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Labour-saving technologies mitigate the effect of women's agriculture time-use constraints on stunting in rural Uganda

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Abstract

Women's time allocation is a dimension of women's empowerment in agriculture, and is recognised as a pathway through which agriculture can affect child nutritional status in developing countries. Longer hours of farm work can potentially increase women's time constraints, reducing the time allocated to child-caring responsibilities and raising the risk of poor child nutritional status. Using a three-wave household panel dataset from the Feed the Future Innovation Lab on Nutrition surveys in the north and southwest of Uganda, we tested the hypothesis that the negative effect of women's agriculture time-use constraints on child stunting is mitigated for households that use labour or time-saving agricultural technologies (LSATs). The results show a positive and significant association between the number of hours per day that women spend on agricultural work and the risk of stunting in children aged zero to 23 months who live in households that do not use animal traction for ploughing. However, this association is statistically insignificant, and even turns negative for households that adopted the labour-saving technology. Our findings indicate that LSATs have the potential to lessen a household's agricultural workload, giving mothers more child-caring time, and hence improving child nutritional status. Therefore, agriculture could have better nutritional outcomes if policies and programmes were designed to have interventions that reduce the workload in farming activities and thus reduce pressure on women's time.

Key words: labour-saving agricultural technologies, stunting, women's time spent on agriculture, Uganda

1. Introduction

Child undernutrition is still a major public health problem in sub-Saharan Africa (SSA). The number of children under the age of five affected by stunting (low height for age) rose in the Africa region between 2000 and 2019, with two out of every five children being stunted (UNICEF *et al*. 2020).

Stunting shows impaired growth and development resulting from a long period of poor nutrition of the child. It contributes considerably to child morbidity and deaths in sub-Saharan Africa (Black *et al*. 2013), and other consequences later in life, such as low cognitive ability, poor work productivity and low income-earning ability (Ricci *et al*. 2006; Bhutta 2013). These consequences also have a negative effect on the economic growth of a nation, and are a cause for concern. Putting an end to child malnutrition is also crucial to achieving the sustainable development goals of reducing under-five mortality and improving the well-being of children.

The agriculture sector is suitably an important driver of nutritional improvements for rural women and children in low-income countries because it provides not only food, but also employment, for the majority of women (FAO 2011; Ruel *et al*. 2013; Grassi *et al*. 2015). Female employment boosts household income and enables welfare-improving expenditure on food and healthcare (Hoddinott & Haddad 1995; Smith *et al*. 2003; Quisumbing & Pandolfelli 2010). However, agricultural work in low-income countries is labour intensive and increases pressure on women's time because they have to carry out household chores and are traditionally the primary caregivers of infants and young children (Grassi *et al*. 2015; Rost *et al*. 2015). The nutritional status of young children may be affected negatively by large agricultural workloads that reduce women's time allocated to child-caring responsibilities such as feeding, preparing food and seeking health care (Ruel *et al*. 2013; Kadiyala *et al*. 2014).

In some African countries, like South Africa, Tanzania, Uganda and Malawi, women not only provide the bulk of labour needed (Palacios-Lopez *et al*. 2017; Haug *et al*. 2021), but also use mainly labour-intensive tools to accomplish tasks such as planting, weeding and harvesting. Agricultural technologies and practices that support these tasks provide an avenue for saving rural women's time (FAO 2019). The time savings that arise would have nutritional benefits if women could use them to improve their health and the care of their children. The link between labour or time-saving agricultural technologies (LSATs) and nutritional outcomes in low-income countries has not been studied widely. In some limited studies, the practice of conservation agriculture, which makes use of zero or minimum tillage and cover crops, and the practice of using herbicides and mulches to control weeds, were shown to reduce women's labour demand and time spent on farming activities in sub-Saharan Africa (Kaumbutho & Kienzle 2007; Giller *et al*. 2009; Mayer 2015; Farnworth *et al*. 2016). Other labour-/time-saving agricultural tools, equipment and practices that save rural women's time include long-hand hoes, knapsack sprayers, animal traction for planting and weeding, integrated pest management, shellers, threshers and the use of wheelbarrows for transporting crops (Grassi *et al*. 2015). However, there is a dearth of research on the welfare effects of these LSAT practices.

The literature linking women's agriculture time-use constraints to child nutritional outcomes is limited. Previous studies largely compared women's work on the farm with work in other occupations, or simply considered women's work away from home and how it affected children's nutrition, rarely providing insight into whether farm work increases pressure on women's time, and its subsequent effect on child nutritional status. For example, a study that analysed demographic and health survey (DHS) data from Uganda showed that children under five whose mothers were engaged in agricultural work had higher odds of stunting relative to those whose mothers were engaged in non-agricultural professional work (Nankinga *et al*. 2019). Similarly, a study done in rural western Tanzania found that women working on farms experienced a time constraint that increased the risk of stunting of children under five (Nordang *et al*. 2015). Another study from Tanzania found that children aged six to 23 months in the care of women who worked on farms were less likely to achieve the recommended minimum meal frequency, mainly due to neglect, as the women were under pressure to accomplish the day's tasks (Manzione *et al*. 2019). In India, Bamji and Thimayamma (2000) found no statistically significant association between rural women's economic activity and the nutritional status of pre-school children. Ngenzebuke and Akachi (2017) found a positive and statistically significant association between women's on-farm work and child weight-for-age Z-scores in Nigeria.

