Gender Norms, Technology Access, and Women Farmers' Vulnerability to Climate Change in Sub-Saharan Africa

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Abstract The challenges of climate change are defined by biophysical unpredictability and the sociocultural context in which communities adjust to these challenges. Gender norms to which women and men generally conform influence women smallholder farmers' vulnerability to climate change. Understanding the social context within which an intervention is introduced can therefore greatly influence its transformative capacity. This review addresses the evidence on the influence of gender norms on climate-smart agricultural systems in sub-Saharan Africa through the dual lenses of equitable system productivity and women's empowerment. It makes a case for inclusive strategies to enhance equitable access to improved seed and other technologies as an adaptation option. We conclude that challenging gender norms around seed systems and extension services in SSA will increase our chance of success in mitigating climate disasters.

Keywords Climate-smart agriculture · Sub-Saharan Africa · Gender norms · Seed systems · Extension services

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1 Introduction

Climate-smart agriculture which emphasizes enhanced agricultural productivity and climate change adaptation and mitigation employs a wide array of approaches, ranging from natural resource management, soil conservation practices to more technology-focused interventions such as crop and livestock diversification (Lipper et al. 2014). Changing crop varieties is a top adaptation strategy employed by both men and women smallholder farmers to mitigate climate change (Twyman et al. 2014). Many climate-smart agriculture practices therefore require access and utilization of quality improved seeds and other agricultural inputs and extension services. The improved seeds and inputs enhance productivity, while agricultural extension services support farmers to access information, link with other actors and services, and form viable institutions through which they can access improved seeds and complementary technologies and services. We argue that in all these interventions, equal attention should be devoted to gender because besides the biophysical factors, social dynamics further contribute to system vulnerability and resilience. Better understanding of gender is particularly vital to cope with the prevailing complex and highly challenging environment characterized by population explosion, fragile natural resources, unfavorable social systems, and gender norms.

Smallholder farming in sub-Saharan Africa (SSA) is intimately intertwined with the social fabric of society. Gender defines how men and women relate within the household, the roles they perform, how they interact with the factors of production, the enterprises they manage, and benefits they enjoy from these investments. The sociocultural construction of men and women, boys and girls manifesting across key institutions at household, local, national, and international level, has usually subordinated women and girls (Kabeer 1999). This has resulted in gender-based constraints and privileges in most cases to the disadvantage of women and girls. For example, studies have revealed disparities in women and men smallholder farmers' access to adoption and benefit from new knowledge and technologies (Doss and Morris 2001; Quisumbing and Pandolfelli 2010, Mudege et al. 2017). Resource-poor farmers, the majority of whom are rural women, often have very limited access to land and improved technologies such as inputs, credit, and extension needed for improving livelihoods (FAO 2011). Resource allocation may also reflect competition, investment trade-off, and gender-linked orientation within the household. Consequently, a holistic understanding of the vulnerability of smallholder agriculture in SSA that embodies the social physical and economic dimensions should underpin climate response interventions. Similarly, there is need to tap into the potential and capacity of women as key players to strengthen resilience such as drawing on their local knowledge, creativity, and existing networks. There is evidence that where women were aware of climate adaptation options, they were likely to adopt, suggesting that targeting women with climate and agricultural information is effective in promoting uptake of new agricultural practices for adaptation (Twyman et al. 2014).

This review aims at highlighting the growing body of evidence regarding the influence of gender norms on sustainable agricultural systems in sub-Saharan Africa through the dual lenses of equitable system productivity and women's empowerment. It assesses how gender norms contribute to the vulnerability of women smallholder farmers in SSA by limiting their access and utilization of improved seeds, complementary technologies, and extension services. While this topic has been widely examined and acknowledged, it has not been satisfactorily integrated into thinking about and planning for climate change. We start by defining gender norms discussing how they affect agricultural technology utilization. In order to attain optimum returns from adoption of improved seeds, farmers often have to access complementary technologies, inputs, and extension services. The chapter therefore expounds how gender norms influence seed and agro-input systems and extension services. This review reveals potential biases engraved in gender norms and important entry points for a more gender inclusive application of improved seeds and other agricultural technologies toward a resilient system in the face of climate change.

2 Gender Norms Defined

Gender norms have been variously defined. The United Nations Statistics Division (2015) defined gender norms as the standards and expectations to which women and men generally conform, within a range that defines a particular society or group, culture, and community at a particular point in time. Kabeer (1994) defined gender norms as rules embedded in the communities, activities or behaviors, resources available, and decision-making which influence the roles and activities of men and women differently. Norms are context specific and time bound as they may change from place to place and over time. Members of a group or community tend to adhere to the norms or rules of that particular group or society. Gender norms are therefore a type of sociocultural regulation, a social control mechanism, and structural elements providing a sense of direction to men and women (Spencer et al. 2015).

