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A review of gender and sustainable land management: implications for research and development

CGIAR RESEARCH PROGRAM ON Livestock


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A review of gender and sustainable land management: implications for research and development

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Abbreviations

FGD	focus group discussion
GR	gender responsive
GTA	gender transformative approach
SLM	sustainable land management
SSA	sub-Saharan Africa
PES	payments for ecosystem service
GALS	gender action learning system

Abstract

The purpose of this paper is to describe how gender has been addressed in sustainable land management (SLM) with specific focus on conservation tillage, fodder production, manure management, water management and agroforestry. We summarize and review 38 recent and relevant studies and interview four knowledgeable experts to provide current and practical perspectives on the issues and challenges of gender integration in SLM. We draw on the review to outline main observations and recommendations. The review is not exhaustive but we are able to identify knowledge gaps and new frontiers for research to better understand interactions of gender, livestock and environmental change. We recommend research approaches that will unveil the complexity within livestock and crop agricultural systems and suggest using intersectional and socially differentiated approaches to better understand and integrate gender issues. Findings may then be used to inform the design of SLM interventions that will achieve gender balanced outcomes. Gender sensitive, responsive and transformative approaches will be essential to ensure that SLM enhances social equity in development and livelihood opportunities.

Introduction

Unsustainable land use is contributing to unprecedented levels of global land degradation (Tarrasson et al. 2016; Vlek et al. 2008; Foley et al. 2005; Vu et al. 2014). Nearly half of the world's degraded land is in areas with high incidence of poverty, and degradation affects the livelihoods of an estimated 1.5 billion people (Millenium ecosystem assessment 2008; Sanz et al. 2017; Bai et al. 2008). Land management programs on conservation tillage, fodder production, manure and water management, and agroforestry have been promoted in developing countries where smallholder agriculture plays a key role in livelihoods to improve and/or reverse the causes and detrimental effects of human-induced land degradation. Programs have resulted in mixed outcomes of successes and failures, highlighting challenges to address the complex, underlying causes and consequences of unsustainable land use in contexts that are characterized by high degrees of poverty. Attention to gender, including access to and control over land, ownership of land and agency regarding productive resources, can affect the adoption and adaptation rates, as well as the success of land management initiatives.

This review is specifically intended for uptake and use by the environment flagship of the International Livestock Research Institute (ILRI), the wider CGIAR and academic community. It addresses two broad questions. First, what does the literature say about how gender dynamics influence land use planning, policies, strategies and management? Second, how do gender dynamics, in relation to decision-making, labor, land use and ownership, improve the success of land management project designs in the agriculturally dependent developing countries?

We begin with a brief review of land management and gender. We then present a summarized review of specific topics: conservation tillage, fodder production, manure management, water management and agroforestry. We provide a table in each of the five sections to summarize how gender dimensions such as labour access to extension have contributed towards positive and/or negative impact on project outcomes and related best practice. In addition, primary data was collected through interviews with experts who have extensive experience in research and development institutions to identify key issues, approaches and recommendations on how to integrate gender in land management interventions. Following these sections, we draw on the primary and secondary sources to provide our observations and recommendations about how best to ensure gender is integrated in land management interventions to support equitable and sustainable development of livelihoods and greater potential for successful land management.

This working paper contributes to a collective understanding of the issues based on current literature and expert opinions. Understanding gendered dynamics within land use systems and interactions between social, technological and environmental trade-offs has potential to enhance the design and implementation of land management interventions towards more gender equitable and balanced outcomes, such as improved gender equality in accessing and adopting sustainable practices. Failure to account for gender may result in gender blind approaches that exclude social groups, or worse yet, cause unintentional harm. This paper's findings and recommendations will specifically inform practice and activities of the environment flagship of Sustainable Livestock Systems Collaborative Research Program. The paper reveals knowledge gaps and frontiers that warrant further research to better identify best practices in SLM interventions.

Sustainable land management

Land management refers to the operational process of implementing land policies on rights, restrictions and responsibilities by adopting comprehensive land use practices (Jespen et al. 2015; Enemark 2007). There has been a proliferation of definitions of land use management. Here we use the 1992 UN Earth Summit's definition of SLM that refers to 'the use of land resources, including soils, water, animals and plants for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions' (Sanz et al. 2017, p. 30). The objective of SLM is holistic and seeks to balance long-term productivity of ecosystems with biophysical, sociocultural and economic needs (Holling 2001; Schwilch et al. 2009) through a combination of land-related institutional arrangements (e.g. land reforms, protection schemes, subsidies) that influence how land, labour and capital inputs are used (Jespen et al. 2015). SLM also supports adaptation to, and mitigation of climate change.

SLM refers to the 'combination of technologies, policies and activities aimed at integrating socioeconomic principles with environmental concerns' in an effort to simultaneously maintain or enhance productivity whilst reducing productivity risks, protecting natural resources (especially from soil and water degradation) and ensuring economic viability and social acceptability (Dumanski and Smyth 1993, p. 80).

Pastoral Borana woman loads donkeys with jerry cans of water at a traditional deep well source at Garba Tulla, Isiolo, Kenya (photo credit: ILRI/Fiona Flintan)

Gender and socially differentiated approaches

Gender is an important category of social differentiation and refers to the socioeconomic, political and cultural attributes that influence the opportunities of both men and women (World Bank et al. 2008). Gender defines what it means to be a man or a woman in a given society at a particular time (Eerdewijk et al. 2017). Gender gaps exist in access, control and ownership of resources such as land, livestock and water; technological assets; and imbalances in

labour contributions and decision-making abilities towards agricultural production and practices. These gaps indicate that gender issues will influence the uptake and impact of SLM, particularly new practices and labour allocation (Villamore et al. 2014).

Social factors, such as gender norms, roles and practices influence land management practices, such as who has access and/or control over land. Gender norms refer to 'differential rules of conduct for women and men, including rules governing interactions between women and men' (Pearse and Connell 2016, p. 35). Context specific norms refer to collectively held definitions of how women and men "should" behave and the benefits they can expect to accrue. Norms shape contexts but cannot determine human action (Petesch et al. 2018). Gender roles are shaped by ideological, religious, ethnic, economic and social factors, to name a few. Since gender is socially defined—unlike sex, which refers to the innate biological categories of male and female—it is possible to work for change through conscious social action through public policy, collective organization and individuals who are influencing change towards gender equality.

Social differentiation can be described by 'the characteristics that individuals have in common, such as age, gender or socioeconomic status, which make them distinguishable from other groups and contribute to shared understanding and experience of the world' (Ripoll et al. 2017, p. 172). Feminist scholars have developed intersectional approaches to better analyze complexity of individual identity and social categories such as gender, class and ethnicity to understand how intersections among these categories give rise to multiple inequalities, oppressions, benefits and opportunities (Berger and Guidroz 2009). 'Such approaches were initially used as a lens to better understand how gender intersects with race and class, but now intersectional approaches are used to now explore difference among any number of social categories, including age and ethnicity' (Thomson 2016). Although we found few examples in the literature adopting an intersectional approach, we nevertheless highlight its importance and implications in shaping SLM outcomes.

Gender research to better understand intrahousehold and community dynamics will be essential to inform the design of SLM interventions to ensure that they are gender responsive and potentially transformative for women and men. SLM outcomes should be socially equitable, acceptable and beneficial for both men and women.

Gender transformative approaches (GTA) examine and seek to change power imbalances by transforming harmful gender norms that threaten to limit the potential of women and men to benefit from agricultural interventions. GTA recognizes gender as part of how society works and builds on collaborative learning, reflection, questioning and action with women, men and communities to potentially shift power imbalances that marginalize groups from owning or managing land (Hillenbrand et al. 2015; Kantor et al. 2015). GTA challenges and strives to change underlying gender norms and power relations that enable gender disparities to exist and persist. Through the design and testing of interventions, GTA aim to close gaps between women and men in access to resources, technologies and markets, and 'help both women and men to expand the quality of their livelihood choices, including by making changes in their roles, responsibilities and relationships to one another' (Kantor 2013, p. 5).

This paper is organized as follows. First, we describe the methodology of the literature review and the interviews. Next, we provide a summarized introduction and synthesis for each of the five areas considered. Then, we outline insights from experts. In the final section, we present our perspectives and recommendations on how to integrate gender to support best practices and gender sensitive, responsive and potentially transformative SLM interventions. An annotated bibliography is supplied in the annex and provides an overview of the existing knowledge on gender dynamics and various land management practices. For each of the articles reviewed, we provide information on the objectives and methodology of the study conducted; gender integration into land management practices and the strategies; and tools and approaches through which more gender balanced engagement and benefits can be achieved from land management.

A Maasai pastoralist taking water from the Olkitikiti Dam, in Olkitikiti village, Kiteto, Tanzania one of four villages forming part of the OLENGAPA shared grazing area (photo credit: ILRI/Fiona Flintan)

Review of methodology

Google Scholar was used to conduct search for relevant articles. Search words and terms included a combination of terms and each of the topics, e.g. "water management" + "gender" + "sustainable land management". Peer reviewed publications and grey literature dating back to 1999 were reviewed. However, most of the literature reviewed was from the last five years. The review is not exhaustive, but it presents current perspectives relevant for practical use among CGIAR scientists and professionals in agricultural development.

A total of 38 articles were reviewed, 10 of which were literature reviews (Table 1). Five articles that dealt with water management presented frameworks especially related to water governance. The papers covered a diverse geographic range, including countries in sub-Saharan Africa (SSA) and Southeast Asia. In our review, we found that gender was seldom included with other topics like climate and livestock. Climate was explicitly mentioned in only four articles and livestock in 10 (26%) of the articles included in this review. Fifteen of the studies used a mixed method approach in which qualitative and quantitative data collection approaches were used to collect and analyze data.

Table 1. Summary description of reviewed papers

Topic	No. of articles	Review	Study	Climate considered	Livestock considered	Locations
Conservation tillage	10	5	5	2	1	Zambia, Philippines, Cambodia, India, Ethiopia
Fodder production	8	2	6	1	5	Kenya, Cambodia, Ethiopia, Tanzania
Manure management	6	1	5	0	2	Kenya, Burkina Faso, Ethiopia, Uganda, Zimbabwe
Water management	9	4	4		1	Nepal, Ethiopia, Kenya, Tanzania, Uganda
Agroforestry	5	2	3	1	1	Kenya, India, Tanzania, Uganda, Mali, Ethiopia
Total	38	10	23	4	10	

Gender and sustainable land management

Key guidelines

We draw on the review of the papers and expert interviews to highlight key guidelines for practitioners, specifically recommendations and best practices to achieve gender balanced outcomes in design, planning and implementation of SLM interventions.

1 Conduct gender research and gather evidence

   a Carry out research to understand household level gender differences and abilities to adopt agricultural intensification practices, technologies and strategies.

2 Target women, men and marginalized groups of society

   a There may be a need for women-specific approaches due to gender disparities and gender gaps that lead to gender-based differences in capacities in the local context. An example would be to facilitate women's opportunities and abilities to form and strengthen associations.

   b Identify strategies to close gender gaps in resources and engage relevant stakeholders. Enhance equitable access and control of productive resources, including land, income and knowledge. Increase women's access to, and engagement with agriculture and livestock extension officers.

   c Caution must be exercised in order to avoid harmful effects of women's engagements in contexts where gender-based violence is prevalent.

3 Implement gender responsive and transformative approaches

   a Utilize and adapt tools to develop innovative gender-transformative practices and intervention options. Targeting groups through agricultural and knowledge training, or building technical skills, does not necessarily change gender dynamics or women's participation and power in decision-making in the household and the community. Due to the gendered contexts of the communities in which SLM is promoted, often in rural communities in developing countries, it will be important to address significant gender inequalities through strategic approaches that change discriminating behaviors.

   b Train for transformation to promote the participation and co-engagement of men and women. Consider additional and relevant intersecting social factors that shape differential opportunities and constraints.

4 Use participatory approaches

   a Conduct gender-responsive priority setting in the community to better support and maximize mutual gender specific benefits.

   b Promote and support gender-sensitive soil management techniques and planning processes.

c Implement participatory action research approaches with a focus on co-learning and use of innovative ICT, cell phone or social media-based approaches.

d Create and support farmer-centered programs such as farmer exchange visits and community learning programs to enhance publicity, sensitization and education.

e Design and support mechanisms to create and sustain community platforms. For example, in water management, it is critical to develop inclusive committees and ensure that relevant representatives are present and active in decision-making.

f Collectively identify social goals and outcomes that will support gender equity and inclusion.

5 Create incentives and support market development to enhance equitable access

a Draw on gender research to tailor gender responsive technical assistance services and identify effective incentives to support household resource intensification.

b Facilitate and support market linkages and access to credit to purchase new technologies.

c Support development of value chains, new markets and opportunities for technologies, e.g. fodder. Assist women to improve their productivity and marketing of products and support women's entry into new segments of the value chain.

d Develop combinations of packages and alternatives that generate benefits to women and men with different capacities, e.g. mechanization and collective action.

6 Be creative and anticipate demand for new technologies

a Design futuring or scenario exercises to anticipate the need for new technologies and consider gender dimensions associated with change, e.g. increased yields and need for storage facilities.

7 Engage with policy makers to influence policy

a Inform, co-develop and support gender policies and strategies for equality and empowerment at international, national and local levels.

b Collaborate closely with governments and tertiary institutions.

c Enforce meaningful affirmative action as needed.

d Support the creation of land tenure and security laws and rights.

e Work with informal institutions as needed (e.g. water rights).

8 Carefully select and consider team dynamics in research and project design

a Project teams should be inclusive of culturally diverse team members with interdisciplinary experience and expertise that include biophysical and social sciences.

Conservation tillage

Tillage is defined as the actions taken by a farmer to prepare the land for planting, which mainly involves soil preparation using mechanical and non-mechanical implements such as ploughs, tractors, animal traction, rippers and hand hoes. These forms of land preparation lead to soil degradation and undermine overall agricultural productivity. The aim of conservation tillage is to minimize soil disturbance by refraining from digging or ploughing where at least 30 per cent of the soil surface is covered with crop residue (Giller et al. 2009; Nyanga et al. 2012). The studies we reviewed recognize that conservation tillage emerged from the need to address widespread soil degradation and has

since been widely adopted particularly by farmers in the Americas. A case in point is the zero tillage revolution in Brazil.

In some of the studies included in this review, conservation tillage—termed also as zero or minimum tillage—is considered under the umbrella of conservation agriculture. Conservation tillage is often combined with crop residue management (mulches) and crop rotation as one of the key pillars of conservation agriculture. Based on a common definition for conservation agriculture, conservation tillage on its own does not constitute conservation agriculture entirely; it's rather one of its components. We describe engagement in, and benefits from conservation tillage, in different gendered contexts below.

Most of the literature that integrates gendered dimensions in conservation tillage falls under the umbrella of conservation agriculture. Nearly 60% of the articles did not integrate a gender analysis. There is general agreement in the literature reviewed that the adoption of conservation tillage can have gendered impacts that specifically increase women's labour in weeding tasks, a task culturally assigned as women's work. Simultaneously, increases in men's and/or women's labour may also occur when herbicide is adopted. Benefits for women and children have been reported among households that adopt herbicides. A few authors discuss intrahousehold dynamics that may favour men more than women because of men's financial ability and means to purchase herbicides for conservation tillage. Generally speaking, women have less access to training and other awareness promoting activities than men. Providing a portfolio of strategies is expected to promote more gender balanced adoption and enhance benefits from conservation tillage practices to provide users with the opportunity to select land management options that are best suited to meet their contexts, circumstances and objectives. Authors suggest providing subsidies and credit services especially for women to purchase required inputs and training that are sensitive to gendered opportunities and constraints, as well as the need for participatory approaches that demonstrate some of the long- and short-term advantages of adopting the practices. Authors encourage building institutional capacity and developing policies that recognize gendered differences in adopting and benefitting from conservation tillage along with conducting systematic gender-based research to inform the design of conservation tillage programs. The need for context specificity in design is emphasized in many of the reviewed articles because sociocultural and agricultural interactions are complex and often require various trade-offs between socioeconomic and environmental benefits.

In one of the Kebelles in Bure, women till the land, while men proactively do house chores like baking injera and cleaning (photo credit: ILRI).

Table 2. Conservation tillage

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/ recommendations
Nyanga, P.H., Johnsen, F. and Kalinda, T. 2012. Gendered impacts of conservation agriculture and paradox of herbicide use among smallholder famers. International *Journal of Technology and Development Studies* 3(1): 1–24.	Labour saving dimensions of new technologies, especially herbicides	Gendered labour for women and men, food security and potential gendered health impacts of herbicide use	Promote a gender sensitive approach that minimizes trade-offs between socioeconomic benefits, environmental sustainability and health concerns
Harman Parks, M., Christie, M.E. and Bagares, I. 2014. Gender and conservation agriculture: constraints and opportunities in the Philippines. *Geojournal* 78(6): 1–18.	Men and women share similar perceptions about soil health.	Gender differentiated constraints on asset ownership and control, e.g. time, resources, labour, land and livestock Women's limited participation in agricultural training and extension services compared to men	Programs need to acknowledge the complex dynamics that may constrain adoption of practices and benefits from conservation agriculture. Increase women's participation in trainings and use gender sensitive approaches
Sumner, D., Christie, M.E. and Boulakia, S. 2017. Conservation agriculture and gendered livelihoods in northwestern Cambodia: decision-making, space and access. *Agriculture and Human Values* 34: 347–362.	Credit is an important incentive to adopt conservation agriculture practices and allows women to allocate more time to other agricultural production activities. Gender differences in labour and tasks exist, e.g. herbicide application, fertilizer application and harvesting – all of which were reduced as a result of adopting conservation agriculture.	Men overlooked women's role in applying herbicides Women had a minimal role in decision-making over herbicide selection.	Acknowledge the multiple gendered spaces where men and women practice agricultural production and challenge what the male dominated practices are
Lai, C., Chan, C., Halbrendt, J., Shariq, L., Roue, P. et al. 2012. Comparative economic and gender, labour analysis of conservation agriculture practices in tribal villages in India. International Food and Agribusiness *Management Review* 15(1): 73–86.	CA reduces labour and can influence male engagement in off farm activities.	Gendered labour patterns, labour reduction and off farm opportunities differ for women and men. Labour differences vary by crop.	Provide financial incentives for adopting conservation agriculture practices and enhance the availability and quality of extension services

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/ recommendations
Teklewold, H., Kassie, M., Shiferaw, B. and Köhlin, G. 2013. Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: impacts on household income, agrochemical use and demand for labor. *Ecological Economics* 93: 85–93.	Female spouse's education level positively influences adoption	Conservation tillage is not gender neutral and increased labour demand, but it was not clear for whom (men or women). Labour across farm activities differed Increased labour allocation for women can reallocate time from important domestic activities such as food preparation and childcare, which are primarily under women's roles and responsibilities.	Policy makers and other stakeholders should promote a combination of technologies that can enhance household food security by increasing income and reducing production costs, whilst being aware of possible gender related outcomes.
Kristjanson, P., Bryan, E., Bernier, Q., Twyman, J., Meinzen-Dick, R. et al. 2017. Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? *International Journal of Agricultural Sustainability* 15(5) 482–500.	The paper does not provide this information.	There are gender gaps in climate change exposure. Increased women's labour on weeding tasks Women in agriculture will remain largely neglected by information and service providers unless their differing needs and access and control of resources are considered at policy and project design stage.	Promote women's empowerment and use gender sensitive implementation approaches Participatory action research approaches with a focus on co-learning and using innovative cell phone or social media-based approaches offer exciting new opportunities. Tools and knowledge of innovative gender transformative practices, intervention options and accountability for serving women and men will be key.
Farnworth, C.R., Baudron, F., Andersson, J.A., Misiko, M., Badstue, L. and Stirling, C.M. 2016. Gender and conservation agriculture in East and Southern Africa: towards a research agenda. *International Journal of Agricultural Sustainability* 14(2) 142–165.	Labour-saving dimensions of new technologies for women and children, especially related to herbicides.	Women's increased labour and unknown gender dimensions related to herbicide purchase and application	Increased crop yields and post-harvest processing and storage facilities would be required, which implies increased labour and storage costs, both of which have gendered dimensions. More research is needed to understand the gendered impacts in terms of cost and benefits of adopting conservation agriculture and whether it can provide gender balanced outcomes.

