs and fertilizer. Following this reasoning, Equation 2 was estimated, interacting women's access to land with the use of farm technology and herbicides. The results are presented in columns 4 and 5 of Table 1. The findings show that there is a significant difference in the calories available to women who adopted technology in farming and used fertilizers such as herbicides, and those who did not. Specifically, women who had access to land and complemented it with technology and herbicides were more likely to increase their calorie intake than women with land but no access to these inputs.

We further examined the joint effect of women's access to land and soil quality, seed type, and land securitization on their nutrition. The result is presented in Table A2 in the Annex. Women who had access to fertile land were more likely to increase their energy calorie intake by 9.9% compared to those who did not have access to fertile land. Using improved seed on their land increased women's calorie availability by 12.4% compared to the use of local seed. The interaction of land access with land securitization is positive and statistically significant, thus supporting the literature that ownership of land rights motivates landowners to invest in the quality of land (Faure, 1995). Our findings show that women who held land that have secured rights will increase their calorie availability by 34.6% more than those who have insecure lands. The large magnitude of the coefficient points to the relative importance of land securitization more than any other farm input.

Column 2 of Table 1 shows that households where women are heads are more likely to increase their consumption of energy calories by 33% compared to households headed by men. The coefficient of household size is statistically significant at 1% and negative. It suggests that an additional member added to a household reduces the energy calorie available to the woman in the household by almost 11%. This finding is consistent with the literature, as food is shared among household members. Sraboni et al. (2014) shared similar findings.

Women's age is strongly statistically significant and negatively influences their energy calorie consumption. One year added to the age of a woman between 15–49 years, marginally reduces their calorie intake by 1.1%. Intuitively, this result appears logical, as women's energy requirements and absorption decline as they grow older, as less physical activity is carried out at an older age (Wakimoto and Block, 2001).

Only two of the four food insecurity indicators are statistically significant and have negative coefficients. Women in households which rely on less preferred foods will have their calorie intake reduced by 1.5%, while women in households which limit the size of their meals will reduce their calorie intake by a larger amount of 5.3%. The latter measure of food insecurity is more severe, and this explains why an additional day in which meal size is reduced will lead to a significant decline of 5.3% in the woman's calorie intake.

Women who acquired their land free of charge or through community distribution are less likely to increase their calorie availability compared to those who acquired it through outright purchase. Women's marital status also plays an important role in determining their nutritional outcome. Married women in a polygamous family are more likely to increase their calorie availability, by 10.7%, compared to women in monogamous family settings. This may be explained by the positive rival effect and its influence on family consumption. In a polygamous family setting, women take turns to prepare meals for their husband. In the process of gratifying their husband, the wives have strong tendencies to prepare food varieties as they compete with one another. The size of agricultural land (plot size) held by women does not have any relationship with their energy calorie intake. This supports our previous finding that what matters is not the size of land, but complementary inputs and securitization of the land.

Higher consumer prices significantly reduce energy calories available to women. A 1% increase in food prices will reduce women's calorie intake by 68%. The reasoning behind this finding is that higher food prices reduces the quantity of food items purchased and available to women and, consequently, the energy calories derived from the food. We included women's dietary diversity score as an independent variable in the model to examine if higher dietary diversity in food consumption affects calorie intake. Our findings indicate a positive and statistically significant relationship between women's dietary diversity and their calorie intake. This indicates that as dietary intake by women becomes more diverse, their energy calorie intake increases. Thus, an increase in women's dietary diversity score by one food group increases calorie intake by 5.9%.

The estimated results of the model using access to credit as an empowerment variable is presented in Table 3. The empowerment variable (credit) is a dummy variable, which takes a value of 1 if a household obtained credit for agricultural purposes and 0 otherwise. Although household credit decisions may be regarded as endogenous, we do not have appropriate instruments to model household credit decisions. We therefore interpreted the relationship between the variables as associative, rather than causative (Malapit et al., 2015; Malapit and Quisumbing, 2015).

