

Gender & Agriculture in Sub-Saharan Africa: Review of Constraints and Effective Interventions¹

by Niklas Buehren²

June 2023



¹ This document is part of a series of technical review papers for the World Bank's Africa Gender Innovation Lab. The author is grateful to the World Bank Umbrella Fund for Gender Equality for funding the research. The author thanks Amy Copley, Bénédicte de la Brière, Daniel Kirkwood, Markus Goldstein, Menaal Ebrahim and Patricia Paskov for valuable contributions.

² Africa Gender Innovation Lab/Gender Group, The World Bank (email: nbuehren@worldbank.org).

© 2023 International Bank for Reconstruction and Development / The World Bank
1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

This work is a product of the staff of The World Bank with external contributions. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of The World Bank, its Board of Executive Directors, or the governments they represent.

The World Bank does not guarantee the accuracy, completeness, or currency of the data included in this work and does not assume responsibility for any errors, omissions, or discrepancies in the information, or liability with respect to the use of or failure to use the information, methods, processes, or conclusions set forth. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Nothing herein shall constitute or be construed or considered to be a limitation upon or waiver of the privileges and immunities of The World Bank, all of which are specifically reserved.

Rights and Permissions The material in this work is subject to copyright. Because The World Bank encourages dissemination of its knowledge, this work may be reproduced, in whole or in part, for noncommercial purposes as long as full attribution to this work is given.

Any queries on rights and licenses, including subsidiary rights, should be addressed to World Bank Publications, The World Bank Group, 1818 H Street NW, Washington, DC 20433, USA; fax: 202-522-2625; e-mail: pubrights@worldbank.org.

Table of Contents

I. Introduction	4
II. Background.....	4
III. Conceptual Framework.....	9
Choice Space.....	9
Constraint Space	10
Contextual Factors	10
IV. Evidence Base on Constraints and Effective Programing	12
Assets and Inputs	12
Land	12
Machinery, Livestock and Inputs.....	15
Information and Skills.....	17
Networks	20
Time Availability	21
Risk	23
Market Orientation.....	23
V. Research Agenda	26
Assets and Inputs	27
Information, Skills, and Networks	27
Time Availability	29
Market Orientation.....	30
Targeting and Defining	30
VI. Concluding Remarks	31
References	32

I. Introduction

Raising agricultural productivity is essential to boosting gross domestic product (GDP), reducing poverty, improving food security, and achieving structural transformation across Africa. Yet, Africa's agricultural intensification has not kept pace with that of other developing regions. One significant and costly inefficiency undermining the region's progress is the pervasive gender gap in agricultural productivity. This gender gap represents not only a substantial impediment to growth in the agricultural sector but, moreover, a forgone opportunity to increase national income and reduce poverty at the regional level. To address the productivity gender gap and realize the potential of African agriculture, establishing a clear understanding of the gender-specific constraints hindering the productivity of women farmers is crucial.

This paper develops a conceptual framework for thinking about the gender gap in agricultural productivity, reviews evidence on the effectiveness of policies and interventions designed to address the constraints faced by women farmers and proposes a research agenda to move the policy debate forward. Section II provides an overview of the agricultural gender gap in Sub-Saharan Africa. Section III presents a framework that establishes linkages between the choices that women farmers make, the constraints and contextual factors influencing their decisions, and the agricultural outcomes they achieve. Section IV identifies the constraints that women farmers face, reviews the evidence on the levels of severity and relative impact of these constraints on productivity, and highlights existing approaches and interventions that tackle these constraints. Section V outlines a research agenda to fill knowledge gaps and generate evidence useful to policymakers in Sub-Saharan Africa and beyond. Section VI concludes.

II. Background

Across Africa, agricultural productivity is critical to GDP growth, poverty reduction, food security, and structural transformation. Yet, performance improvements in the sector have been incremental and lag behind other developing regions. Agriculture accounts for 15 percent of Africa's gross domestic product and more than half of its citizens rely on the sector for their incomes (OECD, 2016). Rural African households obtain two-thirds of their income from agriculture (World Bank, 2018). Agricultural productivity also fosters structural transformation by enabling rural households to invest more in the human capital development for new generations and facilitating the movement of workers to more productive sectors, as fewer farmers are required to produce the same amount of agricultural output (Byerlee et al., 2009). Furthermore, agricultural productivity is important to ensure food security: Africa's population is expected to quadruple over the next 90 years and the benefits of improved nutrition for the current generation will have knock-

on effects for future generations. Investing in agriculture and improving agricultural productivity is therefore critical to spurring growth and reducing poverty. Despite all of these incentives, however, the agricultural sector in Sub-Saharan Africa has yet to fulfill its potential and achieve the kind of leaps in productivity seen in other regions of the world.

While several factors underlie Africa’s relatively low agricultural productivity, one important and costly inefficiency that plagues this sector is the pervasive gender gap in agricultural productivity that poor households and the economies in which they live can ill afford. Recent evidence suggests that women comprise close to half of the labor force in Africa’s agricultural sector (FAO, 2011; Palacios-Lopez et al., 2015). Yet, on average women produce considerably less per hectare than men. In Burkina Faso, for example, Chris Udry (1996) shows that plots controlled by women are less intensively farmed compared to those controlled by men. This inefficient factor allocation alone costs households 6 percent of output. Similarly, in Uganda, women are less productive farmers due to their choices about input use and access to markets and extension information (Palacios-Lopez et al., 2015).³ The estimates of the size of the gender gap may vary depending on the country context and numerous other farmer characteristics, including marital status, position on the productivity distribution, and whether the analysis considers only individually- or also jointly-managed plots (see Box 1).

Regardless of these variations, significant differences exist in the land productivity between male and female farmers. Using data from the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA), the Levelling the Field report (World Bank and ONE, 2014) estimated large gender gaps in agricultural productivity for six countries in Sub-Saharan Africa: Ethiopia (23 percent), Malawi (25 percent), Niger (19 percent), Nigeria (North: 4 percent, South: 24 percent), Tanzania (6 percent) and Uganda (13 percent). Recent women empowerment diagnostic reports in Nigeria and Democratic Republic of the Congo (DRC) reveal gender gaps of 30 percent and 11 percent respectively (World Bank, 2022; World Bank 2021). Even worse, women tend to farm smaller plots and regardless of gender, smaller plots tend to be more productive per unit of land than larger ones. Therefore, for most of these countries the estimated productivity gaps are even greater after taking account of differences in plot size and agro-ecological regions (Figure 1).⁴

³ Other empirical literature on gender productivity differentials in Sub-Saharan Africa includes Moock (1976) for Kenya; Tiruneh et al. (2001) for Ethiopia; Gilbert et al. (2002) for Malawi; Goldstein and Udry (2008) for Ghana; Alene et al. (2008) for Kenya; Peterman et al. (2011) for Nigeria and Uganda; Vargas Hill and Vigneri (2011) for Ghana and Uganda; Kilic et al. (2013) for Malawi; Croppenstedt et al. (2013) for Ghana, Kenya, Malawi, and Nigeria; Aguilar et al. (2014) for Ethiopia; Backiny-Yetna and McGee (2015) for Niger; Akresh (2005) for Burkina Faso; Ali et al. (2015) for Uganda.

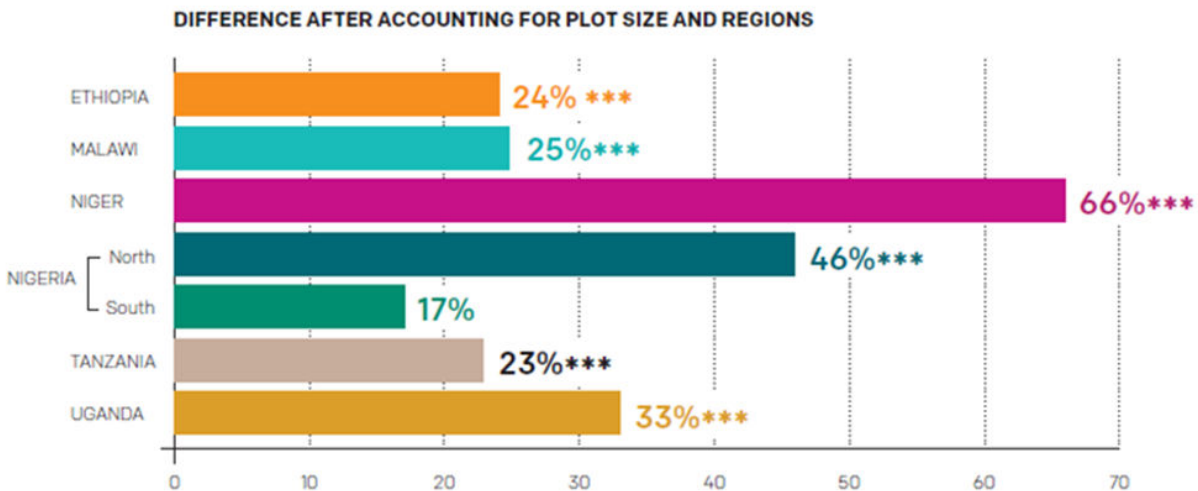
⁴ More details on the estimated gender gap in agricultural productivity for these countries can be found in Kilic, Palacios-Lopez & Goldstein (2015), Slavchevska (2015), Ali et al. (2015), Aguilar et al. (2015), Backiny-Yetna & McGee (2015) and Oseni et al. (2015).

Women are not inherently worse farmers than men but face two major groups of constraints to their productivity: (1) they have less access to productive inputs (the *endowment* effect); and (2) they face discriminatory social norms and practices that lower their returns to these inputs (the *structural* effect) (World Bank and ONE, 2014). The relative importance of these two components of the gender gap varies between countries and even between regions within countries.

Evidence indicates that the endowment effect matters: estimates of the gender gap in agricultural productivity that control for gender differences in access to various inputs tend to find small or no significant gaps. For example, Gilbert et al. (2002) find no significant gender difference in crop yields use among Malawian farmers in a trial supplying all farmers with inputs including inorganic fertilizer. Similarly, Kinkingninhou-Médagbé et al. (2010) find that after controlling for the planting date (which influences access to ploughing equipment), access to irrigation, and level of experience, there is no gender gap in the technical efficiency of rice farmers in Benin. The implications of women's lower access to productive inputs are serious. A report by the FAO (2011) finds that if women farmers in developing countries had access to the same amount of productive inputs as men, total agricultural output could increase by up to 4 percent, lifting 100-150 million people out of hunger.

In some countries, the structural effect also matters: even if women had access to the same level of inputs as men, this would not always be sufficient to fully close the gender gap in agricultural productivity. The *Levelling the Field* report (World Bank and ONE, 2014) points out that the structural effect is more important in Malawi, Niger, Uganda, Tanzania and the northern region of Nigeria. In Uganda, for example, two fifths of the gender gap are explained by unequal returns to the child dependency ratio, while another fifth is explained by unequal returns to access to transport (Ali et al., 2015). A more recent study in Nigeria finds that yields of rice farms managed by male-headed households are about 11 percent more productive than yields of farms of female-headed households. However, they estimate that the endowment effects, measured by the proportion of the gaps ascribed to differences in observed household characteristics, accounts for merely 22 percent, while the structural effects accounts for the remaining 78 percent (Bello et al., 2021).

Figure 1: The Gender Gap in Agricultural Productivity in Six African Countries



Source: WB and ONE (2014)

BOX 1: Which Farmers Should We Compare?