Gender norms influence the roles played by men and women in production activities. In some communities, certain agriculture-related roles are assigned to men and women differently based on the type of crop (Doss 2002). Consequently, men and women are engaged in different activities in the production value chains, and this impacts on their productivity and climate response. Ajambo et al. (2018) found that in nine banana bunchy top disease pilot sites in SSA, gender division of labor in banana production differed across sites. For instance, in Nigeria, men were involved in all banana production activities, while women and children were mostly involved in processing and marketing. By contrast, in Burundi and Gabon, men and women jointly did most banana production activities with the children mainly assisting in activities such as weeding and transporting of planting materials. The different roles performed by men and women were linked to community gendered perceptions. In some cultural contexts, men are perceived as physically stronger than women and

are required to take up strenuous and labor-intensive tasks such as field preparation, while women are expected to engage in "soft" tasks that require keenness such as seed sourcing and processing. In Nigeria, for instance, in Idologun community, men who allowed their wives to engage in labor-intensive banana production activities were regarded as lazy and incapable of providing for their families and were not respected in the community (Nkengla et al. 2018 in press).

3 Gender and Agricultural Technology: A Case of Improved Seeds

Gender norms explain and help to understand the root causes of smallholder women farmers' vulnerability, a useful starting point to developing inclusive strategies for enhanced access to improved seeds and other technologies for climate change response. Besides roles, the norms underpin gender-differentiated needs, priorities, and access to productive resources for men and women (Kristjanson et al. 2014; Meinzen-Dick et al. 2012; Quisumbing and Pandolfelli 2010). Prevailing social and gender norms also shape the way men and women behave, interact, and react toward agricultural technologies including agricultural inputs and extension services as well as benefit sharing from participation and adoption of agricultural technologies (Ajani 2008; Mudege et al. 2015;Twyman et al. 2015; Padmanabhan 2002; Jeckoniah et al. 2013). Several studies in Uganda on climate change showed that gender and class can shape and influence the processing of climate-related information (Roncoli 2006 cited in World Bank Group, FAO and IFAD 2015). Societal norms and beliefs related to resource access and control in developing countries have led to differential vulnerabilities and impacts of climate change for men and women, thus affecting their willingness and capacity to adopt climate-related technologies (Huyer et al. 2015; Kristjanson et al. 2014; Nyasimi et al. 2017). For instance, women's role as collectors of firewood influenced higher adoption of agroforestry systems such as improved tree fallows in Zambia and Uganda (Phiri et al. 2004). Other studies in Nigeria (Sanginga et al. 2007) and Malawi (Gilbert et al. 2002) found higher adoption rate of seeds and fertilizers, respectively, among men. Hence, ignoring gender norms in the dissemination of agricultural technology can impact adoption as it is dependent on access to and decision-making rights over resources such as land and labor which in sub-Saharan Africa is unequal, mostly favoring men (Doss and Morris 2001).

A mainstay in strategies to improve agricultural productivity in SSA has long been the development and delivery of improved seeds, which has had limited success mainly due to the complexity of SSA seed systems. Informal seed systems have undergone restructuring over the past decades, moving from formalization under government control in the 1970s to privatization starting in the 1980s, finally with the 1990s characterized by NGO and relief organizations becoming involved (Rubyogo et al. 2007). Current trends in SSA seed system development include a mixture of formalization of seed systems through links with the private sector,

subregional organizations, and NGOs while also strengthening existing networks and farmer seed multipliers (McGuire and Sperling 2016). Recent investments also focus on integration of formal and informal seed systems, which remain mostly ad hoc and localized (Sperling et al. 2014). Formal seed systems in SSA largely remain undeveloped, with most farmers obtaining seed from informal channels: farm-saved seeds, exchanges, or gifts characterizing the bulk (90%) of seed movement (Maredia et al. 1999; McGuire and Sperling 2016). Adoption rates of improved seeds differ by crop, country, context, but most interestingly also by the sex of the household head (Smale et al. 1991). Technology adoption decisions are informed by access to resources, and with a demonstrated large gender gap in assets, it means improved varieties are often not "gender neutral" but depend on the context within which the technology is released (Doss and Morris 2001). Besides gender, wealth has been found to be another major structuring factor in local seed circulation in Cameroon, with wealthy households having access to wider diversity of seed sources (Wencélius et al. 2016). Smale et al. (2018) also found intersectional variables such as marital status, education, and age, in combination with gender, strongly explained if improved seed was grown in households examined. Though women may have less access to formal seed systems, this is not insurmountable. Women's access to improved seed and input in variety development decision-making can be strengthened through participatory plant breeding approaches, for example (Galiè 2013).