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/ recommendations
Giller, K.E., Witter, E., Corbeels, M. and Tittonell, P. 2009. Conservation agriculture and smallholder farming in Africa: the heretics' view. *Field Crops Research* 114: 23–34.	Only with herbicide use will there be anticipated labour saving results for smallholder farmers.	Increase in women's, and potentially men's labour, especially associated with weeding Access and ability to purchase external inputs and gender dimensions of income Women have less access to training than men.	Consider gendered reallocation of labor Increase access to subsidies and credit, especially for women Increase gender sensitive training and awareness Support policy to reduce gender disparities in adoption and benefits
Lubwama, F.B. 2009. Socio-economic and gender issues affecting the adoption of conservation tillage practices. In: Kaumbutho, P.G. and Simalenga, T.E. (eds), 1999. *Conservation tillage with animal traction. A resource book of the Animal Traction Network for Eastern and Southern Africa (ATNESA)*. Harare, Zimbabwe: 173.	The paper does not provide this information.	Conservation tillage practices fail to promote equal opportunities for participation by men and women as the analysis of gender roles in the design of technologies is overlooked. Women's workloads, gender-blind information dissemination and limited access to information constrain knowledge and adoption of conservation tillage.	Increase gender-balanced adoption of conservation tillage Consider i) the intersection between gender and the socio-economic context, ii) close collaboration with governments and tertiary institutions and iii) enforce affirmative action
Kaumbutho, P.G., Gebresenbet, G. and Simalenga, T.E. 1999. Overview of conservation tillage practises in East and Southern Africa. In: Kaumbutho, P.G. and Simalenga, T.E. (eds), *Conservation tillage with animal traction. A resource book of the Animal Traction Network for Eastern and Southern Africa (ATNESA)*. Harare, Zimbabwe: 173.	Conservation tillage is suitable to address the environmental, agricultural (food security) and socioeconomic needs of smallholder farmers.	Gender is often neglected in conservation tillage and technology transfer programs because the main perception is that the agricultural domain is male dominated.	Training for transformation to promote the participation and co-engagement of men and women Programs should be farmer centred, adopting participatory approaches, such as farmer exchange visits, to enhance publicity, sensitization and education (e.g. platforms). Consider roles of traditional knowledge and practices and environmental protection through gender-sensitive soil management techniques and planning.

Fodder production

In this section, we focus on selected sources from literature that talk about the participation of men and women in using fodder production technologies in rangelands and mixed crop-livestock systems and the impact of engaging in such activities. Fodder is considered among the most affordable feed sources in developing countries and refers to grasses, legumes, tree species and crop residues that are grown explicitly to feed livestock (Njarui et al. 2017). Adequate supply of fodder is; therefore, crucial for millions of livestock keepers who strive to meet their fodder requirements through a combination of productive practices on communal and private lands (Hall et al. 2007). Availability of quality fodder and access to it is a key constraint for many smallholder livestock producers. The need to identify economically, socially and environmentally suitable and sustainable strategies to promote fodder production amidst higher incidences of water, forage and fodder shortages in both arid and rain-fed systems is a key area of research and development. Sustainable approaches to improve livestock production, especially in areas where feed scarcity exists, is anticipated to potentially improve the livelihoods of smallholder farmers, facilitating economic development and enhancing environmental sustainability.

Low levels of uptake of fodder technologies have been observed across developing countries. Constraints to smallholder fodder production include the degradation of natural pastures, often due to overgrazing, soil erosion and climate related factors. However, many underlying challenges to fodder production are socioeconomic, such as gender norms that mediate access to resources and assets (labour, land and income) and poor seed delivery systems (Bayala et al. 2014). Men and women's participation and management of livestock are often gender differentiated, thus the need to understand where gendered opportunities and constraints exist in the household, community and value chain is paramount to appreciating fodder production conditions, practices and acceptability to support sustainable farm and livestock production.

Fodder production is important to increase livestock productivity across rangelands and mixed crop-livestock systems, but smallholders face multiple constraints to establishing fodder on their farms. Most of the reviewed studies analyze the determinants of fodder technology adoption. Authors emphasize the need to enhance extension services and capacity building to increase uptake of fodder production technologies. Gender was not well defined, and gender analysis of opportunities and constraints to fodder production were often not performed. Rather, gender was considered superficially. The unit of analysis for most studies is the household and the focus was often the gender of the head of the household, frequently an insignificant determinant of fodder adoption technologies.

Among the few studies that apply a gender lens, results show gender differences in access and adoption of fodder technologies. Much less is known about intrahousehold dynamics, such as women, men and children's division of labour in fodder related activities. Recommendations are to deepen the analyses of assessment and identification of the roles of gender and age in shaping intrahousehold decision-making and benefit distribution related to fodder production. Similarly, the role of value chains to support income and provision of fodder in the community and elsewhere would yield valuable insights on marketing and relative potential of fodder to supply household income.

Champion farmers demonstrating to trainee farmers about the management of forage crops (photo credit: ILRI).

Table 3. Fodder production

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/recommendations
Studies			
Mureithi, S.M., Verdoodt, A., Njoka, J.T., Gachene, C.K. and van Ranst, E. 2016. *Land degradation and development* 27: 1853–1862.	Increased income was realized by most participants. Women's groups were the majority managers of communal enclosures and were direct beneficiaries from income generated through restored lands, livestock fattening and grass seed harvesting.	Negative gender impacts or dimensions are not discussed.	Provide gender-specific guidelines Environmental, economic and social benefits are important to sustain success of community-based projects. Stronger market linkages for restored rangeland products, capacity building and access to extension services are required to boost the adoption of rangeland restoration initiatives.
Omollo, E.E., Wasonga, O.V., Elhadi, M.Y. and Mnene, W.N. 2018. Determinants of pastoral and agro-pastoral households' participation in fodder production in Makueni and Kajiado Counties, Kenya. *Pastoralism: Research, Policy and Practice* 8(9): 1–10.	The gender of the household head, level of education and membership in social and development groups determined the adoption of rangeland reseeding technologies.	Female-headed households may produce less fodder than male-headed households because of differences in access to labour, agricultural training opportunities and information and extension services.	Inclusion of technical support and extension services for households will enhance the production of fodder in the arid and semi-arid land (ASAL) regions. Create an enabling environment that can encourages the participation of both male and female headed households
Ashley, K., Wilson, S., Young, J.R., Chan, H,P., Vitou, S. et al. 2018. Drivers, challenges and opportunities of forage technology adoption by smallholder cattle households in Cambodia. *Tropical Animal Health Production* 50: 63–73.	Time savings for adult women and men	Land tenure security and access to education were the most crucial determinants of forage adoption. Men are more engaged in forage activities and women are more engaged in forage development.	No specific gender related recommendations are offered by the authors. Consider demographic, socioeconomic and physical environmental factors that influence fodder adoption Institutional arrangements to secure land tenure and farmer education on the benefits of forage cultivation.
Njarui, D., Gatheru, M., Gichangi, E.M., Nyambati, E.M., Ondiko, C.N. and Ndungu-Magiroi, K.W. 2017. Determinants of forage adoption and production niches among smallholder farmers in Kenya. *African Journal of Range & Forage Science* 34(3): 157–166.	Land ownership, access to formal education of the household head and experience in livestock farming influenced fodder adoption. Gender, age, off/on-farm income, number of dairy cattle and amount of milk produced did not influence forage adoption.	The paper did not discuss negative impacts of findings.	No specific gender related recommendations are offered by the authors.
Gebremedhin, B., Ahmed, M.M. and Ehui, S.K. 2003. Determinants of adoption of improved forage technologies in crop-livestock mixed systems: evidence from the highlands of Ethiopia. *Tropical Grasslands* 37: 262–273.	Land tenure security, education level of household heads and wealth of household were important determinants. Age and gender of household heads had no impact on forage adoption.	Household differences exist. Adopters were from households that produced more milk, with slightly older headship, fewer household members, smaller farm sizes, and located nearer to urban centres.	Improve land tenure security through institutional mechanisms to increase the likelihood of farmers' adoption of forage technologies.

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/recommendations
Fischer, G., Wittich, S., Malima, G., Sikumba, G., Lukuyu, B. et al. 2018. Gender and mechanization: exploring the sustainability of mechanized forage chopping in Tanzania. *Journal of Rural Studies* 64: 112–122.	Women and men who adopted mechanized technology often reported reduced labour burden and time.	The results in the social domain reveal contradictory social dynamics.	Conduct gender-sensitive training and establish group models for machine operation based on agreed and fair regulations. Authors provide a list of detailed suggestions for future research and development.
Reviews			
Kidake, B.K., Manyeki, J.K., Kubasu, D. and Mnene, W.N. 2016. Promotion of range pasture and fodder production among the pastoral and agro-pastoral communities in Kenyan rangelands: Experiences and lessons learnt. *Livestock Research for Rural Development* 28(8).	The paper did not discuss positive impacts of findings.	Women's low participation as trainers was attributed to the high labour requirement of livestock production. Women have limited ownership and control of natural/ productive resources that constrained their ability to participate in trainings.	Use participatory approaches with farmers and offer support from research and extension actors Refresher courses on fodder production and monitoring and evaluation feedback mechanisms to facilitate capacity development abilities of men and women Research into suitable alternatives of less labour intensive weed control are presented.
Muyekho, F.N., Mose, L. and Cheruiyot, D.T. 2003. Development and transfer of forage production technologies for smallholder dairying: Case studies of participatory evaluation of species and methods of establishment in western Kenya. *Tropical Grasslands* 37: 251–256.	Tumbukiza method was preferred by the majority of farmers because it produces significantly higher yields than the conventional method and performs better in cost-benefit analysis.	Respondents from female-headed households experienced increased labour requirements.	Scale up technology adoption to increase fodder yields

Manure management

Manure management refers to practices that include the collection, storage, maintenance and utilization of animal manure in an environmentally sustainable manner. Manure management is an important natural soil improvement technique and contributes to sustainable intensification efforts by enhancing the structure and nutrients in soils, unlike inorganic, chemical fertilizers.

Livestock ownership is the most common means to ensure regular supply of manure for home gardens and/or fields. Poverty and gender both affect household access and control of manure. Resource and labour availability are common constraints to manure management. Generally speaking, poorer households own fewer livestock and female-headed households often have comparatively fewer assets— including livestock—than dual-headed households. Consequently, livestock ownership and manure supply in the household is limited. In some instances, markets for manure exist, or households may give manure to others. However, supply may be limited. A key concern in manure management is labour, more importantly, whose labour is used. Zero grazing systems and stall-feeding operations are often near the house, thus manure application in home gardens is relatively less labour intensive than carrying manure to distant fields. Labour dynamics of manure management are often gendered and the use of family and/or hired labor, and gendered agency in decisions related to access and control of income from manure sales, are important to consider where applicable.

In the literature we reviewed, gender differences were explored in the household, on the farm and at plot level across different socioecological contexts that included east and western Africa. A variety of different statistical approaches were also used.

Manure management is often considered within a package, or suite of organic soil fertility practices, as opposed to being evaluated as a single practice. Gender dimensions include resource and labour availability in the household and on farm. In the articles reviewed, there is a focus on comparing adoption of organic and inorganic practices. Manure management is given less attention than other practices. Context specific factors shape trends in manure management and household uptake in different ways. Therefore, existing variations and commonly held assumptions (e.g. women use more organic inputs) must be investigated. Gender technology gaps exist and are often the result of factors operating at different scales. For instance, formal and informal institutions were found to influence on-farm practices. Jagger and Pender (2006) found that the presence of NGOs lowered the implementation of manure practices. They also found that cultural norms influenced women's labour in relation to manure.

Peterman et al. (2014) provide a detailed look at gender differences in use, access to and adoption of non-land agricultural inputs. Empirical findings from different countries revealed disparities in terms of the significance of gender differences between male and female headed households at plot level, suggesting that gender trends in manure management may be more difficult to generalize. Management is linked to household assets and livestock ownership differences, in which cases female-headed households often report lower levels of ownership, hence, access to manure. Ndiritu et al. (2014) performed plot-level analyses in Kenya, where clear gender technology gaps exist and persist in part due to differences in livestock ownership. Thierault et al. (2017) similarly find gender differences at plot level on cereal plots in Burkina Faso.

In summary, gender differences in access, use and labour in manure management must be considered in interventions that introduce manure management as part of a technology package to improve soil fertility and production. Availability of manure is a supply constraint that shapes who adopts or is able to implement these strategies.

Transporting livestock manure to croplands in Oyo State, Nigeria (photo credit: ILRI/Stevie Mann)

28-year-old Madhabi Nandi of Arwa Village in Brahampur, West Bengal, India, spreads out Ghute, palm-sized plates of dung which are stuck to walls to air dry and are then later used for cooking fuel (photo credit: ILRI/Stevie Mann).

Table 4. Manure management

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/recommendations
Review			
Peterman, A., Behrman, J.A. and Quisumbing, A.R. 2014. *A review of empirical evidence on gender differences in nonland agricultural inputs, technology and services in developing countries*. IFPRI Discussion Paper. Washington, DC: IFPRI.	Women's and men's use of manure yielded mixed results that challenge the assumption that women have access to organic fertilizers.	In some cases, reviewed women have lower levels of access to inputs.	Look at food, cash crop choices and labour Thorough and holistic research approaches are recommended to understand gendered diversity within households. Collect and analyze gender disaggregated data in agricultural research and disaggregate data at the plot level to provide insights on female household headship, female owned and/or managed plots and female owned assets.
Studies			
Theriault, V., Smale, M. and Haider. 2017. How does gender affect sustainable intensification of cereal production in the West African Sahel? *World Development. Evidence from Burkina Faso*. 92: 177–191.	A gender differential was not apparent for yield protecting strategies.	Female and male managed plots differ in adoption. Household endowments and labour have effects and differences in availability, and these influence adoption of new technologies.	Research gender differences in the adoption of agricultural intensification strategies to design effective policies to close the gender gap Address the male bias in extension services and improve access of female plot managers to credit, income and equipment.
Pender, J. and Gebremedhin, B. 2006. Land management, crop production and household income in the highlands of Tigray, northern Ethiopia: An econometric analysis. In: Pender, J., Place, F. and Ehui, S. (eds), *Strategies for sustainable land management in the East African highlands*. Washington, DC: International Food Policy Research Institute: 107–140.	Use of manure increased yields comparable to those who use fertilizer.	Female-headed households use less labour and ox power, are less likely to apply manure and obtain substantially lower crop yields and incomes than male-headed households.	Use research to tailor technical assistance services and identify effective incentive regimes to support farm household resource intensification Further research at the farm household level is required to identify the farm household's responsiveness to specific policy incentives.
Horrell, S. and Krishnan, P. 2007. Poverty and productivity in female-headed households in Zimbabwe. *The Journal of Development Studies* 43(8):1351–1380.	No yield differences were observed between male- and female-headed households.	De facto female heads of household receive low prices for their output.	General poverty alleviation policies may benefit female-headed households, but specific interventions via extension services and access to marketing should be implemented.

Water management

Water management refers to 'the control and movement of water resources to minimize damage to life and property and maximize efficient beneficial use'1. van Koppen (2001) emphasizes that water is vital for various agricultural practices (farming, gardening, forestry, raising livestock, fisheries, aquaculture) and other income generating activities; and water management significantly influences human health and development. Water governance as it is used here, refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources and the delivery of water resources at different levels of society (Hall 2003).

Gender dimensions of water management include roles, relations, responsibilities, norms and agency in decision-making pertaining to access, use and labour issues related to domestic, agricultural and commercialization of water (e.g. sale). Formal and informal institutions intersect with gender in ways that shape gender relations in management, especially water rights. Water rights are mechanisms through which a user can access water for a particular use without jeopardizing another user's right. Water rights may be local or customary, the latter meaning that users get access to their water and solve their allocation mechanism among themselves without necessarily having a written document to define volumes and time for abstraction (Sokile and van Koppen 2004).

Water management practices reviewed here include irrigation, water for domestic use and for agricultural purposes. The reviewed papers provide analytical frameworks to better understand gendered patterns in access to, and control over, water in households and communities from projects located in East Africa that include Tanzania, Ethiopia and Uganda.

The articles in this section are diverse and provide a range of information across scales from the individual household to the wider community. Authors describe the complex ways in which formal and informal institutions influence men's and women's access, control and governance of water resources at large2. Articles pertaining to water management that focus on an in-depth understanding of livestock were not found in this review, despite the important role of water resources to support livelihoods in mixed crop-livestock and pastoral systems.

Gender shapes power dynamics in water governance approaches and the review reveals key insights in three main areas. These include: the need to adopt mixed methods and an intersectional perspective; to elaborate, rather than ignore, gendered trade-offs in relation to water resources; and the roles of informal and formal institutions and governance. Simple participation in village water boards, for example, is insufficient to garner equitable changes and may not be gender responsive since participation may simply be to fulfill quota requirements. A better understanding of the efficiency and equity of formal and informal structures will be important to strengthen certain principles and practices in informal institutions that support gender equity and women's participation in negotiation. More research on the complementary, and/or competing roles of formal and informal institutions and management practices could support the development of more inclusive policies. Informal institutions, such as norms and their influence in shaping gendered patterns in access, control and decision-making spaces are also discussed (Mandara et al. 2017).

The articles measure gender differently. This informs approaches to measures, analyses and conclusions about how well particular interventions address gender equity and/or equality. Mixed methods were commonly used and provide more nuanced approaches to understand gender in the community and social difference, especially how norms, agency and opportunity interact and intersect in ways that significantly affect human development. The attention of authors to intersectionality and social differences varied. Quantitative and qualitative methods were used to better understand gender and age-based approaches, primarily because of the labour roles of youth, specifically young women and girls, in daily water collection activities. An example that addresses this complexity is a tool to measure water insecurity by incorporating sociocultural and health related aspects of water collection in Uganda. Given women's roles in daily water collection, it is not surprising that their perceptions of water insecurity are often more acute than men's.

1 https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/manage/

2 The last article does not discuss gender but was deemed relevant because it deals with perceptions of drought and violence in Kenya in an area where livestock is important and considered to be a driver of conflict during times of rainfall deficit.

Understanding these variations, as van Koppen (2001) points out, is critical to developing policies that support inclusion of key categories of intersectionality. Water and poverty are linked to education, markets and agricultural performance as shown in Hanjra et al. (2009). Such a holistic approach is helpful in identifying complementarities to support human development, especially among smallholders living in rural areas.

Approaches such as collective action are often promoted to enhance access to water resources. However, the review shows that collective action approaches are fraught with challenges of how best to meet technical and social objectives, often competing across scales and between different stakeholders. Frameworks to address the complexities of watershed management recommend systematic processes to ensure inclusive development. German et al. (2006) provide practical insights from several different systems and countries that demonstrate how their framework may be adapted to suit different contexts, including those in which livestock is the mainstay of livelihoods. The anticipated and often unanticipated ways in which governance and participatory processes unfold is challenging because of the different interests and power dynamics at play in local and administrative contexts. Authors emphasize the need to elaborate trade-offs, rather than ignore them. The studies provide more insights into understanding how and who to engage to ensure greater inclusivity and equity.