Table 3: Women's calorie intake and access to credit (empowerment)

Variables	**Fixed effect (within estimator)**
Dependent variable:	**Coefficients**
Log women calorie availability	
Access to credit	0.0243
	(0.0216)
Household head is female	-0.3232***
	(0.0380)
Household size	-0.1095***
	(0.0031)
Age of woman (years)	-0.0122***
	(0.0031)
Woman is literate	0.0224
	(0.0250)
Fsec1	-0.0176**
	(0.0077)

continued next page

Table 3 Continued

Variables	Fixed effect (within estimator)
Dependent variable:	Coefficients
Log women calorie availability	
Fsec2	0.0120
	(0.0116)
Fsec3	-0.0501***
	(0.0117)
Fsec4	0.0382
	(0.0233)
Rented for cash	-0.0800
	(0.0694)
Free of charge	-0.2463***
	(0.0338)
Distributed by community	-0.0640**
	(0.0274)
Married (polygamous)	0.1016***
	(0.0366)
Div/Sep/Wid.	-0.1549
	(0.1043)
Never married	-0.0945
	(0.0970)
Log plot size	0.0015
	(0.0111)
Log CPI	-0.6653***
	(0.0870)
MDD-W	0.0587***
	(0.0090)
No. of observations	3607
F-statistics	31.12
Prob>F	0.0000

Robust standard errors are in parentheses. *** significant at 1%, ** 5% and *10%.

The coefficient signs and statistical significance of the estimated variables are similar to those presented in Table 1. Household decisions about credit does not statistically correlate with the calories available to women in the household. A plausible explanation for this finding is that access to credit for agricultural purposes does not necessarily imply that borrowed funds are used for agricultural purposes. Malapit and Quisumbing (2015) also found no association between women's empowerment in credit decisions and their BMI.

A larger household size is negatively associated with women's calorie intake. Similarly, women's ageing is negatively statistically and significantly correlated with the calories available to women. The higher the number of days that a household relies on less preferred foods and limits the size of portions during mealtimes negatively impacts on women's calorie availability. The association between food price changes and women's calorie intake is negative and statistically significant. The consumption of food varieties by women is positively associated with their calorie intake.

Tables 4 and 5 present the estimation results of the impact of women's empowerment on child nutrition, as measured by their anthropometry.[11] The pre-estimation endogeneity tests that were conducted indicated that women's access to land and agricultural credit are exogenous. In the absence of endogeneity problems, we therefore adopted an ordinary least squares estimation technique. The impact of women's access to land on children's HAZ, WAZ and WHZ is presented in Table 4. The model has a good overall fit as indicated by the statistical significance of the F-statistic at 1% and 5%.

The coefficient of the women's empowerment variable (access to land) has a positive sign and is statistically significant in the HAZ and WAZ model specifications, suggesting that women who have access to land are more likely to increase their children's HAZ and WAZ anthropometry scores by 0.55 and 0.37, respectively.

Table 4: Children's anthropometry z-scores and women's empowerment (access to land): Ordinary least squares estimation (2015/2016)

Independent variable	HAZ	WAZ	WHZ
Urban	0.2786	0.2093	-0.0564
	(0.2461)	(0.1826)	(0.1833)
Child's age (months)	-0.0128	-0.0027	-0.0002**
	(0.0094)	(0.0072)	(0.0068)
Boy=1	-0.2817*	-0.3135*	-0.0431
	(0.1608)	(0.1222)	(0.1098)
Child is unhealthy=1 (0, otherwise)	-0.1642	-0.2693	-0.2974*
	(0.2553)	(0.1990)	(0.1676)
Child drinks from safe water source	0.0682	-0.0031	-0.0244
	(0.1667)	(0.1275)	(0.1170)
Mother's age in years	0.0210*	0.0150*	0.0021
	(0.0123)	(0.0091)	(0.0074)
Woman's access to land	0.5551**	0.3795**	0.0624
	(0.2513)	(0.1661)	(0.1624)
Access to land × boy	-0.8887*	-0.5417*	-0.0723
	(0.4596)	(0.3079)	(0.3084)
Household size	-0.0839**	-0.0354	0.0258
	(0.0425)	(0.0302)	(0.0270)

continued next page

Table 4 Continued

Independent variable	HAZ	WAZ	WHZ
Mother is literate	0.7173***	0.1624	-0.3597***
	(0.1638)	(0.1241)	(0.1137)
No. of meals eaten by child per day	-0.0313	0.0230	-0.0157
	(0.0680)	(0.0504)	(0.0476)
Age dummy (=1 if child is 0–2 years)	0.2940	-0.0345	-0.1885
	(0.3308)	(0.2596)	(0.2312)
Constant	-0.0952	-2.3535	0.1037
	(0.6838)	(0.5456)	(0.4910)
Observations	841	871	805
F-statistic	6.53	2.68	1.96
Prob.	0.0000	0.0022	0.0291
R-squared	0.0678	0.0242	0.0238

Robust standard errors are in parentheses. *** significant at 1%, ** 5% and *10%.