Time-use data have only been used in a small number of studies. In rural Tanzania, Debela *et al*. (2019) differentiated between maternal on-farm and off-farm work but found no statistically significant association between mothers' time allocated to work on a farm and children's height-for-age Z-scores. Another time-use study, by Komatsu *et al*. (2018), showed that women's time spent on agricultural work increased the likelihood of attaining a minimum acceptable diet for children aged six to 23 months in Mozambique. The above evidence is inconclusive of whether women's work on farms heightens the time constraint and whether this affects their child-caring responsibilities. This study contributes to the literature on the relationship between rural women's time constraints and child nutrition in two ways. First, the study employs time-use data to analyse how many hours spent on agricultural work by women have a negative effect on child nutritional status. Second, as noted in Johnston *et al*. (2018), the relationship between the agriculture time-use burden and nutritional outcomes might be mediated. Thus, by considering the influence of LSATs, our study examines one potentially mediating factor in the relationship between women's agricultural time-use constraints and child nutritional status in rural Uganda.

2. Country policy context and conceptual framework

In Uganda, the government has promoted the adoption of various agricultural technologies to improve the household welfare of small-scale farmers. Agriculture technology adoption boosts farm production and productivity, which indirectly affects the nutrition of household members. The 1997 Plan for Modernisation of Agriculture (PMA) had the goal to transform Uganda's agriculture sector from predominantly subsistence to commercial farming (Bahiigwa *et al*. 2005). The PMA was operationalised by the National Agricultural Advisory Services programme, which provided agricultural information and procured and distributed a range of agricultural inputs (such as improved seeds, improved livestock breeds, pesticides and inorganic fertilisers) to rural farmers. Thus, a key objective of the PMA was to improve the adoption of agricultural technology among smallholder farmers in Uganda. Similarly, to improve production and productivity, the Agriculture Sector Strategic Plan for 2015 to 2020, which was the implementing instrument for the African Union's Comprehensive Africa Agriculture Development Programme and for the agriculture sector objectives of the National Development Plan, prioritised the dissemination and adoption of agricultural technology, including LSATs for women farmers (National Planning Authority [NPA] 2015). Among the tools and implements that had already been developed in Uganda with the objective of saving smallholders time in farming activities include the rice seeder, rice weeder, animal-drawn plough, hand-held maize sheller, and forage chopper (Wanyama *et al*. 2016).

The UNICEF conceptual framework for malnutrition identifies childcare activities as an underlying influencer of children's nutritional status in a household (UNICEF 1991). We used the agri-nutrition pathway that links women's employment in agriculture to child nutritional outcomes, as presented in Kadiyala *et al*. (2014). Women's engagement in agriculture, with subsistence-diversified food production and/or cash cropping, has a positive influence on food availability and the dietary diversity of a household. In addition, income from cash cropping may be used to improve household healthcare expenditure. Consequently, child nutritional status would improve due to a better nutritional intake (after six months of exclusive breastfeeding) and access to health care. On the other hand, women's engagement in agriculture may have positive or negative effects on child nutritional status via time spent on childcare.

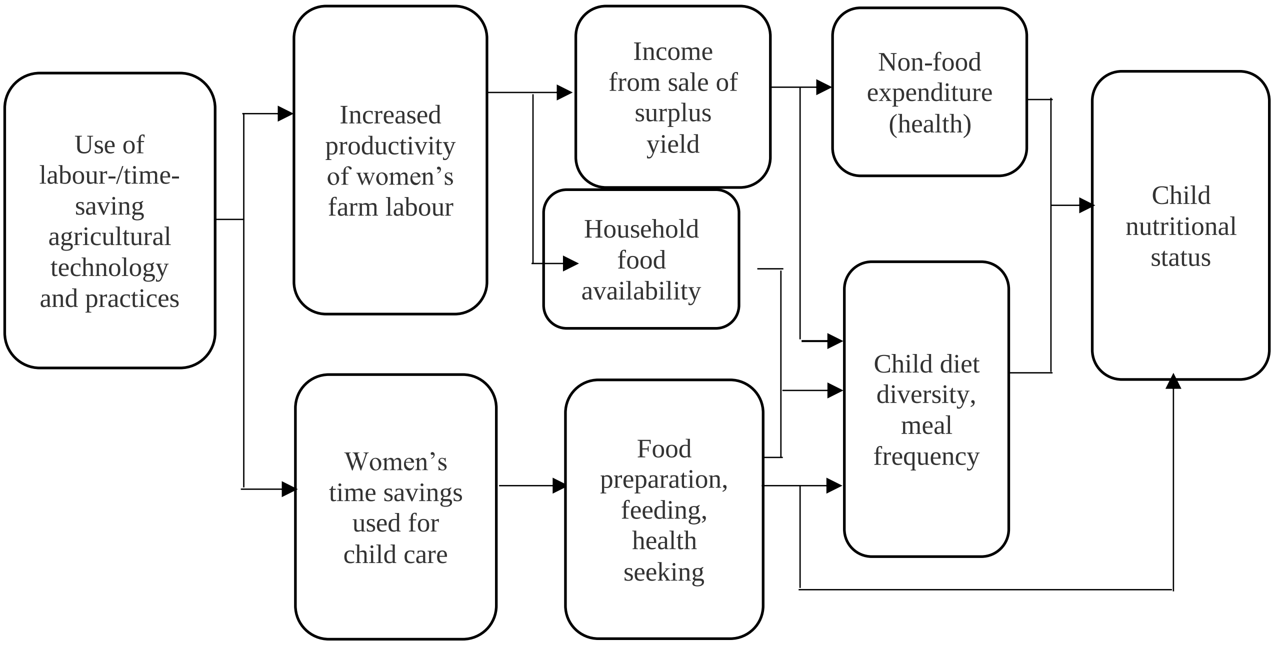

Figure 1: Hypothesised relationship between LSATs, women's agriculture time use and child nutritional status
Adapted from Kadiyala *et al*. (2014) and Johnston *et al*. (2018)