A woman pumps water for her livestock in Lhate Village, Chokwe, Mozambique (photo credit: ILRI/Stevie Mann)

Table 5. Water management

Reference	Positive impacts	Negative impacts	Best practices/recommendations
Studies			
Sokile C. and van Koppen, B. 2004. Local water rights and local water user entities: the unsung heroines to water resource management in Tanzania. *Physics and Chemistry of the Earth* 29 (15–18): 1349–1356.	Though not gender specific, local informal associations effectively manage water and resolve conflicts because they are influential, powerful and attractive to local communities. Most people feel a stronger sense of identity and belonging than in the formal water user associations.	Local rights are not necessarily gender sensitive.	Explore whether informal institutions are more efficient, cost-effective, longer lasting and widely accepted among local water users than most top-down state-driven institutions.
Tsai, A.C., Kakuhikire, B., Mushavi, R., Vořechovská, D., Perkins, J. et al. 2016. Population-based study of intra-household gender differences in water insecurity: reliability and validity of a survey instrument for use in rural Uganda. *Journal of Water Heath* 14 (2): 280–292.	Men generally perceived household water insecurity as being less severe compared to women across the eight items of the measurement scale.	Gendered labour patterns exist.	"Household water insecurity access scale" is a reliable and valid measure of water insecurity, especially among women, and is recommended to inform and evaluate interventions to improve water access in limited resource settings.
Graham, J.P., Hirai, M. and Kim, S . 2016. An analysis of water collection labour among women and children in 24 sub-Saharan African countries. *PLOS One* 11: e0155981.	Gender and age are important factors to consider when looking at the intersection of water use, collection, health and school attendance.		Calculate relative gendered labour and rest ratios.
Asaba, R.B., Fagan, H., Kabonesa, C., Mugumya, F. 2013. Beyond distance and time: gender and the burden of water collection in rural Uganda. *The Journal of Gender and Water* 2(1): 31–38.	Positive impacts were not discussed.	Water collection labour burdens for women and children are significant.	Conduct more research and develop measures that take into account time and distance, as well as sociocultural, environmental and health-related conditions.
Frameworks			
van Koppen, B. 2001. Gender in integrated water management: an analysis of variation. *Natural Resources Forum* 25: 299–312.	Positive impacts were not discussed.	Water use and types of farming systems have gendered implications.	Gender dimensions must be analyzed and integrated into policy and interventions in the water sector. Case specific recommendations for female and dual farming systems must recognize women farmers and include them as equals with men and, in male farming systems, support the minority of women farmers.

Reference	Positive impacts	Negative impacts	Best practices/recommendations
Hanjra, M.A., Ferede, T. and Gemechu, G.D. 2009. Reducing poverty in sub-Saharan Africa through investments in water and other priorities. *Agricultural Water Management* 96: 1062–1070.	The paper does not provide any explicit gender findings.		Identify synergies across land and water resources development, human resources, rural infrastructure and agricultural and labour market. There is a need to improve equity and consider the multiple uses of water and multiplier effects on non-farm sectors.
Cleaver, F. and Hamada, K. 2010. 'Good' water governance and gender equity: a troubled relationship. *Gender and Development*. 18(1): 27–41.	Outcomes vary for different people in different ways and people create mechanisms of water governance through the management of water and events activities and experiences. Gendered agency and identities are complex.	Gender inequality is embedded and reinforced through and within water governance institutions and mechanisms.	Development interventions must frame and understand how mechanisms are connected and linked to the wider social context in the interests of equity.
German, L., Taye, H., Charamila, S., Tolera, T. and Tanui, J. 2006. *The many meanings of collective action: lessons on enhancing gender inclusion and equity in watershed management*. Wasington, DC: International Food Policy Research Institute (IFPRI).	Participatory action research methods were used to highlight challenges and problems related to common grazing land, limited feed, declining water quantity and quality and limited diversity and income generation of enterprises that include livestock.	Relative strengths and weaknesses of different approaches for enhancing gender inclusion and equity occur throughout the stages of problem diagnosis, planning and monitoring.	Structure a community interface to develop a committee and to ensure that watershed representatives are present and active in decision-making. Collective identification of social goals and outcomes can support gender equity and inclusion.
Mandara, C.G., Niehof, A. and van der Horst, H. 2017. Women and rural water management: Token representatives or paving the way to power? *Water Alternatives* 10(1): 116–133.	Women participate at rates of 50% in village water committees.	Women's participation in water management institutions is a popular gender-responsive approach but does not necessarily change gender relations (participation may be to fulfill quota).	Involve women in the local decision-making structures on domestic water. There is a need to understand the influence of specific norms on bargaining and participation.

Agroforestry

Agroforestry is a land use management system in which trees are integrated with crops. Its benefits include potential to enhance soil fertility, reduce erosion and increase biodiversity relative to other land uses such as monocrops. Gender dimensions of agroforestry include ownership and property rights. Gender roles in agroforestry systems are not well understood. However, there is evidence that women's and men's roles differ with respect to property rights to trees and labour on farms where agroforestry is part of the land management practice or strategy. The role of gender in agroforestry is important because it is a common land use that supports agricultural production and potentially greater biodiversity and ecosystem services relative to other productive land uses, particularly in mountainous regions. Agroforestry is often promoted and bundled as part of payments for ecosystem service (PES) schemes that will be reviewed below. Agroforestry PES schemes contribute to climate change mitigation efforts and serve as important adaptation strategies (Benjamin et al. 2016; Masiga et al. 2012). Agroforestry as a form of conservation and climate-smart agriculture is not gender neutral in terms of economic empowerment (Farnworth et al. 2016), in part due to the prevalence of traditional land tenure systems that often discriminate women in access, ownership and control over land.

Based on this review, the agroforestry literature engages with gender in nuanced and often complex ways. While earlier works like Kiptot and Franzel (2012) present a simple and straightforward approach of women's participation in agroforestry in a myriad of ways, later approaches grapple with the complexity of gender, such as multiple users, often depicting gendered rights as different parts of a tree. More holistic approaches to understand gender in agroforestry systems provide more practical insights for interventions to better meet the diverse needs of women and men, as suggested by Kiptot and Franzel (2015) in their later work. Women's roles and potential to benefit from agroforestry schemes and payments for PES must be better understood. Benjamin et al. (2018) measure empowerment through an economic lens. Approaches that neglect the wider social context raise questions about conclusions that PES schemes in fact empower women, when empowerment is defined in terms of net farm profit.

Few of the articles reviewed sought to understand gendered changes in relation to climate effects on the environment, e.g. forest transition or social relations and livelihoods. The final articles; however, grapple with the complexities of gender and social differentiation as they relate to system level changes. Djoudi and Brockhaus (2011) explain some of the gendered implications of change related to the drying out of a lake and subsequent transition to an agroforestry system in Mali. Through a rich description, they explain how drying effects of the lake have spurred a de-feminization of agriculture that is coupled with simultaneous feminization of livestock management. Gendered labour implications and opportunities for charcoal commercialization differ as a result of the intersection of gender, identity and ethnicity. Such deep analyses provide rationale for research approaches to understand gender-specific capacities. Lastly, the final paper's focus is on home gardens, traditionally diverse sources of food for household consumption, that are increasingly transitioning to monoculture production of a cash crop—khat. These case studies help us to better understand expansion and restrictions in gender roles, responsibilities and opportunities, all of which are occurring in rapidly changing and complex environments.

Table 6. Agroforestry

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/recommendations
Benjamin, E.O., Ola, O. and Buchenrieder, G. 2018. Does an agroforestry scheme with payment for ecosystem services (PES) economically empower women in sub-Saharan Africa? *Ecosystem Services*. 31: 1–11.	Women who participate in agroforestry schemes with PES reduce their profit inefficiency.	Targeting women will not suffice to ensure that women are active decision makers in agroforestry PES schemes.	Schemes can target poor female smallholders to achieve maximum economic empowerment gains. Gender differences in adaptive capacities exist. Explore assumptions about male and female farmers and land size.
Djoudi, H. and Brockhaus, M. 2011. Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. *International Forestry Review*, 13(2): 123–135.	Potential long-term impacts that bring about change in women`s roles could be both societal (division of labour and power, and new social spaces), and economic (market access and livestock wealth).	Feminization of livestock trends exist. There are gender differences in women's capabilities to adapt to climate change.	Further research should be done on local realities and women's active roles in adaptation, particularly on the following fronts: 1. Women-specific adaptive capacities 2. The links between local adaptive strategies and women's vulnerability 3. Best practices for gender sensitive responses to climate change across levels and scales.
Gebrehiwot, M., Elbakidze, M., and Lidestav, G. 2018. Gender relations in changing agroforestry homegardens in rural Ethiopia. *Journal of Rural Studies* 61: 197–205.	None provided	Customary institutions restrict women's access to land, market and trading, and decision-making process at the household and community levels. Formal laws are not well implemented.	Gender policies and strategies for equality and empowerment at international, national and local levels. Reconcile customary law and gender equity by demonstrating common challenges and possible pathways towards minimizing the tension.
Kiptot, E. and Franzel, S. 2012. Gender and agroforestry in Africa: a review of women's participation. *Agroforestry Systems* 84(1): 35–58.	Fodder adoption can increase milk production. Women are interested in low cost agroforestry technologies to improve soils. Women can benefit from sales of agroforestry products, e.g. shea nut and fruits.	There are female and male household level differences in adoption rates, labour allocation and enterprise participation.	Policy, technological and institutional interventions are needed. These include: 1. Facilitating for women to form and strengthen associations 2. Assisting women to improve productivity and marketing of products considered to be in women's domains 3. Improving women's access to information

Reference	Positive impacts on project outcomes	Negative impacts on project outcomes	Best practices/recommendations
Kiptot, E. 2015. Gender roles, responsibilities and spaces: implications for agroforestry research and development in Africa. *International Forestry Review* 17(4): 11–21. 10.1505/146554815816086426.	Women and men gain differential access and control over parts of trees. Women may control tree products, e.g. shea nuts.	Women tend to exercise low levels of control in decisions about trees compared to men. Women may provide labour, yet men benefit from fodder sales. Women tend to access and manage lower value tree products.	Authors recommend: 1. Understanding sociocultural norms and taboos in the community 2. Undertaking a gender-responsive species priority setting exercise in the community. 3. Maximizing produce from gender-specific spaces for mutual benefits. 4. Development of appropriate microcredit institutions and the private sector to boost their capital and move up the value chain. Women need greater control in resource management decisions, which may be achieved through gender transformative approaches.

Expert insights

Interview methods

Experts with extensive experiences in gender and land management were consulted to provide current and practical insights to supplement the literature review that highlighted research gaps. ILRI colleagues were consulted to generate a list of six experts who were contacted by email to participate in a Skype discussion or, for the sake of convenience, asked if they would prefer to provide typed responses to the semi-structured interview guide. Four experts responded with expertise in the fields of animal science, agricultural science and social science. The experts drew upon their knowledge and experiences in international agricultural research and academic institutions (including from CGIAR such as ILRI, World Fish, CIMMYT, IWMI, ICARDA, CIAT, and University of Florida) and nongovernmental organisations (NGOs) including the International Land Coalition, Winrock and Heifer International and USAID. Experts have integrated gender across a spectrum of land management projects that include participatory land management approaches, animal production (indigenous poultry and livestock), agricultural value chains, climate change adaptation and mitigation, and climate smart agriculture strategies.

In the following section we present a summary of expert insights, specifically their identification of key issues, research approaches, practical experiences, reflections on institutional changes and recommendations.

Key issues and research approaches

Generally speaking, experts think that gender has been poorly integrated, if at all, into the design of interventions concerning livestock and conservation agriculture. Gender budgets are often insufficient because gender is not addressed comprehensively in proposals. Such approaches compromise systematic gender integration through project stages, from proposal development to implementation and impact measurements. Such oversights can increase women's work burdens in conservation agriculture. As one expert described:

'…in general, gender is rarely considered a variable in project design, implementation and evaluation of conservation agriculture though some projects target women specifically. There's an incredible paucity of academic peer-reviewed research on gender in conservation agriculture, [yet] women and men are active participants in agricultural systems. A key finding from the sparse literature is that conservation agriculture can be very burdensome for women, because men's tasks are often mechanized. For example, use of the Magoye ripper is primarily, though certainly not exclusively, targeted to men, whereas women use hoes. The weeding burden associated with conservation agriculture falls very heavily on women with a large increase in the number of days spent on weeding vis-a-vis the case when land is ploughed. Households express reluctance to spend income on herbicides because the opportunity costs of women's labour do not seem to be assessed or valued.' — Expert 1

'Understanding gendered access and control over resources such as agricultural technologies can inform efforts to support more sustainable and equitable land management practices. A combination of gender and land management also highlights the ways in which 'technically oriented solutions [alone] may not fix gender inequities.' —Expert 2

In the opinion of one expert, land management approaches provide less contentious and less politicised approaches to understand men's and women's use of land and labour in diverse agricultural landscapes and is often a less threatening approach than starting with gender as an entry point.

Mixed methods, such as qualitative and quantitative approaches and analyses, and participatory techniques were encouraged. 'A survey is useful to understand control over resources but understanding the story behind the data requires qualitative approaches such as participatory tools and focus group discussions.' —Expert 3

Interactive methods to collect information can mitigate relatively more "extractive" research methods and simultaneously build more collaborative research processes between diverse stakeholders. They also require complementary budget and costs.

Expert 3 says, '…methodologies should also be suited and adapted to contexts and different units of analysis. For instance, mixed methods are useful to better understand intra household decision-making dynamics. Also, social network analysis is useful to understand social dimensions of technology diffusion in the community.'

Expert 1 described the merits of the gender action learning system (GALS) to foster greater collaboration and long term and sustainable behaviour changes. 'Household methodologies like GALS, could be used as research instruments to (a) co-develop analyses with respondents of specific issues, and (b) become a means of livelihood change through the visioning process. This ensures that research is not just extractive but that the local respondents remain with their own research findings and have a methodology with which they can work to translate the findings into livelihood change long after the researchers have departed.'

All experts agreed that a multidisciplinary approach is necessary to better understand gendered dimensions in land management. As expert 4 explained, the tendency in agricultural sciences has been to employ 'privileged biotechnical approaches where social scientists leave the system and biophysical scientists develop surveys but may not necessarily know how to collect data or how to analyse social science research. We need different levels and types of expertise, both social science and biophysical; there is strength in diversity. Gender and biophysical scientists should have a working knowledge of each other's fields to talk with each other.'

Conducting gender research in isolation is counterproductive. 'I feel that gender research on its own runs the risk of not talking to biophysical scientists etc. and this is really very risky and makes our [gender] research of less value to them. Also, they can feel side-lined and hostile to work on gender. There's a real and dangerous backlash.' —Expert 1

Experience: successes and failures

Research and development institutions have changed their emphases on gender. Expert 3 attributed this change to a major shift in donor attitudes (FAO, World Bank and the Bill and Melinda Gates Foundation) and support from influential individuals and institutions, such as Hilary Clinton and Bill Gates. Today there are more opportunities and space for gender specialists within the agricultural research and development sector, where gender features as a key component of programming and budgeting, more so than a decade ago. However, the change has been slow due to gender imbalances in technical disciplines and project cycles that are often too short to evaluate change in behaviour, norms or relations.

"Success" is a long-term target and requires time, often conflicting with short term projects and targets. Evaluations require monitoring over an extended period. Gender and land management interventions require monitoring, knowledge transfer and participation. Success will, in part, depend on the extent to which research from institutions is adopted by implementers. Actual practice of integrating gender in land management tends to be conducted by 'those

who are not responsible for making the changes', Expert 3 says. In other words, implementers of interventions, often project partners on the ground (e.g. NGO partners), will in large part determine success and whether sustainable change in gender and land management will occur.

Experts 1 and 3 acknowledged that many interventions have failed to integrate gender in land management because they exclude women from technology trainings, whether advertently or inadvertently. Frameworks and indicators of success are often identified a priori. The perception of local beneficiaries on success may differ and reconciliation of these perceptions are often difficult.

Expert 1 described an experience in Malawi, where a fishpond intervention led to perceptible increase in adoption and uptake of fishponds. However, the perception of stakeholders differed from development researchers, who saw the intervention as a failure.

'[The ponds] were successful based on farmer perceptions, but not by experts, who envisioned success of fishponds differently. Success measures of experts were that fishponds were managed to best capacity and large fish were sold in the market. But locals found fishponds to be beneficial since they used the water for horticultural crops and got fish as needed for ceremonies. These were unintended and positive effects, but successes, as envisioned by those in the research organization, were conceived through a narrow lens'.

Crop-livestock systems in Vietnam (photo credit: ILRI/Hung Nguyen)

Discussion

We identified gendered issues and concerns in SLM practices in diverse contexts, many of which occur in SSA. Projects often generated gender differentiated impacts for women, some positive and some negative. Trade-offs in resource, labor, economy and land use decision-making are critical gender dimensions of SLM. Gendered contexts, and more specifically, the influence of gender norms, roles, responsibilities and practices, significantly influence gender relations in the household, community and landscape. Among the topics considered, we consistently found that women's unpaid labour contributions are substantial and likely to increase with the adoption of new practices, such as weeding tasks in conservation agriculture. Institutions and formalization of governance of community resources are also fraught with challenges that can undermine equitable and sustainable development. Access and control over productive resources condition women's adoption and potential to benefit from agroforestry species and related enterprises. Such persistent inequalities highlight the need to design interventions that are gender transformative, or address behavior change of women and men in the household.

In the following section, we conclude the paper with research and development insights.

Research

Conceptualization of gender and new knowledge frontiers

The conceptualization of gender was simplistic in a few of the papers included in this review. Binary and sex disaggregated approaches, as a standalone approach towards understanding gender in the household, will be insufficient to understand the dynamic and intersectional ways that SLM influences gender relations in households through labour and capital reallocation and benefit distribution. In the papers that look at water collection in Uganda, both sex and age affect roles, and young women and girls are often engaged in water collection activities perhaps even more than adult women. In addition, conflating household headship and gender as a variable does not shed understanding on intrahousehold resource allocation of decision-making. Household structures do not convey social dimensions of the household and members in the household, especially who does what and how different members of the household may engage with SLM. Certainly, it should be anticipated that SLM may reinforce existing and sometimes unequal patterns of labour division and/or create new patterns. A holistic approach of calculating labour among household members, whether paid or unpaid, domestic or outside the household, can be useful to estimate, and sometimes mitigate, such changes.

Our review also revealed the use of multiple definitions of empowerment resulting in inconsistent use and measures to evaluate project successes and failures. The PES scheme for example, found that women were empowered; but this finding was narrowly based on economic and productive efficiencies that would certainly be debated in feminist literature. Such variations and assessments make it difficult to generalize gender trends in SLM interventions.

We advocate for more intersectional, relational and embedded approaches. It will be important to consider how age, gender and perhaps ethnicity intersect—in other words, to use a socially differentiated approach. Clearly, what is positive, negative, or what works for one individual or community may differ across contexts. The value of

understanding change and what they mean for people—for example, gendered coping strategies such as migration and commercialization—must also be incorporated in the development of interventions that seek to build on and enhance adaptive capacities. Empirical evidence and recommendations to identify trade-offs, such as who will bear more labour burdens or shoulder more losses, should be anticipated a priori so as not to reinforce harmful gender practices and norms. Research for development approaches that facilitate a better understanding of complexity can be used to develop practical mechanisms that engage different stakeholders and marginalized groups in the context of changing systems and will improve the likelihood of equitable outcomes in land management projects.

