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Supporting access and implementation of agricultural extension services for female smallholder farmers – a systematic review

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ABSTRACT

Women have always played a central role in smallholder agriculture in many farming systems of the Global South. However, they have had, and still have, low access to agricultural information, and even less ability to enact on training or advice received, in comparison to male farmers. The paper investigates what is needed for female smallholders to better benefit from agricultural advice and training. A systematic literature review of 2665 articles, with data extraction from 111 articles was implemented. A thematic content analysis on the articles that were ranked as highly relevant gave further insights into critical factors needed for agricultural advisory services to better serve women farmers in contexts across the Global South. Our findings show how a focus on the women themselves, in terms of their basic education, their time burden, their confidence, is insufficient if approaches do not also consider the relations of women with men in the context and the gendered power dynamics. Policy, research and extension must grapple with these deeper and more sensitive aspects of societal norms, traditions, and structural inequalities that perpetuate unequal terms for female farmers.

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KEYWORDS

Agricultural training;
developing countries;
empowerment; gender
sensitive extension, women

1. Introduction

Agricultural production among smallholders in the Global South needs positive development in several ways to achieve zero hunger in keeping with the Sustainable Development Goal (SDG) second goal. An increasing number of mouths to feed (especially urban-based), a less reliable future climate and a lack of social support services from governments are some of the reasons prompting renewed attention to agriculture (FAO et al., 2023). Gender equality (SDG #5) and the empowerment of women are known to be critical ingredients in improving productivity and food security and reducing hunger (Alkire et al., 2013; FAO et al., 2023). Women are key players in small-scale agriculture across the Global South (Olumakaiye & Ajayi, 2006; Scanlan, 2004), although their contributions towards household

food security on farm or in home gardens are often unrecognized in statistics (UN Women, 2018). Women are rarely specifically targeted by the agricultural information and extension services (Farnworth et al., 2018; Lamontagne-Godwin et al., 2019), and in order to get new knowledge they rely to a larger degree on their own social networks than men (Alvi et al., 2021; Randell & McCloskey, 2014). Currently, women are often discriminated against in knowledge acquisition and implementation processes, both overtly and obliquely as a result of societal bias, systemic discrimination and an imbalance in household and community power relations (Adebayo & Worth, 2022; UN Women, 2018). Much is already known on the kinds of barriers and factors limiting female smallholder farmers across the Global South from accessing information, attending meetings and training events,

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or being able to actually implement good agricultural information and technical know-how in their daily farming activities (Saito & Weidemann, 1990; Umar et al., 2021; UN Women, 2018). Strategies and solutions to overcome some of these barriers have however been somewhat less documented and less analysed, and certainly less implemented and mainstreamed (Diaz & Najjar, 2019).

1.1. AIM

This study explores the key factors regarding female farmers in the Global South and their ability to gain expertise and skills, and apply these to their fields or animal husbandry, in order to improve their agricultural productivity, nutritional intake, income and overall family well-being. The systematic literature review aimed to map and analyse the published literature on the barriers and enabling factors affecting female smallholder farmers' access to, attendance and implementation of agricultural extension. For the articles ranked as highly relevant and solutions-oriented during the systematic review process, a thematic content analysis around the kinds of solutions and enabling factors that may support sustained improvement for these women was carried out. The work highlights some of the most critical factors needed for agricultural advisory services and research to better serve diverse female smallholder farmers in contexts across the Global South. Our over-arching research question asked 'what is needed for female smallholders to better be able to access and implement agricultural advice and training to benefit their livelihoods and family well-being'.

The specific objectives were to:

- map the characteristics of the published work within this topic
- improve the understanding of the barriers and enablers for female smallholder farmers to access and implement knowledge and skills from agricultural advice
- analyse, and assess how research and extension can best contribute, and outline current research gaps

Agricultural advisory services denotes, in this paper, a wider umbrella term for knowledge related to farming: specific agricultural practices, marketing advice or advice related to livestock husbandry, trees/agroforestry, business planning, or credit

systems etc. It includes more formal state-run agricultural extension agencies, but also refers to private actors or civil society organizations or research bodies that provide agriculture-related advice. Essentially, any service or approach that aimed to advance and improve the farm outcomes for female smallholder farmers and their families was considered.