Our hypothesis was built on the premise that, in the absence of substitute care in a household, agricultural workloads that put pressure on a woman's time reduce childcare time and imply inadequate feeding or food preparation for children, along with limited health seeking. Previous empirical work has shown that time constraints arising from heavy work burdens for mothers have negative implications for the quality of care of infants (Coreil 1991; Engle 1991). This finding suggests that interventions designed to reduce work burdens would increase women's child caregiving time and have a positive effect on child nutritional status. Studies also suggest that the presence of substitute caregivers at home in the form of older siblings, other adults or extended family may alter the potential negative effect of maternal engagement in time-consuming work outside the home on time available for child care (Montagne *et al*. 1998; Kadiyala *et al*. 2014; Johnston *et al*. 2018).

The conceptual framework is based on the hypothesis that the negative effect of women's agriculture time-use constraints on child stunting is mitigated for households that use LSATs.

3. Methodology

3.1 Data source and area of study

The secondary data used in this study was obtained from farm-household panel surveys conducted by Feed the Future Innovation Lab for Nutrition in southwestern and northern Uganda. The surveys were carried out to evaluate the Community Connector Project (UCCP), a USAID-funded initiative in Uganda that aimed to improve the livelihoods, health and nutrition of rural agricultural households (FHI 360 2015). The project, which was a partnership between the government and USAID, supported the implementation of the Agricultural Sector Development Strategy and Investment Plan for 2010 to 2015 and implemented a range of agriculture and health interventions in 15 districts in southwestern and northern Uganda. Examples of intermediate outcomes resulting from the interventions were homestead vegetable gardens; water, sanitation and hygiene facilities in the home;

and household acquisition of production tools such as spray pumps, ploughs and wheelbarrows. Surveys were conducted in six districts in three panel rounds in 2012, 2014 and 2016, interviewing 3 597, 3 302 and 3 196 farm households respectively. Data was collected from the districts of Agago, Dokolo, Kole and Lira in northern Uganda, and from Kamwenge and Kisoro districts in the southwest. The main respondent in these surveys was a caregiver/mother or a woman of reproductive age (18 to 49 years).

Our analysis used a panel sample of 2 763 households with an index child in the age group of zero to 23 months. The dataset contained information on gendered time use in a 24-hour recall period, showing the hours spent on agricultural work, non-agricultural work, household work of caring for children or the sick or the elderly, and leisure/personal time. The surveys also gathered information on the anthropometric measurements of children under the age of five, the health status of children under the age of five, infant and young child feeding practices, children's dietary intake, household size and composition, and the characteristics of the child's primary caregiver, such as educational attainment, dietary intake, antenatal care visits, source of nutrition information and adoption of agricultural technologies and practices.

3.2 Description of variables

The outcome variable of this study was stunting of children aged zero to 23 months. Stunting was estimated using the height-for-age classification of World Health Organization ([WHO] 2006), according to which children with Z-scores two or more standard deviations below the median height of the WHO reference population are categorised as stunted. Stunting, which is an indicator of child nutritional status, shows impaired growth and development resulting from a long period of poor nutrition of the child.

Women's time devoted to farm work and a household's use of LSATs, which is also our policy variable, served as the study's main independent variables. From the time-use module of the survey we determined the number of hours, whether paid or unpaid, spent by a representative woman of the household on agricultural work within 24 hours prior to the survey. Given that women often perform the majority of farm work in subsistence-oriented households in many African countries (Palacios-Lopez *et al*. 2017; Haug *et al*. 2021), women's use of LSATs was proxied by a household's use of animal traction for ploughing. The inclusion of other covariates, such as child, maternal/caregiver and household-level characteristics, was further informed by the UNICEF conceptual framework of malnutrition (UNICEF 1991). Child's sex, birth weight, diet, breastfeeding status at the time of the survey, mother's education, mother's diet, antenatal care, household size, household wealth group and household access to clean water[1] were among the specific variables considered in the study.

[1] The study used a binary variable of whether or not the minimum diet diversity (MDD) of a child was achieved. MDD considers at least four food groups out of seven consumed in a 24-hour recall period (WHO 2008). The seven food groups considered were grains/roots/tubers/plantain; legumes/nuts; dairy products; flesh foods, eggs, vitamin A-rich fruits and vegetables, and other fruits and vegetables. Another binary variable, indicating whether a mother/caregiver met the minimum dietary diversity for women (MDD-W), was constructed following the FAO and FHI 360 (2016). A mother was considered to have met the MDD-W if at least five out of ten food groups was reported to have been consumed in the 24 hours preceding the survey. The ten food groups included pulses (beans, peas, lentils); dark green leafy vegetables; other vitamin A-rich fruit and vegetables; nuts and seeds; dairy (milk and milk products); eggs; other fruit; other vegetables; meat, poultry and fish; and grains, roots, tubers and plantain (starchy staples). To assess the economic status of a household, three wealth quantiles were constructed from an asset index. This asset index was estimated using principal component analysis from data on agricultural and durable assets owned by the household. The assets included in this analysis were land, cattle, cash crops, sheep/goats, radio, phone, bicycle and motorcycle. A household was considered to have access to a clean water source if the water used was from a public tap, protected well/spring, borehole, piped water or was bottled water.