To that effect, and in concert with the experts interviewed, a systems approach should be used. Systems approaches explore technological change within a larger, more complex system of actions and interactions that are composed of diverse actors, social and economic institutions and organizational cultures and practices (Davis et al. 2007). In this review, most of the topics were described using more compartmentalized approach, e.g. soil fertility practices considered separately from water governance. Rather, soil fertility, water management, adoption of conservation agriculture, herbicide application and mechanization should be considered together to better articulate trade-offs in productivity and food security. Understanding local cultural and behavioural factors, and how gender norms influence innovation processes, is essential for designing successful technology dissemination and scaling strategies (Beuchelt and Badstue 2013; Duffy et al. 2017; Jost et al. 2016), but analytical frameworks to understand gender in agricultural innovation are often inadequate, if not overlooked altogether (Kingiri 2013; Malhorta et al. 2009; Pyburn and Woodhill 2016; Iradukunda et al. 2019).

We identified a new and critical knowledge gap for further exploration within the environment flagship, ILRI, CGIAR and beyond. This includes the nexus of gender, livestock and climate adaptation and mitigation strategies. Exciting research to better understand the linkages, synergies and trade-offs can inform the design of projects and interventions that seek to provide more sustainable alternative livelihood options through SLM. It will be essential to evaluate the nexus of poverty, gender and livestock to explain how it supports and/or hinders SLM uptake and scaling.

Methods, design and approaches

The reviews and expert insights demonstrated the value of mixed method approaches. A combination of qualitative and quantitative data collection and analyses provides robust and richer understandings of SLM and guidelines or best-bet practices than any standalone approaches.

Research design approaches should incorporate strategic methods to go both deep and wide, e.g. landscape scale and case studies seem to be best suited to tailor and address specific needs and challenges in gender and land management in livestock systems. Also, the units of analysis vary, and finer scale of analyses are useful, e.g. plots within the household. Financial and time related constraints create challenges to conduct longitudinal studies, access to metadata, etc. However, collaborative and strategic efforts during proposal and project implementation stages can support more multi-scalar analyses of gender in SLM. We thus recommend nested approaches of understanding institutional contexts and enabling factors that exist in the household, community, landscape and value chains. These may include understanding gender norms, roles and responsibilities. While most research is cross-sectional in nature, a more geographic lens would support a systems-oriented understanding that is more realistic. Contexts are changing rapidly in response to urbanization, local economic opportunities and land use change. Gender roles are similarly changing, and not always in predictable ways. The use and application of feminist geographic frameworks that illustrate, or at least acknowledge flows, transitions and change in temporal and geographic locations, could be used to improve understanding of SLM innovations (Bullock and Tegbaru 2019). Interdisciplinary research teams, together and in participation with stakeholders will provide richer understanding of these challenges.

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Annex

Gender and sustainable land management: annotated bibliography

Conservation tillage

Farnworth, C., Frédéric, B., Andersson, J., Misoko, M., Badstue, B. and Stirling, C. 2016. Gender and conservation agriculture in east and southern Africa: towards a research agenda. *International Journal of Agricultural Sustainability* 14 (2): 142–65.

This paper provides a comprehensive and explicit account of the status of knowledge on gender and conservation agriculture. The aim of the study is to identify key research gaps to develop a robust research agenda on this critical issue of importance in enhancing smallholder agriculture. The study considers conservation tillage as part of the suite of conservation agriculture practices dominant in current debates on achieving food security whilst increasing the resilience and adaptation to climate change of farmers in Africa. Even though it is widely accepted that the adoption of conservation agriculture by African smallholders will be influenced by capital and labour requirements, the authors highlight that barely any attention has been focused on the influence of these factors from a gendered perspective. The factors that affect adoption from both inter and intra household perspective are also identified as largely neglected from the literature and debate on conservation agriculture. As such, not much is known about the role of gendered dynamics in decision-making, divisions of labour, access and control over productive assets, and input and output markets in the adoption of conservation agriculture. Related knowledge identified as limited within literature includes the gendered impacts in terms of cost and benefit of adopting conservation agriculture and whether it can provide gender-balanced outcomes. Specifically, this paper conducts an in-depth study of the literature on (i) the changing agricultural landscape in east and southern Africa, (ii) gendered assets and investment ability, and (iii) how access to extension services shapes men's and women's abilities to adopt conservation agriculture practices.

The authors present a convincing body of empirical findings supporting the view that under conservation agriculture, labour and capital requirements, empowerment and economic benefits are not gender neutral. Conservation agriculture practices influence gender relations and the ability for men and women to realize their goals. According to the literature, adopting conservation tillage (or zero tillage) without the application of herbicides, increases the demands on women's labour. The studies reviewed in this paper also emphasize that smallholder farmers are less likely to adopt the complimentary use of herbicides because of aspects around affordability or availability in rural areas. In eastern and southern Africa, where weeding is largely women's task, there would be a gender imbalanced demand on labour.

The authors highlight the consistency in literature regarding the importance of herbicide application to save labour. The benefits of herbicide use have been shown to allow more time for women and children to rest, for children to attend school and for women to engage in income generation activities. Despite the advantages of adopting herbicides, the authors also highlight some factors to consider regarding the ability of women to purchase herbicides

and the negative and positive implications to be considered. For example, the outcomes of intra household bargaining processes for the purchase of herbicides may disadvantage women because weeding is primarily women's activity. However, herbicide use may increase the demand for men's labour as men are culturally allocated spraying tasks, in the absence of which, women may be required to hire labourers increasing their unit cost per hectare. An important projection made by the authors is that if adoption of conservation agriculture increases crop yields, post-harvest processing and storage facilities would be required, which implies increased labour and storage costs—both of which have gendered dimensions.

In smallholder contexts, herbicide provision through subsidies is recommended to increase adoption of conservation tillage. Despite this commonly documented finding, the authors highlight that key gaps in knowledge still remain. The authors emphasize that evidence from studies that explore the gendered nature of labour shortages or labour hiring practices are scant. The authors stress even further that nearly no conservation agriculture studies acknowledge that agricultural labour is family-based and characterized by the work of boys, girls, women and men. Overlooking labour composition in the household obscures the different implications of how the work of different members constrains or enables individual and collective development outcomes, or the common oversight that leads to the assumption that women's labour can be interchangeable with that of their male counterparts. Women's increased labour contribution for weeding may impact the welfare of other household members such as children. The paper ends with a list of overarching questions through which the gendered dimensions of conservation agriculture, and by default, conservation tillage can be better understood.

Giller, K.E., Ernst, W., Marc, C. and Pablo, T. 2009. Conservation agriculture and smallholder farming in Africa: the heretics' view. *Field Crops Research* 114 (1): 23–34.

Giller et al. provide a critical account of factors influencing the uptake and success of conservation agriculture in sub-Saharan Africa (SSA). The authors maintain that while the potential for conservation agriculture to increase yields, reduce labour requirements, improve soil fertility and reduce erosion has been widely observed in the Americas, it is much more poorly understood in the SSA context. The study emphasizes that few articles provide a critical analysis of conservation agriculture despite being actively promoted, funded and supported by major international initiatives and research and extension programs on the African continent.

The study presents an overview on what is known about the benefits of conservation agriculture. The purpose of the overview is to identify the conditions under which conservation agriculture can be successful for smallholder agricultural initiatives in SSA. Specifically, the paper explores literature to understand which farmers in which settings are likely to maximize their utility from conservation agriculture approaches. With this information, the authors proceed to better inform the targeting of conservation agriculture initiatives.

The results reveal various trade-offs and contradictions in the literature regarding the benefits of conservation agriculture for smallholder farmers. The authors report only scant evidence on the role of gender in the conservation tillage literature. For example, while conservation agriculture is described as offering a major benefit by eliminating the practice of tillage and allowing for a larger share of the land to be cropped, refraining from soil tillage increases the development of weeds. The labour required for weeding is often provided by women and it is possible that the increases in labour requirement under conservation agriculture may outweigh the labour saving gained by not tilling the land unless herbicide use is adopted as a weed control mechanism. The authors highlight that the increased labour burden on women is the likely outcome of conservation agriculture in the absence of a reallocation of gendered divisions of labour or herbicide use in agricultural production. The results also review other critical constraints with a gendered dimension to the adoption of conservation agriculture as the competing uses for crop residues and the lack of access to land use of external inputs.

The authors arrive at the conclusion that, in the short term, conservation agriculture without the use of herbicides is unlikely to result in significant net savings in total labour requirements given the increased labour burden for women. In the long term; however, net savings appear to be possible when conservation agriculture is adopted with the use of herbicides.

Parks, H., Christie, M. and Bagares, I. 2014. Gender and conservation agriculture: constraints and opportunities in the Philippines. *GeoJournal* 80 (1): 61–77.

This paper identifies gender-based constraints and opportunities for the adoption of conservation agriculture by smallholder farmers from two villages in the Philippines. The rationale of the study is that it is critical for development programs to understand the socioeconomic aspects influencing women's perceptions, priorities and concerns because these may differ from men's and can affect development outcomes. Specific justifications for the integration of gender in conservation agriculture are emphasized as gender differentiated impacts on assets (such as time, resources and labour) due to considerable changes in farming systems, women's less visible contribution to agriculture and their limited participation in important agricultural training and extension services compared to men. The overarching aim of the paper is to understand the role of gender in negotiating the livelihoods of rural families and the influence this may have on the gendered adoption of conservation agriculture.

Using a feminist political ecology approach, the study draws from the livelihoods framework to understand important gendered dimensions of food security and soil conservation. The study adopts a mixed methods approach by including focus group discussions and household interviews, as well as geospatial data such as participatory and GPS mapping. A total of 83 respondents were sampled for the study. The study specifically explores the gendered dimensions of access to assets or resources, agricultural practices and knowledge and perceptions. This study works with 15 households sampled from beneficiaries of a USAID/ICRAFCA project[3]. Specifically, the study reviewed (i) access and control over assets; (ii) beliefs and perceptions; (iii) practices and participation, and (iv) laws, legal rights and institutions. The concept of "power" was also included as a crosscutting aspect of the model.

The study finds important gendered differences in access to assets, especially in relation to land, with women having less access than men; roles and responsibilities with men more likely to be working on the farm and women in the domestic sphere; and in perceptions about soil quality with both men and women acknowledging that local soils are degrading and that plant growth is a useful indicator of soil health. The study was unique in its focus on gendered roles in livestock management. Men and women also have different access to livestock assets. For example, the study found both men and women perceived that men have greater access, control and labour over the cows while women have greater access, control and labour over the chickens, pigs and goats. The study also found that men were more likely to highlight that access to what was once communal pastureland has been restricted to individual land. This has not only increasing men's labour, but also the competition between land uses of cultivation and grazing on individual lands. For the most part, men are primarily responsible for land preparation activities (under conventional tillage) involving livestock because the steep landscape renders the use of tractors for land preparation unsafe and the use of large livestock for ploughing extremely difficult and requiring of "great physical strength".

Therefore, the results highlight that gendered spaces, assets and roles influence gendered perceptions of ability to adopt conservation agriculture. Tillage is deemed necessary by both men and women, making the adoption of conservation tillage a challenge. Women were more likely than men to be constrained by lack of access to land tenure and training, but also constrained by the threat of increased labour contribution for weeding. Men were more likely than women to face constraints to adoption due to limited pastureland and reduced incomes from not being able to work on tillage as hired labourers.

The study concludes that 'gender-based constraints and opportunities both create and reflect a complex web of assets and resources, practices and knowledge that impact men and women's everyday life'. However, the authors can only infer about whether conservation agriculture adoption would benefit or burden a household. On the one hand, men and women recognize that soils are degraded, but on the other hand, gendered constraints may affect the long-term capacity for farmers to adopt conservation agriculture.

The paper concludes that programs need to acknowledge the complex dynamics that may constrain the gendered adoption and benefits from conservation agriculture. The authors suggest increasing women's participation in trainings

3 The United States Agency for International Development (USAID) and International Centre for Research in Agroforestry (ICRAF)

may be required for the adoption of conservation agriculture practices to be gender sensitive whilst designing a communication strategy that highlights any short-term economic benefits.

Kaumbutho, P.G., Gebresenbet, G. and Simalenga, T.E. 1999. Overview of conservation tillage practices in east and southern Africa. *Soil and Tillage Research* 103: 23–32.

This paper provides an overview of conservation tillage in East and Southern Africa (ESA). The authors stress that conservation tillage is complex because it is embedded within a system comprising various natural factors which influence human capacity to manage soils. Therefore, soils are viewed in this paper as a small part of a larger human-natural system. Specific attention is paid in this paper on the role of gender as a critical socioeconomic issue in conservation tillage.

The paper relies on secondary data to review the progress and efforts in ESA on conservation tillage. The authors provide a firm conceptual explanation for why, despite challenges, conservation tillage is suitable for addressing environmental, agricultural (food security) and socioeconomic needs of smallholder farmers in the continent. The cases reveal that the topic of gender is often neglected in conservation tillage and technology transfer programs because the main perception is that the agricultural domain is male dominated. However, Kaumbutho et al. recognize that where gender has been integrated, it was more of a "fashion" rather than as a substantial contribution to rural development.

One specific approach recommended to increase and enhance gender sensitive conservation tillage is that of training for transformation to promote the participation and co-engagement of men and women in building institutions which enable small holder farmers to become self-reliant. The authors also promote the need for conservation tillage to be farmer-centred, adopting participatory approaches such as farmer exchange visits to enhance publicity, sensitization and education. To enhance the engagement of women and men, the authors further emphasize the need to "marry" the traditional knowledge of farmers and practices with new knowledge on conservation tillage.

Kristjanson, P., Bryan, E., Bernier, Q., Twyman, J., Meinzen-Dick, R. et al. 2017. Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? *International Journal of Agricultural Sustainability* 15(5): 482–500.

This study synthesizes key findings from integrated quantitative and qualitative analyses on the relationship between gender, agriculture, development and climate change. The results show that conservation agriculture can increase the demand for women's labour on weeding. Authors note links between farm household, intrahousehold, community and institutional level data and highlight gender differences in adaptive capacity of individuals and communities to respond to climate change. The gender gap is also substantial in exposure to climate change and its impacts, and uptake of new practices that lower vulnerability. Authors suggest promoting women's empowerment through agricultural development using gender transformative approaches. They conclude that more research is required to fill the knowledge gap on the strategies available for improving men's and women's welfare outcomes from adoption of climate change adaptation strategies.

Lai, C., Catherine, C., Jacqueline, H., Linsey, S., Pravat, R. et al. 2012. Comparative economic and gender, labor analysis of conservation agriculture practices in tribal villages in India. *International Food and Agribusiness Management Review* 15(1): 73–86.

This study emphasizes the importance of shifting towards a more sustainable farming systems in India where 30% of the Odisha state economy depends on agriculture. The authors identify a clear research gap that at the time of writing, not much was known about the benefits and trade-offs of various integrated conservation agriculture practices in India. What is recognized is that combining practices such as minimum tillage and intercropping can improve input use, yield, income and gender equity whilst promoting long-term environmental sustainability. How these benefits are experienced is determined by social and economic contexts—contexts which need to be better understood if the selection and implementation of appropriate conservation agriculture practices are to benefit all smallholders. The

study seeks to evaluate the socioeconomic contexts driving food security in rural Odisha state through the lens of minimum tillage and intercropping conservation agriculture practices.

A mixed methods approach is adopted for this study to i) estimate the yield, labour and profitability differences between conservation agriculture practices of minimum tillage and intercropping, and the use of convention tillage on representative maize-based farms; and ii) evaluate the implications on gendered labour use (time) when conservation agriculture practices have been adopted. The authors explore whether conservation agriculture practices reduce labour for men and women and the extent to which opportunities to exploit off farm income opportunities can be generated to increase household incomes. The authors highlight that off farm income opportunities vary according to gender, with fewer activities available for women than men. A total of 145 households participated in the study, selected based on key sample criteria including agricultural and demographic characteristics, proximity to extension office and presence of subsistence farmers.

Gendered labour patterns reveal that women are more involved than men in weeding and fertilizer application, while men are more involved than women in land preparation tasks such as ploughing. Minimum tillage was found to reduce labour hours by 28.6%, as land preparation for the field is only ploughed once compared to twice under conventional tillage. Therefore, adopting conservation tillage may influence the availability of male farmers to engage in other activities. When combined with intercropping of cowpea, the results show that labour hours increase by 40% due to the additional effort required for weeding when compared with maize only fields. The study shows gendered changes in labour hours for minimum tillage in land preparation (typically male activity) and weeding (typically female activity), as well as increases in time spent sowing and harvesting (shared activity). The economic analysis found that adopting minimum tillage allows farmers to increase their incomes only when off farm opportunities are available; however, with no available opportunities for off farm income generation, the study found that the profitability of a minimal tillage practice decreases by 31.11% due to yield decreases and labour hours saved. Given women's limited off farm opportunities, conservation tillage practices would not be as financially beneficial as it would be to men, who have greater opportunities to generate secondary income.

The study recommends that the best scenario for women is to adopt minimum tillage with only maize as it requires the least on farm labour and saved labour can be used for off farm employment. The implication is that even with a reduction in farm labour, women's potential to earn additional incomes may be limited due to fewer opportunities. However, incorporating minimum tillage should be encouraged due to the potential for long-term gains, such as higher yields over time. Because such benefits in yield and soil improvement may take a longer period to materialize, the study encourages the provision of financial incentives for adopting conservation agriculture practices and enhancing the availability and quality of extension services.

Lubwama, F.B. 1999. Socio-economic and gender issues affecting the adoption of conservation tillage practices. In: Kaumbutho, P.G. and Simalenga, T.E. (eds), *Conservation tillage with animal traction. A resource book of the Animal Traction Network for Eastern and Southern Africa (ATNESA)*. Harare, Zimbabwe: 173.

This paper places socioeconomic and gender-related issues at the centre of its review of the adoption of conservation tillage practices. The authors argue that despite the theoretical and practical advantages of conservation tillage, the adoption of its practices within the African context has been limited by critical socioeconomic factors, especially gender.

The paper draws on secondary data to outline the constraints posed by i) the physical activities in conservation tillage such as soil cover management, weeding management and soil and water conservation; and ii) the socioeconomic constraints such as culture and tradition, competitive use of crop residues, availability of sustainable inputs and implements, limited knowledge and support services, inappropriate technology, inadequate technology transfer and insecure land tenure. The paper emphasizes that these constraints all have a gendered component that needs attention if conservation tillage and its adoption is to promote improvements in agricultural production in a gender sensitive way.

The author draws specific reference to the role of gender and technology and describes the importance of understanding whether technology is gender neutral or blind and the relationship between technology and women's participation, or the extent to which technology addresses gender concerns in agricultural production. The author argues that conservation tillage technologies to increase production often become biased towards one gender. The paper reports on research that illustrates how social and economic conditions influence agricultural practices and processes of technology selection and adoption are seldom gender neutral. The paper also argues that conservation tillage practices, especially those pertaining to soil and water conservation, fail to promote equal opportunities for participation by men and women as the analysis of gender roles in the design of technologies is overlooked. Women's heavy workloads, gender blind information dissemination and limited access to information are among the main constraints limiting women's knowledge and adoption of conservation tillage.

The paper concludes with a number of recommendations to increase gender balanced adoption of conservation tillage. For example, the intersection between gender and the socioeconomic context should be integrated into institutional frameworks through which conservation tillage technology is designed and delivered, there should be close collaboration with governments and tertiary institutions for the allocation of financial resources to study gender related constraints to conservation tillage adoption and affirmative action should be enforced to ensure the direct participation of women in all aspects of technology design and adoption.

Nyanga, P., Johnsen, F. and Kalinda, T. 2012. Gendered impacts of conservation agriculture and paradox of herbicide use among smallholder farmers. *International Journal of Technology and Development Studies* 3 (1): 1–24.

This paper presents an assessment of the gender-based impacts of conservation agriculture among smallholder farmers in a Zambian initiative known as Conservation Agriculture program. The study is grounded by a concrete theoretical model of gender illustrating why most of the factors leading to women's poor access to resources and opportunities related to agricultural production are gender based.