1.2. Contextualization: the need for more gender-sensitive agricultural extension

There is an increasing engagement by women in agriculture, especially in small-scale farms, which is crucial for an increased agricultural production in many countries (Alkire et al., 2013). The agricultural sector has evident gender inequalities that discriminate women in the agricultural labour market and in terms of decision-making power and access to resources (Adebayo & Worth, 2022; UN Women, 2018). Ogolla et al. (2022) have shown that female smallholders mostly perform productive tasks for jointly-owned small ruminants while men are the ones with more decision-making power over livestock. However, female smallholders in many cases lack the education and training, as well as access to land, inputs and other agricultural resources, to more efficiently benefit from their agricultural labour, and women tend to receive less financial returns from their efforts, especially in sub-Saharan Africa. This in turn, acts as a break on household and community development (Matthew et al., 2022).

Female smallholders often feel uncomfortable in the presence of extension workers, do not feel confident that extensionists are interested in supporting them, and may lack the confidence to raise questions or request support (Umar et al., 2021). Extension agents may fail to consider the knowledge level of the recipients of their information and they rarely consider the role of traditions or culture of women in reaching them with adequate advice (Umar et al., 2021). Women do the work in the fields, but are rarely part of the decisions (Adebayo & Worth, 2022). Misunderstandings and mistrust easily develop between farmers and extension agents when understanding of one another's reality is low. Introducing information and communication technologies (ICT), such as radio/TV, webpages or mobile phone applications, has been highlighted as a solution in some cases, provided gendered inequalities in access to such technologies are overcome (Saito, 1991).

The majority of extension workers in most countries are male. Traditions, religions and cultural norms can make it hard for female smallholders to access, participate and implement agricultural advice. In many regions, women, for example, are not supposed to interact with unrelated males (Alvi et al., 2021; Medendorp et al., 2022). Female farmers often also have more limited time to attend trainings or farmer field schools than male farmers since they tend to carry main responsibility for the reproductive work essential to household maintenance (taking care of children, the home, food and water provision) (Carnegie et al., 2020; Mengistu, 2021; Neway & Zegeye, 2022). Female farmers are in less formal control or ownership of the land they farm, which may exclude them from several technological, agroeconomic, financial and land management decisions (Neway & Zegeye, 2022). Yet numerous studies emphasize how benefits to women more often translate to wider family and societal development than benefits accruing in the hands of male farmers (Adebayo & Worth, 2022; FAO et al., 2023; Oumer et al., 2014; UN Women, 2018).

The remainder of this paper describes the systematic review, including the thematic analysis methodology, outlines the key findings on what is needed to better support female smallholders and thereby accelerate progress towards poverty reduction and the achievement of the sustainable development goals. The discussion considers the implications of the findings for both agricultural advisory services, and for scientific research, and ends by highlighting key approaches and strategies found in the literature that would be necessary to mainstream a more gender-sensitive agricultural support system that benefits female farmers themselves, as well as their families and overall societal development.

2. Method

2.1. Review methodology

To get an overview of the research field in a comprehensive and more objective way, a structured review was conducted of published scientific literature (until 22 March 2022) on the topic of female farmers and extension services/agricultural advice. The review followed the steps of a systematic review using a structured search strategy (Table 1) and predefined inclusion and exclusion criteria as described in the following sections (Chapman,

Table 1. The search string used and results in terms of number of articles (up to March 22nd in 2022).