3.3 Analytical model

The aim of this study was to determine whether increasing women's time in agriculture negatively affected child nutritional status and whether the use of LSATs had a mitigating effect in this relationship. We estimated a random effects probit model (Greene 2007), taking into account the unbalanced panel nature of the data, using Equation (1).

$$P(Y_{it} = 1) = F(\alpha_1 WTA_{it} + \alpha_2 X_{it} + \mu_i + \varepsilon_{it}), \quad (1)$$

where Y_{it} represents the binary outcome variable – stunting status of a child, i.e. $Y_{it} = 1$ for a stunted child *i* at time *t*, and 0 otherwise; F shows the cumulative distribution of a standard normal distribution function; WTA_{it} is the measure of women's time spent working in agriculture in 24 hours; X_{it} is a vector of control variables including child, maternal and household socioeconomic characteristics of household *i* at time *t*; μ_i represents the random effect assumed to be uncorrelated with the independent variables; and ε_{it} is an error term. The parameter, α_1, is the focus of the study.

In order to test for robustness, a three-level categorical variable was created from the WTA variable for zero hours, one to six hours, and more than six (> 6) hours of agricultural work. We would expect a negative impact of hours of agricultural work longer than six hours on a child's nutritional status. To analyse the policy variable, we controlled for the use of LSATs by estimating Equation (1) for two subsamples comprising mothers in households that used animal traction for ploughing, and those from households that did not. Moreover, to substantiate our proposition in the conceptual framework, we analysed the relationship between time spent by women in household caregiving and child nutritional status. To this end, Equation (1) was modified in a separate regression to have women's hours in household caregiving as the variable of interest.

4. Results and discussion

4.1 Descriptive analysis

Table 1 shows that 24% of the households had stunted children in the age group of zero to 23 months. Given the current national average of 28.9% prevalence of stunting among children under five years of age, such a high proportion of stunted children in the age group of zero to 23 months solely demonstrates an existing undernutrition problem in the study area. This could be partially due to the limited time the mothers have for child care, as they spent an average of only six hours in caregiving work (taking care of children, the sick or the elderly). On the other hand, about 40% of the mothers spent one to six hours on agricultural work, while 18% spent more than six hours. The proportion of women who spent time on agricultural work declined over the survey years, while there was an increase in the proportion of women with zero hours in farm work. The proportion of households using an LSAT (animal traction for ploughing) increased from 35% in 2012 to 42% in 2016.

Table 1: Characteristics of children, women and households in the sample

	Pooled		2012	2014	2016
	N	**Mean**	**Mean**	**Mean**	**Mean**
Outcome variable:					
Stunting (0 to 23 months old) (1 = yes, 0 = no)	2 763	0.24 (0.43)	0.24 (0.43)	0.22 (0.42)	0.25 (0.43)
Explanatory variables:					
Mother's agricultural time in 24 hours					
0 hours (yes = 1, 0 = no)	2 763	0.42 (0.49)	0.38 (0.49)	0.39 (0.49)	0.54 (0.50)
1 to 6 hours (yes=1, 0 = no)	2 763	0.39 (0.49)	0.43 (0.50)	0.40 (0.49)	0.32 (0.47)
> 6 hours (yes=1, 0 = no)	2 763	0.18 (0.39)	0.19 (0.39)	0.21 (0.41)	0.14 (0.35)
Mother's caregiving time in 24 hours	2 763	5.69 (3.52)	5.77 (3.40)	5.35 (3.62)	5.90 (3.62)
Mother completed primary education (1 = yes, 0 = no)	2 763	0.22 (0.41)	0.24 (0.43)	0.18 (0.39)	0.22 (0.41)
Household used animal traction for ploughing (1 = yes, 0 = no)	2 763	0.37 (0.48)	0.35 (0.48)	0.36 (0.48)	0.42 (0.49)
Mother reported at least four antenatal care visits (1 = yes, 0 = no)	2 763	0.61 (0.49)	0.56 (0.50)	0.67 (0.47)	0.67 (0.47)
Mother had minimum dietary diversity (1 = yes, 0 = no)	2 763	0.12 (0.33)	0.16 (0.37)	0.09 (0.28)	0.08 (0.28)
Male child (1 = yes, 0 = no)	2 763	0.51 (0.50)	0.50 (0.50)	0.54 (0.50)	0.49 (0.50)
Child's weight at birth ≥ 2.5 kg (1 = yes, 0 = no)	2 763	0.95 (0.22)	0.96 (0.20)	0.95 (0.21)	0.94 (0.23)
Child was breastfeeding (1 = yes, 0 = no)	2 763	0.88 (0.33)	0.87 (0.33)	0.89 (0.32)	0.88 (0.33)
Acceptable minimum diet after five months old (1 = yes, 0 = no)	2 763	0.14 (0.34)	0.17 (0.38)	0.10 (0.30)	0.11 (0.32)
Initiation of complementary feeding after five months old (1 = yes, 0 = no)	2 763	0.97 (0.17)	0.96 (0.20)	0.98 (0.15)	0.98 (0.15)
Household size > 7 members (1 = yes, 0 = no)	2 763	0.35 (0 .48)	0.27 (0.44)	0.39 (0 .49)	0.48 (0.50)
Household wealth tercile: Low (1 = yes, 0 = no)	2 763	0.34 (0.47)	0.34 (0.47)	0.35 (0.48)	0.33 (0.47)
Middle (1 = yes, 0 = no)	2 763	0.33 (0.47)	0.32 (0.47)	0.33 (0.47)	0.35 (0.48)
High (1 = yes, 0 = no)	2 763	0.33 (0.47)	0.34 (0.47)	0.32 (0.47)	0.32 (0.47)
Household accessed a clean water source (1 = yes, 0 = no)	2 763	0.64 (0.48)	0.63 (0.48)	0.65 (0 .48)	0.65 (0.48)