The social context within which an intervention is introduced to communities under threat of climate change can greatly influence adaptive capacity, especially for disadvantaged groups (Kristjanson et al. 2017). In Ethiopia, households most vulnerable to extreme weather events (drought) chose landraces over improved sorghum varieties to mitigate risk, whereas households with only moderate risk chose to adopt improved varieties (Cavatassi et al. 2011), putting into question the use of improved varieties as a means to mitigate climate stress. The same study questioned the suitability of different varieties to handle different kinds of climate stresses (catastrophic vs chronic), which should be considered in developing varieties. On the other hand, new seeds may in fact benefit marginalized groups and their ability to weather climate shocks. Randomized control trials (RCTs) with flood-tolerant rice varieties in India showed that the highest gains in productivity were in regions where flooding was most severe, where lower caste social groups tended to cultivate land due to historical land allocation practices (Dar et al. 2013).

Barriers to women's access to farm inputs including improved seeds exacerbate the gender gap in agriculture (World Bank 2008) and, without amelioration, will only widen the gender gap in climate change resilience (Nyasimi and Huyer 2017). Men are more likely than women to adopt climate-stress-tolerant seeds (Kristjanson et al. 2017), in line with the observation that adoption rates of agricultural technologies remain low among women in SSA, likely due to gender norms (Peterman et al. 2014; see section on how gender norms influence extension services). In Ghana, for example, men mentioned adoption of improved varieties as a climate change mitigation strategy, while women did not (Naab and Koranteng 2012). Similarly, in Tanzania 95% of farmers used improved crop varieties as climate-smart agriculture (CSA) practices, yet when the data was disaggregated by sex, improved varieties

were mentioned three times more by men than by women, indicating key differences in CSA practices of choice among men and women (Nyasimi et al. 2017). Decisions around crop diversification (including use of new varieties) in response to climate stress in maize production systems in Benin varied significantly by gender (Yegbemey et al. 2013). This may be explained by the higher land ownership enjoyed by men in the region, which was found to be highly correlated to any climate change adaptation strategies in the same study. Lastly in Uganda, studies by Fisher and Carr (2015) revealed that women farmers have much lower adoption rates of drought-resistant varieties of maize than men. The cumulative results of these studies indicate that despite the availability of climate-smart seeds and best intentions to distribute them, gender-based barriers may constrain women's access to these as a mitigation strategy.

From a holistic standpoint, agricultural technology can affect farmers positively or negatively. Some innovations that aim at achieving increased productivity may worsen gender (and other social) inequity. For instance, introduction of agricultural technologies may affect the well-being of women farmers resulting in labor drudgery, increased time for farm activities or household chores, and lower access to agricultural inputs and technology (Doss 2001; Ragasa 2012). To ensure that vulnerable groups such as women have equal access to proposed technologies, it is important to identify and consider the impediments embedded in gender norms in the society. It is now apparent that agricultural innovation that does not consider the socio-technical aspects often different for men and women (Jacobson 2011) is likely not to acquire the desired results.

There are no silver bullets in combating climate change, including improved seed. What is clear though is that any proposed intervention and practice should include women as part of the solution through researchers and communities working to overcome gender-based constraints to women's adoption of climate resilience practices (Kristjanson et al. 2017). This is part of the "transformative change" vision put forth by CCAFS to overcome gender norms and empower women to become agents of change in the face of climate change (Jost et al. 2016). Gender-responsive CSA practices and technologies provide an opportunity to close the gender gap as well as bring women into the forefront in the fight against climate change (Nyasimi and Huyer 2017). There is great potential in empowering women to lead the drive against climate change in SSA.

4 Gender and Agricultural Extension Services

Agricultural extension services play a key role in farmers' uptake of improved technologies. The traditional role of such services has been to provide information on reliable sources of quality inputs (including seeds) to farmers coupled with unbiased training and advice on proper utilization and agronomic practices. More recently, the role of extension is evolving to embrace emerging needs to organize farmers into institutions that promote collective action, empowerment, voice, and

efficient access to productivity enhancing technologies and services. This is in response to the increased recognition of the complexity involved as practitioners of commercializing SSA agriculture have began to adopt a value chain focus. The prevailing setup necessitates linking farmers with a range of actors in the innovation system through multi-stakeholder innovation platforms and other institutions where extension's capacity building, brokering, and convening roles are central.