Analyses and estimates on gender gaps in agricultural productivity vary depending on which farmers we compare. Three common approaches are **inter-household**, **intra-household**, and **plot** comparisons, all of which provide different insights into and evaluations of gender gaps.

Inter-household analyses typically compare female- and male-headed households, exposing the challenges of female-headed households that require tailored solutions. In general, inter-household analyses find a large significant gender productivity gap in the range of 20 to 30 percent, mostly explained by differences in access to resources (Ali et al., 2015; see Horrell and Krishnan 2007; Kinkingninhoun-Medagbe et al. 2010; Oladeebo and Fajuyigbe 2007).

Intra-household analyses compare male and female farmers in households with at least one adult couple, as these comprise the majority of farmers in Africa. Intra-household analyses can use plot-manager level data to compare production on male- and female-managed plots within the same household. However, most intra-household studies tend to use very small samples, so their applicability within and across countries is problematic (Ali et al., 2015). Additionally, most farming is done on plots that are jointly managed by women and men, while most intra-household studies only compare men's and women's individually managed plots. Some studies entail both inter- and intra-household comparisons by comparing the agricultural productivity between male and female plot managers such as those on which the *Leveling the Field* report (WB and ONE, 2014) is based.

Plot analyses compare women's and men's relative productive contributions on a jointly managed plot, revealing conflicting evidence on the performance of jointly-managed versus individual

male-managed plots.⁵ As Doss (2015) points out, because most agricultural production is done on plots that are jointly managed or are entirely managed by men, we must work out how to measure women's and men's relative productive contributions within such plots. One way to do this is to design rigorous evaluations of interventions which randomly allocate new technology to men and women on jointly-managed plots.

The diverse findings of these analyses highlight the importance of thinking carefully about who a woman farmer is and how to design studies that help identify solutions for different groups.

Gender gaps in access to inputs, returns to inputs, and overall agricultural productivity are costly and are a forgone opportunity to raise national income and reduce poverty. A recent joint report from the UN and World Bank (2015) estimates the monetary value of the gender gap at US\$100 million (1.85 percent of GDP) in Malawi, US\$105 million (0.46 percent of GDP) in Tanzania, and US\$67 million (0.42 percent) in Uganda. The potential gross gains to GDP that these figures represent could help lift large numbers of people out of poverty: 238,000 people in Malawi, 80,000 in Tanzania and 119,000 in Uganda. However, the impact of closing the gender gap in agricultural productivity would likely go beyond these numbers, with significant intergenerational effects. Closing the gender gap would empower women economically and when a woman gains more control over her income, she gains more say over important decisions that affect her family, especially her children. Evidence shows that families in which women have more influence over economic decisions allocate more income to food, health, education and children's nutrition, thus improving the human capital of future generations (Ruel et al., 2013; Smith, 2003).

Understanding the gender gap in productivity and its underlying causes would enable policy makers to better design interventions to close this gap. This study develops a conceptual framework for the gender gap and review the available but limited evidence on the effectiveness of interventions and policies designed to address the constraints facing women farmers in Sub-Saharan Africa. The following sections will highlight rigorous impact evaluations that utilize a credible design to causally link interventions to changes in outcomes, and we supplement this review with evidence from inferential studies. Based on these findings, the research agenda identifies evidence gaps in the literature and propose a research agenda to find new solutions and move the policy debate forward. This paper makes the case for more rigorous evidence on the

⁵ In Mali, Guirkinger et al. (2015) find that both women's individual plots and jointly managed household plots are less productive than men's individual plots. In Uganda, De la O Campos et al. (2016) also find significant differences between women's and men's individual plots and estimate that these differences are larger than the difference between women's individual plots and jointly managed household plots. On the other hand, Kazianga and Wahhaj (2013) find that jointly managed household plots are more productive than both men's and women's individual plots, which they find to be equally productive in Burkina Faso.

relative importance of the underlying causes of the gender gap to build a more accessible and relevant evidence base for policymakers.

III. Conceptual Framework

The proposed framework links agricultural productivity to the choices women make given a set of key constraints and contextual factors that serve as obstacles. More precisely, the framework establishes the links between: (1) agricultural production and the use of produce as the final outcome, from which we derive important markers for individual and household welfare as well as women's economic empowerment; (2) the strategic choices women farmers make; and (3) the key constraints and contextual factors faced by women farmers that represent obstacles on their path to higher productivity levels. Furthermore, we link contextual factors and endowment constraints (i.e. modern inputs, knowledge and labor) to the choices women farmers make that ultimately determine their productivity levels.

To add structure to the discussion, Figure 2 presents a framework that tracks the following: (1) how women's agricultural activities transform into economic empowerment and welfare; and (2) which decisions influence this process. That is, women farmers have to take a range of strategic choices when it comes to their farm management. These decisions will largely determine the harvest and the amount of produce available for home consumption and commercialization.

Choice Space

As illustrated in Figure 2, this framework looks at the factors that impact farmers' choices in two main areas: (1) the production process itself; and (2) the subsequent use of the outputs of that production process. We distinguish several factors that play an important role during the agricultural production process, from field preparation to harvest.⁶ We assign these factors to three broad categories that form part of many production functions in the economics literature: capital, technology and labor. Under capital we list the most important physical inputs that farmers use such as land, tools and machines. Under technology, we summarize all the knowledge a farmer possesses related to the agricultural production process. Under labor, we distinguish the pure quantity of labor inputs from its quality and the type of worker who provides the labor.

⁶ It is important to note that the factors described above and in Figure 2, correspond to both the (a) decisions that farmers have to make and (b) indicators that characterize farmers' behavior and frequently serve as outcomes for agricultural policies. For example, the farmer decides on which farming practices, such as row planting or conservation farming, to apply, but this decision may also serve as an outcome indicator for policy makers who try to influence farmers' use of agricultural technologies. Similarly, the presence of a newly established outgrower scheme may allow a farmer to opt in and at the same time the rate of participation may be seen as an outcome indicator for a policy maker whose goal is to strengthen market linkages between smallholders and aggregators.

Once the production process is concluded, farmers decide how to use their output. This includes deciding on the proportion of the harvest that will be consumed or sold, the proportion that will be processed or stored, and the technology required for any processing. When farmers access markets, additional factors play an important role, such as deciding on whether to sell to traders or directly to consumers.

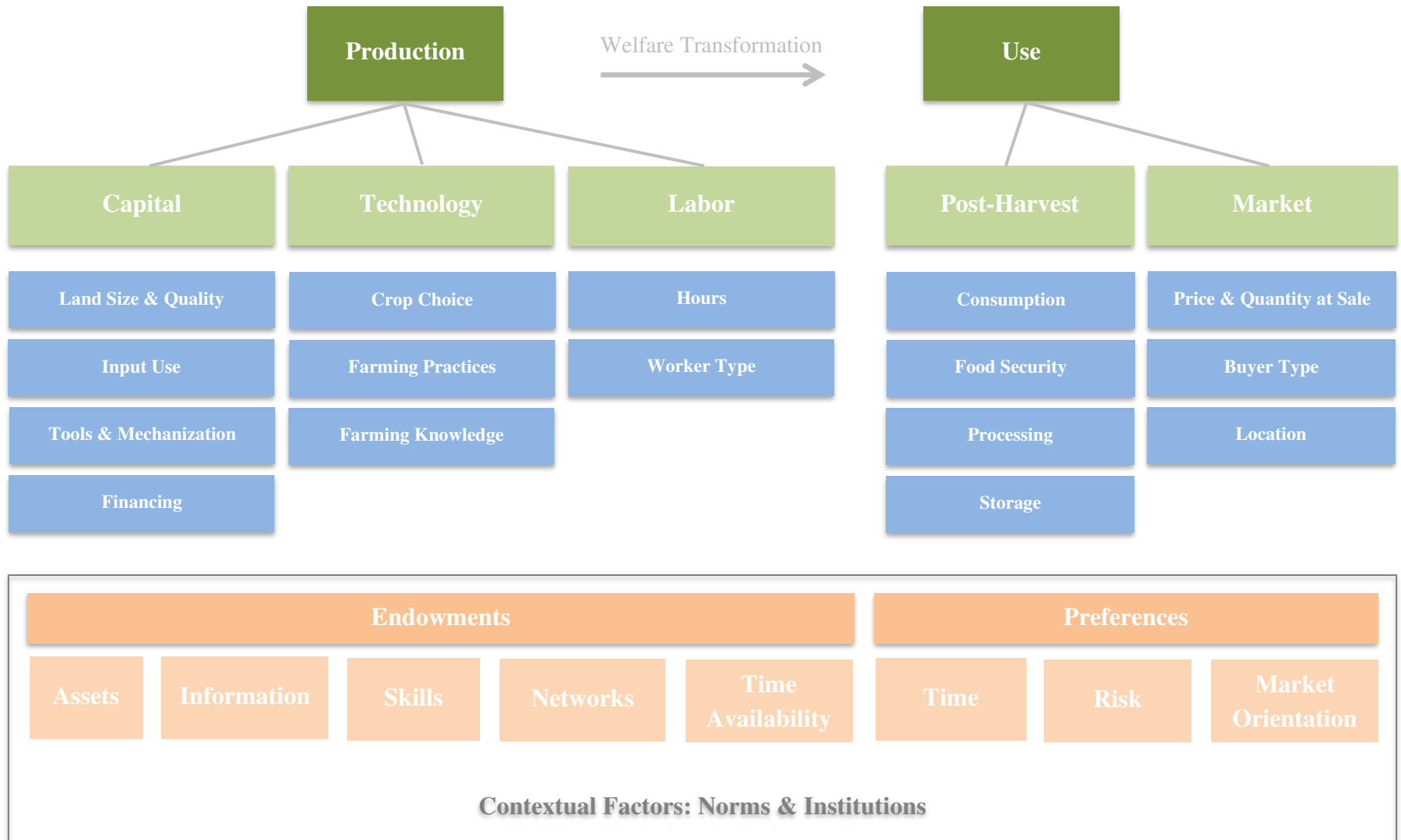
Constraint Space

The bottom section of the conceptual framework (Figure 2) summarizes the areas of underlying constraints that cause gender disparities in the use of factors of production. These constraints can be broadly categorized into those related to farmers' (i) endowments; and (ii) preferences. We look at both groups of constraints in detail in the next section when we review the evidence base on these constraints and potential approaches to effectively lift them.

Contextual Factors

Our framework highlights the links between the constraints we identify and contextual factors, namely norms and institutions. We suggest that the gender constraints we identify do not happen in a vacuum and that they are influenced by (and in turn influence) household dynamics, social norms and market and non-market institutions. Hence, it is imperative that these contextual factors are considered when designing policies to tackle gender gaps. In some cases, it may be necessary to adjust policies to fit with the institutional setting and the prevailing gender norms. In other cases, if prevailing norms and institutions are a truly insurmountable barrier to progress, it may be necessary to first use interventions to change some of these existing contextual factors before it is possible to address any of the constraints we identify below. This is important if a substantial portion of the gender gap in agricultural productivity can be attributed to the differential returns that women reap from productive inputs due to structural effects as shown in some cases in the decomposition analysis discussed in the *Leveling the Field* report (World Bank and ONE, 2014).