The authors adopt a mixed method approach where quantitative data were analyzed using descriptive statistics and qualitative data were analyzed using content analysis. One of the key questions from this study asked what the impacts of conservation agriculture are among men and women smallholder farmers in Zambia, specifically in relation to the differential effects of minimum tillage (and digging and planting basins) on labour among men and women farmers.

The results show various advantages and disadvantages of adopting the conservation agriculture approach. It was an advantage that the conservation agriculture approach reduced labour for women and children especially regarding the clearing of fields prior to tillage and during weeding under the condition that herbicides were correctly used and improved household food security. The disadvantages of conservation agriculture are linked to gendered contributions to labour, gendered concerns about food security and potential gendered health impacts of herbicide use. Regarding labour, the gendered findings show that women and children contributed more labour than men to handle weeding activities, while men's increased labour activity was attributed to the spraying of herbicides. The study also highlights that although herbicides affected labour requirements differently for men and women, women were more likely to display concern that herbicides may undermine food security in their mixed cropping systems, especially regarding the production of wild vegetables. The last disadvantage puts to question the extent to which conservation agriculture is environmentally sustainable, especially regarding the use of herbicides. The paper concludes by promoting a gender sensitive approach to conservation agriculture which seeks to minimize trade-offs between socioeconomic benefits, environmental sustainability and health concerns.

Sumner, D., Christie, M. and Boulakia, S. 2017. Conservation agriculture and gendered livelihoods in northwestern Cambodia: decision-making, space and access. *Agriculture and Human Values* 34 (2): 347–62.

This study investigates the gender-based opportunities and constraints associated with the dissemination of conservation agriculture where practicing conservation tillage (minimal or no tillage soil management) is one of

the three key pillars. The study is based in Cambodia where the Sustainable Agriculture and Natural Resource Management Innovation Lab (SANREM IL4) program provided subsidies and interest free credit to lower the barriers farmers face when transitioning to tillage free production systems.

The study adopts a mixed methods approach to collect and analyze gender disaggregated data. It explores the relationships between farmers' access to productive resources and the intrahousehold decision-making processes influencing their (non) adoption of conservation agriculture. Qualitative data was collected through focus group discussions (FGDs), semi structured (intra household) interviews and participant observations; whereas quantitative data was collected using a household survey. Two FGDs were conducted separately for men and women while 26 intra household interviews were completed with 46 participants.

The results showed that 73% of men and 84% of women considered the credit offered by the program to be an important incentive for farmers to adopt conservation agriculture practices. Those who adopted conservation agriculture practices did so on an experimental level using conventional tillage practices on their remaining land parcels. 72% of men and 78% of women respondents indicated that adopting conservation agriculture enabled them to allocate more time to additional agricultural production activities; however, the differences experienced by adopters were gendered. Reportedly, men were primarily involved in tillage activities and herbicide application due to their greater physical strength; whereas women were involved in what the male respondents referred to as "lighter" activities such as fertilizer application and harvesting, most activities of which were reduced as a result of adopting conservation agriculture. Respondents attributed the relocation of their additional time to embedded sociocultural norms and beliefs. Despite women's involvement in agricultural practices, men overlooked their role in applying herbicides, while women indicated that both genders and children are involved in herbicide application. Both genders reported that women had a minimal role in decision-making over herbicide selection.

The paper concludes that conservation agriculture was perceived as an attractive alternative to conventional tillage especially due to the interest free credit and the sowing and herbicide application services offered by SANREM IL. However, the gender differences observed in agricultural practices and intra household level decision-making are expected to influence the ability for men and women to adopt conservation agriculture in the long term, affecting livelihood practices. The use of a mixed method approach was viewed as advantageous in the documentation of gendered agricultural relations, especially through separate male and female interviews. The study argues that development programs promoting conservation agriculture must acknowledge the multiple gendered spaces where men and women practice agricultural production and challenge the assumption that conservation agriculture and other agricultural activities are male dominated practices.

Teklewold, H., Kassie, M., Shiferaw, B. and Köhlin, G. 2013. Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: impacts on household income, agrochemical use and demand for labor. *Ecological Economics* 93: 85–93.

This paper considers conservation tillage as part of the larger strategy of Sustainable Agricultural Practices (SAPs), which are defined as those 'strategies that can increase productivity in a sustainable way by addressing the degradation of ecosystem services and increasing the ability of smallholder farmers to adapt to climate variability and change' (Antle and Diagana 2003; Lee 2005; Pretty et al. 2011; Woodfine 2009 cited in Teklewold et al. 2013). The paper is unique because it analyses the application of various combinations of three SAPs, one of which is conservation tillage in explicit relationship to the demand for agricultural labour from men and women. This paper presents a valuable contribution to the relatively thin empirical evidence on SAP adoption and agrochemical and labour use.

The study draws on a quantitative approach by using the multinomial endogenous switching regression model to explore farmers' choice of a combination of SAPs and various related impacts and implications on factors such as family labour use, maize income and use of agrochemicals in rural Ethiopia.

4 SANREM is part of USAIDs Feed the Future Innovation Lab for Collaborative Research on Sustainable Agriculture and Natural Resource Management.

Results reveal that female spouse's education level positively impacts the adoption of the improved variety–conservation tillage package. The adoption of SAPs either individually or as packages was found to affect male and female labour time allocation differently. The results show that when used in isolation, conservation tillage increased labour demand but it is not clear from the paper if this demand increased for both men and women. The authors indicate that increased demand is likely due to farmers' efforts to compensate for reduced tillage. Only when farmers adopted conservation tillage jointly among other diversification practices did they find that there were no significant impacts on family labour use (and pesticide use) observed. The adoption of most of the other SAP packages increased women's workload since women spend more time working on the farm compared to men. The authors explain that the increased labour allocation for women is therefore likely to have a negative impact on larger households by reallocating time from important domestic activities primarily under women's roles and responsibilities, such as food preparation and childcare.

The authors conclude that agricultural intensification technology interventions based on SAPs are not gender neutral. Therefore, policy makers and other stakeholders are encouraged to promote a combination of technologies that can enhance household food security through increasing income and reducing production costs while also being aware of possible gender related outcomes.

Fodder production

Ashley, K., Wilson, S., Young, J.R., Chan, H.P., Vitou, S. et al. 2018. Drivers, challenges and opportunities of forage technology adoption by smallholder cattle households in Cambodia. *Tropical Animal Health Production* 50: 63–73.

The introduction of forage technology into smallholder cattle systems in Cambodia has provided alternatives to the traditional feed sources of rice straw and native pastures. Introducing feed technologies is expected to improve animal nutrition and reduce the labour intensiveness of feeding cattle. However, the authors emphasize that widespread adoption of these technologies requires farmers' recognition of the suitability of their land to establish forage plots, access to sufficient water for the sustainable growth of seeds/seedlings, access to adequate fertilizer, knowledge of correct harvesting procedures and ability to apply the required weed management practices. Farmers are also expected to understand the trade-offs associated with adopting forages rather than growing only traditional food crops. To understand the motivation, challenges and opportunities for forage technology adoption by smallholder cattle households in Cambodia, the authors argue that research is required for widespread adoption and identification of areas for improvement.

The study adopted a quantitative approach with 40 forage growing farmers, 20 of which were female, from two villages involved in the village-based biosecurity for livestock disease risk management project in Cambodia (VBLDRM). Interviews sought to understand the experience of farmers who had adopted forage technologies by examining their reasons for forage establishment; use of inputs and labour requirements for maintaining forage plots; and use of forages for feeding and fattening and sale of grass, seedlings or silage. For household labour activities, the survey reviewed cutting, weeding and the application of chemicals, manure and water.

The results showed that the main reason for adopting forage production technologies was because of time saved by household members. Time spent was reported as one hour per day on forage maintenance and cattle feeding. However, it is not clear from the results how much time was spent prior to adoption. Adult males were found to be mostly involved in forage activities (83%), although 60% of respondents reported that adult females were also involved in forage development activities (it is not clear from the results presented what the distinction of activities between men and women was). The main challenge faced by farmers who adopted forage technologies was reported as constraints to water availability. Lack of labour, fencing, competition from natural grasses, irrigation costs and limited experience were also identified by a small number of households as key challenges faced in forage production. The study also found that cattle fattening and sale of cut forage grass and seedlings were activities only carried out by 10–25% of households.

The study recommends that there is potential to expand forage plots and cattle activities. However, current constraints must be addressed with provision of water if feed technology for smallholder cattle households in Cambodia is to be sustainable.

Fischer, G., Wittich, S., Malima, G., Sikumba, G., Lukuyu, B., Ngunga, D. and Rugalabam, J. 2018. Gender and mechanization: exploring the sustainability of mechanized forage chopping in Tanzania. *Journal of Rural Studies* 64: 112–122.

Mechanization in agricultural research and development is important and there is a new emphasis on equity and sustainability. This study evaluates the introduction of forage chopper machines in northern Tanzania from a farmer's perspective. Qualitative data collected through focus group discussions and a survey are used for a gender analysis of this technology within a broader sustainable intensification indicator framework. The results draw attention to smallholder challenges, such as high operational costs or weak supporting infrastructures, and also show how the technology's sustainability is contingent upon equity dynamics at the household and community levels. Suggestions for promoting the chopper's sustainability include gender-sensitive training and the establishment of group models for machine operation based on agreed and fair regulations.

Gebremedhin, B., Ahmed, M.M. and Ehui, S.K. 2003. Determinants of adoption of improved forage technologies in crop–livestock mixed systems: evidence from the highlands of Ethiopia. *Tropical Grasslands* 37: 262–273.

Gebremedhin et al. emphasize the fact that various national and international agencies have developed feed technologies to address the constraints of inadequate feed in livestock production. However, the low adoption of these technologies calls attention to the need to identify key socioeconomic and policy factors that hinder the adoption of improved feed technologies in order to inform the design of policies and interventions that can boost adoption.

The study adopted a quantitative approach whereby panel data from mixed-crop livestock systems in the Ethiopian highlands was used to explore key socioeconomic factors that may affect technology adoption. The data collected from 212 observations included information on land use, labour allocation, draught power, inputs and outputs, income and expenditure, household resource endowments, cropping and livestock activities and demographic characteristics.

The results show that forage adoption was influenced strongly by land tenure security, education level of household heads and wealth of households. The integration in market-oriented activities and intensification of crop production were also identified as important factors positively influencing the adoption of forage technologies. However, age and gender of household heads were found to have no impact on forage adoption. The results highlight that where livestock productivity and outcomes from improved feed technology are higher, and where production is more market oriented, the adoption of improved forage is higher (for example in mixed farming systems where smallholders farm dairy cattle). An important explanation for this potential for increasing fodder adoption is that of complementarity between dairy related cash income and the opportunity to engage in intensified crop production. This way, both crop and livestock productivity improvement are reinforced.

Although no gender specific recommendations are provided, the study emphasizes that in areas where farm households have no ownership rights to land, the improvement of land tenure security through institutional mechanisms can increase the likelihood of farmers' adoption of forage technologies. However, the study warns that because the systems reviewed are characterized by typically high population densities, land scarcity and degradation is still likely to contribute to low land productivity. The threat that competition with food crops will undermine the adoption of forage because farmers are less likely to sacrifice food production is further emphasized.

Kidake, B.K., Manyeki, J.K., Kubasu, D. and Mnene, W.N. 2016. Promotion of range pasture and fodder production among the pastoral and agro-pastoral communities in Kenyan rangelands: experiences and lessons learnt. *Livestock Research for Rural Development* 28 (8).

Kidake et al. recognize the social, ecological and economic importance of livestock rearing activities in ASALs and describe the challenges facing Kenya's livestock keepers. They acknowledge that increasing attention from institutions and organizations on pasture and fodder technologies, such as natural pasture improvement, range pasture establishment, pasture seed production, processing and storage, range fodder/pasture utilization, and conservation and preservation are among those promoted in the country's ASALs. Given the array and significance of fodder and seed interventions, the study sets out to review experiences and lessons learned from Kenya's drylands with regard to pasture and fodder technologies for the promotion of improved livestock productivity.

The study adopts a unique mixed methods approach drawing from a combination of participatory methods such as farmer training, on-farm demonstrations, participant observations, key informant interviews and group discussions with farmers from seven ASAL counties in Kenya. Thirty one of the 209 farmers that were trained across the seven ASAL districts were female.

The results revealed that farmers recognized the loss of traditionally adapted fodder species which have been replaced by shrubs, bush, unpalatable species and bare patches, and supplementary feed is often minimal and limited to those individuals with greater resource endowments. In their evaluation of knowledge sharing activities within the various communities, the study posited that women's low participation as trainers was attributed to the high labour requirement of livestock production. Women were found to have limited ownership of and control over natural/productive resources (such as land and livestock) and finances which constrained their ability to participate in training where demonstrations and upscaling technologies for other group members to learn and observe were required. Women's participation as trainers and trainees was also constrained by their obligations to meet social responsibilities. The findings on women's limited participation were considered by the authors to be a reflection of their subordinate role in ASAL societies. Although the implications for gendered labour were not highlighted explicitly, the results on pasture/fodder management found that the proliferation of weeds was common and the labour involved was considered by respondents to be a deterrent to the application of manure.

The study concludes that participatory approaches with farmers (peer-to-peer diffusions) and support from research and extension actors can be a useful means to disseminate information on fodder technology and enhance adoption. The authors suggest refresher courses on fodder production and monitoring and evaluation and feedback mechanisms to facilitate capacity development abilities of men and women. Further efforts to increase gender inclusivity within fodder adoption interventions are considered necessary as well. For example, research into suitable alternatives of less labour intensive weed control are presented as a means to encourage the use of manure by men and women for better productivity in ASALs. Therefore, the combination of multiple approaches is expected to inform effective dissemination methodologies of research results on pasture and fodder improvement technologies and promote methods for upscaling technologies to facilitate success.

Mureithi, S.M., Verdoodt, A., Njoka, J.T., Gachene, C., Mayerhoff, E. et al. 2016. Benefits derived from rehabilitating a degraded semi-arid rangeland in communal enclosures, Kenya. *Land Degradation and Development* 27: 1853–1862

Mureithi et al. emphasize that agropastoral livelihoods and local biodiversity are under threat due to land degradation caused by climatic and environmental changes that undermine the potential for land to provide critical environmental services, especially provisioning services. Evaluating fodder production efforts through rangeland grass reseeding is considered to be important for understanding the available options and strategies to restore degraded pastures and improve the potential for livestock production and wildlife conservation within agropastoral systems.

The study takes the case of the Rehabilitation Arid Environments (RAE) Trust in Baringo, Kenya which implemented the first rangeland reseeding project on Kenya's communal lands in 1982. The RAE interventions are considered

successful in terms of community members' acceptance of their potential to improve food security, reduce poverty and rehabilitate rangelands. The article describes how RAE provided support to establish two main types of enclosure: communal and private. Communally owned and managed enclosures are reseeded based on community group-based decisions (of which a considerable share were women's community groups) and backstopped with RAE extension services. According to the article, since its establishment, RAE has rehabilitated over 700 privately held enclosures (approximately 50 enclosures annually) which are owned and managed by individual farmers based on exclusive access and user rights but also receiving extension services from RAE. The objective of the study was to quantify the benefits from the project.

The study adopted a mixed methods approach where all maintenance and utilization activities conducted by RAE on enclosures were analyzed quantitatively and qualitatively. Qualitative approaches involved the revision and cross checking of detailed field notes with field reports which were summarized in tabular format. Additionally, filed monitoring quantitative data from enclosures was ordered and categorized according to quantitative and qualitative benefits. Quantitative benefits referred to tangible products with immediate economic value, whereas qualitative benefits referred to those that could not be immediately transferred to cash but enhanced environmental outcomes as well as household and community welfare.

The results showed that women's groups were the majority managers of communal enclosures and were considered to be direct beneficiaries from income generated through restored lands. Specifically, the first and second highest tangible benefit was livestock fattening and grass seed harvesting, respectively. Dry season grazing was the main use of the enclosures generating income for a large majority of participants. Other tangible benefits included grass and wood cutting and bee keeping. The article also highlights that labour-oriented activities benefitted community members directly. Specifically, grasses were found to provide an available source of thatching materials for houses and granaries which enabled longer storage of harvested grass seed and other crops, thus promoting household food security. The main qualitative benefit from the enclosures was the restoration of high biodiversity of flora and fauna. Improved livelihoods and land and livestock management highlighted other key benefits recognized by communities to have emerged from rangeland rehabilitation.

The article does not single out gender exclusive recommendations. However, they emphasize the conditions for successful communal enclosures in rangeland regeneration interventions. Environmental, economic and social benefits are emphasized in this study as the key reasons for the sustained success of the RAE community-based projects. For community members to further benefit, the authors argue that stronger market linkages for restored rangeland products, capacity building and access to extension services are required to boost the adoption of such rangeland restoration initiatives.

Muyekho, F.N., Mose, L. and Cheruiyot, D.T. 2003. Development and transfer of forage production technologies for smallholder dairying: case studies of participatory evaluation of species and methods of establishment in western Kenya. *Tropical Grasslands* 37: 251–256.

In the mixed farming regions of Kenya, crop residues are used as livestock feeds and livestock provide manure for crop fertilizer, milk for food and income from sales. However, inadequate livestock feeds and poor quality of soils are critical constraints to livestock productivity and development. The adoption of high yielding forage technologies has been identified as a practice to offset these challenges and there is a need to conduct participatory studies with farmers to identify their priorities for technology adoption.

This study presents a selection of case studies that adopt participatory evaluation of forage management with smallholder farmers. One of the studies evaluates the benefits and farmer acceptance of Napier grass, while another study evaluates five different fertility management strategies consisting of organic and inorganic fertilizers and their combinations on the productivity and acceptance by farmers for Napier grass. One of the key methods evaluated was the Tumbukiza method (referring to a Kiswahili word meaning "placing in a hole") which was a new method adopted by farmers in the study area involving the planting of fodder in holes of 60×60×60 cm (depth, length and width).

The results show that the methods for planting Napier grass influenced productivity, with the Tumbukiza method being preferred by the majority of farmers because it produces significantly higher yields than the conventional method. The Tumbukiza method was also preferred because of the cost-benefit ratio while the conventional method using inorganic fertilizers gave the best return to labour. However, in the gender-segregated interviews, respondents from female-headed households argued that the Tumbukiza method was inappropriate, especially regarding labour requirements. Specifically, the Tumbukiza method was labour intensive requiring activities such as digging holes, collecting manure and mixing with topsoil before planting. They argued that hiring extra labour would increase the adoption of the Tumbukiza approach. However, farmers acknowledged that under the Tumbukiza method, weeding and harvesting were easier when compared to fodder planted using the conventional method.

The study concludes by recognizing that farmers have access to different Napier grass production strategies, as shown by their choice to adopt conventional or Tumbukiza methods depending on the most suitable circumstances. The need for scaling up technology adoption is required for facilitating high yielding fodder for dairy.

Njarui, D., Gatheru, M., Gichangi, E., Nyambati, E.M., Ondiko, C.N. and Keziah, W. 2017. Determinants of forage adoption and production niches among smallholder farmers in Kenya. *African Journal of Range and Forage Science* 34(3): 157–166.

Njauri et al. emphasize that the quality of natural pastures and crop residues, on which ruminant livestock in Kenya subsist, is generally low, leading to low productivity of livestock. Efforts to promote the cultivation of forages in mixed crop-livestock systems have been met with low adoption rates across Africa. The authors recognize that farmers often prefer to utilize their land for the production of food crops rather than forage, leading to livestock feed shortages. Given the increased demand for livestock products in Kenya, this article draws from a renewed interest in conducting research on feeds for livestock productivity improvement. Specifically, the authors wish to understand the determinants for adopting fodder production technologies. The study objective of the authors was to assess the demographic, socioeconomic and physical environmental factors influencing the adoption of forage technologies in smallholder crop-livestock systems in Kenya.