Women's access to land has no relationship with a child's WHZ. The inference from our findings is that women's access to land has a positive impact on the nutritional status of their children through the use of farm income to purchase a nutritious diet and consumption of own farm produce. Our study is in harmony with Smith et al. (2003), who found a positive association between women's relative decision making and WAZ scores for children in Nigeria. Schijven (2016) also reported a positive link between women's land holding in Zambia and Uganda and their children's HAZ and WHZ scores. Similarly, Alaofe et al. (2017) showed a positive nexus between women's empowerment and anthropometry scores for boys and girls in Northern Benin.

However, Malapit and Quisumbing (2015) and Malapit et al. (2015) found a weak association between women's empowerment scores and children's anthropometry. The latter authors found that the production diversity of a household had a greater positive impact on children's nutrition and that women's control over income in a dual-decision maker household has a significant association with the HAZ score. The choice of the disaggregated women's empowerment indicators in these studies may be a basis for our differing findings. Malapit et al. (2015) explicitly excluded land ownership as one of their women's empowerment indicators, because asset ownership contributes only 2.4% to women's disempowerment in Nepal.

The impact of other independent variables on the anthropometry scores of children is presented in Table 5. In line with the findings of Guha-Khasnobis and Hazarika (2006), the location of children, whether urban or rural, does not influence their nutritional status. Each additional month added to a child's age reduces his/her WHZ score by 0.0002. Malapit et al. (2015) for Nepal, Guha-Khasnobis and Hazarika (2006) for Pakistan, and Schijven (2016) for Zambia and Uganda, found similar results.

Girls are more likely to have better nourishment in terms of HAZ and WAZ, and therefore to increase their anthropometry scores by 0.2817 and 0.3135, respectively, more than boys as reflected in the negative coefficient of the boy (dummy) variable. Schijven (2016) found similar results. The sanitation practices of households do not affect children's nutritional status as indicated in the non-statistical significance of the water source variable. Being unhealthy reduces a child's WHZ score by 0.297. This variable is not statistically significant for HAZ and WAZ. This is not surprising, as our indicator of a child's health (frequent visits to the hospital in four weeks) is related to the growth and development of a child, rather than age-based. An additional year added to a woman's age increases her children's HAZ and WAZ by 0.021 and 0.015, respectively. This implies that older women have better childcare practices that can improve the nutritional status of their children.

The statistical significance of the interaction of the women's empowerment variable with gender (boy), shows that women's empowerment has a differential impact on boys' and girls' anthropometry. Girls in households where the woman is empowered through ownership of agricultural land are more likely to have their HAZ and WAZ scores improved by 0.881 and 0.541, respectively, compared to boys. Children in larger households have a lower HAZ, as indicated by the negative correlation and statistical significance between HAZ and household size. Our findings also suggest that the literacy of mothers has a positive and significant relationship with their children's HAZ scores. However, it correlates negatively with WHZ.

The number of daily meals eaten by children does not have a statistical and significant relationship with their anthropometry scores. Similarly, there is no differential impact between the anthropometry scores of younger children (aged 0–2) who are expected to have recently received their required immunizations and older children (above 2 years) who had been immunized some time ago.

Table 5 shows that access to agricultural credit by households has a positive and statistically significant correlation with the HAZ scores of their children. This finding is consistent with results in the literature, such as the study by Malapit and Quisumbing (2015). Borrowing from these authors, a probable explanation is that credit empowerment gives women the ability to smooth consumption and enable them cope during periods of food shortage. However, credit as an empowerment tool has a lesser impact on child anthropometry compared to women's access to land, as indicated by the larger coefficient of the women's access to land variable. Other variables in the credit model have the expected signs and mimic findings in the women's access to land model.

Generally, a mother's age positively impacts child anthropometry. A larger household size has a negative effect on the long-term nutritional measure, HAZ. Increasingly larger households, without corresponding increases in food expenditure, will reduce the meal portions available to children, thus leading to stunting. The number of meals consumed by children does not have an impact on their nutritional status, possibly implying that what matters is the quality of diet and not quantity.