| Search string | | |
|---------------|---|---|
| Agent | (women OR woman OR female* OR gender) | |
| Intervention | (extension* OR advi* OR train*) | |
| Topic | ((agric* OR crop* OR livestock* OR farm*) AND small*) | |
| Impact | (use* OR access* OR adopt* OR embrace* OR practi* OR perform* OR appl* OR utili* OR implement* OR attend* OR join*) | |
| Date | Database | Search result in number of articles from combined search string |
| 22 Mar 2022 | Web of Science Core collection (Topic) | 598 |
| 22 Mar 2022 | Scopus (article title, abstract, keywords) | 1014 |
| 22 Mar 2022 | BIOSIS Citation index (Topic) | 332 |
| 22 Mar 2022 | CABI: Cab abstracts | 1818 |
| | TOTAL | 3762 |

2021). A team of four researchers were responsible for the screening process, using similar approaches as developed by Haddaway et al. (2018). The team started by screening selected articles together and continued to have regular meetings to ensure a calibration of the process. The team agreed on the design of the analytical strategy and categorized the data. Title, abstract and full text screening was performed using Rayyan software (Ouzzani et al., 2016) by two people per article, whereas full text data extraction was carried out by one person per article. During full-text extraction, a number of parameters concerning the article meta-data and content framed the work to ensure a shared approach and interpretation.

2.2. Search strategy

The search strategy of the systematic review included keywords designed to select works that considered measures or arrangements that could enable or hinder women in smallholder families to gain access to agricultural advice, to be able to attend/take part in any such trainings, demonstrations or meetings, or articles that considered what was needed (or preventing) women from being able to practice and implement any knowledge they may have received. Given the interdisciplinary nature of agricultural research and of extension and advisory services, the databases chosen were those that included both social and natural science studies: Web of Science

Core collection, Scopus, BIOSIS Citation index and CABI: Cab abstracts.

The search (Table 1) focused on peer-reviewed literature, but during the analytical process we did retain inclusion of some grey literature (working papers, or published reports) by key international organizations such as the Food and Agriculture Organisation (FAO), or the World Bank.

2.3. Inclusion criteria

For an article to be included, all the inclusion criteria had to be full-filled. The language had to be English, Swedish or Swahili (the languages of the authors). The article should study an area in sub-Saharan Africa, South or South-East Asia or Latin America (Global south) and should not be clearly large-scale agriculture. The information had to have a human focus and a gender focus as well as cover factors relating to agricultural advice. Any duplicates were removed to retain only one copy. A paper that was not available as full text through the university library, not found online, and not available after contacting the corresponding author and waiting for one month, was also excluded.

2.4. Data extraction and analysis

In order to guide and streamline each team member's reading, extraction and assessment of the articles, a number of broad categories and sub-sections (inspired by the sustainable livelihoods framework (SLF)) (Ashley & Carney, 1999) were used to document bibliographic, methodological, sectoral and content data. Additions were made with a separate extension related category as well as sub-categories of social capital, which was also expanded with social structures to capture the many diverse aspects. Data extraction was carried out with regards to the categories and also grouped by whether they influenced access and implementation of agricultural advice and if different factors were brought up as enabling or disabling. The categories and sub-sections are listed below, and explained in detail in Appendix 1:

- (i) Individual Livelihood Capital Assets (either the farmer's or the extensionist's)
 - Human Capital
 - Natural Capital

- Financial Capital
- Physical Capital
- Social Capital
- (ii) Societal Structures and Processes
 - Household Level
 - Group Level
 - Extension Institution Level
 - Societal Level Norms, Culture, Religion
 - Societal Level Policies, Institutions, Laws

2.5. Thematic analysis

During the full-text analysis of the 111 articles each reviewed article was categorized into either 'somewhat relevant', 'relevant' or 'highly relevant' when scrutinized against the overall research question, i.e. focused on solutions to better ensure agricultural advice could benefit female smallholders. This process resulted in just 17 articles out of the 111 reviewed that were highly solutions-oriented around gender sensitive extension that would benefit female farmers. The other articles focused on describing barriers and problems or exploring gender as a quantitative variable with only these 17 articles (15%) really analysing/testing how to overcome extension-related challenges facing female farmers. A further thematic analysis was then carried out with these 17 articles to assess their content and explore themes in that data. Nvivo software was used for this part of the analysis using the themes described in the preceding section. Once the articles had been coded in Nvivo, each category was collated and the findings were summarized.