The study adopted a quantitative approach whereby 786 smallholder crop-livestock farmers were selected from across 12 agroecological zones from four regions of the country. One hundred and twenty-two of these were female-headed households. Data was collected using questionnaires that captured the gender of household heads, household size, ownership, farm size, livestock holdings and adoption of forages cultivated on own farm and access to incomes. Napier grass (a fodder grass) and Rhodes grass (a pasture grass) were considered for the study.

The results revealed that 58% of the respondents had adopted forages; 73 of the 462 forage adopters were found to be female-headed households. Compared with non-adopters, adopters were found to be from households that produced more milk, with slightly older headship, fewer household members, smaller farm sizes and located near urban centres. Land ownership, access to formal education of the household head and experience in livestock farming were found to be the key factors that influenced fodder adoption both positively and significantly. Gender, age, off-farm income, number of dairy cattle and amount of milk produced were factors that were found not to influence forage adoption.

The study recommends that it is important to consider the demographic, socioeconomic and physical environmental factors that influence fodder adoption for the suitable farmers to be targeted. Given that land tenure security and access to education were identified as the most crucial determinants of forage adoption, institutional arrangements to encourage secure land tenure are recommended together with increased investment in programs that educate farmers on the benefits of forage cultivation. No specific gender related recommendations are offered by the authors. Collectively, these recommendations are expected to facilitate the adoption of forages by educating farmers of the benefits.

Omollo, E.E., Wasonga, O.V., Elhadi, M.Y and Mnene, W.N. 2018. Determinants of pastoral and agro-pastoral households' participation in fodder production in Makueni and Kajiado Counties, Kenya. *Pastoralism: Research, Policy and Practice* 8(9): 1–10.

Rangeland pasture reseeding is among the most commonly adopted fodder production technologies in dryland systems where pasture scarcity represents a major constraint for livestock production. Omollo et al. present a study on the adoption of fodder production among communities in Kenya where limited information on how to guide the targeting and prioritization of scaling up options exists. While various determinants of fodder production have been identified in the literature (such as farmer's age and education level, years of farming experience, farm size, herd size, access to grazing reserves and membership groups), these determinants are context specific and vary according to region and farmer. The study analyzes the socioeconomic and demographic factors influencing participation of households in, and livelihood benefits from, fodder production in Kenya.

The study looked specifically at the Agricultural Research Supports Program Phase Two (ARSP-II) which was established in 1998. The objective of ARSP-II was to disseminate fodder production technologies to communities in Kenya's ASALs. Enclosure of natural pastures and range reseeding were among the key technologies introduced. These ASAL areas are characterized by rainfall-dependent fodder production hosting grass species that are adapted to local environments that are drought resistant and highly palatable. Land preparation and other production activities are managed through own/family labour that is locally available and affordable.

A mixed method approach was conducted by the authors. Quantitative data was collected from 216 households using a systematic random sampling procedure with households participating in the ARSP-II. The semi-structured interview questionnaires administered captured socioeconomic and demographic characteristics of respondents. The study's hypothesis was that female-headed households are less likely to adopt fodder production technologies than male headed-households due to their constrained access to critical production resources such as land and water. Qualitative data was collected from 11 focus group discussions with members producing fodder in the study areas, and 38 key informant interviews with fodder producers and actors in the fodder production value chain, such as extension providers, to verify the data collected in the household surveys.

The results revealed that various factors determined the adoption of rangeland reseeding technologies. The gender of the household head, level of education, membership in social and development groups and access to extension services were the most important determinants identified. 74% of households producing fodder were male-headed and members of social groups where access to extension services was much higher than in the non-fodder producing households interviewed. While these findings were not entirely new, the authors pay specific attention to the gender-related results. The authors highlight that male-headed households may be better represented among fodder producing households than female-headed households for a number of reasons. Households headed by men are considered in the study to have access to more labour and time thus enabling better access to agricultural training opportunities and information and extension services compared to households headed by women. Creating an enabling environment that can encourage the participation of male- and female-headed households was predicted to increase the likelihood of fodder adoption by 20%.

The study recommends the inclusion of technical support and extension services for households within existing social groups, or in the process of establishing social groups, to enhance the production of fodder in ASAL regions.

Manure management

Jagger, P. and Pender, J. 2006. Impacts of programs and organizations on the adoption of sustainable land management technologies in Uganda. In: Pender, J. Place, F. and Ehui, S. (eds), *Strategies for sustainable land management in the East African highlands*. Washington, DC: International Food Policy Research Institute.

The transition from centralized to decentralized provision of extension services, input supply, rural credit delivery, regulation, and other aspects of natural resource management may have significant implications for the capacity of smallholders to sustainably manage their resources. This article explores the challenges and opportunities for institutional change in the face of government devolution and increasing land degradation in Uganda. Authors characterize agricultural programs and organizations in Uganda and determine whether community and/or household involvement in programs and organizations have influenced household-level adoption of land management technologies.

Authors collected data from a series of surveys (community, village, and household level), conducted between 1999 and 2001. They characterized community-level programs and organizations based on a survey of 107 LC1s (local councils comprised of one or a few villages), and villages from throughout most of Uganda conducted in 1999–2000 and use a random sample of LC1s that were stratified by agricultural potential, market access, and population density. Authors describe the classification of agricultural potential into six zones and market access using the measure of potential market integration based on proximity to major roads and towns. Both highland (elevation greater than 1,500 meters above sea level) and lowland sites are represented in the sample.

One village was randomly selected from within each LC1 and respondents were groups of approximately 8 to 15 LC1 or village members selected to represent different ages, occupations, and genders. Household surveys were conducted during 2000–01 with four or five randomly selected households from within each LC1 and the household head and other members of the household who were actively engaged in household decision- making were interviewed. Data on household-level involvement with all types of programs and organizations and information on sustainable land management technologies used by the household was collected and a total sample size of 451 households was reached.

The results from the econometric analysis of the determinants of adoption of land management technologies indicate that the presence of an agriculture- or environment-focused program or organization at the community level had a negative effect on the adoption of animal manuring and a positive effect on the adoption of pesticides. This suggests that spillover effects of programs and organizations may be greater for technologies that have short-term benefits and that require some degree of coordination to be most effective.

Regression results showed that a higher proportion of households adopted pesticides when there was an agriculture- or environment-focused program or organization in the LC1. Rates of adoption of inorganic fertilizer, animal manure, and applying crop residues were only slightly lower in the same communities. There were no significant results to suggest that involvement in programs and organizations influences the adoption of land management technologies. However, respondents perceived strong positive effects of several types of organizations on crop production, land quality, and livestock production.

Households with higher numbers of male members were more likely to adopt organic technologies such as manuring and crop residues. Female- headed households and households with more women were more likely to adopt inorganic fertilizer. Wealthier households, or those with more cattle, bulls, and bicycles were more likely to adopt some technologies (inorganic fertilizer, manuring, and mulching), suggesting that wealthier households will be more likely to invest in land management technologies characterized by medium- to long-term returns, such as manuring and mulching. Households with access to extension services were more likely to adopt inorganic fertilizer, manuring, mulching, and pesticides. Households with older heads were less likely to use animal manure. Access to both formal

and informal credit was negatively associated with adoption of animal manure in 2000. Households with resource-dependent primary and secondary income sources were less likely to use inorganic fertilizer and pesticides.

Authors conclude that centralized community level programs and organizations were better distributed during the 1990s throughout Uganda and reached more poorer areas than current programs. In light of these results, authors note that it is important to evaluate devolution and how NGOs and CBOs will fulfil the need to reach these areas where demand for services is substantial. While respondents are engaged in organizations, fewer households were involved in organizations focused on agriculture and the environment. They found that female-headed households and, among those, households with high numbers of women were more likely to be involved in organizations. However, women's participation does not necessarily lead to uptake because of women's limited agency in household-level decision-making regarding the adoption of land management technologies. Thus, further investigation into household-level decision-making regarding technology adoption is required.

In summary, the findings provide some insights into the influence of agriculture- and environment-focused organizations in Uganda and should be considered in the broader context of the government devolution of services to NGOs and CBOs. Further analysis is needed to evaluate links between organization and land management in Uganda, particularly understanding opportunities and constraints to technology adoption.

Ndiritu, S.W., Kassie, M. and Shiferaw, B. 2014. Are there systematic gender differences in the adoption of sustainable agricultural intensification practices? Evidence from Kenya. *Food Policy* 49: 117–127.

This paper explores whether there are systematic gender differences in the adoption of multiple sustainable intensification practices (SIPs) in Kenya, thereby contributing to a better understanding of gender and farm management systems in Africa. A key contribution of the work is that it enhances understandings of differential technology adoption patterns based on a suite of adoption of practices or SIPs of male-female plot managers from diverse farming systems in Kenya. We specifically focus on the application of manure. The paper also differs in that many studies focus mainly on the adoption of external inputs (e.g. seed and fertilizer), while here they consider the adoption of a range of SIPs (e.g. maize-legume intercropping, maize-legume rotation, manure application and minimum tillage) required for sustainable intensification of production.

The paper adopts a mixed methods approach where sex-disaggregated survey data at the plot level was collected in 2011 by the International Maize and Wheat Improvement Center (CIMMYT) in partnership with the Kenya Agricultural Research Institute (KARI) and included 613 households farming 2,851 plots in the western and eastern regions of Kenya. Secondary data was collected to understand the farming system of the study areas, adjust the questionnaire and develop the sampling strategy. This was followed by interviews with key informants to better understand crop and livestock production. Multi-state sampling procedures were used.

They analyze plot level adoption decisions of SIPs by male, female or joint plot managers within the household since rights to, and control of, resources differ significantly within the household depending on whether the man or the woman or both have managerial responsibilities on farmland and other household assets. The authors compare women and men's decisions based on the plot owner, while controlling for household characteristics, asset wealth and land quality factors that condition investments in intensification options. They use a multivariate probit model and explore gender differences in the adoption pattern for SIPs.

The results show that there are gender gaps in technology adoption and the effect of the gender specific farm or plot manager on the adoption of multiple agricultural technologies is observed. Males dominate in the management of good fertile soil, while female plot managers manage less fertile soils. 22% of the plots managed by women were perceived to have poor soil fertility relative to 4% of plots under men and 16% of plots under joint management. Fertilizer requires more capital inputs and explains, in part, why female farmers apply chemical fertilizers at a lower rate in female-headed households, particularly where credit markets are not functioning well. Female-managed plots have a lower rate of application of livestock manure than male managed plots. Authors explained these low levels in terms

of labor, saying that labor requirements differ, especially when crops are distant from the households. Also, women in female-headed households own fewer livestock compared to men and women in male-headed households. Almost half of the plots in male-headed households (45%) are reported to be jointly managed by both the male and female in the household; however, females manage smaller plots. Livestock ownership increased the likelihood of animal manure application. Female plot managers own less livestock which may limit the amount of manure available for soil fertility management. On the other hand, compared with male-managed plots, jointly managed plots are more likely to adopt maize-legume intercropping, maize-legume rotations and improved seeds.

The findings of the paper contribute to understanding the gendered nature of farm management systems in Africa, especially in relation to the adoption of interdependent farm innovations and emerging literature on the gendered technology gaps and the effect of the gender specific farm or plot manager on the adoption of multiple agricultural technologies. They recommend designing and implementing technology delivery and extension services that recognize the gender differentials within heterogeneous families managing different farm plots. They also recommend that more efforts to build capacity with poor women should be made, especially when they manage poor soils and lack knowledge and capital. Such approaches would lend to closing the gender technology gap.

Pender, J. and Gebremedhin, B. 2006. Land management, crop production and household income in the highlands of Tigray, northern Ethiopia: An econometric analysis. In: Pender, J., Place, F. and Ehui, S. (eds), *Strategies for sustainable land management in the East African highlands.* Washington, DC: International Food Policy Research Institute: 107–140.

Low agricultural productivity, poverty, and land degradation are critical problems in the highlands of Tigray located in northern Ethiopia. In response to these challenges, the regional government of Tigray implemented regional development programs in 1991 that focuses on "promoting conservation of natural resources and improvement of agricultural productivity and welfare through a broad program of rehabilitation of natural resources, investment in infrastructure, agricultural extension, education, and other services".

The purpose of this study is to assess proximate causes of changes, if any, in agricultural production and per capita income. Determinants that are included in the econometric analysis include household choices regarding income strategies, land management, decisions, and the underlying determinants of these choices.

Authors draw on household and plot-level surveys conducted in 100 villages in 50 tabias[5]in the highlands of Tigray during 1999–2000. This sampling technique and the information collected enable investigation of the impacts of community-level factors that include population density, investments in irrigation and roads, and household and plot-level factors such as household wealth, education, land tenure, and other factors on land management and the implications for agricultural productivity and land degradation.

The dependent variables analyzed in this study include the amounts of inputs used on each plot in 1998 (labor, draft animal power, and seeds), adoption of the most common crop and land management practices in 1998 (use of fertilizer, improved seeds, manure or compost, burning to clear the plot, contour plowing, reduced tillage, and intercropping or mixed cropping), the value of crop production on the plot, per capita income of the household, and whether the household head participated in the extension program, used formal or informal credit, or participated as a member in certain community organizations.

Fertilizer was used on 27 percent of plots, and manure or compost on about 20 percent of plots in 1998. They found that farmers are more likely to use fertilizer or manure and other inputs on plots closer to their homestead, and attribute this to the labor burden, or difficulty of transporting inputs to distant plots. They found that small ruminant producers are less likely to apply manure or compost or to use intercropping. Households that depend on food aid or other assistance are less likely to apply manure or compost, to use burning, or to use intercropping, which the authors attribute to their relatively limited ability to farm as intensively as others. Authors found that fenced plots are managed differently than non-fenced plots. Labor use and the use of manure is higher on fenced plots. The number of

5 The lowest administrative unit in Tigray, usually comprising four or five villages.

oxen owned also increases use of manure and compost. Households with cash savings are more likely to use fertilizer and less likely to use manure and compost. Female-headed households are less likely to apply manure or compost.

Use of manure was found to increase yields that were comparable to those who use fertilizer. Use of manure or compost was found to significantly increase yields by 13 percent (significant at the 10% level). Characteristics of female- headed households are that they use much less labor and ox power, are less likely to apply manure, and obtain substantially lower crop yields and incomes than male-headed households. Explanations for these differences include cultural taboos, exclusion of women from agricultural extension programs.

The authors' quantitative methodology for identifying relevant dimensions for village development domains that determine the scope for specific land use and production systems can be useful for extension and policy purposes. Results can be used as a first step for the definition of recommendation domains for technical assistance services and for the identification of effective incentive regimes that permit farm household resource intensification. The methodology gives insight into the different local development pathways and the critical factors that influence farmers' livelihood strategies. Further research at the farm household level is required to identify the farm household's responsiveness to specific policy incentives. The approach offers a more generalized analysis compared to location-specific farming systems research and was not intended to offer precise policy recommendations, but rather provides guidance to the directions in which these policy recommendations might be found.

Peterman, A., Behrman, J. and Quisumbing, A. 2014. A review of empirical evidence on gender differences in nonland agricultural inputs, technology, and services in developing countries Gender in agriculture. ESA Working Papers 289010, Agricultural Development Economics Division (ESA): Food and Agriculture Organization of the United Nations.

This paper reviews microeconomic empirical literature on gender differences in use, access and adoption of nonland agricultural inputs in developing countries. Authors focus on four key areas: technological resources, natural resources, human resources and social and political capital.

The authors find that there has been more empirical research on inorganic fertilizers, seed varieties, extension services and group membership than on tools and mechanization. Men generally have higher input measures than women; however, this generalization is subject to the methods used in studies, whereby authors sometimes use models that control for other background factors. Similarly, the way in which gender indicators are defined and used differs in the studies that were included.

Manure was considered in five of the reported studies in the review. Brief findings from studies conducted in Nigeria, Zimbabwe, Uganda and Ethiopia are presented and these studies employ approaches that include multivariate analysis, Tobit models and two-stage probit.

Studies that evaluated women's and men's use of manure yielded mixed results that challenge the assumption that women would have access to, thus use more organic fertilizers that include manure and compost, especially compared to the use of purchased fertilizer products. In the literature on inorganic fertilizer, when given equal access to fertilizer (controlling for other inputs and background factors), female farmers adopted fertilizer at the same rate as male farmers, suggesting that accessibility is a key issue for many female farmers. Doss and Morris's (2001)[6] study of 420 maize farmers in Ghana, in which the economic model controlled for access to complementary inputs (land, education and labor), showed no significant difference in rates of adoption between male and female farmers. Horrell and Krishnan (2007) found no significant differences in use of manure between female and male heads of household in Zimbabwe. In Uganda, a study of 80 plots found female owners report higher use of manure in comparison to male owners (70% versus 62.5%). However, in Nigeria, among 62 cassava producing households, female farmers applied manure on 19% of plots, whereas manure was applied to 71% of male-owned plots (Goldman and Heldenbrand 2001[7];

6 Doss, C. and Morris, M. 2001. How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics* 25(1): 27–39.

7 Goldman, A. and Heldenbrand, K. 2002. Gender and soil fertility management in Mbale district, southeastern Uganda. *African Studies Quarterly* 6(1): 45–76.

Enete et al. 2001[8]). In Ethiopia, interestingly, little difference was found between female- and male-headed households when it came to burning crop residues and women were actually less likely to use manure and composting. Pender and Gebremedhin (2006)[9] found that female heads of households in Ethiopia are no different than their male counterparts in burning to prepare fields; however, women are less likely to use manure and composting to increase productivity.

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

Female headship is increasing worldwide, and types of headship differ: widowhood, divorce and de facto headship, arising from the illness of a spouse or outmigration to an urban area to find work. These different types of headship have implications for poverty levels in female headed households. In this article authors compare poverty and agricultural productivity of de facto and de jure female-headed households to those with a male head in rural Zimbabwe. Manure management is considered as one as one of the potential determinants of difference between poverty and agricultural productivity across household types.

Data is collected from a survey of 300 households across three rural areas in Zimbabwe – Chivi in Masvingo province, Mutoko in Mashonaland East and Makoni in Manicaland – to explore the position of different types of female-headed households. Two aspects of female-headship are investigated: whether there is a higher incidence of poverty in households headed by women and how female headship and next, how this relates to the household's productivity in agriculture. The survey recorded whether respondents were single, married, divorced or widowed. Out of the total sample of 52, 17 married women were heads of household and classified as de facto female heads, 52 were widowed or divorced and classified as de jure female heads. The remainder of the sample were households headed by males. Survey data provided information about whether female headship is associated with lower crop yields than male headed households, and inputs for and output of each crop grown to examine the factors determining yields per acre. Specific factors that are hypothesized to affect female headed households are fewer number of males, who may participate in markets for the household and low levels of access to extension services. Authors conducted a re-survey of 20 of the original households. In each case, the dependent variable was the yield per acre of the specified crop. Labour inputs, family and hired and capital inputs included the amounts of fertilizer, manure and seed used per acre and the acreage devoted to the crop. The inputs of household labour time and total labour time used for the production of the crop, manure, fertilizer and seed per acre is considered for both maize production and across up to five different crops per household.

Descriptive results showed that labour available to the household, manure, fertilizer and seed used largely determined output per acre. Tobit regressions confirm these results. Estimating the decision to grow the crop together with yields highlighted the importance of manure, fertilizer and seed inputs for female farmers. Results show that, once inputs are accounted for, female-headed households' productivity is lower than that found for male-headed households only for growing cotton. Analysis of the inputs into all crops shows the same tendency for de facto female-headed households to use less household labour but, outside labour makes up for this deficiency. Additionally, the interaction term between female-headed households and growing cotton is also significant and negative for manure usage. Fewer women use manure in growing cotton than do men that may be a result of widows' limited ownership of livestock. In summary, maize yield differences did not differ between male and female-headed households. However, de facto female heads of household receive low prices for their output and a lack of access to selling consortia may be the source of this disadvantage. In cotton production, de jure female-headed households achieve low yields. Manure inputs are lower.