Figure 2: Framework Description



IV. Evidence Base on Constraints and Effective Programing

This section reviews the evidence on constraints to women’s agricultural productivity and highlights findings from interventions that aim to alleviate these constraints.⁷ For each constraint, we provide key contributing factors and then point out promising areas for programming. Contextual factors such as social norms and institutions are interwoven into the discussion of each constraint. We concentrate on women farmers who stay engaged in agricultural production.⁸ Therefore, we do not discuss programs that, for example, are specifically designed to move women farmers into non-agricultural self-employment. Instead, we discuss the literature from a position where profitable and desirable investments in agriculture exist. Given that the role of women in agriculture is complex, heterogeneous, regionally varying and dynamic in how it responds to economic changes (Doss, 2001), generalizable conclusions need to be drawn selectively.

Assets and Inputs

Land

Access to land is one of the most important and valuable production pre-requisites for a farmer. The quantity and quality of a farmer’s land are crucial determinants of her productivity, capacity to manage risk, and ability to make productive investments. However, women own a smaller total area of land and smaller individual land plots compared to men. In northern Nigeria, female-managed plots are, on average, 42 percent smaller than those managed by men (Oseni et al., 2015), while in Uganda women’s plots are 36 percent smaller (Ali et al., 2015). Furthermore, women often have to cope with lower levels of tenure security over the land they do own (Doss and Meinzen-Dick, 2020; Kang, Schwab and Yu, 2020). Analysis of LSMS data from Ethiopia and Tanzania shows that tenure security positively and significantly affects households’ productivity, especially for female-headed households (Melesse and Awel, 2020).

Women’s lower access to land is often underpinned by discriminatory customary law and traditional practices that favor men in terms of ownership and inheritance rights.⁹ For example, in Northern Nigeria, the emergence of Sharia Law further impeded women’s access to

⁷ While a comprehensive body of literature focuses on the effectiveness of policies and interventions designed to address overall inefficiencies and market failures in the agricultural sector (e.g. see Jack, 2013), we focus only on interventions that tackle constraints specific to women farmers.

⁸ Furthermore, we mainly focus on crop production, but the applicability of many of the interventions we assess may extend to livestock.

⁹ There are also examples of discrimination in statutory law, though these are less frequent and there have been many encouraging reforms in recent years. However, even where statutory law protects gender equality, discriminatory customary law often overrides these protections.

land despite the gender neutrality of the Land Use Act of 1978 (Peterman et al., 2011; Aluko and Amidu, 2006). The 2012 World Development Report finds that under this law, a deceased husband's family has greater inheritance rights than his wife, inheriting the majority of the deceased's assets in 61 percent of cases (World Bank, 2012). Qualitative research from Ragsdale et al. (2019) reveals that in Ghana, customary law allows a husband to reclaim his wife's land in exchange for a different plot of land. This lack of tenure security in turn made some women reluctant to invest in improvements to their farm plots, fearing their upgraded plots would be taken away from them.

Evidence indicates that female farmers not only have less land, but also lower quality land.

Evidence on this subject is limited and mixed, however, several researchers have identified differences in land quality between male- and female-controlled plots in Sub-Saharan Africa. For example, Ali et al. (2015) find that in Uganda, female-managed plots are more likely to be hilly (12 percent versus 8 percent) and are more likely to be self-reported as having poor soil quality (6.9 percent versus 5.5 percent). Goldstein and Udry (1999) report that women-controlled plots in Southern Ghana have lower levels of organic matter than male-controlled plots. These inequalities did not come about naturally, but because of conscious and subconscious biases in the way households, communities, and nations allocate resources and design policies and interventions. In Nigeria, land reform programs have tended to favor men and provide women with less fertile land (Ogunlela and Mukhtar, 2009). These differences may manifest themselves through differences in productivity: evidence from the *Levelling the Field* report (World Bank and ONE, 2014) finds that women in Ethiopia and Tanzania achieve lower returns than men to each hectare of land. While this may be due to deficiencies in other productive inputs, such as fertilizer, land quality may also play an important role.

Land reforms can facilitate potential uses of land by formalizing ownership and usage rights and by improving land tenure security. Land formalization programs typically involve a systematic land demarcation process and provide formal written evidence of land rights to beneficiaries, but they differ in the scope of rights awarded to landholders (Goldstein et al., 2015). From a gender perspective, formalizing land ownership can help alleviate women's constraints related to discriminatory customary law provisions and enforcement of land use rights. However, the interventions reviewed below show a variety of impacts, especially depending on women farmers' marital status.

A quasi-experimental study on the impact of Rwanda's pilot land tenure regularization program indicates that the program was successful in boosting rural land investment, especially among married women. The program included a provision for married female spouses to be registered as co-owners of land by default. According to the analysis, which uses the discontinuity created by pilot location boundaries, the program had almost double the impact on

female-headed households' productive investments in land than it did on the same measure for male-headed households – a 19 percent increase versus a 10 percent increase (Ali et al., 2014). However, the program resulted in a drop in documented land ownership for women who were not legally married. The Government of Rwanda was able to modify the program to take account of these results, but this case highlights the importance of designing policies with the differential needs of specific groups of women in mind. In Benin, Goldstein et al. (2015) study a systematic land demarcation program using randomized control trial evaluation design. The analysis indicates that the program led to an increase in long-term land investment and perceived land rights for both men and women landholders. Interestingly, this study supports the hypothesis that constraints related to land tenure might differ between men and women. In response to the program, women-headed households shifted production to their parcels located outside of treatment areas presumably to guard their claims on those lands.

Another study employing quasi-experimental variation to estimate the impact of land certification program in Ethiopia suggests that the program led to an increase in the productivity of self-managed plots owned by female-headed households (Bezabih et al., 2012). The program's gradual rollout that reached certain Woredas prior to others enabled the authors to apply a difference-in-differences method to estimate the impact of land certification on households in the East Gojjam and South Wollo regions. Female-headed households experienced gains in productivity in part due to their increased participation in the land rental market following land certification. The authors find that, in addition to productivity gains on self-managed plots in both regions, the program led to an increase in productivity on rented out plots owned by female landlords only in South Wollo. This study focuses on the mechanism that land certification leads to an increase in land rental. On the other hand, Agyei-Holmes et al. (2020) conduct an impact evaluation of a land titling program in Ghana and find that the program did not translate into increased agricultural investments or credit taking but caused households to decrease labor allocations and sharecropped landholdings. The intervention, however, allowed women to switch to non-farm economic activities resulting in a considerable increase in their business profits.

Other land interventions in different regions have focused on increasing households' access to large plots through financial support. However, the evidence on the effectiveness of this type of intervention is relatively scarce and mixed. Datar et al. (2009) use a propensity score matching methodology to assess the short-run impact of a program that combined conditional cash grants to poor families for the purchase of larger plots with agricultural inputs and extension services, as well as the provision of individual and group land titles in Malawi. The authors find that asset levels for treated female-headed households increased relative to treated male-headed households. Relying on a similar estimation strategy, Mueller et al. (2014), however, find that the program may have diminished the property rights of women within male-headed households. More precisely, women in those households reported a lower relative share of land purchased with a title and leased

compared to the male head. Finally, Mendola and Simtomwe (2015) also use propensity score matching and find improvements for male-headed households on farm yields and food security, but not for female-headed households in Malawi. Increases in asset levels across male- and female-headed households, however, were comparable.

Machinery, Livestock and Inputs

Assets like machinery and livestock help farmers to store and accumulate wealth, improve productive processes, provide security during negative shocks, and facilitate riskier investments. However, female farmers are less likely than their male counterparts to own or have access to assets. Quisumbing et al. (2015) estimate that men in Burkina Faso owned nearly 135,000 CFA francs of total assets compared to 47,000 CFA francs owned by women. Furthermore, men owned higher value agricultural assets whereas women owned higher value household durables. Dillon and Quinones (2010) find that men in northern Nigeria own twice the value of livestock compared to women, with women tending to own smaller types of livestock than men (e.g. goats rather than cattle). A recent joint World Bank and UN (2015) report finds that women's lower access to machinery and other production tools is one of the key constraints in Malawi and responsible for nearly 18 percent of the gender gap observed in agricultural productivity. A recent study from Côte d'Ivoire shows that providing men with a productive asset (such as traction oxen) can benefit women by freeing up their time, but that impacts vary depending on the underlying social norms (Brudevold-Newman et al., 2023).

Even when women live in households that own productive assets, men in the household usually have priority when it comes to allocating those assets between different household members. In Mozambique, Quisumbing et al. (2015) find that even when livestock is jointly owned, men remained the decision-makers with respect to input and technology use and production practices. On the other hand, households that are headed by women tend to be poorer and are less likely to have productive assets or finance, as these households are less likely to include a husband or another adult man, and women's access to assets is often only secured through men. In Kenya and Tanzania, for example, less than 10 percent of irrigation pumps are purchased by women because men are the ones primarily responsible for big purchases, leaving women little autonomy to make decisions on agricultural capital investments (Theis et al., 2018).

These disparities in access to assets extends to relatively lower value implements and working capital. Consequently, female-headed households and female plot managers are less likely to use modern inputs. Moreover, when women do use such inputs, they apply them less intensively than men (Sheahan and Barrett, 2014). The Levelling the Field report (World Bank and ONE, 2014) documents gender gaps in access to and returns from fertilizer and other non-labor inputs and finds that this contributes to the gender gap in agricultural productivity in each of the countries it

examines. In Malawi, Niger, Northern Nigeria and Uganda, women use less fertilizer than men, while in Ethiopia and Tanzania women achieve lower returns to the use of fertilizer. In Nigeria, for example, male farmers use over 8 times more fertilizer and 50 percent more herbicide per hectare than their female counterparts (World Bank, 2022). Similarly, 63 percent of male farmers were found to use chemical fertilizer compared to only 54 percent of female farmers in Malawi (Djurfeldt et al., 2019). However, the size of these gaps does not always accurately reflect the relative importance between the use of and returns to fertilizer to productivity gaps. In Uganda, input use is so low that it does not contribute much to the gender productivity gap, with structural effects being much more important (Ali et al., 2015).

Farmers often cite the lack of access to finance as one of the main barriers to adopting modern agricultural practices and technologies. Despite significant variation in input use rates across countries in Sub-Saharan Africa, the use of credit for external inputs purchases is roughly consistent at only 6 percent of those households that purchase inputs (World Bank, 2018). Most households use cash from crop sales or non-farm income to purchase inputs. Therefore, it's not surprising that to date much attention has been placed on designing and promoting credit and savings instruments that meet farmers' needs. Credit is especially relevant given the difficulty for smallholder farmers to accumulate meaningful amounts of financial wealth.

Several characteristics of rural credit markets pose considerable challenges to financial institutions operating or entering this market. First, traditional methods to combat the adverse selection and moral hazard problems inherent to credit markets, such as screening and pledging collateral, are often inadequate. Traditional screening methods fail given the lack of accessible credit history in the absence of credit bureaus and, more generally, the informality of financial transactions and the lack of relevant financial records. In addition, the loan sizes are typically very small relative to the transaction costs that financial institutions incur. Finally, the rigid repayment schedules favored by many microfinance institutions are often inadequately synchronized with the agricultural growing cycle, which prevents farmers from effectively managing their highly seasonal cash flow. Consequently, the agricultural credit market is dominated by small-scale initiatives to either build farmer associations that can access private credit sources, to interlink markets that enable exporters to provide seasonal input credit to farmers using a farmer's projected harvest as collateral, to operate government-run credit programs or to facilitate access to credit among smallholders through NGOs (Kelly et al., 2003).