Note: Calculated based on Feed the Future Nutrition Innovation Lab panel data of 2012, 2014 and 2016. Standard deviations are in parentheses.

The difference in means analysis presented in Table 2 shows t-statistics of associations between women's agricultural time use and stunting outcomes. The result suggests a higher mean of stunted children when women spend more than six hours in farm work than when they spend one to six hours. The analysis further shows a lower mean of stunted children living in households that adopted an LSAT, viz. animal traction for ploughing, compared with households that did not use this technology. Specifically, when women spent one to six hours on agricultural work, 26% of LSAT non-adopting households had stunted children, compared with 17% in adopting households. On the other hand, when women spent more than six hours in farm work, 34% of LSAT non-adopting households had stunted children, compared with 18% in adopting households.

Table 2: Agriculture time use, adoption of LSATs and stunting outcome – difference in means

	Stunting (mean)	Pearson chi^2
Agricultural time (0 hours)		
Yes (n = 1 168)	0.222	2.872*
No (n = 1 595)	0.250	
Agricultural time		
1 to 6 hours (n = 1 091)	0.225	11.491***
> 6 hours (n = 504)	0.304	
Household used animal traction for ploughing		
Yes (n = 526)	0.175	23.339***
No (n = 1 069)	0.286	
Agricultural time (1 to 6 hours)		
Household used animal traction for ploughing (n = 408)	0.174	9.562***
Household did not use animal traction for ploughing (n = 683)	0.255	
Agricultural time (> 6 hours)		
Household used animal traction for ploughing (n = 118)	0.178	11.498***
Household did not use animal traction for ploughing (n = 386)	0.342	

Note: * and *** denote statistical significance at the 10% and 1% levels respectively.

4.2 Econometric results

We now present and discuss the results of the regression model clarified in Equation (1), with the stunting status of children aged zero to 23 months as the outcome variable and a mother/caregiver's hours devoted to agricultural work as the main independent variable. We also present an analysis of the association between women's time spent on agricultural work and the risk of stunting with and without the use of LSATs and practices. Table 3 is divided into sub-table 1, which presents the results of the analyses without the inclusion of control variables, and sub-table 2, which considers the control variables (with full results provided in Table A1 in the Appendix). Both sub-table 1 and sub-table 2 show a strong, statistically significant and positive association between the number of hours women spend on agricultural work and the risk of stunting in children aged zero to 23 months (Model 1). Specifically, the risk of stunting sets in when mothers spend more than six hours on agricultural work (Model 2). Given that rural women in Africa are socio-culturally required to provide labour on their family farms and do household chores, which include attending to child care (feeding, food preparation and health seeking), they have less time to complete household chores or less than six hours of caregiving to their children before sunset when they spend more than six hours on agricultural work. This has a negative effect on the children's nutritional status. A study by Feed the Future (2018) suggests that rural women in Africa can spend the entire morning or even day on the farm during the rainy season. In the absence of substitute care, this would leave young children unattended. Our finding is thus not unexpected and is consistent with that of Nordang *et al*. (2015), who found that women working on farms in rural western Tanzania faced a time constraint that increased the risk of stunting of children under the age of five. Furthermore, as illustrated in the conceptual framework, the finding of a negative and statistically significant association between women's hours of caregiving and the risk of stunting was expected (Model 3).

Table 3: Marginal effects of women's time spent on agriculture on stunting

Variables	Stunting		
	Model 1	Model 2	Model 3
Sub-table 1			
Hours of agricultural work	0.0082***(0.0024)		
Agricultural work (1 to 6 hours) (yes = 1)[a]		0.0049 (0.0175)	
Agricultural work (> 6 hours) (yes = 1)[a]		0.0727*** (0.0236)	
Hours of household caregiving			-0.0049** (0.0023)
Controls	No	No	No
Number of observations	2 763	2 763	2 763
Number of distinct children	2 034	2 034	2 034
Sub-table 2			
Hours of agricultural work	0.0068*** (0.0022)		
Agricultural work (1 to 6 hours) (yes = 1)[a]		0.0151 (0.0171)	
Agricultural work (> 6 hours) (yes = 1)[a]		0.0556** (0.0223)	
Hours of household caregiving			-0.0050** (0.0022)
Controls	Yes	Yes	Yes
Number of observations	2 763	2 763	2 763
Number of distinct children	2 034	2 034	2 034

Note: Marginal effects are from random effects probit models. Standard errors clustered at the household level are in parentheses. ** and *** denote statistical significance at the 5% and 1% levels respectively.
[a] The reference category is zero hours of agricultural work

Does the use of LSATs and practices mitigate the effect of women's agriculture time-use constraints on stunting?