Authors recommend that, while general poverty alleviation policies may benefit female-headed households, specific interventions via extension services and access to marketing should be implemented.

8 Enete, A.A., Nweke, F.I., Achike, A.I. and Tollens, E. 2001. Differentiated gender ownership of cassava fields and implications for root yield variations in small holder agriculture of south Nigeria. *Tropicultura* 19(3): 105–109.

9 Pender, J. and Gebremedhin, B. 2006. Land management, crop production and household income in the highlands of Tigray, northern Ethiopia: An econometric analysis. In: Pender, J., Place, F. and Ehui, S. (eds), Strategies for sustainable land management in the East African highlands. Washington, DC: International Food Policy Research Institute: 107–140.

Theriault, V., Smale, M. and Haider, H. 2017. How does gender affect sustainable intensification of cereal production in the West African Sahel? Evidence from Burkina Faso. *World Development* 92: 177–191.

In this study the authors explore gender differences in the adoption of agricultural intensification strategies in Burkina Faso. They examine gender differences in adoption rates, likelihood and determinants of adopting strategy sets that enhance yields, protect crops and restore soils in the West African Sahel based on analysis of cereal production in Burkina Faso. Manure is one of the strategies considered. Theriault et al. use data from a nationally representative household panel and use the individual plot as unit of analysis and control for plot manager characteristics along with other covariates. The nationally representative sample includes 4,130 household farms in 826 villages across all 45 provinces.

Using a multivariate probit model, they find that female managers of individual cereal fields are less likely than male counterparts to adopt yield enhancing and soil restoring strategies and that adoption determinants differ by gender. The results also find that no differential is apparent for yield protecting strategies. Plot manager characteristics, including age, marital status and access to credit or extension services also influence adoption decisions. Household resources similarly influence the probability of adoption. For female plot managers, availability of household labour strongly influences the adoption of soil restoring strategies that contrast with men for whom variables such as livestock owned, value of non-farm income, and area planted to cotton affect the adoption choices. While no gender differences were found in the adoption of fertilizer, gendered differences in the use of manure and minimum tillage were observed. Authors explain the latter results by saying that the sociocultural farming context, combined with the economic attributes of technology affect adoption.

Authors recommend that a better understanding of gender differences in the adoption of agricultural intensification strategies will be crucial for designing effective policies to close the gender gap while sustainably enhancing farm productivity. They recommend addressing the male bias in extension services and improving female plot manager's access to credit, income and equipment to contribute to sustainable agricultural intensification.

Water management

Asaba, R.B., Fagan, H., Kabonesa, C. and Mugumya, F. 2013. Water Beyond distance and time: gender and the burden of water collection in rural Uganda. *The Journal of Gender and Water* 2(1): 31–38.

In this paper the authors explore gender differences in water collection in Uganda. Authors lend insights to understanding the burden of fetching water and consider the roles of sociocultural, gender and environmental conditions, which the authors claim are generally overlooked.

The authors use mixed method approaches. The main quantitative approach adopted is cross-sectional[10] surveys of which 602 were conducted. Qualitative approaches included in-depth interviews with key water actors at village, parish and sub-county levels; sex disaggregated focus groups (10); and participant observation in the study area of south-central Uganda where crop and livestock farming are common. The study took place from April 2011–January 2012. It appears a convenience sampling approach was adopted for all data collected, though the authors are not explicit in explaining this.

Using descriptive statistics, they present results in the form of graphs and charts that compare groups by age and sex. They find that children and women provide the most labor for water collection, and men may fetch water during times of drought or for commercial purposes. Results from the qualitative data show that young men also collect water. Children are also involved and usually fetch water in the morning before school and in the afternoon/evening after school. They found that in households where children are present, they provide more labor than women in married households unless the children are ill. In so far as health is concerned, queuing at water collection at improved sources is especially long and collectors suffer from health complications. Verbal and physical assault was reported for those who travel to improved and to unimproved water sources alike. These findings are based on estimations of time spent on water collection and on numbers of daily trips by household members, most commonly once or twice per day for the latter. Headload is the most common method of transporting, and male youths reported using wheelbarrows and bicycles. This type of gendered analysis provides some useful insights into understanding water collection.

The paper is finalized with research recommendations. While measures of time and distance are important, there is a need to also consider sociocultural, environmental and health-related conditions that children and women face while collecting water in rural developing communities.

Cleaver, F. and Hamada, K. 2010. 'Good' water governance and gender equity: a troubled relationship. *Gender & Development* 18(1): 27–41.

This paper presents a framework to better understand water governance, arguing that a narrow focus on gender-sensitive mechanisms of water delivery (such as committees, tariffs and technologies) will not guarantee gender equitable outcomes.

In this article, water governance refers to the range of political, social, economic and administrative systems in place to develop and manage water resources, and the delivery of water resources, at different levels of society). Authors expand on this definition to include diverse definitions and articulate "good governance" that is linked to principles such as accountability, transparency and probity and establishing gender institutional arrangements that support agency and mediate needs of different stakeholders.

Water use is gendered and the reproduction of gender inequalities in water projects is common. Analyses of water governance must be expanded in two directions: the ways in which societal resources are allocated (through economic policies and legislation, for example) that shape mechanisms in particular and meaningful ways and to

10 Refers to data from a population or a representative subset at a specific point in time.

consider how different people are able to influence the outcomes of particular governance arrangements to produce gendered outcomes (for health and wellbeing, access and livelihoods, and political voice).

The authors reference previous work in which Franks and Cleaver (2007)[11] have developed an analytical framework to help understand how arrangements for water governance are shaped, and how they impact positively and negatively on different people. The framework draws on case studies and theories that include social theory, post-institutional theory, livelihoods approaches, chronic poverty research and gendered empowerment. Although not initially intended to conduct a gendered analysis of water interactions, the framework reveals gendered patterning in access and control of water resources. The resources of society and the ways in which individuals and groups mobilize these are patterned gendered social norms and expectations are emphasized also by Kabeer (2000)[12]. Access to resources is shaped and mediated through "mechanisms", i.e. context specific arrangements for organizing access to water. The authors use the example of water schools in Nepal and efforts to ensure that landless, poor women and men and different ethnic groups were included. This required a process of adapting schools to reach those who felt marginalized, e.g. less literate. The current framework for water governance aims to facilitate a broader and more holistic way to secure gender equality goals. Authors emphasize the importance of understanding constraints of poor people that include different abilities to take effective action and shape people's possibilities.

Authors provide insightful considerations to understand and develop equitable water governance arrangements. In summary, it must be recognized that outcomes vary for different people in different ways and people create mechanisms of water governance, both consciously and subconsciously, through the management of water, and through the events and day to day activities and experiences, e.g. subordinate women and children. Gendered agency must be understood, including recognizing that identities and "motivations" are complex and multilayered, as are the channels through which resources are accessed (talking about how caste and gender relations may result in inequalities). "Structure and voice" are critical to ensure participation of marginalized people (including women) in institutions for collective management.

This paper presents a convincing rationale for why we must look beyond the local level mechanisms for accessing water and consider wider processes of governance to better understand how gender inequality is embedded and reinforced through and within water governance institutions and mechanisms. To sum up, this requires understanding how resources, actors, mechanisms and outcomes shape how women and other marginalized groups are able to gain access to water sources. Development interventions need to frame and understand how such mechanisms are connected and linked to the wider social context to better work towards shaping and redistributing the resources of society in the interests of equity. Approaches must go beyond service delivery and the narrow focus on women's participation.

German, L., Taye, H., Charamila, S., Tolera, T. and Tanui, J. 2006. *The many meanings of collective action: lessons on enhancing gender inclusion and equity in watershed management*. Washington, DC: International Food Policy Research Institute (IFPRI).

The paper presents a conceptual approach to enhance and better facilitate equitable collective action in agriculture and natural resource management. Collective action is often viewed as being synonymous with social structure or formal organizations, and while the authors agree with the definitions of other researchers that emphasize the actions or functions of collective action, they specifically highlight diverse definitions to provide a better framework to evaluate collective action in watershed management. The authors argue that, in spite of abundant literature concerning participation and power dynamics in natural resource management, there are few practical lessons on how to engage with local communities in ways that promote equitable participation of women, the poor and other stakeholders. Rather, there is an overemphasis and superficial focus on numbers of participants that overlooks the power dynamics that shape who participates and why.

11 Franks, T. and Cleaver, F. 2007. Water governance and poverty: a framework for analysis. *Progress in Development Studies* 7(4):291–306.

12 Kabeer, N. 2000. Resources, agency, achievements: reflections on the measurement of women's empowerment. *Development and Change* 30(3): 435–464.

The approach is one that is under development as part of the African Highlands Initiative in highland areas of Ethiopia, Kenya and Tanzania. Qualitative case studies are used to show the strengths and weaknesses of different approaches for enhancing gender inclusion and equity throughout the stages of problem diagnosis, planning and monitoring. The paper draws on experiences in participatory watershed management in the highlands of eastern Africa and highlight diversity in meaning and function of collective action approaches.

The results reveal important practical insights and describe a participatory diagnosis of watershed level natural resource management problems in the three study contexts. Communities identified five different types of problems that included challenges related to livestock such as access to grazing land and feed shortage. Key and commonly identified issues included: i) problems associated with the management of common property resources (water, grazing lands, forest); ii) problems of natural resource access and distribution; iii) transboundary problems between neighboring farms or landscape units, including boundary disputes and negative influences on agricultural productivity; iv) declining productivity due to the absence of collective action institutions; and v) livelihood problems that are best addressed through collective rather than individual action. Authors note that each of these categories of problems require collective action to be effectively addressed.

While challenging, the authors argue that it is possible to address and meet technical and equity goals. They provide an example of a case within mixed crop-livestock systems in Ethiopia and Tanzania. Participatory action research methods were used to highlight challenges and problems related to access and overuse of common grazing land, limited feed, declining water quantity and quality and limited diversity and income generation of enterprises that include livestock. They go on to describe the process of how to address these problems to enhance gender inclusion and equity.

Key components of the approach are to structure the community interface to develop a committee and to ensure that watershed representatives are present and active in decision-making. The authors provide a few case studies to describe this, such as a stakeholder-based interface that brings together local interest groups who are concerned with specific issues, e.g. livestock movement. They also describe a process of liaising with existing groups. They continue to describe next steps, eliciting views and negotiating benefits that are elaborated in the three case studies. During the stage of negotiating benefits, authors highlight stakeholder approaches in Tanzania and farmer research group community negotiations and administrative structures in Ethiopia. Following these descriptive case studies, the authors complete a table that is a framework to assess the effectiveness of each of the processes used organized by purpose and elaborated in terms of representation, political equity and social movement. The framework serves as a mechanism to evaluate strengths and weaknesses of different approaches.

The authors propose evaluation methods to weigh and consider the strengths and weaknesses of different approaches and the different forms that collective action can take, some of which may be better at fostering gender inclusion and equity in watershed management. Their framework is useful to show diverse forms or "faces" of collective action and the diversity of roles or functions collective action assumes within participatory watershed management. Collective action in watershed management must give due consideration to the diverse social goals that will likely characterize these processes and the trade-offs inherent in using diverse methods must be acknowledged. For instance, participation in processes can lead to elite capture and inequitable outcomes, e.g. the purposive selection of members based on technical characteristics or aspects can lead to unequal and biased participation in nontransparent processes. Oftentimes researchers tend to select "early innovators" who can serve as model farmers in the target area and to keep group size to a manageable level (to facilitate trainings and ensure that benefits do not become too diffuse). Such approaches may not be equitable and undermine gender equitable watershed objectives.

Among best practices, authors recommend collective identification of social goals and outcomes during planning, implementation and monitoring watershed management programs to support gender equity and inclusion.

Graham, J.P., Hirai, M. and Kim, S. 2016. An analysis of water collection labor among women and children in 24 sub-Saharan African countries. *PLoS ONE* 11(6): e0155981.

Authors draw on nationally representative surveys, the Demographic and Health Survey (DHS) and Multiple Indicator Cluster Survey (MICS) collected between 2005 and 2012 in 24 sub-Saharan African (SSA) countries. The data that is used for this study was selected to include only those who reported spending more than 30 minutes collecting water.

Water collection is a key concern, particularly since an individual's proximity to water sources affects nutrition and disease, and labour and energy expenditure significantly affect an individual's health and there are also increased exposure to risks in traveling, e.g. abuse or violence. Because children often collect water, it is essential to use a child- or age-specific focus. Children's roles in water collection negatively affect and reduce their school attendance and performance. Also, children may be pulled out of school to watch younger children while mothers go to collect water or to collect the water themselves.

Among the key findings are that adult women are the primary collectors (46–90% of reported collectors) and female children are more likely to collect water than male children. A data shortcoming was an inability to say specifically how "improved" access affects the time that households spend collecting water. Such information could be used to calculate whether an improved well leads to a significant reduction in time, thus lowering labor burdens and freeing up women and children's time, for instance.

The authors recommend research approaches that explore and understand gender and age differences and argue that we need to better understand accessibility to water and water collection tasks carried out by children. In addition, a calculation of relative gendered labor and rest ratios for water collection, especially when collection times are long or labor burden high, would also be useful to better understand water collection in SSA. These metrics should be considered as key indicators for measuring progress in the water, sanitation and hygiene sector.

Hanjra, M.A., Ferede T. and Gemechu, G.D. 2009 Reducing poverty in sub-Saharan Africa through investments in water and other priorities. *Agricultural Water Management* (96): 1062–1070.

This review article looks at issues surrounding water and poverty using an interdisciplinary approach that considers social relations, including gendered power relations. Authors examine the linkages between agricultural water, education, markets and rural poverty through a review of published studies.

Their review includes only topical studies showing linkages and complementarities between irrigation, education, markets and poverty. Nearly all studies included in the review rely on econometric models and show that irrigation is a positive and significant determinant of income and consumption, and a negative determinant of poverty. A case study in Ethiopia is used to explore the irrigation and poverty nexus and unintended adverse consequences, particularly with regards to discussions on equity.

The authors make claims for investments in agricultural water management, including, but not limited to irrigation, to improve production and reduce poverty. Although gender is identified as an important variable, the paper does not provide any explicit gender findings.

Authors conclude that there is a need to link agricultural, water, education, and market interventions, which are so often implemented separately, to generate more effective poverty reduction and hunger eradication programs. Among suggested key pathways to address and break the poverty trap are to identify synergies across land and water resources development, human resources, rural infrastructure and agricultural and labour markets. Such pathways will lead to higher productivity; higher employment; higher income and consumption; better nutrition and health; better education; lower variability in output, income, and employment; improved equity; multiple uses of water; and multiplier effects on non-farm sectors.

Mandara, C.G., Niehof, A. and van der Horst, H. 2017. Women and rural water management: Token representatives or paving the way to power? *Water Alternatives* 10(1): 116–133.

This paper discusses the ways that informal structures intersect with formal structures by looking at women's participation in formally created decision-making spaces that manage domestic water at the village level in Tanzania. Encouraging and supporting women's participation in water management institutions, e.g. quotas, is a popular gender-responsive approach to water services. In Tanzania, the national water policy has set quotas for women's participation as representatives in village level water management structures.

The authors develop a conceptual framework based on Moser's distinction of practical and strategic gender needs to develop a better understanding of women's involvement in management of village water service and its formal-informal intersections. The framework highlights how formal and informal structures influence women's involvement in village level domestic water management. Authors draw linkages between formal and informal spaces, the latter of which include norms, traditions, practices, perceptions and behaviour. Typologies of participation based on Agarwal (2001, 2010) are used to assess the different ways in which women participate, each which have implications for women's empowerment, e.g. nominal and active participation. The study looks at the household, where water is needed, used and managed, and the community, wherein village institutions such as the VWC and Village Council govern water schemes and use.

Nine villages in the rural districts of Kondoa and Mpwapwa, Dodoma region, central Tanzania were sampled in 2011-2012. The villages were selected on the basis of the presence of a public water project, type of water source, management arrangements and distance to the district headquarters. Quantitative and qualitative methods were used and included a household survey, focus group discussions (FGDs), key informant interviews, observation and case studies. Survey interviews were done in 221 randomly selected households, and 218 women respondents in the same households. Men and women participated in the FGDs and the key informant interviews. In addition, three women's cases are included to describe the "how and why of women's involvement in local governance of rural water services".

In the results section authors first describe domestic water management approaches followed by women's engagement in the community. Women's participation in village water committees is 50% in all villages except for one. The criteria for participation in water committees are elaborated. Next, authors describe village assemblies and women's speaking activities in these meetings, an important measure of meaningful participation. Women attend meetings at a lower rate than men and speak less often; particularly since a common norm is that women's speaking is socially unacceptable and harms marital prospects of unmarried female family members. Men and women's tasks in infrastructure maintenance and reporting are gendered. Cleaning, repairing and reporting are more often tasks that are carried out by men. Men are more frequently members in village councils. Women find alternative mechanisms to express their voice, through Women Social and Economic Groups (WSEGs), in which they convey their dissatisfaction about the water services, lobby for changes in leadership positions. Interviews and FGD data showed that WSEGs are an important gender responsive platform for advocacy of good leadership and water services.

Authors conclude that the creation of formal structures and efforts to involve women in the local decision-making structures on domestic water does not necessarily guarantee women's participation and may not necessarily enhance gender-responsive services. The results demonstrate the "layered and contextual nature of the interfaces between formal and informal structures". Authors call attention to the need to understand specific norms and how these differentially influence bargaining and participation, e.g. older women and widows found gender norms to be less restrictive that younger women. Women's compliance with traditional gender roles must also be understood. Women social and economic groups (WSEGs) facilitate structural change and enable women members to gain experience.
In conclusion, authors find that their findings about women's participation in local water governance structures are similar and consistent with the literature. It is essential to pay attention to the local context in the provision and management of the water services.

Sokile C. and van Koppen, B. 2004. Local water rights and local water user entities: the unsung heroines to water resource management in Tanzania. *Physics and Chemistry of the Earth* 29 (15–18): 1349–1356.

Water resource management in Tanzania has undergone a series of transformations over the past and emphasis has been placed on the creation of state-based formal institutional arrangements to develop and manage water rights, through implementation of water fees and water user associations. In this article, authors describe the intersection of water rights and formal and informal institutions in terms of effectiveness and equity.

The study was conducted in the Mkoji sub-catchment of the Great Ruaha River Catchment in the Rufiji basin between July 2002 and June 2003, under the auspice of the Raising Irrigation Productivity and Releasing Water for Intersectoral Needs (RIPARWIN) project. Nine villages were randomly selected from the upper, middle and lower zones of the Mkoji catchment, three from each zone. Participatory Rural Appraisal (PRA) was conducted in each of the three zones to identify similarities and differences in formal and informal institutions with a specific interest to understand how these structures work, fail to work in local contexts. FGDs were conducted to triangulate the findings and were followed up by semi-structured structured interviews with key informants and two workshops that brought together participants from the three zones and senior basin and national level stakeholders.

Authors find that there are significant challenges to implementing formal rights to water, especially given the existence of dated, precolonial acts and policies that are not applicable to local contexts. Water user associations exhibit high levels of inequality, partiality and isolation, often favoring few local-level elites and the village level bureaucrats:" Those who can talk, walk, and work before, during and after the formation of a WUA". Local, informal arrangements are better able to manage local water rights that result in effective water distribution that is inclusive, relies on voluntary labor and supports negotiations. In conclusion local informal associations are found to effectively manage water because they are influential, powerful and attractive to the local communities. Most people feel a stronger sense of identity and belongingness than in the formal WUAs. Informal associations are better suited to resolve conflicts. However, formal institutions and courts discredit informal institutions and seldom recognize informal rights.