A key factor in this context is the ability to obtain credit that allows farmers to acquire such machinery along with other expensive inputs, such as fertilizers and irrigation (Porter and

Philips-Howard, 1997).¹⁰ However, women farmers frequently do not own the types of collateral that are typically required to secure loans – especially land. Women also often own fewer large, valuable livestock, impeding their ability to cope with negative shocks and make riskier investments (Deaton, 1992).

Recognizing that financial hurdles are an important constraint to adopting inputs and technologies, numerous development initiatives offer technologies and inputs at a subsidized price or even for free. Frequently, these offers are made for a limited time only. These technologies are not usually thought to be unprofitable at their existing price, but the subsidy or free provision is meant to nudge farmers to test and evaluate these technologies so they can make an informed decision about continuation and scale-up. In Malawi, for example, around 60 percent of households receive subsidized fertilizer (World Bank, 2018). Several studies that have looked at the impacts of fertilizer subsidy programs (Gine et al., 2015; Kilic et al., 2015; Karamba and Winters, 2015; Machina et al., 2019) conclude that while such programs increased women’s access to fertilizer and increased agricultural productivity for men and women, they had little effect on reducing the gender gap in agricultural productivity. Input support programs should therefore supplement, or take into consideration, other persistent gender-related inefficiencies.

Information and Skills

Access to information on growing techniques, agricultural technologies and crop choice, is critical in allowing farmers to optimize agricultural production. Male farmers tend to have more diverse channels of information as well as better quality of information compared to women. Njuki and Sanginga (2013) find that men were exposed to multiple formal and informal sources of information, whereas farmer-to-farmer interaction was the key source of market information for women farmers in Mozambique. Ultimately the authors find that better informed farmers sold a maize at an average price that was 12 percent higher than the one received by uninformed farmers. While a multitude of informational sources is available to farmers, national agricultural extension systems are the most prominent example of a formal source. However, these systems are often implicitly or even explicitly targeted at male farmers.

The *Levelling the Field* report (World Bank and ONE, 2014) finds that women have less access to information on improved agricultural techniques. Extension services often target heads of households and these tend to be men. Thus, women often get information second hand from their husbands. Women who are single, widowed or divorced have even more difficult time

¹⁰ Findings from World Bank (2018) suggest that credit is used infrequently by African farmers to procure inputs despite the large focus in the development community on pushing credit. Rather, farmers use non-farm and other income sources to purchase inputs.

accessing information. For example, in Uganda, the National Agricultural Advisory Services extension activities reached only 17 percent of female plot managers, compared to 23 percent of their male counterparts. The gap was even wider for extension services from other providers (Ali et al., 2015). Similarly, a report from the World Bank and IFPRI (2010) documents large gender inequalities in access to extension services in Ghana and Ethiopia and highlights the important role information plays in facilitating technology adoption.

Extension systems are key providers of training but learning outcomes are usually falling short, especially for women farmers. Many development initiatives in the agricultural sector include the provision of information and training on agricultural practices and technologies to smallholder farmers. These interventions can and do target virtually all stages of the agricultural value chain and frequently go well beyond agricultural practices, by including trainings on topics such as nutrition and managing household finances. However, public extension systems have been criticized for their low quality, low levels of accountability, inadequate incentives for extension agents, elite capture, and inadequate targeting and adaptation to the needs of poor and female farmers (Anderson and Feder, 2007; Ragasa, 2014). A study looking at women farmers across Ethiopia, Madagascar and Tanzania, for example, finds that the main constraints to technology adoption are institutional and cultural in nature and related to the mode of delivery of extension services (Achandi et al., 2018). One possible reason for this is that extension agents tend to be men and social norms may prevent women from interacting effectively with men who are not family members.

Gilligan et al. (2014) assess factors that influence the effectiveness of extension programs, highlighting the importance of women's bargaining power in information use and technology uptake. More precisely, the authors study the impact of an input distribution and intensive training intended to increase the uptake of a specific variety of sweet potatoes in Uganda. They factor in female bargaining power, measured by share of land and nonland assets controlled by women, which is then used to examine how intra-household gender relations affect adoption decisions. They find that female bargaining power does not unambiguously increase the probability of adoption. The probability of adoption is highest on parcels over which there is joint control but where women take the lead in deciding which crops are grown. Hence, the evidence indicates that women play an important role, and often a leading role, in the decision to adopt information and techniques, but that this decision is often jointly made with their husbands.

There is some evidence on training interventions that directly address constraints particularly binding for women through programming. A study from Mozambique looks at the impact of the gender of extension agents on their ability to influence farmers. The study finds that male extension agents had a significant impact on male farmers but not on female farmers

(Kondylis et al., 2016). In contrast, female farmers were more likely to learn and adopt in communities in which a female extension agent was added. The authors suggest that this was due to the increase in the supply of extension as well as complementarities between male and female extension agents. An experiment in Uganda tested whether it makes a difference whether women or men were targeted to receive agricultural information (Lecoutere et al., 2019). The authors find that targeting women within the household (as opposed to only the male co-head) had a positive effect on different domains of empowerment, knowledge outcomes, production-related outcomes, such as maize yield and market participation. However, targeting both spouses is perhaps even more effective. Donald et al. (2022) find that training Ivorian couples in rubber farming households leads to increased agricultural investment at lower cost, and increased women's management of cash-crop tasks.

Other studies mostly report sex-disaggregated impacts of programs equally aimed at men and women and find mixed results. For example, Buehren et al. (2019) study the impact of a project that aimed at strengthening and increasing the outreach of the agricultural service systems in Ethiopia. The study finds that project impacts for female- and male-headed households are similar. However, the project was not able to reduce the pre-existing gender gap in agricultural outcomes. In the same vein, in Cote d'Ivoire and the Gambia, Diagne (2006) and Dibba et al. (2012) find that the provision of seeds and information on *NERICA*, a new rice variety, had an equal impact on adoption for female and male farmers. However, it is worth noting that it remains unclear whether these studies had enough statistical power to detect impact differences between farmers of different genders. In contrast, in Benin, Agboh-Noameshie et al. (2007) find that women were able to reap higher benefits in terms of yields and incomes from an intervention that provided both information and inputs to grow *NERICA*. Building on the same data, Adekambi et al. (2009) extend the analysis to studying the intervention's impact on household expenditures and find a positive impact that is higher for female-headed households.

Farmer field schools are one mechanism for delivering extension services that many see particularly well suited to the needs of women farmers. The group setting and more informal context of this training approach elicit positive reactions from female farmers. Davis et al. (2012) study the impact of farmer field schools in a quasi-experimental setting in Kenya, Tanzania and Uganda using longitudinal data. They find that tackling the informational constraint in this way particularly increases income from agriculture for female headed households.

Other potential avenues for effective knowledge transfer emerge from programs that build on ICT. Unlike conventional extension approaches, ICT-based extension has the potential to reach a greater number of farmers more easily, often in a timely and cost-effective way (Davis, 2008; Saravanan, 2015). Zossou et al. (2009), for example, report that farmer-to-farmer videos were more effective in improving rice parboiling practices compared to more traditional training among

female farmers in Benin. Besides video-based technologies, modern phone-based ICT can improve the performance of agricultural extension as well, especially in the context of the COVID-19 pandemic. Even though the digital gender gap is wide, Africa, access to ICT is still on the rise (Hoffmann & Roscoe, 2016). Examples of new digital extension services include SMS-based market information services, Interactive Voice Response (IVR), call centers for technical farm advice, facilitation of farmer-to-farmer knowledge sharing via participatory video, or decision support systems implemented as smartphone apps (Aker, 2011; Aker et al., 2016; Baumüller, 2018). Dione et al., 2021 assessed the effectiveness of IVR in delivering biosecurity messages in Uganda and find that the technology significantly improved knowledge outcomes for farmers who were exposed to it and that the technology seems gender sensitive, as most farmers were able to use their own phone and plan sessions according to their convenience without needing approval from their partners.

Networks

Formal and informal networks are important forums for farmers to exchange knowledge and join forces with others to solve problems that are difficult to solve by oneself. Although the literature provides mixed results, there is suggestive evidence that women farmers' networks are less effective than men's networks at spreading information relevant to agricultural productivity. Women may also have smaller social networks. Beaman and Dillon (2018), for example, use social network data collected from 52 farming communities in Mali and find that women have about 63 percent fewer direct contacts. Women are also frequently less represented or in leadership positions in formal networks.¹¹

Interventions that build or strengthen farmer networks and create formal or informal farmer groups are intended to bundle knowledge and resources, enable peer learning and improve the bargaining position of individual smallholders. Small-scale farming is typically defined by a high degree of self-determinism, with each farmer essentially acting as an individual business operator. This situation is accompanied by farmers' weak individual bargaining power in input and output markets, limited technology transfer between farmers and financial self-reliance. Against this background, the hope is that creating farmer groups can be an effective mechanism to increase access to inputs, markets, credit, information and bargaining power but socio-cultural norms, women's household duties, their status, age, education, and the organizations' rules of entry and legal policy environment are some of barriers that women farmers' face when forming and participating in groups (Kaaria et al., 2016). For instance, in Ethiopia, women constitute only 20 percent of cooperative membership and only 18 percent of the cooperatives reported women in

¹¹ Agrawal et al. (2006) find that women's representation in communal committees on forest governance has substantial positive effects on regulating illicit grazing and felling in India.

leadership positions (Woldu and Tadesse, 2015). In Mali, Beaman and Dillon (2018) study how information regarding a composting technology diffuses through social networks of female and male farmers. First, women are significantly less likely to receive this information compared to their male peers. Second, women living in communities in which individual information disseminators were chosen based on their network (betweenness) centrality, experienced significantly less knowledge transfer than women in other villages. This demonstrates how social network targeting could reinforce existing gender inequality.

Women farmer groups offer an opportunity to collectively address gender-specific constraints and increase bargaining power. An intervention in DRC examined the impacts of innovation platforms (IPs) within the maize value chain on female farmers (Mumbeya et al., 2020). IPs are social structures comprised of various stakeholders that facilitate information flows, access to input and technology, and encourages shared risk taking. Along with studying the impacts of being part of an IP, the study compared performances of female farmers in all-female IPs against those in mixed IPs. Participants in all-female IPs were better able to address challenges, improve their market participation, and had higher yields compared to women in mixed IPs. The study cautions though that the members of these groups should be socio-economically homogenous, as the authors observed divergent and conflicting interests between women from different socio-economic strata.

As evidence on programs to increase network effectiveness for women is sparse, Section V highlights relevant research questions to prioritize.

Time Availability

Farmers have only a limited amount of time and must decide how to allocate that time between agricultural tasks, other income-generating tasks, and non-income-generating tasks. Prevailing gender norms mean that women tend to allocate a greater proportion of their time to tasks that do not directly generate income, such as caring for children and the elderly, cooking, and collecting water and fuel wood. Consequently, the time constraint may be relatively more binding for women farmers than for their male peers. For example, the study of women's participation in the WIA extension program in Nigeria indicates that women's participation in agriculture led to less time for childcare and food preparation, less time for the education of both girls and boys and less time for social activities for women (Odurukwe et al., 2006). Recent evidence shows that providing female farmers with childcare can increase their agricultural productivity and lead to income gains for their households (Donald and Vaillant 2023), but this is just one data point.