Smallholder women farmers in SSA are not able to fully benefit from extension services that support climate response despite their crucial role illustrated in the above sections. Many obstacles to gender equitable extension services are rooted in the local culture of various SSA countries which shapes women's roles and position in society. Gender norms which manifest in extension organizations, farmer organizations, and households largely explain this status quo. They shape the extension staffing, methods used, extension packages, or messages promoted all of which disadvantage women. There are bottlenecks at the level of access whereby women have been found to have less contact with services compared to men; and participation in farmers' institutions is often used as a vehicle for service delivery.

Women often have to travel to access information and training and purchase seeds and other technologies, yet they are often more constrained than men in their movements. Gender norms that vary across societies determine where, when, for how long, and for what reasons women should leave their homes. These restrictions are more prevalent in rural areas (Mandel 2004; Porter 2011). Constraints related to mobility influence women's access to information, training, and adoption of agricultural technologies (Bergman Lodin et al. 2018 in press). However, in some regions, unmarried women are often able to move more freely to secure a living since they do not need to seek approval from husbands or other family members. Several case studies (Uganda, Kenya, Malawi) from the GENNOVATE project indicate that the inability of women to move freely limits their learning and exposure to agricultural related information. Reasons postulated for this restriction include withholding of permission by families and communities, household drudgery, and jealousy by husband for fears of promiscuity (GENNOVATE 2017). Restrictions on interaction with men extension staff further limit opportunities to participation in extension activities. Other cultural prohibitions include women not being allowed to leave home alone, use public transport, or ride a motorbike all of which effectively prevent women from attending trainings in neighboring villages or work as extensionists (GIZ 2013).

Women need resources to access improved seed, complementary technologies, and supporting extension services to cope with climate change. Lack of decision-making powers on certain agricultural enterprises and lack of access to and control over land and other factors of production demotivate women from investing time and other resources needed to participate in extension activities related to such enterprises. Gender norms around roles and responsibilities in productive, reproductive, and community spheres place a heavy burden on women. Women's disproportionately heavier workload also rooted in the norm that women are expected to take care of domestic work, childcare, elder care, and care of the sick among other

domestic tasks, leaves them with limited time to earn an income and seek services available in the public sphere which would promote technology utilization.

Besides social norms in the wider community, organizational gender-based barriers within the extension service organizations and organizations offering complementary services (e.g., microfinance and marketing) further limit capacity to effectively serve women farmers. Within extension organizations, women extension staff face challenges attributed to traditional, male-dominated organizational dynamics and cultural barriers to women's education in science and agriculture, professional performance, and career advancement (Mangheni et al. 2010; FARA and AFAAS 2015). These challenges have partly led to women's minority status in agricultural professions in general and in many extension organizations in particular, especially in leadership positions (Mangheni et al. 2010). This in turn contributes to gender-biased decision-making and priority setting within extension organizations (Manyire and Apekey 2010). This is particularly important in cultures that restrict interactions between men extension providers and women farmers. Other gender issues within extension organizations include extension messages that are not responsive to strategic agricultural activities, interests, and responsibilities of women small-scale farmers' choice of advisory methods and approaches that exclude women, for instance, those requiring high literacy levels and commitment of much time (which women don't have) also exclude women. In Malawi, Mudege et al. (2015) reported that gender and cultural norms influence access to training and agricultural information. It was revealed that with men mostly identified as household heads, extension officers tend to be biased in selecting more men than women when running their training programs. Inadequate capacity within agricultural extension service organizations creates a key barrier to gender-responsive services. There is inadequate gender awareness and capacity in most organizations (Chipeta 2013), particularly the public sector which has the mandate for policy guidance and quality assurance within the pluralistic extension systems consisting of multiple providers in the public and private sector.

Addressing the above issues calls for gender-responsive extension and advisory services designed and implemented in a manner that effectively addresses needs (practical and strategic), interests, and issues affecting men and women beneficiaries, with guiding principles of promoting gender equity and women's agency (Chipeta 2013). Such services would by necessity take into consideration the complex sociocultural aspects of the target communities and other relevant institutions including the implementing extension organizations in order to deliver gender-equitable agricultural extension that empowers women (GIZ 2013). The packages disseminated to farmers and the delivery approaches and methods used to reach them should incorporate gender-specific targeting of women by providing them with their preferred types of seed varieties, technologies, information, and knowledge, in a form they understand and can use, within an organizational and institutional context guided by the principles of gender equality and women's empowerment. For example, in instances where women farm smaller plots and have low purchasing power, extension can promote marketing of seeds in smaller packs suited to the women's needs. The organizational and institutional context is key because

institutions (rules, attitudes, routines) and policies form the enabling environment that largely determines practices (Rasheed and Davis 2012). Transformation at this level is a key driver of gender equity and women's empowerment.