In conclusion authors highlight the lessons learned and the significance or looking at informal institutions that may be relatively more efficient, more cost-effective, longer-lasting and more widely accepted among local water users than most top-down state-driven institutions.

Tsai, A., Kakuhikire, B., Mushavi, R., Vořechovská, D., Perkins, J.M. and McDonough, A.Q. 2016. Population-based study of intra-household gender differences in water insecurity: reliability and validity of a survey instrument for use in rural Uganda. *Journal of Water and Health* 14(2): 280–292.

This paper's primary objective is to develop valid measures of water insecurity and investigate gender difference in perceptions of water insecurity in rural Uganda. Water insecurity is defined as having limited or uncertain availability of safe water or the ability to acquire safe water in socially acceptable ways. The authors note this is typically overlooked by development organizations that focus on water availability. Given the high priority on ensuring water security, it is surprising that the authors found only two studies, in urban Bolivia and rural Ethiopia that attempt to develop robust and valid household water insecurity measures.

Developing a construct for water insecurity was the main objective for the study which was conducted using an innovative step-wise mixed methods approach. In the first step, prior to data collection, the authors conducted a population census of all 758 households in Nyakabare Parish of Mbarara District in Uganda. From the 758 households, 358 were selected in which there was a child under the age of five years, a woman of reproductive age (18–49 years), or emancipated minors aged 16–18 years who considered Nyakabare their primary place of residence, were available to interview and capable of providing consent. Of the 358 potentially eligible women initially identified in the census, authors interviewed 327 female participants from June 2014–February 2015, for a response rate of 91%. Quantitative survey data was implemented with laptops and adapted based on the Household Food Insecurity Access Scale (HFIAS). Socioeconomic details and household daily water usage information was also collected.

They employed creative qualitative research approaches to improve accuracy and reliability in understanding primary household water sources by utilizing photo identification. This enabled respondents to more accurately identify water sources for objective water quality testing and distance/elevation measurement. The authors then developed measures that demonstrated robust internal structure, reliability and validity of a new 8-item Household Water Insecurity Access Scale (HWIAS). Authors performed factor analysis on the scale items, using principal factors extraction and orthogonal varimax rotation. They describe the process of arriving to an 8-item scale in a thorough and convincing manner. The authors then used this scale to measure intrahousehold gender differences in perceptions of water insecurity.

The results show that men generally perceived household water insecurity as being less severe compared to women across the eight items. Within each linked pair, 27–43% of the men gave a severity/frequency rating that was less than the rating reported by the woman in the same household. These differences were also reflected in the global differences across households. The mean HWIAS score was lower among men compared to women (8.9 vs. 10.3; $t=2.23$, $P=0.03$). Compared to the standard deviation among women, this represented $1.4/6.8 = 0.21$ standard deviation units.

The authors conclude that their "Household Water Insecurity Access Scale" is a reliable and valid measure of water insecurity, especially among women. They suggest that the scale may be useful for informing and evaluating interventions to improve water access in resource limited settings.

van Koppen, B. 2001. Gender in integrated water management: an analysis of variation. *Natural Resources Forum* 25: 299–312.

This paper argues that policies related to water must be gender inclusive across scales. The author stresses that concrete actions and steps can only be taken when variations of gender dimensions across the different uses of water are recognized. Gender patterns within household are considered critical in this paper in order to better understand these patterns. Ideally, policies would also consider the wide range of local contexts and intra-household gender roles to better define the options for the development agenda.

The paper has two aims, to present generic conceptual tools to identify water related gender issues at household level and to provide generic policy implications in different contexts, supplemented with case studies and literature. The author recommends that a systematic gender analysis be undertaken to better inform any policy and interventions in the water sector.

The article is composed of sections that focus on the different uses of water and domains. These include domestic water provision, specifically the division of unpaid household. At the community level, key gender issues concern women's involvement in decision-making, for instance in water supply projects. Water can also be a key source of women's income, depending on the intra-household organization of production and irrigation development. It is thus essential to understand women's and men's involvement such enterprises, and their agency in decision-making over income. It is also important to understand the gendered organization of agricultural production, which can be done using a "gender classification of farming systems", that will identify the different decision-makers for irrigated plots in a specific scheme, for instance. Such a classification makes it possible to see which plots are male-managed, dual-managed or female-managed. Indeed, there will be global variations in these patterns.

Several case studies are presented, including Burkina Faso, which exemplifies a case in which organizations fail to distinguish and identify female farming systems. A second case study highlights gender issues in male-managed farming systems in India, where women provide significant unpaid labour, yet are minor decision-makers. An analysis of intra-household division of costs and benefits of water use reveals new and different key issues that policy makers and interventionists need to address in order to be more gender inclusive.

This article demonstrates that the highly variable, intrinsically gendered nature of water use has far-reaching implications for policy. Gender dimensions must be analyzed and integrated into policy and intervention in the water sector. Case study specific recommendations for female and dual farming systems are to recognize women farmers

and include them as equals with men and, in male farming systems, to support the minority of women farmers and strive to achieve greater gender-balanced rural economic development. Water agencies play important roles, since they are key actors in determining gender-inclusion or exclusion.

Agroforestry

Benjamin, E.O., Ola, O. and Buchenrieder, G. 2018. Does an agroforestry scheme with payment for ecosystem services (PES) economically empower women in sub-Saharan Africa? *Ecosystem Services* 31: 1–11.

Authors investigate links between economic and gender objectives of agroforestry with payments for ecosystems services (PES) and women's empowerment. PES refers to 'voluntary transactions between service users and service providers that are conditional on agreed rules of natural resource management for generating offsite services' (Wunder 2014, p. 8)[13]. The objective of the study is to determine whether equitable agroforestry schemes with PES have a positive effect on the agribusiness profitability of female smallholder farmers and to describe the characteristics of poor women (not) participating in agroforestry PES schemes.

Their specific research questions are:

1 Does an equitable agroforestry scheme with PES have the potential to economically empower women in sub-Saharan Africa?

2 Can these female smallholder farmers, who benefit from agroforestry PES schemes, be characterized as poor or even as the poorest of the poor? (based on the understanding that women are not a homogenous group)

The authors evaluate an agroforestry scheme with PES to test whether an equity and economic efficiency approach can promote economic empowerment among women. They use the case of International Small Group Tree Planting Program TIST, an agroforestry PES scheme currently operational in four countries— Kenya, India, Tanzania and Uganda. In this study, they focus on Kenya. Details of TIST organization are provided. TIST farmers organize themselves into groups with up to 12 members and each group is required to cultivate between 420 and 840 trees to qualify for PES depending on the farmland availability (Masiga et al. 2012[14]; Shames et al. 2012[15]). Each group receives extension services in the form of diverse training on health issues, financial services and farm management.

The authors adopted a quantitative data collection approach in Embu, Meru and Laikipia counties. 120 TIST and 90 non TIST smallholder farmers were randomly selected for a survey using group stratification of villagers and proximity to the TIST centre as the reference points. Empowerment is measured in terms of net farm profit and it is assumed that this would lead to women's access and control over resources.

Summary statistics showed that TIST female farmers had larger farms, were older and had more years of experience in agriculture than non TIST female farmers. OLS regression shows that agricultural inputs and farm size are positively correlated with profit for the aggregated female smallholder farmer sample and the values are quite similar. The results show that women who participate in agroforestry schemes with PES reduce their profit inefficiency and conclude that this contributes to their economic empowerment. Also, women with larger farms derive greater benefits from participating in agroforestry with PES as compared to smaller farms. For non-participants, an additional year of formal education and experience could reduce profit inefficiency.

The human and social capital components of PES agroforestry should not be undervalued, especially since women gain access to information previously available to men and because simply targeting women will not suffice to ensure that women are active decision makers in agroforestry PES schemes.

13 Wunder, S. 2014. Revisiting the concept of payments for environmental services. *Ecological Economics* 15: 234–243.

14 Masiga, M., Yankel, C. and Iberre, C. 2012. *The international small group tree planting program (TIST) Kenya*. Institutional analysis and capacity building of African agricultural carbon projects case study. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

15 Shames, S., Heiner, K., Kapukha, M., Kiguli, L., Masiga, M. et al. 2016. Building local institutional capacity to implement agricultural carbon projects: participatory action research with Vi Agroforestry in Kenya and ECOTRUST in Uganda. *Agricultural Food Security* 5: 1–13.

Findings are used to support authors' suggestion that schemes can target poor female smallholders in order to achieve maximum economic empowerment gains. The authors also emphasize important gender differences in adaptive capacities. Specifically, the authors refer to extreme changes in the environment that can bring about change in gendered roles. Rather than conceive these changes as obstacles, the authors emphasize the importance of viewing women as opportunities too.

Djoudi, H. and Brockhaus, M. 2011. Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. *International Forestry Review* 13(2): 123–135.

This paper examines the dynamics of change in livestock systems. In the Lake Faguibine area in northern Mali, the social, political and ecological conditions have changed rapidly and remarkably in the last three decades. While the article does not refer explicitly to agroforestry as a means to improve adaptation to climate change, this article remains relevant to our review as the authors improve understanding of gendered climate change impacts and dimensions of adaptation. Authors carefully explore and describe vulnerability and adaptive capacity and the ways in which climate change and variability affects people. The authors draw on and link several strands of literature and provide further evidence on women's vulnerability and its role in adaptation using a case study from northern Mali.

Authors conducted six single gender participatory workshops using Participatory Rural Appraisals (PRA) in two communities to better understand gendered adaptation and coping strategies.

The research took place from July–October 2008. Data was collected at different levels: national (Bamako), regional (Timbuktu), district (Goundam) and two local Lake Faguibine communities (Tin Aicha and Ras El Ma). Authors focus on results from the local community workshops. Six participatory workshops with adult men, women and youth were organized in the two communities of Tin Aicha (sedentary farmer community) and Ras El Ma (pastoral community). Each workshop had 25–35 participants. PRAs were used to discuss topics that included vulnerability and adaptation strategies; tools used included fodder calendars and resource maps, historical axes and ranking exercises. Authors asked questions about the socioeconomic, institutional and political factors that have influenced past and present coping strategies and why some people cope better than others and which conditions allow people to cope better with climate events. Historical timelines were used to draw up the bundle of strategies used to cope with droughts. These strategies were then ranked in terms of preference and feasibility.

The results emphasize that vulnerability is a theoretical concept and subject to different interpretations. At the local level, authors sought to define vulnerability in a context specific way, or one adapted way to the local realities. They go on to describe context and gender specific vulnerability and adaptation in the socioecological system around Lake Faguibine. With the drying up of the lake, women had to diversify their livelihoods. Sedentarization as a consequence of drought and seasonal and non-seasonal migration of men was a coping strategy which has increased women's burden because they have to manage activities traditionally regarded as male activities, such as tending livestock. When men migrated, women had to take up livestock keeping (mainly small ruminants), which was once a male domain. This shift, one the authors refer to as the defeminization of agriculture and a feminization of livestock keeping, has led to a replacement of activities that increase labor. Women's labor burdens have increased with these changes and, coupled with restricted food availability, increased women's health risks. As a consequence, women's workload has increased with the evolution of adaptive livelihood strategies.

The transformation from a lake to a forest also brings new income generating activities such as charcoal production. However, women's participation in forest livelihoods differs in the communities under study and signifies the importance of looking at community contexts. Local norms prohibit women in one community from making charcoal. Women's opportunities in charcoal production are shaped by the intersection of gender, ethnicity and identities.

These nuanced and intersectional findings reveal the complexity of adaptation and vulnerability. It shows that men and women have different preferences in coping strategies to climate change and variability. Adaptation has various gender

related gaps and the potential to change societal roles. These could have different impacts on gendered traditional and societal roles and responsibilities.

Further research is needed for a deeper understanding of local realities and women's active roles in adaptation, particularly on the following fronts:

1 Women-specific adaptive capacities, and their complementarities and roles with men in shaping adaptation and decreasing vulnerabilities.

2 The links between local adaptive strategies and women's vulnerability, especially gender and migration. Societal, cultural and policy barriers and obstacles to women's participation in short- and long-term decision-making. A key issue is how to enhance the role of women in the collective management of forest ecosystems and in decision-making on ecosystem-based adaptation. A related issue is market access and value chain governance.

3 Developing and mainstreaming best practices for gender sensitive responses to climate change across levels and scales.

Gebrehiwot, M., Elbakidze, M., and Lidestav, G. 2018. Gender relations in changing agroforestry home gardens in rural Ethiopia. *Journal of Rural Studies* 61: 197–205.

This paper looks at changes in dynamics of agroforestry home gardens, a dominant feature of farming in Southern Ethiopia. Home gardens have been a traditional source of food and important for food security of rural households. This study has two main research questions: (i) have the gender relations in agroforestry home gardens in Ethiopia changed due to the ongoing transition towards monoculture production of new cash crops? (ii) how do the existing formal and informal institutions define gender rights?

Traditionally, women and men contributed similar labor inputs but women often had unequal rights to access and control over land and farm products. Since the 1990s, traditional agroforestry home gardens have been gradually changing from subsistence farming towards mainly commodity production of cash crops, dominantly khat. Changes in agriculture profoundly affect the structure and identity of a rural society (Brandth 2002[16]; Deere and Doss 2006[17]). Implications of these changes in gendered farming practices are poorly understood. This study contributes to better understanding how formal and customary institutions address the gender relations in changing agroforestry home gardens.

Authors adopt a mixed methods approach and review 22 legal documents, conduct 24 key informant interviews, 40 household level semi-structured interviews and 8 focus group discussions in the Sidama zone. They test the "fit/misfit" hypothesis that is based on the assumption that effectiveness of policy implementation depends on the level of correspondence between regulatory patterns at international, national and local levels.

The study found that customary institutions restrict women's access to land, market and trading, and decision-making process at the household and community levels. Formal laws strive to garner more access and rights for women; however, there are discrepancies between customs and implementation of formal laws. They also find changes in farming systems that have significant implication for women's power in decision-making. As home gardens have shifted to more khat dominant systems and monoculture, the traditional roles of women in production, processing and marketing of farm products and the equal share and distribution of farm food among family members has been challenged. Authors describe the shift as being harmful for women since khat farming excludes women from access and control of farm resources. There are also changes in that women had not previously been involved in the buying or selling of livestock, whereas now they are, which has led to concurrent labor increases.

16 Brandth B. 2002. Gender identity in European family farming: a literature review. *Journal of Rural Studies* 22: 17–27.

17 Deere, C. and Doss. C. 2006. *Gender and the Distribution of Wealth in Developing Countries*. Economic research paper 115.

Gender polices and strategies for equality and empowerment at international, national and local levels and its effective implementation are crucial for enhancing sustainable rural development. Reconciling customary law and gender equity by demonstrating common challenges and possible pathways towards minimizing the tension is crucial to guarantee women's right in rural Ethiopia.

Kiptot, E. and Franzel, S. 2012. Gender and agroforestry in Africa: a review of women's participation. *Agroforestry Systems* 84(1): 35–58. 10.1007/s10457-011-9419-y.

Authors present a review of agroforestry based on specified research questions in Africa and describe women's participation relative to men. Specifically, they describe gender challenges and successes in fodder production and utilization, soil fertility management, woodlots and indigenous fruit and vegetable production and processing.

This paper presents a review of papers to fill the gap in understanding women's participation in agroforestry in Africa to come up with strategies that challenge imbalances, thus ensuring gender equity. Article selection was based on an understanding of participation based on four research questions: (i) what is the proportion of women participating in agroforestry? (ii) are women able to manage agroforestry technologies? (iii) do women benefit from agroforestry and how? (iv) do women have access to agroforestry information? Agroforestry practices examined include fodder production and utilization, soil fertility improvement technologies, fruit and vegetable production and processing and woodlot technology.

The authors find that female-headed households implement fewer practices and allocate less area to soil fertility management practices than male-headed households. Women provide more labor than men in agroforestry systems. Women participate in fewer high value enterprises when compared to men and are generally limited to lower level positions in the value chain, resulting in lower profits than men.

Authors recommend policy, technological and institutional interventions that include: i) facilitating women to form and strengthen associations; ii) assisting women to improve productivity and marketing of products considered to be in women's domains; and iii) improving women's access to information by training more women extension staff, holding separate meetings for women farmers and ensuring that women are fully represented in all activities. The authors stress the need for more nuanced approaches and more strategic ways to identify solutions to increase the success of women's participation in agroforestry initiatives.

Kiptot, E. 2015. Gender roles, responsibilities, and spaces: implications for agroforestry research and development in Africa. *International Forestry Review* 17(4): 11–21.

In this paper, the authors emphasize the need to conduct agroforestry research using an approach that seeks to understand roles, responsibilities and spaces, all of which are gendered to provide more useful insights for agroforestry research and development.

The paper is based on a review of a number of publications that include books, journals, conference proceedings and unpublished reports. Google Scholar searches and library collections were used to find publications on gender and agroforestry. Overall, very few studies published on gender and agroforestry were found and the search was expanded to include agroforestry adoption, gender in forest management, rural resource management and ecology. Additional topics include gender and marketing of non-timber forest products, land tenure and extension. Leads were also followed from publications on gender and forestry, gender and agriculture, and gender and land tenure to identify references related to gender and agroforestry. Authors acknowledge shortcomings related to the coverage in that only articles published in English were considered and potential sources of grey literature may have been overlooked.

The results show that women and men are responsible for different types of work, i.e. productive and reproductive work, and exercise authority in different spaces in fields. For example, women and men gain differential access to and control over parts of trees. In Malawi, evidence is provided illustrating that 'women's influence on harvesting decisions decreases from the twigs to the trunk, which contrast to men's decision-making power that increase as decisions move from twigs to the trunk' (Kiptot, 2015). With respect to gendered spaces and species, authors discuss

tree tenure and how various components of agroforestry, such as pollarding, are likely to entail different rights of ownership and use. Women generally plant food and fuel trees yet exercise low levels of control in decisions about trees. Preferences for tree species were also found to vary. One tree may have many gendered uses, including firewood and timber. The authors note that it is particularly important to identify multiple uses of fuelwood because fuelwood may be used for more than cooking at home; it can also be used to support men's commercial enterprises that include curing tobacco in certain contexts. The study further finds that women and men may dominate certain domains. For instance, women dominate the sale of shea, whereas men dominate the production of fodder species which are more common in male-headed households, yet women provide much of the labor.

The authors provide solid recommendations for the ways forward in agroforestry research and development. These include, in summary: i) understanding sociocultural norms and taboos in the community; ii) undertaking a gender responsive species priority setting in the community, e.g. carrying out a species prioritization exercise involving men and women to take into account their priorities; iii) maximizing produce from gender specific spaces for both women and men to benefit; iv) developing appropriate technologies such as domestication of tree species important to women; and v) linking farmers, especially women, to micro-credit institutions and the private sector in order to boost their capital and move up the value chain. In order to increase women's personal benefits from agroforestry, women need greater control in resource management decisions, that may be achieved through gender transformative approaches that seek to transform gender roles and promote more gender equitable relationships between men and women and a more socially equitable environment (Farthworth and Colverson 2015)[18].

18 Farnworth, C. and Colverson, K. 2015. Building a gender-transformative extension and advisory facilitation system in sub-saharan Africa. *Journal of Gender, Agriculture and Food Security* 1(1): 20–39.

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The International Livestock Research Institute (ILRI) works to improve food and nutritional security and reduce poverty in developing countries through research for efficient, safe and sustainable use of livestock. Co-hosted by Kenya and Ethiopia, it has regional or country offices and projects in East, South and Southeast Asia as well as Central, East, Southern and West Africa. ilri.org

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