3. Findings

3.1. Characteristics of the reviewed literature

The initial search of databases retrieved 3762 articles, which through the screening process ended up being 111 articles to extract information from and 17 articles that were of high relevance for the research question with a focus on solutions and therefore were used in the thematic analysis (Figure 1). Only fifteen of the selected papers could not be retrieved for full text screening. The list of exclusion criteria (reasons for exclusion could be several for one article) is in Table 2.

The journals that were most commonly represented were Journal of Agricultural Education and Extension; Gender, Technology and Development; Climate and Development; and Journal of Rural

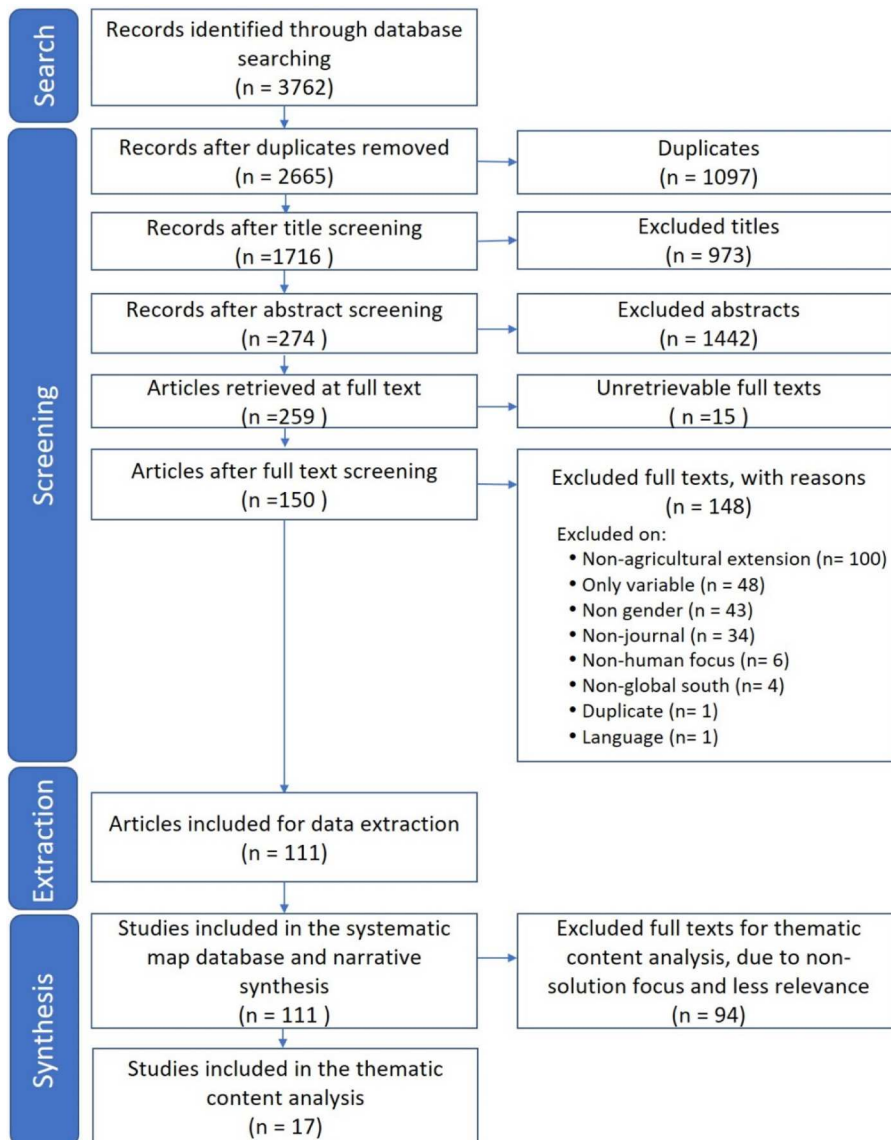


Figure 1. Flow diagram (modified from Haddaway et al., 2018) showing the screening process of literature from 3762 articles in the search to 111 extracted, and 17 articles carried forward to a thematic content analysis.