A synthesis of findings from seven country scoping studies (Benin, Ethiopia, Ghana, Malawi, Nigeria, Sudan, and Uganda) conducted by the Forum for Agricultural Research in Africa (FARA) and the African Forum for Agricultural Advisory Services (AFAAS) via desk reviews and key informant interviews documented case studies and identified best practices for effectively targeting women and youth (FARA and AFAAS 2015). The study recommended that gender-responsive extension approaches should address the formal and informal exclusion and/or unfavorable inclusion of women in the development process. In addition, best practices for gender-responsive rural advisory services should embody characteristics along the continuum of targeting deliberate participation, inclusion, and empowerment of women and, ultimately, transformation of the gender status quo. Tackling the root causes of women's subordination calls for questioning the status quo which is often sensitive, with a risk of eliciting resistance from the community. This requires long-term interventions, a lot of funds, and expertise which many extension service providers do not ordinarily possess. Such interventions also fall outside the conventional mandate of most extension organizations particularly those in government ministries of agriculture. Effective interventions would therefore call for establishment of partnerships with other organizations and/or review of mandates, structures of extension organizations, as well as training curricula for extension service providers. Since the concerned organizations fall under different ministries/organizational settings, coordinated harmonized action is quite challenging. This may explain why most innovations in gender-responsive extension often make no serious attempts to address cultural root causes of women's marginalization. In order to achieve women's empowerment goals, advisory services will have to include practical services that address issues related to women's rights and reduce obstacles to women's participation in extension services, for example, services that enhance women's voice in households and society and secure property rights. However, for greater impact, these need to be combined with or linked to other types of advocacy efforts at higher strategic and policy levels.

5 Conclusion

Climate change is a complex challenge threatening both current and future agricultural productivity in SSA. It is not only the biophysical unpredictability that defines the complexity of climate change and its potential impact on smallholders in SSA but also the sociocultural context in which communities face these challenges. Gender norms have enormous implications on the "who's" and "how's" that could underpin climate mitigation strategies. CSA practices offer a diverse basket of options to communities impacted by climate change, shaping how they may adapt to changing patterns of rainfall and temperature. This chapter

considered one of these CSA options: improved seeds. We argue that effective and efficient interventions in seed systems that foster resilience to climate stress should be gender responsive. This applies from the varietal design stage, where design principles for considering gender throughout the crop breeding cycle should be applied to the dissemination stage through seed and extension systems. There is a need to understand the gender norms governing the target communities to identify the constraints and opportunities for targeted seed interventions. Known gender-based constraints including access to labor, land, inputs, and training may all impact the adoption and utilization of CSA seeds and must therefore be carefully mapped out and identified through gender analysis and foresight studies. This diagnosis should anticipate potential negative impacts on women such as increase in workload and reduced access to seed arising from privatization of seed systems and commercialization.

Extension services that support CSA, seed, and technology dissemination programs should be designed to positively impact women. However, overcoming gender bias requires an understanding of the root causes of inequitable extension service provision, rather than simplistic strategies that address symptoms by targeting women. This calls for rigorous studies to map out and understand negative gender norms affecting extension which are often grounded in the wider societal and policy environment and rural development norms. Such studies can also uncover positive gender norms, on which one can build more effective CSA.

The vision for transformative change to empower women to become more effective agents of change in the face of climate change is a powerful narrative that aims to empower women by challenging norms and practices that perpetuate their disadvantaged status. CSA practices, including seeds and systems to disseminate these, should be coupled with these transformative approaches to improve on the norms that hinder or limit the participation of women. Moreover, understanding gender norms surrounding agricultural practices and agricultural technology uptake is a vital step toward appropriate and gender-responsive strategies for technology adoption. Gender equity is a key determinant in success of CSA practices, and expansion to scale is only possible if gender norms are challenged in partnership with communities to ensure that women have the same opportunities to combat climate change. We conclude that challenging gender norms around seed systems and extension systems in SSA will increase our chance of success in mitigating climate disasters. Women are affected by climate change as much as if not more than men, so they must be given a place at the table and a voice to help shape the solutions that will have such a large impact on their future as farmers in SSA. It is clear that considering gender in CSA technology design and dissemination is not only smart but necessary if success of a technology is to be determined by the number of lives it improves on adoption.