Women have lower access to labor-saving technologies (LSTs) than men. LSTs aim to reduce the drudgery in farming, and include practices and technologies such as conservation agriculture, roof water harvesting, or grain mills that more efficient than traditional practices. The use of LSTs is widespread, but women have lower adoption rates due to lower access information, extension services and availability of technology (Vemireddy & Choudhary, 2021). But when women use LSTs, studies find benefits of time savings, cost reductions and increased labor productivity on farms (Fischer et al., 2018; Theis et al., 2019). Of course, time savings are a vital impact of LST adoption. For example, studies have found that 450 hours of labor for weeding are required via direct seeding of rice when hand broadcasted, but hours are reduced by 90 percent when using a transplanter (Naylor, 1992). Findings from South Africa show that men's time saved from weeding operations was used for other income-generating activities and women were more likely to engage in housework and managed community vegetable plots (Gouse et al., 2016).

In addition to their own time, farmers can allocate the time of other people including household members or laborers. This is especially relevant in Sub-Saharan Africa, where low levels of mechanization mean that labor plays a more critical role than in other parts of the world. However, African women lack access to labor. In fact, the Levelling the Field report (World Bank and ONE, 2014) identifies women's inferior access to labor as the main barrier to closing the gender gap in agricultural productivity across all six countries on which the report focuses. A joint World Bank and UN (2015) study recently found that women's lower access to male family labor accounts for 97 percent of the gender productivity gap in Tanzania and 45 percent of the gap in Malawi. In addition, an analysis on the determinants of the gender gap in agricultural productivity in Nigeria revealed that the gap was traceable to labor market imperfections which tend to be biased against women (Olakojo, 2017).

Women lack access to labor for a number of reasons. Firstly, female farmers tend to live in households with fewer members, so they have a smaller pool of household labor to draw upon. In northern Nigeria, Oseni et al. (2015) find that female plot managers live in households that have an average of 1.26 male household members, compared to 1.94 in the households of male plot managers. Some of the reasons why women live in smaller households are related to widowhood, migration, and divorce. For example, in Tanzania, 67 percent of sole female plot managers are divorced (World Bank and UN, 2015). Moreover, in some countries, even after controlling for the number of household members, female farmers deploy fewer male household laborers to their plots and those laborers who are used on female-managed plots tend to be less productive than those who are used on male-managed plots (World Bank and ONE, 2014). This may suggest that men are less inclined to work hard for a female boss, that women have less control over the allocation of household labor, or that women have less time to effectively supervise their laborers. In the case of women's lower returns to hired (i.e. non-household) labor, a key factor may be that women are less able than men to afford the most productive workers (Carranza et al., 2017). Within

households, priority is given to male plot managers first, so female plot managers are left with both fewer and less productive labor (Pierotti et al., 2022).

As evidence on programs to increase female farmers' time availability and access to high quality agricultural labor is sparse, Section V highlights relevant research questions to prioritize.

Risk

In many Sub-Saharan countries, while men disproportionately farm cash crops, women farmers are responsible for growing food crops. For example, in Malawi tobacco (a cash crop) is grown on only 3 percent of women's plots, compared to 10 percent of men's plots, while in Uganda only 1.3 percent of female-managed plots grow coffee (also a cash crop), compared to 6.5 percent of male-managed plots (Ali et al., 2015). This trend may be due to risk preferences. Growing cash crops can be seen as riskier as it frequently requires upfront investments in terms of inputs and scale in order to meet market demands as well as exposure to price fluctuations in the output market. Both risks, if they materialize, can result in severe income shocks to farmers.

Differences in risk preferences not only influence crop choice but can also impact other important strategic decisions by farmers. A lab-in-field experiment in Tanzania uncovered that women's risk aversion and men's loss aversion was negatively correlated with improved variety use (Magnan, 2020). If the husband tended to overestimate the likelihood of low probability events, the household was less likely to adopt modern seeds. If the wife had a tendency to overestimate this probability, the household was more likely to do so. This implies that both men's and women's preferences matter for seed choice. Another lab-in-field experiment finds that men prefer to take production and market risks more often than women, spending higher amounts on risky investments (Keenan et al., 2021). In fact, women who participated in a gender-related training program ended up taking more risks and made investment decisions closer in line with her preferences when jointly deciding with her spouse. In Senegal and Burkina Faso, Delavallade et al. (2014) show, with a randomized field experiment, that women plot managers are less likely than their male counterparts to take out agricultural weather insurance and are more likely to invest in savings for emergencies, even though the weather insurance was shown to lead to greater yields. The authors speculate that the results may be indicative of women facing risks that are not covered by weather insurance, such as those associated with higher fertility, childbirth or childcare.

Market Orientation

Women's low involvement in cash crop cultivation may be linked not only to risk preferences but also norms. In many countries certain crops are seen as men's crops and other crops as women's crops. Women consistently farm less valuable crops, like roots and tuber crops in Nigeria

and cassava in DRC (World Bank, 2022; World Bank, 2021). In Kenya, Tanzania and Uganda, researchers found that female headed households were less likely to grow cash crops, mainly due to resource constraints and social norms. They also find that women placed higher value on crops for food security whereas men favored income potential (Reynolds et al., 2020). Duflo and Udry (2004), for example, use variability in rainfall to show how consumption expenditure patterns shift depending on whether crops grown by either men or women face favorable weather conditions and thereby documenting the implications of gendered crops on household welfare. However, these norms are not fixed and may be influenced by profitability; there is evidence from some countries suggesting that once a previously unprofitable crop or activity becomes profitable, men tend to take over from women. This was thought to be the case, for example, with the recent switch in Mali from shea butter production being an activity dominated by women to one increasingly dominated by men (Government of Mali's Gender Policy, 2009).

As cash crops command higher market prices than other crops, women's relative absence from cash crop farming has serious consequences. Moreover, the *Levelling the Field* report (World Bank and ONE, 2014) finds that women in Malawi, northern Nigeria and Uganda actually receive higher returns from moving into high-value agriculture than men. Thus, the potential returns to addressing the gender division between cash and food crops is significant. The overall importance of gender constraints to cash crop farming is captured by a joint World Bank and UN (2015) report which estimates that women's lack of access to cash crop farming accounts for 28 percent and 13 percent of the gender gap in productivity in Malawi and Uganda. Crop choice also appears to be critical in Kenya. Wa Githinji et al. (2014) find that while women grow a lower value of crops overall, gender gaps disappear after accounting for endogenous crop choice, suggesting that crop choice is the critical barrier. A similar finding is made by Peterman et al. (2011) who find crop choice to be an important determinant of productivity gaps in Nigeria. However, women's choice of whether to engage in cash crop farming may be more about skills than preferences: In Malawi, Montalvao et al. (2017) find that an increase of one standard deviation in women farmers' non-cognitive ability is associated with a 40 percent increase in their likelihood of growing tobacco. Focus group discussions in Tanzania, indicate that while men and women harvested crops jointly, men conducted the sales. One reason for that was that some products were taken to the market using bicycles, which women reported not being able to ride when heavily loaded. In addition, when bulk buyers purchased produce at the farm gate and the husband was away, women could only sell at the price agreed upon with the husband (Njuki et al., 2014).

Moving from subsistence farming to more market-oriented and commercial agriculture requires smallholders to adapt to incomplete markets. However, even if farmers adapt their practices and technologies effectively, this is often not sufficient as there are serious barriers to accessing output markets and selling their produce. These barriers include incomplete output markets with high transaction costs, high price fluctuations and limited demand for high-volume

sales. These barriers create an environment in which the optimal approach for farmers is to focus on a high degree of diversification of food crops. Responding to these constraints, many interventions try to establish linkages between markets, buyers and aggregators on one side, and smallholder farmers on the other side. Examples include forming marketing groups or cooperatives, instituting buying stations and connecting smallholders to outgrower schemes. However, we simply do not have much evidence on whether gender differences in these market imperfections exist.

However, there is nascent evidence that small nudges can help women to overcome intra-household barriers to market participation. Ambler, Jones and O’Sullivan (2018) find that by simply encouraging men to register sugarcane blocks in their wife’s name can bring women closer to commercial activities in Uganda. The take-up of the contract intervention was high at 70 percent, even in groups least likely to participate. The study also found that the blocks transferred to women were not of lower quality but were smaller and closer to home. However, analysis of how these patterns evolve, and the longer-term impacts of this intervention on increasing women’s involvement is still needed.

As evidence on programs to increase females’ market orientation is sparse, Section V highlights relevant research questions to prioritize.

BOX 2: Challenges to Evaluating Comprehensive & Multipronged Approaches

Programs that try to simultaneously address a multitude of constraints, sometimes referred to as **value chain interventions**, are based on the rationale that many farmers find themselves in a low productivity trap that they cannot escape with only the help of narrow interventions that focus on one or a small number of constraints. Value chain interventions combine selected elements into a single, comprehensive package. For example, outgrower schemes provide farmers with training, credit, farming services, and market access. In many contexts, value chain interventions appear to be justified: if farmers are entirely unable to access markets, merely providing them with the knowledge on how to grow cash crops may have limited success (and appeal).

While value chain interventions employ an interesting and comprehensive approach, it is difficult to provide substantive evidence on the effectiveness of their individual elements. In some cases, it might be possible to isolate impacts of individual components or combinations of components through the creation of several treatment groups. However, as take-up of many of these interventions is voluntary, selection problems make impact identification difficult. Self-selection into different intervention packages biases estimates and undermines any attempts to rigorously identify impacts of individual program components. Furthermore, contamination of and spill-over

effects between the treatment groups pose a considerable challenge to measurement. As such, value chain intervention evaluations pose great barriers to identifying components that are unnecessary to or inefficient in reaching the program objectives.

Of course, estimating the impact of value chain approaches can be immensely important for cost-benefit calculations. However, overall, value chain interventions evaluations come at the cost of obtaining impact estimates on a frequently unknown package of interventions. They appear to have limited potential to provide insight into how to design effective and efficient programs for women farmers.

V. Research Agenda

As delineated in the previous section, the body of evidence on constraints and solutions to women’s agricultural productivity provides heterogenous and largely inconclusive findings. Hence, more work is needed to provide solid and comprehensive advice on the design of effective, cost-efficient and scalable interventions that support women farmers to increase their productivity and incomes from smallholder farming. In this section, we highlight evidence gaps within each constraint and prioritize some areas that we see as particularly relevant for future research.

We identify targeted research topics for impact evaluations as well as broader questions for constraint documentation. While some topics are particularly suited for impact evaluation methodologies in order to test and document which and to which degree constraints are binding, other topics are better suited for constraint documentation, which seeks to systematically uncover and document the underlying constraints specific to women farmers.¹² This is paramount in light of the limited evidence on consistent success of any type of intervention discussed in Section IV.¹³ Ensuring that the constraints that actually matter are identified in the first place can only help to design better policies. In this section, research topics for impact evaluations are marked as **IE**, while research questions for constraint documentation are marked as **CD**. At the end of this section, we highlight two questions on targeting (**T**) and definitions (**D**).

¹² Impact evaluations are one way to test assumptions regarding which constraints are binding but they also demand considerable efforts and resources. In addition, results typically become available only well after the evaluation period. To inform the design of interventions a priori, however, other methodologies such as inferential and qualitative research are extremely important especially if the objective is to adapt and fine-tune tested interventions to the local context.

¹³ Current inconsistencies in literature may result from a multitude of explanations, including implementation failures, inadequate program financing, or study design shortcomings.