The use of LSATs appears to lower the risk of stunting in children between the ages of zero and 23 months when we account for a household's usage of animal traction for ploughing in Model 5 (Table A1). The hypothesis that was being tested, though, was whether using LSATs would mitigate the effect of women's agriculture time-use constraints on stunting. Figure 2 displays the subsamples created and the analysis performed to compare the stunting outcomes in the LSAT-adopting and non-adopting households. The result shows a positive and statistically significant association between women's hours spent on agricultural work and stunting for households that did not use animal traction for ploughing. The risk of stunting sets in when women spend more than six hours on agricultural work and do not use LSATs. Conversely, a statistically insignificant association that turns negative is observed for households that used animal traction for ploughing. We interpret this finding to mean that the use of animal traction for ploughing reduced their workload and, consequently, women's hours spent doing farm work reduced. The time that was saved as a result was probably put to greater use in child care, which improved the nutritional status of children in these households. These findings, along with the descriptive analysis in Table 2, suggest that the effect of women's agriculture time-use constraints on child stunting is effectively mitigated by the use of labour- and time-saving agricultural technologies by farm households.

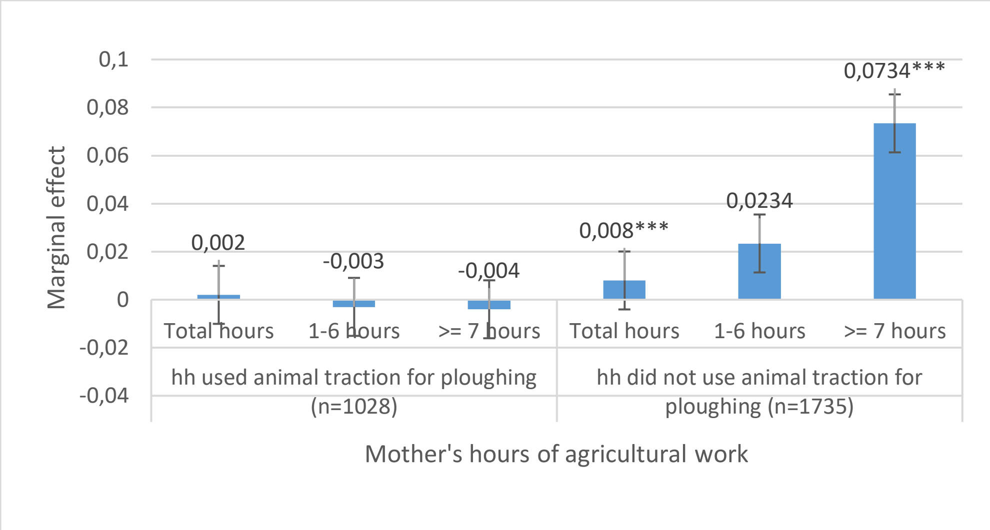

Figure 2: Marginal effect of women's agricultural time use on stunting with and without the use of LSATs

Key: Marginal effects are from a random effects probit model, with standard errors clustered at the household level. The reference category for one to six hours and ≥ 7 hours of mothers' time on agricultural work is zero hours of agricultural work. *** denotes significance at the 1% level.

5. Conclusion and policy implications

We tested the hypothesis that the negative effect of women's agriculture time-use constraints on child stunting is mitigated for households that use LSATs. We found a positive association between mothers' time spent on agricultural work and the risk of stunting in children aged zero to 23 months. However, the risk of stunting sets in specifically when mothers spend more than six hours on farm work, indicating an agriculture time-use constraint on child nutritional status. The relationship between mothers' time spent on agricultural work and the risk of stunting, however, became statistically insignificant and even negative when households adopted and used LSATs. In rural Africa, social and cultural norms that mandate women to perform the majority of agricultural work as well as household chores place pressure on women's time. The lesson for agricultural policies and programmes, therefore, is to have them designed with complementary interventions that reduce women's workload on the farm. This will reduce pressure on a mother's time and will allow her to engage more adequately in child-care activities, such as food preparation, feeding, hygiene and sanitation, as well as healthcare visits, which all influence child nutritional status. Accordingly, agriculture would have better nutritional outcomes for children. Future studies could investigate women's use of different LSATs with respect to specific farm activities (such as land preparation, planting, weeding and harvesting) to analyse the resulting time savings and whether they are used to improve child care among subsistence-oriented households in SSA. In addition, it is important to understand whether the available agriculture LSATs are gender adaptable. Women do the majority of farming activities (in addition to household chores) in many African countries, and therefore LSATs that favour men leave women with agriculture time-use constraints.

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References

Bahiigwa G, Rigby D & Woodhouse P, 2005. Right target, wrong mechanism? Agricultural modernization and poverty reduction in Uganda. World Development 33(3): 481–96.

Bamji MS & Thimayamma BVS, 2000. Impact of women's work on maternal and child nutrition. Ecology of Food and Nutrition 39(1): 13–31.

Bhutta ZA, 2013. Early nutrition and adult outcomes: Pieces of the puzzle. Lancet 382(9891): 486–7.

Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, De Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, Uauy R & the Maternal and Child Nutrition Study Group, 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 382(9890): 427–51.

Coreil J, 1991. Maternal time allocation in relation to kind and domain of primary health care. Medical Anthropology Quarterly 5(3): 221–35.