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References

Ajambo S, Rietveld A, Nkengla L, Omondi A, Niyongere C, Dhed'a D, Olaosebikan DO, Nitunga E, Toengaho J, Lava Kumar P, Hanna R, Sufo Kankeu R (2018) Recovering banana production in banana bunchy top affected areas in Sub-Saharan Africa: developing gender-responsive approaches. ActaHortic. 1196. ISHS 2018. https://doi.org/10.17660/ActaHortic.2018.1196.27

Ajani OI (2008) Gender dimensions in agriculture, poverty, nutrition and food security in Nigeria. Nigeria Strategy Support Program (NSSP). IFPRI. pp. 5–7

Bergman Lodin J, Tegbaru A, Degrande A, Nkengla-Asi L, Gaya HI, Bullock R (2018) Gendered mobilities and immobilities and women's and men's capacities for agricultural innovation. Insights from Kenya and Nigeria. Gend Place Cul, in press

Cavatassi R, Lipper L, Narloch U (2011) Modern variety adoption and risk management in drought prone areas: insights from the sorghum farmers of eastern Ethiopia. Agric Econ 42:279–292. https://doi.org/10.1111/j.1574-0862.2010.00514.x

Chipeta S (2013) Gender Equality in Rural Advisory Services. Towards a common understanding: A working document. GFRAS Working Group on Gender Equality in Rural Advisory Services. Global Forum for Rural Advisory Services (GFRAS), Lindau, Switzerland. http://www.g-fras.org/en/activities/gender-equality-in-ras-3.html. Accessed 11 May 2018

Dar MH, de Janvry A, Emerick K, Raitzer D, Sadoulet E (2013) Flood-tolerant rice reduces yield variability and raises expected yield, differentially benefitting socially disadvantaged groups. Sci Rep 3. https://doi.org/10.1038/srep03315

Doss C (2001) How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. Agric Econ 25:27–39. https://doi.org/10.1016/S0169-5150(00)00096-7

Doss C (2002) Men's crops? Women's crops? The gender patterns of cropping in Ghana. World Dev 30(11):1987–2000

Doss CR, Morris ML (2001) How does gender affect the adoption of agricultural innovations: the case of improved maize technology in Ghana. Agric Econ 25(1):27–39

Fisher M, Carr ER (2015) The influence of gendered roles and responsibilities on the adoption of technologies that mitigate drought risk: the case of drought-tolerant maize seed in eastern Uganda. Glob Environ Chang 35:82–92

FARA and AFAAS (2015) Scoping study of gender-responsive agricultural services for rural poverty reduction in Africa. Accra, Ghana, FARA

FAO (2011) The state of food and agriculture 2010–2011: women in agriculture: closing the gender gap for development. Food and Agriculture Organization of the United Nations, Rome, Italy

Galiè A (2013) Governance of seed and food security through participatory plant breeding: empirical evidence and gender analysis from Syria. Nat Res Forum 37:31–42. https://doi.org/10.1111/1477-8947.12008

Gilbert RA, Sakala WD, Benson TD (2002) Gender analysis of a nationwide cropping system trial survey in Malawi. Available at http://agris.fao.org/agrissearch/search.do?recordID=GB2013201770. Accessed 11th May 2018

GENNOVATE RTB-HT team (2017) Gender in agricultural change: towards more inclusive innovation in farming communities. GENNOVATE Report to the CGIARResearch Programs on Roots, Tubers and Bananas and Humidtropics. GENNOVATE Research Paper, RTB, Lima, Peru

GIZ (2013) Gender and agricultural extension. A report produced for the Federal Ministry for Economic Cooperation and Development (BMZ)

Huyer S, Twyman J, Koningstein M, Ashby J, Vermeulen SJ (2015) Supporting women farmers in a changing climate: five policy lessons. CCAFS Policy Brief 10. CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark

Jacobson JP (2011) The role of technological change in increasing gender equity with a focus on information and communications technology. Wesleyan university, Middletown

Jeckoniah J, Mdoe N, Nombo C (2013) Mapping of gender roles and relations along onion value chain in Northern Tanzania. Int J Asian Soc Sci 3(2):523–541

Jost C, Kyazze F, Naab J, Neelormi S, Kinyangi J, Zougmore R, Aggarwal P, Bhatta G, Chaudhury M, Tapio-Bistrom ML, Nelson S (2016) Understanding gender dimensions of agriculture and climate change in smallholder farming communities. Clim Dev 8(2):133–144