Assets and Inputs

Which interventions alleviate challenges to adoption and continued use of *fertilizer and other non-labor inputs* (IE)? Given the emphasis that many agricultural programs place on promoting the use of modern inputs, this is clearly a research area with tremendous potential especially considering the high costs and enormous benefits that some of these inputs can have. Both men and women face challenges related to the adoption and continued use of modern inputs. The goal is to test interventions that alleviate the challenges for both but to also effectively address constraints specific to female farmers.

- What effective and affordable interventions can encourage women farmers to test and use more and higher-quality fertilizer or other productivity enhancing chemicals?
- How can we increase women's ability to finance, identify, obtain and use improved seeds?
- Can we design financial tools to effectively allow women farmers to fund innovation and upscale of their agricultural production?

Which dimensions of *intra-household power relations* most critically influence the gender gap in agricultural productivity (CD)? There is mounting evidence that intra-household power relations can constrain women's agricultural production decisions as well as their access to resources. However, we know very little about which dimensions of these power relations, such as bargaining processes or resource allocation, are the most critical. For example, it may be that the underlying constraint is that women do not have sufficient agency to make changes to their farming practices independently. In these cases, working with only women is unlikely to produce any change and engaging men might be key to address the lack of agency.

Information, Skills, and Networks

How can *extension services* better reach female farmers (IE)? One of the key questions here is whether there are ways to optimally tailor extension services and make them more responsive to women farmers' needs. Related to this question is how female farmers can be better targeted as it seems to be the case that reaching and involving women farmers is a first stage challenge. One of the main challenges, but also opportunities in this context is how policies and programs can leverage social networks.

- Are there ways to optimally tailor extension services to women's needs and design these services in order to better target female farmers and be more responsive to their agricultural information needs?
- Can policies or programs that leverage social networks be used to effectively channel agricultural knowledge to women farmers?
- How can ICT technologies be leveraged to best disseminate information?

What *implementation modalities* most effectively transmit information to female farmers (CD)? Many solutions to lifting the constraints faced by women farmers may be similar to those that are effective for men. For example, both men and women farmers benefit from information on new agricultural practices. However, experimenting with implementation modalities to increase women's participation and economic empowerment can be both (i) relatively straightforward to design and implement; as well as (ii) highly effective to support women farmers more successfully or even necessary to reach women farmers in the first place. Potential questions to explore include:

- How can innovative implementation modalities address challenges unique to women (i.e. mobility-related challenges, accessing workshops, etc.)?
- What small tweaks to existing approaches can help overcome barriers to women's participation and economic empowerment?
- Which approaches can improve the functioning of horizontal networks (between peers) and vertical networks (between actors at different levels of the value chain)?

What is the degree of effectiveness of *group-based approaches* in varying contexts (CD)? Many interventions designed to target female farmers work through female-only farmer groups. Of course, there are several rationales for this approach including that, for example, women farmers often feel more comfortable interacting with male program staff when they are in a group with other women, or that group-based approaches create network linkages between the participating women. However, questions remain about the degree of effectiveness of group-based approaches in varying contexts. Potential questions to explore include:

- When does a group-based approach effectively channel an intervention to a target group?
- In what contexts do female-male farmer connections effectively introduce agricultural knowledge and practices about traditionally male domains (i.e. growing cash crops) to women?
- What systems can effectively set up networks between input dealers, agro-processors or other actors in output markets?

How can programs best disseminate *information on technologies and markets* (CD)? The role of information about agricultural technologies and markets and the importance of information diffusion through networks is emphasized by many agricultural development initiatives. However, there is still a lack of clarity on how programs can be tailored to meet women's specific needs and bridge the information gender gap. These questions are now particularly relevant given the opportunities presented by technological advancements and the rapidly improving access to information services and mobile technologies, even in rural Sub-Saharan Africa. Potential questions to explore include:

- In which contexts is it most effective to provide information passively, through ICT-based services versus actively, as in the case of more traditional extension services?

- In which contexts is it most effective to utilize horizontal networks versus vertical networks?

Time Availability

What approaches increase women's access to high quality labor (IE)? Access to agricultural labor stands out as one of the more severe constraints to bridging the gender gap in agriculture as well as one of the areas that the intervention and programming space typically doesn't address. Hence, the potential to identify or design cost-efficient programs that are particularly beneficial to women farmers appears to be particularly promising.

- What is the most effective and cost-efficient way to improve women's access to hired labor? Can offering women farmers financing to hire farm labor or tasking agents with helping women farmers to find and manage labor increase access to hired labor?
- How can women access more household labor?
- Can the provision of rural, community-based childcare centers help lift women's time constraints and reduce household demands?
- Does enhancing women's use of tools and mechanized equipment reduce the amount of labor they require on the farm? How can women farmers be provided with adequate financing options for hiring or purchasing machinery?

Which factors most constrain women farmers' access to time and/or agricultural labor (CD)?

To release women's own time, interventions can aim to either free up time women spent on tasks other than agricultural production, such as domestic demands including childcare, or to introduce labor-saving technologies such as mechanization. Providing women with greater access to farm labor is another option. More evidence is needed to understand potential approaches to increasing women's access to time and/or agricultural labor. Potential questions to explore include:

- Which interventions allow women to contribute more time to agricultural production? Given a variety of contexts, what are the effects of interventions that:
 - Introduce labor-saving technologies like mechanization?
 - Free up women's time spent on non-agricultural tasks (i.e. domestic demands, childcare)?
- Which interventions increase women's access to farm labor? Given a variety of contexts, what are the effects of interventions that:
 - Allow women to hire high quality labor despite fewer financial resources and lower social standing?
 - Increase women's ability to effectively supervise labor despite lower educational levels and less time?

- Equalize workers' efforts for female managers despite cultural norms that may dictate that workers work harder for male managers?
- Ensure timely access to high quality labor during key planting and harvesting periods in a context in which laborers are hired by men first?

Market Orientation

Which interventions can shift women towards more *profitable markets* (IE)? Women farmers can benefit from being better connected to output markets in different ways. First, they may be able to achieve higher prices for their produce. Second, having market access allows women to switch to growing crops with higher value additions and to specialize. Finally, market participation helps women break down other constraints such as having no control over cash or first-hand exposure to market opportunities.

- What are the most promising means through which women's cultivation of higher-value or cash crops can be promoted?
- What are appropriate measures to improve women's access to and effective participation in markets?

Targeting and Defining

Who should agricultural interventions target (T)? As agricultural interventions are one of the primary means to reach the rural poor, their targeting approaches are potentially geared towards identifying the most vulnerable instead of those on whom the interventions may have the biggest impacts. While this approach is completely understandable from a perspective that puts a high emphasis on inclusivity, it may also explain why program impacts in terms of increasing agricultural productivity and shifting agricultural practices can be more difficult to document. While program beneficiaries of other development initiatives are sometimes tediously selected, such as entrepreneurship program grant recipients who are selected through business plan competitions, programs in agriculture are often much less selective. To identify which constraints are the most binding for women farmers and to maximize the impacts of interventions, more research is needed on how to design effective targeting approaches.

- What are the most effective targeting approaches to alleviate the most binding constraints for women farmers and maximize intervention impact?
- Which farmers should be reached through each particular intervention?
- Which interventions are most beneficial for particular groups of farmers?
- What are the trade-offs between equity and efficiency for male versus female farmers?

What constitutes a female farmer (D)? The discussion on what works to promote women farmers' agricultural productivity is complicated by the notion of what constitutes a women farmer. More precisely, women often closely coordinate and carry out agricultural activities in conjunction with other household members. As a matter of fact, this interconnectivity will extend to the decision-making related to the agricultural production and the use of productive assets, as well as the resulting produce. Therefore, while it is relatively straightforward to determine whether a woman is active in agriculture, attributing production outcomes and decisions to her individually poses challenges. Differentiating between male- and female-headed households to derive constraints specific to women farmers and to contrast impacts can be misleading given the numerous other potential differences that may exist between male- and female-headed households and, thus, comparisons may suffer from confounding factors.

It is difficult to arrive at a universally acceptable definition of what constitutes a woman farmer that is adequate across a wide range of contexts. Any single definition alone may not adequately reflect reality in all cases. One implication is that programs and evaluations have to be careful in outlining the results chain in order to be very explicit about which indicators and to which extent these indicators can be influenced by women farmers alone. It appears to be extremely important to measure outcomes at different stages of the results chain in order to better understand the limits of individuals' influence in an integrated system such as household agriculture.

Essentially, we need better data about who does what and why during joint production in order to better understand how to target the various elements of programs. Typically, programs target the household head but that might not make sense for some interventions where the workers are making decisions and steer the production process.

VI. Concluding Remarks

Women farmers are consistently found to be less productive than men farmers in Sub-Saharan Africa. Unfortunately, as of now, there is very limited evidence on effective programming to close this gender gap. In fact, we have yet to systematically uncover and document the underlying constraints that help equalize women farmers' access to productive resources and to eventually equalize productivity. While this paper highlights an emerging body of evidence related to the constraints that give rise to gender disparities in agriculture, for many constraints we still lack sufficient empirical proof that they bind on women's agricultural productivity. For instance, existing evidence does not adequately examine the relationship between women's time availability and their agricultural productivity. The role of intrahousehold dynamics, networks, and farm labor—and how they contribute to the agricultural productivity gender gap—has also not been

well documented. As a result, additional research is needed to establish how these constraints drive the gender gap in agricultural productivity before we know which interventions to test to narrow the gap. Meanwhile, two interrelated, cross-cutting issues that warrant further examination include how to design effective targeting approaches and take into women's role in joint production to maximize impact for women farmers.

Additional knowledge work is needed to generate robust policy recommendations on the design of effective, cost-efficient and scalable interventions that not only help women farmers to catch up to their male peers in terms of agricultural production, but also, more generally, to advance women's economic empowerment in agriculture. Progress in closing the agricultural productivity gender gap remains critical to strengthening the growth prospects of the agricultural sector and stimulating the structural transformation that the continent aims to achieve.

References

Achandi, E. L., Mujawamariya, G., Agboh-Noameshie, A. R., Gebremariam, S., Rahalivavololona, N., & Rodenburg, J. (2018). Women's access to agricultural technologies in rice production and processing hubs: A comparative analysis of Ethiopia, Madagascar and Tanzania. *Journal of Rural Studies*, 60, 188-198.

Adekambi, S. A., Diagne, A., Simtowe, F., & Biao, G. (2009, August). The impact of agricultural technology adoption on poverty: the case of Nerica rice varieties in Benin. In International Association of Agricultural Economists' 2009 Conference, Beijing, China, August 16 (Vol. 22, p. 2009).

Agboh-Noameshie, A. R., Kinkingninhou-Medagbe, F. M., & Diagne, A. (2007). Gendered impact of NERICA adoption on farmers' production and income in Central Benin. In 2nd Conference of the African Association of Agricultural Economists, Accra, Ghana (pp. 18- 22).

Agrawal, A., Yadama, G., Andrade, R., & Bhattacharya, A. (2006). Decentralization and environmental conservation: gender effects from participation in joint forest management. CAPRI working papers 53, International Food Policy Research Institute (IFPRI).

Ambler, K., Jones, K., and O'Sullivan, M. (2021). Facilitating women's access to an economic empowerment initiative: Evidence from Uganda. *World Development* 138(2021): 105224.

Anderson, J. R., & Feder, G. (2007). Chapter 44: Agricultural Extension. In R. Evenson and P. Pingali (Ed.), *Handbook of Agricultural Economics* (Vol. Volume 3, pp. 2343–2378). Elsevier.