Debela BL, Gehrke E & Qaim M, 2019. Links between maternal employment and child nutrition in rural Tanzania. American Journal of Agricultural Economics 103(3): 812–30.

Engle PL, 1991. Maternal work and child-care strategies in peri-urban Guatemala: Nutritional effects. Child Development 62(5): 954–65.

Farnworth CR, Baudron F, Anderson JA & Misiko M, 2016. Gender and conservation agriculture in East and Southern Africa: Towards a research agenda. International Journal of Agricultural Sustainability 14(2): 142–65.

FAO, 2011. The role of women in agriculture. ESA Working Paper No. 11-02, Agricultural Development Economics Division, Food and Agricultural Organization of the United Nations, Rome, Italy. Available at https://www.fao.org/3/am307e/am307e00.pdf

FAO, 2019. Fostering the uptake of labour-saving technologies and practices. How to develop effective strategies to benefit rural women. Rome: Food and Agriculture Organization of the United Nations. Available at https://www.fao.org/3/CA2731EN/ca2731en.pdf

FAO & FHI 360, 2016. Minimum dietary diversity for women: A guide for measurement. Rome: FAO. Available at https://www.fao.org/3/i5486e/i5486e.pdf

Feed the Future, 2018. Women's empowerment in agriculture study: Feed the Future Senegal–Naatal Mbay. Available at https://pdf.usaid.gov/pdf_docs/PA00T8KB.pdf

FHI 360, 2015. Uganda Community Connector Project: Barriers and facilitators to the uptake of CC See 10 Elements. USAID Community Technical Notes Series No. 6. Available at https://www.fhi360.org/sites/default/files/media/documents/ucc-technical-notes-6.pdf

Giller KE, Witter E, Corbeels M & Tittonell P, 2009. Conservation agriculture and smallholder farming in Africa: The heretics' view. Field Crops Research 114(1): 23–34.

Grassi F, Landberg J & Huyer S, 2015. Running out of time: The reduction of women's work burden in agricultural production. Rome: Food and Agriculture Organization of the United Nations. Available at https://www.fao.org/3/a-i4741e.pdf

Greene HW, 2007. Econometric analysis. Sixth edition. Upper Saddle River NJ: Pearson Prentice Hall.

Haug R, Mwaseba DL, Njarui D, Moeletsi M, Magalasi M, Mutimura M, Hundessa F & Aamodt JT, 2021. Feminization of African agriculture and the meaning of decision-making for empowerment and sustainability. Sustainability 13(16): 8993.

Hoddinott J & Haddad L, 1995. Does female income share influence household expenditures? Evidence from the Cote d'Ivoire. Oxford Bulletin of Economics and Statistics 57(1): 77–96.

Johnston D, Stevano S, Malapit HJ, Hull E & Kadiyala S, 2018. Review: Time use as an explanation for the agri-nutrition disconnect: Evidence from rural areas in low and middle-income countries. Food Policy 76: 8–18.

Kadiyala S, Harris J, Headey D, Yosef S & Gillespie S, 2014. Agriculture and nutrition in India: Mapping evidence to pathways. Annals of the New York Academy of Sciences 1331(1): 43–56.

Kaumbutho P & Kienzle J, 2007. Conservation agriculture as practised in Kenya: Two case studies. Nairobi, Kenya: African Conservation Tillage Network; Paris: Centre de Cooperation Internationale de Recherche Agronomique pour le Développement; Rome: FAO. Available at https://www.act-africa.org/lib.php?com=5&com2=20&res_id=47

Komatsu H, Malapit HJL & Theis S, 2018. Does women's time in domestic work and agriculture affect women's and children's dietary diversity? Evidence from Bangladesh, Nepal, Cambodia, Ghana, and Mozambique. Food Policy 79: 256–70.

Manzione LC, Kriser H, Gamboa EG, Hanson CM, Mulokozi G, Mwaipape O, Hoj TH, Linehan M, Torrres S, Cougar Hall P, West JH & Crookston BT, 2019. Maternal employment status and minimum meal frequency in children 6-23 months in Tanzania. International Journal of Environmental Research and Public Health 16(7): 1137.

Mayer AM, 2015. Potential for nutrition-sensitive conservation agriculture in Zambia: Final report of a study on the potential of conservation agriculture to improve nutrition. Dublin: Concern Worldwide. Available at https://www.concern.net/knowledge-hub/potential-nutrition-sensitive-conservation-agriculture-zambia

Montagne JF, Engle PL & Zeitlin MF, 1998. Maternal employment, childcare and nutritional status of 12–18 month-old children in Managua, Nicaragua. Social Science and Medicine 46(3): 403–14.

Nankinga O, Kwagala B & Walakira EJ, 2019. Maternal employment and child nutritional status in Uganda. PLoS ONE 14(12): e0226720.

National Planning Authority (NPA), 2015. Second National Development Plan (NDPII) 2015/16–2019/20. Kampala, Uganda: NPA.

Ngenzebuke RL & Akachi Y, 2017. Female work status and child nutritional outcome in Nigeria. WIDER Working Paper No. 2017/196, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki.

Nordang S, Shoo T, Holmboe-Ottesen G, Kinabo J & Wandel M, 2015. Women's work in farming, child feeding practices and nutritional status among under-five children in rural Rukwa, Tanzania. British Journal of Nutrition 114(10): 1594–603.

Palacios-Lopez A, Christiaensen L & Kilic T, 2017. How much of the labor in African agriculture is provided by women? Food Policy 67: 52–63.