Table 5: Children's anthropometry z-scores and women's empowerment (access to credit): Ordinary least squares estimation (2015/2016)

Independent variable	HAZ	WAZ	WHZ
Urban	0.3634	0.2666	-0.0491
	(0.2407)	(0.1778)	(0.1764)
Child's age (months)	-0.0131	-0.0029	-0.0002
	(0.0093)	(0.0072)	(0.0068)
Boy=1	-0.3002*	-0.3213***	-0.0436
	(0.1606)	(0.1222)	(0.1096)
Child is unhealthy=1(0, otherwise)	-0.1651	-0.2562	-0.2863*
	(0.2577)	(0.2001)	(0.1670)
Child drinks from safe water source	0.0762	0.0056	-0.0182
	(0.1657)	(0.1275)	(0.1166)
Mother's age in years	0.0250**	0.0172*	0.0020
	(0.0123)	(0.0090)	(0.0073)
Women's access to credit	0.3723*	-0.0402	-0.1693
	(0.2025)	(0.1465)	(0.1364)
Access to credit × boy	0.0757	0.0877	0.1287
	(0.4060)	(0.2916)	(0.2749)
Household size	-0.0960**	-0.0415	0.0263
	(0.0430)	(0.0302)	(0.0271)
Mother is literate	0.7588***	0.1836	-0.3618***
	(0.1632)	(0.1235)	(0.1123)
No. of meals eaten by child per day	-0.0394	0.0151	-0.0200
	(0.0671)	(0.0503)	(0.0474)
Age dummy (=1 if child is 0–2 years)	0.2909	-0.3522	-0.1899
	(0.3305)	(0.2595)	(0.2308)
Constant	-0.1474	-0.2106	0.1522
	(0.6890)	(0.5482)	(0.4893)
Observations	841	871	805
F-statistic	6.12	1.95	2.09
Prob.	0.0000	0.0306	0.0186
R-squared	0.0676	0.0211	0.0254

Robust standard errors are in parentheses. *** significant at 1%, ** 5% and *10%.

5. Policy recommendations and conclusion

This study provides empirical evidence on the link between women's empowerment through access to agricultural land and credit, their energy calorie intake and anthropometry scores of their children. Our findings show no relationship between women who have access to land or credit and their energy calorie intake. Nevertheless, the impact of women's land holding on their calorie intake is strongly observed when access to land is interacted with agricultural inputs such as herbicides, soil quality, seed type, and secure land rights. Land holding by women is necessary, but insufficient to improve their nutritional calorie intake. This finding reiterates the argument in the literature that women's access to land must be complemented by access to key agricultural inputs in order to fully harness the benefits of land holding.

Another inference from the findings is that, as women are discriminated against in the allocation of land whether as a result of communal practices or poor implementation of existing legal rights favouring them, it is important that women have access to secure land. This would ensure optimal investment in the quality of soil and, consequently, its productivity which would increase their calorie intake. This can be achieved through legislation favouring joint spousal land ownership. Governments at all tiers should enforce strict compliance with this law, as well as existing laws.

We found that dietary diversity plays an important role in increasing the calorie intake of women. Policy interventions through food programmes aimed at women should incorporate diversity in diets in order to ensure that women at reproductive age get an adequate calorie intake.

Women's access to land and credit positively impacts their children's short and long-term nutritional measures. However, credit availability as a form of empowerment has less nutritional impact on children relative to women's access to land. Hence, quick wins can be achieved if nutrition-based intervention programmes focus more on increasing women's access to agricultural land. Women's empowerment has a differential impact on boys' and girls' anthropometry, in favour of the latter. The implication is that, as women's empowerment is likely to have more impact on girls' HAZ and WAZ scores, improving girls' nutrition can be considered low-hanging fruit in intervention programmes. Our findings also suggest that as a woman advances in age, the child's anthropometry scores improve. We interpret this to mean that older women have a greater ability to provide the required childcare resources necessary for child development.

Notes

1. http://www.fao.org/gender-landrights-database

2. See SOFA Team and Doss (2011) on "The Role of Women in Agriculture". ESA Working Paper No. 11-02.

3. Development Initiatives (2017).

4. Smith et al. (2003) adopted an age range of 0–3 years.

5. Significant agricultural activities take place in rural areas.

6. AWARD was established in 2008 to promote gender-responsive agricultural research and development, and to correct the observed gender gap in agricultural productivity (AWARD, 2018).