Aguilar, A., Carranza, E., Goldstein, M., Kilic, T. & Oseni, G. (2015). Decomposition of gender differentials in agricultural productivity in Ethiopia. *Agricultural Economics*, 46.3, pp. 311-334.

Agyei-Holmes, A., Buehren, N., Goldstein, M., Osei, R. D., Osei-Akoto, I., & Udry, C. (2020). The Effects of Land Title Registration on Tenure Security, Investment and the Allocation of Productive Resources. Global Poverty Research Lab Working Paper, (20-107).

Aker, J. C. (2011). Dial ‘A’ for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, 42(6), 631–647.

Aker, J. C., Ghosh, I., & Burrell, J. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics*, 47(S1), 3548.

Ali, D. A., Bowen, D., Deininger, K., & Duponchel, M. F. (2015). Investigating the Gender Gap in Agricultural Productivity: Evidence from Uganda. World Bank Policy Research Working Paper No. 7262.

Ali, D. A., Collin, M., Deininger, K., Dercon, S., Sandefur, J., & Zeitlin, A. (2014). The Price of Empowerment: Experimental Evidence on Land Titling in Tanzania. World Bank Policy Research Working Paper No. 6908. Washington, D.C.: World Bank.

Aluko, B. T., & Amidu. A. (2006). Women and land rights reforms in Nigeria. *5th FIG regional conference, on Promoting Land Administration and Good Governance. Accra, Ghana.*

Ambler, K., Jones, K. M., & O'Sullivan, M. (2018). What is the role of men in connecting women to cash crop markets? Evidence from Uganda (Vol. 1762). Intl Food Policy Res Inst.

Backiny-Yetna, P. & McGee, K. (2015). Gender differentials in agricultural productivity in Niger. World Bank Policy Research Working Paper No. 7199. Washington, D.C.: World Bank

Baumüller, H. (2018). The little we know: An exploratory literature review on the utility of mobile phone-enabled services for smallholder farmers. *Journal of International Development*, 30(1), 134–154.

Beaman, L., & Dillon, A. (2018). Diffusion of Agricultural Information within Social Networks: Evidence on Gender Inequalities from Mali. *Journal of Development Economics*, 133, 147-161,

Bello, L. O., Baiyegunhi, L. J., Danso-Abbeam, G., & Ogundeji, A. A. (2021). Gender decomposition in smallholder agricultural performance in rural Nigeria. *Scientific African*, 13, e00875.

Bezabih, M., Holden, S., & Mannberg, A. (2012). The Role of Land Certification in Reducing Gender Gaps in Productivity in Rural Ethiopia. Norwegian University of Life Sciences Centre for Land Tenure Studies Working Paper No. 01/12.

Brudevold-Newman, A., Donald, A., & Rouanet, L. (2023). Steered Away from the Fields: Short-Term Impacts of Oxen on Agricultural Production and Intra-Household Labor Supply. <https://custom.cvent.com/4E741122FD8B4A1B97E483EC8BB51CC4/files/event/192dc645bb4640f392198ab420fdad16/10e5169808984833a54885b94c9a02a5.pdf>

Buehren, N., Goldstein, M., Molina, E., & Vaillant, J. (2019). The impact of strengthening agricultural extension services on women farmers: Evidence from Ethiopia. *Agricultural Economics*, 50:4, 407-419.

Byerlee, D., de Janvry, A., & Sadoulet, E. (2009). Agriculture for development: Towards a new paradigm. *Annual Review of Resource Economics*, 1, 15–31.

Carranza, E., Donald, A., Jones, R., & Rouanet, L. (2017). Time and money: a study of labor constraints for female cotton producers in Cote D'Ivoire.

Croppenstedt, A., Goldstein, M., & Rosas, N. (2013). Gender and Agriculture: Inefficiencies, Segregation, and Low Productivity Traps. *World Bank Research Observer*, 28:1, 79-109.

Datar, G., Del Carpio, X. V., & Hoffmann, V. (2009). Can a Market-Assisted Land Redistribution Program Improve the Lives of the Poor? Evidence from Malawi. World Bank Policy Research Working Paper No. 5093. Washington, D.C.: World Bank.

Davis, K. (2008). Extension in Sub-Saharan Africa: Overview and assessment of past and current models, and future prospects. *Journal of International Agricultural Extension and Education*, 15, 15–28.

Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development*, 40(2), 402-413.

- Deaton, A. (1992). Household Saving in LDCs: Credit Markets, Insurance and Welfare. *Scandinavian Journal of Economics*, Wiley Blackwell, vol. 94(2), pages 253-73.
- de la O Campos, A. P., Covarrubias, K. A., & Patron, A. P. (2016). How Does the Choice of the Gender Indicator Affect the Analysis of Gender Differences in Agricultural Productivity? Evidence from Uganda. *World Development*, 77, 17-33.
- Delavallade, C., Dizon, F., Hill, R. V., & Petraud, J. P. (2015). Managing risk with insurance and savings: Experimental evidence for male and female farm managers in the Sahel. World Bank Policy Research Working Paper No. 7176. Washington, D.C.: World Bank.
- Diagne, A. (2006). Diffusion and adoption of NERICA rice varieties in Côte d'Ivoire. *The Developing Economies*, 44(2), 208-231.
- Dibba, L., Diagne, A., Fialor, S. C., & Nimoh, F. (2012). Diffusion and adoption of new rice varieties for Africa (NERICA) in the Gambia. *African Crop Science Journal*, 20(1).
- Dillon, A. and Quinones, E. (2009). Asset Dynamics in Northern Nigeria. IFPRI Discussion Paper No. 01049. Washington, D.C.: IFPRI.
- Dione, M., Kangethe, E., Poole, E. J., Ndiwa, N., Ouma, E., & Dror, I. (2021). Digital Extension Interactive Voice Response (IVR) mLearning: Lessons Learnt From Uganda Pig Value Chain. *Frontiers in veterinary science*, 8.
- Djurfeldt, A. A., Joshua, M., Kaleng'a, W., Kalindi, A., Msuya, E., Mulwafu, W., & Wamulume, M. (2019). Agricultural intensification and gender in Malawi, Tanzania and Zambia.
- Donald, A., Goldstein, M., & Rouanet, L. (2022). Two Heads Are Better Than One: Agricultural Production and Investment in Côte d'Ivoire. World Bank Policy Research Working Paper No. 10047. Washington, D.C.: World Bank.
- Donald, A., & Vaillant, J. (2023). Experimental Evidence on Rural Childcare Provision. <https://custom.cvent.com/4E741122FD8B4A1B97E483EC8BB51CC4/files/f78b0532284f438187be23552d76a3d3.pdf>
- Doss, C. R. (2001). Designing agricultural technology for African women farmers: Lessons from 25 years of experience. *World Development*, 29 (12), 2075–2092.
- Doss, C. R. (2015). Women and Agricultural Productivity: What Does the Evidence Tell Us?. *Yale University Economic Growth Center Discussion Paper* No. 1051.

- Doss, C., & Meinzen-Dick, R. (2020). Land tenure security for women: A conceptual framework. *Land Use Policy*, 99, 105080.
- Doss, C., & Morris, M. L. (2001). How Does Gender Affect the Adoption of Agricultural Innovations? The Case of Improved Maize Technology in Ghana. *Agricultural Economics*. 25: 27– 39.
- Duflo, E. & Udry, C. (2004). Intrahousehold Resource Allocation in Cote d'Ivoire: Social Norms, Separate Accounts and Consumption Choices," NBER Working Papers No. 10498.
- FAO (2011). The State of Food and Agriculture 2010–2011: Women in Agriculture: Closing the Gender Gap for Development. FAO Home, <http://www.fao.org/docrep/013/i2050e/i2050e00.Htm>.
- Fischer, G., Wittich, S., Malima, G., Sikumba, G., Lukuyu, B., Ngunga, D., & Rugalabam, J. (2018). Gender and mechanization: Exploring the sustainability of mechanized forage chopping in Tanzania. *Journal of Rural Studies*, 64, 112-122.
- Frese, M. Goldstein, M., Kilic, T., & Montalvao, J. (2017). Soft Skills for Hard Constraints: Evidence from High-Achieving Female Farmers. World Bank Policy Research Working Paper No. 8095. Washington, D.C.: World Bank.
- Goldstein, M., & Udry, C. (1999). Gender and Land Resource Management in Southern Ghana.
- Goldstein, M., Hounghbedji, K., Kondylis, F., O’Sullivan, M., & Selod, H. (2015). Formalizing Rural Land Rights in West Africa: Evidence from a Randomized Impact Evaluation in Benin. World Bank Policy Research Working Paper. Washington, D.C.: World Bank.
- Gouse, M., Sengupta, D., Zambrano, P., & Zepeda, J. F. (2016). Genetically modified maize: less drudgery for her, more maize for him? Evidence from smallholder maize farmers in South Africa. *World Development*, 83, 27-38.
- Government of the Republic of Mali (2009). *Plans d’Action de la Politique Nationale Genre du Mali*, Government of Mali.
- Gilbert, R. A., Sakala, W. D. & Benson T. D. (2002). Gender analysis of a nationwide cropping system trial survey in Malawi. *African Studies Quarterly*, 6 (1).

- Gilligan, D. O., Kumar, N., McNiven, S., Meenakshi, J. V., & Quisumbing, A. R. (2014). Bargaining power and biofortification: The role of gender in adoption of orange sweet potato in Uganda. IFPRI discussion papers 1321, International Food Policy Research Institute (IFPRI).
- Gine, Xa., Patel, S., Cuellar-Martinez, C., McCoy, S., & Ralph, L. (2015). Enhancing Food Production and Food Security Through Improved Inputs: An Evaluation of Tanzania's National Agricultural Input Voucher Scheme with a Focus on Gender Impacts. 3ie impact evaluation report no. 23. New Delhi: International Initiative for Impact Evaluation.
- Githinji, M., Konstantinidis, C., & Barenberg, A. (2014). Small and Productive: Kenyan Women and Crop Choice. *Feminist Economics*, 20 (1): 101–29.
- Guirking, C., Platteau, J.-P., & Tatiana Goetghebuer, T. (2015). Productive Inefficiency in Extended Agricultural Households: Evidence from Mali. *Journal of Development Economics*. 116: 17–27.
- Hoffmann, N. I., & Roscoe, A. (2016). Investing in women along agribusiness value chains (No. 121535, pp. 1-65). Washington, D.C.: World Bank.
- Horrell, S., & Krishnan, P. (2007). Poverty and productivity in female-headed households in Zimbabwe. *The Journal of Development Studies*, 43(8), 1351-1380.
- Jack, B. K. (2013). Constraints on the adoption of agricultural technologies in developing countries. Literature review, Agricultural Technology Adoption Initiative, J-PAL (MIT) and CEGA (UC Berkeley).
- Kang, M., Schwab, B., & Yu, J. (2020). Gender differences in the relationship between land ownership and managerial rights: Implications for intrahousehold farm labor allocation. *World Development*, 125, 104669.
- Karamba, W., & Winters, P. C. (2015). Gender and agricultural productivity: implications of the Farm Input Subsidy Program in Malawi. *Agricultural Economics*, 46(3), 357– 374.
- Kaaria, S., Osorio, M., Wagner, S., & Gallina, A. (2016). Rural women's participation in producer organizations: An analysis of the barriers that women face and strategies to foster equitable and effective participation. *Journal of Gender, Agriculture and Food Security* (Agri-Gender), 1(302-2016-4754), 148-167.