Kabeer N (1994) Reversed realities. Gender hierarchies in development thought. London, Verso

Kabeer N (1999) Resources, agency, achievements: reflections on the measurement of women's empowerment. Dev Chang 30:435–464

Kristjanson P, Waters-Bayer A, Johnson N, Tipilda A, Njuki J, Baltenweck GD, MacMillan D (2014) Livestock and women's livelihoods: a review of the recent evidence. In: Quisumbing A, Meinzen-Dick R, Raney T, Croppenstedt A, Behrman JA, Peterman A (eds) Gender in agriculture closing the knowledge gap. Springer with FAO, New York, NY, pp 209–233

Kristjanson P, Bryan E, Bernier Q, Twyman J, Meinzen-Dick R, Kieran C, Ringler C, Jost C, Doss C (2017) Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? Int J Agric Sustain 15:482–500. https://doi.org/10.1080/14735903.2017.1336411

Lipper L, Thornton P, Campbell BM et al (2014) Climate-smart agriculture for food security. Nat Clim Chang 4:1068–1072. www.nature.com/natureclimatechange

Mandel J (2004) Mobility matters: women's livelihood strategies in Porto Novo, Benin. Gend Place Cult 11(2):257–287

Mangheni MN, Ekirikubinza TL, Forsythe L (2010) Gender issues in agricultural education within African Universities. Gender background paper. Ministerial conference on higher education in agriculture in Africa. Accessed 10/8/2018 from https://www.nri.org/images/documents/development-programmes/gender_soc_dif/publications/Gender_Issues_AgrHrhEd.pdf

Manyire H, Apekey AD (2010) Mainstreaming gender equality in African agricultural research and development: a study of constraints and opportunities. Forum for Agricultural Research in Africa (FARA), Accra, Ghana

Maredia MK, Howard JA, Boughton D, Naseem A, Wanzala MN, and Kajisa K (1999) Increasing Seed System Efficiency in Africa: Concepts, Strategies and Issues, Food Security International Development Working Papers 54578, Michigan State University, Department of Agricultural, Food, and Resource Economics.

McGuire S, Sperling L (2016) Seed systems smallholder farmers use. Food Sec 8:179–195. https://doi.org/10.1007/s12571-015-0528-8

Meinzen-Dick R, Quisumbing A, Behrman J, Biermayr-Jenzano P, Wilde V, Noordeloos M, Beintema N (2012) Engendering agricultural research, development and extension. International Food Policy Research Institute (IFPRI), Washington, DC. Retrieved from http://www.ifpri.org/sites/default/files/publications/rr176.pdf. Accessed, 10th May 2018

Mudege NN, Mdege N, Abidin PE, Bhatasara S (2017) The role of gender norms in access to agricultural training in Chikwawa and Phalombe, Malawi. Gend Place Cul 24(12):1689–1710. https://doi.org/10.1080/0966369X.2017.1383363

Mudege NN, Chevo T, Nyekanyeka T, Kapalasa E, Demo P (2015) Gender norms and access to extension services and training among potato farmers in Dedza and Ntcheu in Malawi. J Agric Educ Ext 22(3):291–305. https://doi.org/10.1080/1389224X.2015.1038282

Naab JB, Koranteng H (2012) Using a gender lens to explore farmers' adaptation options in the face of climate change: results of a pilot study in Ghana. Working Paper No. 17, CGIAR Research Programme on Climate Change, Agriculture and Food Security. Nairobi, Kenya

Nkengla L, Olaosebikan DO, CheVicent S, Rachid H, Lava Kumar P (2018) Gender norms and implications for Banana recovery and Banana Bunchy Top Disease containment in West Africa. J Gend Agric Food Sec, in press

Nyasimi M, Huyer S (2017) Closing the gender gap in agriculture under climate change. Agric Dev 30:37–40

Nyasimi M, Kimeli P, Sayula G, Radeny M, Kinyangi J, Mungai C (2017) Adoption and dissemination pathways for climate-smart agriculture technologies and practices for climate-resilient livelihoods in Lushoto, Northeast Tanzania. Climate 5:63. https://doi.org/10.3390/cli5030063

Padmanabhan MA (2002) Trying to grow: gender relations and agricultural innovations in Northern Ghana. Rurale Geschlechterforschung 3:255. Munster: LIT Verlag

Peterman A, Behrman JA, Quisumbing AR (2014) A review of empirical evidence on gender differences in non-land agricultural inputs, technology, and services in developing countries. In: Gender in agriculture. Springer, Dordrecht, pp 145–186