7. The MDD-W measures the number of food groups consumed by women of reproductive age (15–49) based on a 24-hour recall. Based on FAO and FANTA (2014), the minimum food requirement is set at consumption of five out of ten food groups. It is a continuous variable in our model from 0 to 10.

8. We adjusted for the effect of price changes on energy calories consumed by women. The state-level food consumer price index was used. This captured both urban and rural food prices.

9. The World Health Organization's upper and lower bounds for z-scores were used in this study. These bounds ensure that extreme or potentially incorrect z-score values are flagged and identified.

10. The first-stage regression is presented in Table A1 in the Annex.

11. The analysis of the children's estimation is restricted to the most recent cross-sectional data (2015/2016) due to a significant reduction in sample size when tracking children of 0–59 months across the three ISA-LSMS waves.

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Annex

Table A1: First-stage regression analysis of women's calorie intake and access to land (empowerment)

Variable	IV fixed effect
Dependent variable: Access to land	**Coefficient**
Household head is female	-0.0263***
	(0.0120)
Household size	-0.0036
	(0.0027)
Age of women (years)	-0.0004
	(0.0009)
Woman is literate	0.0105
	(0.0078)
Fsec1	-0.0017
	(0.0024)
Fsec2	0.0018
	(0.0037)
Fsec3	0.0079**
	(0.0036)
Fsec4	-0.0121*
	(0.0067)
Rented for cash	-0.0015
	(0.0200)
Free of charge	-0.0103
	(0.0122)
Distributed by community	-0.0065
	(0.0097)
Married (polygamous)	0.0071
	(0.0104)
Div/Sep/Wid.	0.7416***
	(0.0552)
Never married	0.0040
	(0.0361)

continued next page

Table A1 Continued

Variable	IV fixed effect
Dependent variable: Access to land	**Coefficient**
Log plot size	0.0018
	(0.0033)
Log CPI	-0.0828***
	(0.0257)
MDD-W	0.00001***
	(0.0026)
Age gap	-0.0012
	(0.0008)
Proportion of male children	-0.0082
	(0.0287)
Observations	3616
F-statistic	30
Prob>F	0.0000
R-square	0.3799

Robust standard errors are in parentheses. *** significant at 1%, ** 5% and *10%.

Table A2: Women's calorie intake and access to land (interacted with soil quality, seed type and land securitization), 2015/2016

Variables	Ordinary least squares		
Dependent variable: log women calorie availability	**Coefficient**	**Coefficient**	**Coefficient**
Access to land	-0.3006	-0.2632	-0.1943
	(0.4500)	(0.2826)	(0.2693)
Soil quality	0.0485*		
	(0.0266)		
Seed type		0.0642**	
		(0.0305)	
Land securitization			0.1293***
			(0.0345)
Access to land × soil quality	0.0994**		
	(0.0401)		
Access to land × seed type		0.1246***	
		(0.0159)	
Access to land × land securitization			0.3464**
			(0.1415)
Household head is female	0.0950***	0.0901***	0.0997***
	(0.0335)	(0.0347)	(0.0342)

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Table A2 Continued

Variables	Ordinary least squares		
Dependent variable: log women calorie availability	**Coefficient**	**Coefficient**	**Coefficient**
Household size	-0.0486***	-0.0480***	-0.0468***
	(0.0040)	(0.0040)	(0.0043)
Age of women (years)	-0.0022*	-0.0022*	-0.0019
	(0.0013)	(0.0013)	(0.0014)
Woman is literate	-0.0457	-0.0414	0.0202
	(0.0207)	(0.0210)	(0.0224)
Fsec1	-0.0022	-0.0038	0.0019
	(0.0073)	(0.0074)	(0.0074)
Fsec2	-0.0304***	-0.0290**	-0.0240**
	(0.0115)	(0.0116)	(0.0117)
Fsec3	-0.0400***	-0.0366***	-0.0436***
	(0.0110)	(0.0112)	(0.0107)
Fsec4	-0.0347*	-0.0343*	-0.0382*
	(0.0199)	(0.0203)	(0.0208)
Rented for cash	-0.0508	-0.0915	-0.1238
	(0.0551)	(0.0573)	(0.1025)
Free of charge	-0.0003	0.0004***	-0.2371*
	(0.0358)	(0.0381)	(0.1355)
Distributed by community	0.0607	0.0552	0.0790*
	(0.0417)	(0.0416)	(0.0421)
Married (polygamous)	0.0723***	0.0724***	0.0820***
	(0.0251)	(0.0254)	(0.0266)
Div/Sep/Wid.	0.2462***	0.2261***	0.2040**
	(0.0854)	(0.0832)	(0.0925)
Never married	0.7857***	0.7841***	0.4789*
	(0.1969)	(0.2027)	(0.2777)
Log plot size	0.0434***	0.0471***	0.0538***
	(0.0084)	(0.0083)	(0.0087)
Log CPI	-0.5673	-0.6192	-0.4476
	(0.3629)	(0.3815)	(0.4060)
MDD-W	0.0535***	0.0558***	0.0551***
	(0.0072)	(0.0073)	(0.0076)
Observations	1,740	1,688	1,506
F-statistic	17.97	16.90	16.91
Prob>F	0.0000	0.0000	0.0000
R-squared	0.1718	0.1703	0.1738