Kazianga, H., & Wahhaj, Z. (2013). Gender, Social Norms and Household Production in Burkina Faso. *Economic Development and Cultural Change*, 61 (3): 539–76.

Keenan, M., Pamuk, H., Karanja Ng'ang'a, S., & Hella, J. P. (2021). Investment and Household Bargaining in Small-scale Farming Households-A Lab-in-the-Field Experiment from Rural Tanzania. CGIAR Research Program on Climate Change, Agriculture and Food Security Working Paper.

Kelly, V., Adesina, A., & Gordon, A. (2003). Expanding access to agricultural inputs in Africa: a review of recent market development experience. *Food Policy*, 28: 379-404.

Kilic, T., Palacios-Lopez, A., & Goldstein, M. (2015). Caught in a productivity trap: a distributional perspective on gender differences in Malawian agriculture. *World Development*, 70, pp. 416-463.

Kondylis, F., Mueller, V., Sheriff, G., & Zhu, S. (2016) Do Female Instructors Reduce Gender Bias in Diffusion of Sustainable Land Management Techniques? Experimental Evidence From Mozambique. *World Development*, 78, pp. 436-449.

Kinkingninhoun-Médagbé, F. M., Diagne, A., Simtowe, F., Agboh-Noameshie, A. R., & Adégbola, P. Y. (2010). Gender Discrimination and Its Impact on Income, Productivity, and Technical Efficiency: Evidence from Benin. *Agriculture and Human Values* 27 (1): 57–69.

Lecoutere, E., Spielman, D. & Campenhout, B. (2019), Women's empowerment, agricultural extension, and digitalisation: Disentangling information and role model effects in rural Uganda. International Food Policy Research Institute (IFPRI), Discussion Paper 1889.

Machina, H., Ngoma, H., & Kuteya, N. A. (2019). Are agricultural subsidies gender sensitive? Heterogeneous impacts of the farmer input support program in Zambia. Feed the Future Innovation Lab for Food Security Policy Research Paper 141. East Lansing: Michigan State University.

Magnan, N., Love, A. M., Mishili, F. J., & Sheremenko, G. (2020). Husbands' and wives' risk preferences and improved maize adoption in Tanzania. *Agricultural Economics*, 51(5), 743-758.

Mbo'o-Tchouawou, M., & Colverson, K. (2014). Increasing access to agricultural extension and advisory services: How effective are new approaches in reaching women farmers in rural areas? International Livestock Research Institute Project Report.

Manfre, C., and Nordehn, C. (2013). Exploring the Promise of Information and Communication Technologies for Women Farmers in Kenya. MEAS Case Study 4.

Melesse, T. M., & Awel, Y. M. (2020). Land Tenure, Gender, and Productivity in Ethiopia and Tanzania. In *Women and Sustainable Human Development* (pp. 89-108). Palgrave Macmillan, Cham.

Mendola, M., and Simtowe, F. (2015). The Welfare Impact of Land Redistribution: Evidence from a Quasi-Experimental Initiative in Malawi. *World Development* 72 (August): 53–69.

Mueller, V., Quisumbing, A., Lee, H. L., & Droppelmann, K. (2014). Resettlement for Food Security's Sake: Insights from a Malawi Land Reform Project. *Land Economics* 90 (2): 222–36.

Mulokozi, G., Mselle, L., Mgoba, C., Mugyabuso, J.K.L., & Ndossi G.D. (2000). Improved Solar Drying of Vitamin A-rich Foods by Women's Groups in the Singida District of Tanzania. International Center for Research on Women. Research Report Series.

Naylor, R. (1992). Labour-saving technologies in the Javanese rice economy: recent developments and a look into the 1990s. *Bulletin of Indonesian Economic Studies*, 28(3), 71-91.

Njuki, J., & Sanginga, P. C. (2013). Women, livestock ownership and markets. Bridging the gender gap in Eastern and Southern Africa. Londres-Nueva York: Earthscan Routledge.

Njuki, J., Waithanji, E., Sakwa, B., Kariuki, J., Mukewa, E., & Ngige, J. (2014). Can market-based approaches to technology development and dissemination benefit women smallholder farmers?: A qualitative assessment of gender dynamics in the ownership, purchase, and use of irrigation pumps in Kenya and Tanzania (Vol. 1357). Intl Food Policy Res Inst.

Odurukwe, S., Matthews-Njoku, E., & Ejiogu-Okereke, N. (2006). Impacts of the women-in-agriculture (WIA) extension programme on women's lives; implications for subsistence agricultural production of women in Imo State, Nigeria. *Livestock Research for Rural Development*, 18(18).

OECD and FAO (2016). OECD-FAO Agricultural Outlook 2016-2025. Paris: OECD.

Ogunlela, Y. I., & Mukhtar, A. A. (2009). Gender issues in agriculture and rural development in Nigeria: The role of women. *Humanity & social sciences Journal*, 4(1), 19-30.

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

Olakojo, S. A. (2017). Gender gap in agricultural productivity in Nigeria: a commodity level analysis. *Economics of Agriculture*, 64(2), 415-435.

Oseni, G., Corral, P., Goldstein, M. & Winters, P. (2015). Explaining gender differentials in agricultural production in Nigeria. *Agricultural Economics*, 46.3, pp. 285-310.

O'Sullivan, M. B. (2017). Gender and property rights in Sub-Saharan Africa: a review of constraints and effective interventions. Policy Research working paper; no. WPS 8250. Washington, D.C.: World Bank.

Palacios-Lopez, A., Christiaensen, L., & Kilic, T. (2015). How much of the labor in African agriculture is provided by women?. *Policy Research working paper*; no. WPS 7282. Washington, D.C.: World Bank.

Paulin Njingulula Mumbeya et al., (2020). Can Innovation Platforms (IPs) Improve Rural Women Participation in Maize Value Chain? Evidence from the Eastern DR Congo. *European Journal of Agriculture and Food Sciences* 2, no. 3

Pierotti, R. S., Friedson-Ridenour, S., & Olayiwola, O. (2022). Women farm what they can manage: How time constraints affect the quantity and quality of labor for married women's agricultural production in southwestern Nigeria. *World Development*, 152, 105800.

Peterman, A., Quisumbing, A., Behrman, J., & Nkonya, E. (2011). "Understanding the complexities surrounding gender differences in agricultural productivity in Nigeria and Uganda." *Journal of Development Studies*, 47 (10), 1482-1509.

Porter, G., & Phillips-Howard, K. (1997). Comparing Contracts: An Evaluation of Contract Farming Schemes in Africa. *World Development*, 25(2): 227-238.

Quisumbing, A., Rubin, D., Manfre, C., Waithanji, E., van den Bold, M., Olney, D., Johnson, N., & Meinzen-Dick, R. (2015). Gender, assets, and market-oriented agriculture: learning from high value crop and livestock projects in Africa and Asia. *Agriculture and Human Values*, 32(4): 705-725.

Ragasa, C. (2014). Improving Gender Responsiveness of Agricultural Extension. In A. R. Quisumbing, R. Meinzen-Dick, T. L. Raney, A. Croppenstedt, J. A. Behrman, & A. Peterman (Eds.), *Gender in Agriculture* (pp. 411–430). Dordrecht: Springer Netherlands.

Ragsdale, K., Read-Wahidi, M., Méndez, G. R., & Lower, K. (2019). Why gender and land matter: Examples from rural Ghana. *African Journal of Food, Agriculture, Nutrition and Development*, 19(5), 15155-15158.

Reynolds, T., Tobin, D., Otieno, G., McCracken, A., & Guo, J. (2020). Differences in crop selection, resource constraints, and crop use values among female-and male-headed smallholder households in Kenya, Tanzania, and Uganda. *Journal of Agriculture, Food Systems, and Community Development*, 9(4), 1-28.

Ruel, M. T., 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? *The Lancet*, 382(9891), 536-551.

Saito, K. A., Mekonnen, H., & Spurling, D. (1994). Raising the Productivity of Women Farmers in Sub-Saharan Africa. *World Bank Discussion Paper*, No. 230. Washington D.C.: World Bank.

Saravanan, R., Sulaiman, R. V., Davis, K., & Suchiradipta, B. (2015). Navigating ICTs for extension and advisory services. Note 11. GFRAS Good Practice Notes for Extension and Advisory Services. Lindau: GFRAS.

Sheahan, M., & Barrett, C. B. (2014). Understanding the agricultural input landscape in Sub-Saharan Africa: recent plot, household, and community-level evidence. *Policy Research working paper*; no. WPS 7014. Washington, D.C.: World Bank.

Slavchevska, V. (2015). Gender differences in agricultural productivity: the case of Tanzania. *Agricultural Economics*, 46.3, pp.335-355.

Smith, L. C. (2003). The importance of women's status for child nutrition in developing countries. Vol. 131: Intl Food Policy Res Inst.

Theis, S., Lefore, N., Meinzen-Dick, R., & Bryan, E. (2018). What happens after technology adoption? Gendered aspects of small-scale irrigation technologies in Ethiopia, Ghana, and Tanzania. *Agriculture and Human Values*, 35(3), 671-684.

Theis, S., Krupnik, T. J., Sultana, N., Rahman, S. U., Seymour, G., & Abedin, N. (2019). Gender and agricultural mechanization: a mixed-methods exploration of the impacts of multi-crop reaper-harvester service provision in Bangladesh (Vol. 1837). Intl Food Policy Res Inst.

Udry, C. (1996). Gender, Agricultural Production and Theory of the Household. *Journal of Political Economy*, 104 (5): 1010–1046.

van den Bold, M., Pedehombga, A., Quisumbing, A. R., & Olney, D. K. (2013). Can integrated agriculture-nutrition programs change gender norms on land and asset ownership? Evidence from Burkina Faso International Food Policy Research Institute (IFPRI) Discussion Paper No. 1315.

Vemireddy, V., & Choudhary, A. (2021). A systematic review of labor-saving technologies: Implications for women in agriculture. *Global Food Security*, 29, 100541.

Woldu, T., & Tadesse, F. (2015). Women's Participation in Agricultural Cooperatives in Ethiopia (No. 1008-2016-80335).

World Bank (2011). *World Development Report 2012: Gender equality and development*, Washington, D.C.: World Bank.

World Bank and IFPRI. (2010) *Gender and governance in rural services: Insights from India, Ghana, and Ethiopia*. Washington, D.C.: World Bank.

World Bank and ONE (2014). *Levelling the Field: Improving Opportunities for Women Farmers in Africa*. Washington, D.C.: World Bank.

World Bank and UN (2015). *The cost of the gender gap in agricultural productivity in Malawi, Tanzania, and Uganda*. Washington, D.C.: World Bank.

World Bank (2018). *Agriculture in Africa: Telling Myths from Facts*. Washington, D.C.: World Bank.

World Bank (2021). *Women's Economic Empowerment in the Democratic Republic of the Congo: Obstacles and Opportunities*. Washington, D.C.: World Bank.

World Bank (2022). *Closing Gaps, Increasing Opportunities: A Diagnostic on Women's Economic Empowerment in Nigeria*. Washington, D.C.: World Bank.

Zossou, E., Van Mele, P., Vodouhe, S. D., & Wanvoeke, J. (2009). Comparing farmer-to-farmer video with workshops to train rural women in improved rice parboiling in central Benin. *Journal of Agricultural Education and Extension*, 15(4), 329-339.