Quisumbing AR & Pandolfelli L, 2010. Promising approaches to address the needs of poor female farmers: Resources, constraints, and interventions. World Development 38(4): 581–92.

Ricci KA, Girosi F, Tarr PI, Lim Y-W, Mason C, Miller M, Hughes J, Von Seidlein L, Agosti JM & Guerrant RL, 2006. Reducing stunting among children: The potential contribution of diagnostics. Nature 444(Suppl. 1): 29–38.

Rost L, Bates K & Dellepiane L, 2015. Women's economic empowerment and care: Evidence for influencing. Baseline research report. Oxfam Research Reports. www.policy-practice-empowerment-and-care-evidence-for-influencing-578732/

Ruel MT, Alderman H & the Maternal and Child Nutrition Study Group, 2013. Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition? Lancet 382(9891): 536–51.

Smith LC, Ramakrishnan U, Ndiaye A, Haddad L & Martorell R, 2003. The importance of women's status for child nutrition in developing countries. IFPRI Research Report 131, International Food Policy Research Institute, Washington DC.

UNICEF, 1991. Strategy for improved nutrition of children and women in developing countries. The Indian Journal of Pediatrics 58(1): 13–24.

UNICEF, WHO & World Bank, 2020. Levels and trends in child malnutrition: Key findings of the 2020 edition of the joint malnutrition estimates. Geneva: World Health Organization.

Wanyama J, Banadda N, Kiyimba F, Okurut S, Zziwa A, Kabenge I, Mutumba C, Tumutegyereize P, Komakech AJ & Kiddundu N, 2016. Profiling agricultural engineering technologies for mechanizing smallholder agriculture in Uganda. CIGR Journal 18(4): 40–51.

World Health Organization (WHO), 2008. Indicators for assessing infant and young child feeding practices: Part I definition). Available at https://www.who.int/publications/i/item/9789241596664

Appendix

Table A1: Full results for findings on marginal effects of women's time spent on agriculture on stunting

Variable	Stunting				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Hours of agricultural work	0.0068*** (0.0022)			0.0057** (0.0025)	
Agricultural work (1 to 6 hours) (yes = 1)[a]		0.0151 (0.0171)			0.0117 (0.0171)
Agricultural work (> 6 hours) (yes = 1)[a]		0.0556** (0.0223)			0.0491** (0.0222)
Hours of caregiving			-0.0050** (0.0022)	-0.0031 (0.0024)	
Household used animal traction for ploughing (yes = 1)					-0.0478*** (0.0169)
Child's sex (male = 1)	-0.1683*** (0.0154)	-0.1678*** (0.0155)	-0.1691*** (0.0155)	-0.1690*** (0.0155)	-0.1679*** (0.0155)
Child's weight at birth (≥ 2.5 kg) (yes = 1)	-0.1540*** (0.0421)	-0.1521*** (0.0420)	-0.1531*** 0.0420	-0.1556*** (0.0421)	-0.1557*** (0.0422)
Child was breastfeeding (yes = 1)	-0.0532** (0.0258)	0.0535** (0.0259)	-0.0490* 0.0257	-0.0518** (0.0258)	-0.0497* (0.0257)
Acceptable minimum diet after five months old (1 = yes)	-0.0404* (0.0229)	-0.0408* 0.0229	-0.0398* 0.0230	-0.0407* (0.0229)	-0.0431* (0.0227)
Initiation of complementary feeding after five months old (yes = 1)	0.0829* (0.0459)	0.0827* 0.0459	0.0853* 0.0454	0.0826* (0.0459)	0.0795* (0.0465)
Mother had minimum dietary diversity (yes = 1)	-0.0723*** (0.0229)	-0.0728*** (0.0228)	-0.0734*** 0.0227	-0.0722*** (0.0228)	-0.0694*** (0.0229)
Mother completed primary education (yes = 1)	-0.0132 (0.0196)	-0.0137 (0.0196)	-0.0118 (0.0197)	-0.0128 (0.0196)	-0.0175 (0.0194)
Mother reported at least four antenatal care visits (yes = 1)	-0.0465*** (0.0160)	-0.0474*** (0.0160)	-0.0473*** (0.0160)	-0.0461*** (0.0160)	-0.0455*** (0.016)
Household size > 7 (yes = 1)	-0.0313* (0.0169)	-0.0319* (0.0169)	-0.0345** 0.0169	-0.0331* (0.0169)	-0.0321* (0.0168)
Household wealth index: Middle tercile (yes = 1)[b]	-0.0703*** (0.0200)	-0.0706*** (0.0200)	-0.0717*** 0.0200	-0.0698*** (0.0200)	-0.0619*** (0.020)
High tercile (yes = 1)[b]	-0.1002*** (0.0200)	-0.1002*** (0.0201)	-0.1022*** 0.0201	-0.0995*** (0.0200)	-0.0868*** (0.020)
Household had access to a clean water source (yes = 1)	-0.0414** (0.0171)	-0.0412** (0.0172)	-0.0423** (0.0172)	-0.0409** (0.0171)	-0.0360** (0.0172)
Number of observations	2 763	2 763	2 763	2 763	2 763
Number of distinct children	2 034	2 034	2 034	2 034	2 034

Note: Marginal effects are from a random effects probit model. Standard errors (in parentheses) are clustered at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively. [a] The reference category is 0 hours of agricultural work. [b] The reference category is the low-wealth tercile.