Robust standard errors are in parentheses. *** significant at 1%, ** 5% and *10%.

Table A3: Description of variables

Variable	Description	Source
Women's calorie availability	Calories consumed by woman in 24-hour recall period. Calculated by dividing aggregate calories consumed by household size and 7 days	ISA-LSMS, FAO
MDD-W	MDD-W; 1 to 10, based on FAO grouping of food categories into 10	ISA-LSMS, FAO
Age of woman in years	Continuous variable, from 15–49 years	ISA-LSMS
Woman is literate	1 if woman is literate, 0 otherwise	ISA-LSMS
Household head is male	0 if household head is female, 1 otherwise	ISA-LSMS
Urban	1 if woman lives in urban area, 0 if rural	ISA-LSMS
Marital status	Married (monogamous), married (polygamous), divorced, separated, and widowed, never married	ISA-LSMS
Access to land	1 if female owns or manages land, 0 otherwise	ISA-LSMS
Credit	1 if household took agricultural loan, 0 otherwise	ISA-LSMS
Income use	1 if woman decides on use of her earnings, 0 otherwise	ISA-LSMS
Household size	Continuous variable counting number of individuals in household	ISA-LSMS
Plot size	Measured in square metres using Global Positioning System	ISA-LSMS
Agricultural technology	1 if technology is used on farm, 0 otherwise	ISA-LSMS
Herbicide	1 if herbicide is applied on farm, 0 otherwise	ISA-LSMS
Land registration	1 if land has title or is registered, 0 otherwise	ISA-LSMS
Soil quality	1 if soil is good, 0 if soil is fair. Sandy, clay, mixture of sand and clay are categorized as fair. Loamy and rich clayey loamy soil categorized as good	ISA-LSMS
Seed type	1 if seed is hybrid/improved, 0 if seed is local/ traditional	ISA-LSMS
Consumer price index	State-level urban and rural food consumer price index	NBS
Land ownership	Outright purchase, rented for cash or in-kind, used free of charge, distributed by community/family or inheritance	ISA-LSMS
Food security 1	Days household relied on less preferred food	ISA-LSMS
Food security 2	Days household reduced number of meals	ISA-LSMS
Food security 3	Days household limited portion sizes during meals	ISA-LSMS
Food security 4	Days the household had no food in the house	ISA-LSMS
Geopolitical zone	North East, North Central, North West, South East, South South, South West	ISA-LSMS
Spousal age gap	Age difference between male and female decision maker	ISA-LSMS
Proportion of male children	Number of male children expressed as share of total number of children	ISA-LSMS

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Table A3 Continued

Variable	Description	Source
HAZ	Height-for-age score for under-five children	ISA-LSMS, computed using WHO Anthro software
WAZ	Weight-for-age score for under-five children	ISA-LSMS, computed using WHO Anthro software
WHZ	Weight-for-height score for under-five children	ISA-LSMS, computed using WHO Anthro software
Child's age	Continuous variable ranging from 0–59 months	ISA-LSMS
Boy	1 if gender is male, 0 if female	ISA-LSMS
Child is unhealthy	1 if child is unhealthy, 0 otherwise. Unhealthy is defined as frequent visits to the hospital in the last four weeks	ISA-LSMS
Safe water	1 if child drinks from safe water source, 0 otherwise	ISA-LSMS
Meals eaten by child	Number of meals eaten by child in a day	ISA-LSMS
Age dummy	1 if child is 0–2 years, 0 if above 2	ISA-LSMS

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