Phiri D, Franzel S, Mafongoya P, Jere I, Katanga R, Phiri S (2004) Who is using the new technology? The association of wealth status and gender with the planting of improved tree fallows in Eastern Province, Zambia. Agr Syst 79:131–144

Porter G (2011) "I think a woman who travels a lot is befriending other men and that's why she travels": mobility constraints and their implications for rural women and girls in sub-Saharan Africa. Gend Place Cul 18(1):65–81

Quisumbing AR, Pandolfelli L (2010) Promising approaches to address the need of poor female farmers: resources, constraints, and interventions. World Dev 38(4):581–592

Rasheed SV, Davis K (2012) The "new extensionist": Roles, strategies and capacities to strengthen extension and advisory services. Global Forum for Rural Advisory Services (GFRAS), Lindau, Switzerland. http://www.g-fras.org/en/activities/the-new-extensionist.html. Accessed 11 May 2018

Ragasa C (2012) Gender and institutional dimensions of agricultural technology adoption: a review of literature and synthesis of 35 case studies. http://ageconsearch.umn.edu/bitstream/126747/2/IAAE.2012.gender.pdf. Accessed 08, 2018

Rubyogo JC, Sperling L, Nasirumbi L, Kasambala SP (2007) Developing seed systems with and for the marginalized : Case of common bean (Phaseolus vulgaris L.) in East, Central and Southern Africa. In: Farmer First Revisited Conference (2007, Sussex, England). Papers presented. Future Agricultures Consortium; Institute of Development Studies (IDS), Sussex, Great Britain. https://hdl.handle.net/10568/56162

Sanginga PC, Adesina AA, Manyong VM, Otite O, Dashiell KE (2007) Social impact of soybean in Nigeria's southern Guinea savanna Ibadan, Nigeria: International Institute of Tropical Agriculture, Ibadan, Nigeria

Smale M, Assima A, Kergna A, Thériault V, Weltzien E (2018) Farm family effects of adopting improved and hybrid sorghum seed in the Sudan savanna of West Africa. Food Policy 74:162–171. https://doi.org/10.1016/j.foodpol.2018.01.001

Smale M, Kaunda ZHW, Makina HL, Mkandawire MMMK, Msowoya MNS, Mwale DJEK, Heisey PW (1991) Chimanga cha makolo, hybrids, and composites: an analysis of farmers' adoption of maize technology in Malawi, 1989–91. Economics Program Working Paper 91–04. CIMMYT, Mexico, DF

Spencer RA, Rehman L, Kirk SF (2015) Understanding gender norms, nutrition, and physical activity in adolescent girls: a scoping review. Int J Behav Nutr Phys Act 12(1):–6

Sperling L, Boettiger S, Barker I (2014) Integrating seed systems, Planning for Scale Brief # 3: AgPartnerXChange. https://seedsystem.org/wp-content/uploads/2014/03/Integrating-Seed-Systems-.pdf

Twyman J, Green M, Bernier Q, Kristjanson P, Russo S, Tall A, Ndourba Y (2014) Adaptation actions in Africa: evidence that gender matters (CCAFS Working Paper no. 83). Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Retrieved from https://cgspace.cgiar.org/handle/10568/51391

Twyman J, Muriel J, García M (2015) Identifying women farmers: informal gender norms as institutional barriers to recognizing women's contributions to agriculture. J Gend Agric Food Sec 1(2):1–17

Wencélius J, Thomas M, Barbillon P, Garine E (2016) Interhousehold variability and its effects on seed circulation networks: a case study from northern Cameroon. Ecology and Society 21. https://doi.org/10.5751/ES-08208-210144

United Nations Statistics Division (UNSD) (2015) Global gender statistics programme. Available at: http://unstats.un.org/unsd/genderstatmanual/Glossary.ashx. Accessed on, 09th May 2018

World Bank, Food and Agriculture Organization, International Fund for Agricultural Development (2008) Gender in agriculture sourcebook. The World Bank. https://doi.org/10.1596/978-0-8213-7587-7

World Bank Group, FAO and IFAD (2015) Gender in climate-smart agriculture: module 18 for the gender in agriculture sourcebook. http://www.fao.org/3/a-i5546e.pdf. Accessed 27 May 2018

Yegbemey RN, Yabi JA, Tovignan SD, Gantoli G, HarollKokoye SE (2013) Farmers' decisions to adapt to climate change under various property rights: a case study of maize farming in northern Benin (West Africa). Land Use Policy 34:168–175. https://doi.org/10.1016/j.landusepol.2013.03.001