Table 2. Reasons for exclusion of articles during the whole screening process.

| Exclusion reason | No of articles |
|--|----------------|
| Non-agricultural extension focus | 2368 |
| Non-human focus | 646 |
| Gender as variable only | 473 |
| Non-Global south | 334 |
| Non gender focus | 326 |
| Language other than English, Swedish and Swahili | 173 |
| Non journal | 170 |
| Duplicate | 61 |
| Non-retrievable full texts | 15 |
| Non smallholder agriculture | 11 |

Studies. The majority of the articles selected for extraction were focused on sub-Saharan Africa, 30 of the 111 articles on Asia and just one on South America, while the remaining 14 had a global focus (Figure 2). The most frequently covered countries were India, Ethiopia, Uganda, Ghana, Kenya, Malawi, Tanzania and Bangladesh.

The oldest selected article was from 1984, however a majority of the articles had been published during the last ten years 2012–2022 and continuously increasing in number (Figure 3), suggesting a possible

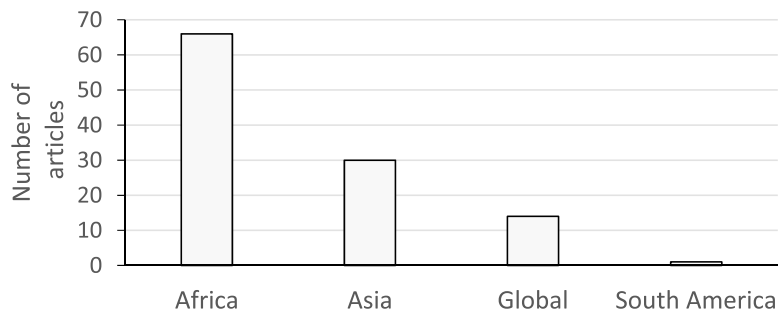


Figure 2. Number of selected articles with different geographical focus ($n = 111$).

growing interest in this topic, even when comparing with the overall increase in scientific publications in the web of science database (Fire & Guestrin, 2019). The apparent drop in papers during 2022 is due to the search being done only up to 22nd of March 2022.

Close to all of the 111 articles were social science studies where around one fifth of the studies were based on a quantitative study including questionnaires/surveys while eleven percent were literature or systematic reviews. A majority were studies with either mixed qualitative methods or mixed qualitative and quantitative methods. These findings are not surprising given that the search strategy was informed by a social science question. The three most common ways of analysing the information was through descriptive statistics, narrative or thematic analysis as well as regression or more advanced quantitative statistical methods.

The main focus in majority of the articles were the smallholder farmers themselves (Table 3). In total, more than 60 000 farmers were in some way included (interviewed, surveyed, trained, part of farmer field schools etc.) in the 111 studies, while far less extension staff, policy makers, salespersons and others

were involved in the research documented. This indicates a large research gap in the lack of involvement of extension providers in research when trying to capture the reasons to why or why not extension services reach both women and men. Most common was to have studies including both male and female smallholder farmers (more than 63% of studies) while 23% of the articles had a women-only focus.

Close to 30% of the articles had no farmers at all included in the study while around half of the studies had 100 farmers or more included (Figure 4). However, the majority of the 111 reviewed articles did not conduct farmer interviews but instead provided literature or thematic/narrative analyses.

The main focus of the articles was to a larger extent gender (66%) and close to all studies had gender as its primary or secondary focus. The primary emphasis on extension was in just 49% of the studies and a few studies had extension more as a variable in the analysis. This may suggest that our search term picked out more gender-related literature, or that extension-related literature has had less of a gendered focus.

Trainings observed, were most often held in the local village if it was at all specified in the article and it was commonly group trainings. The topic of

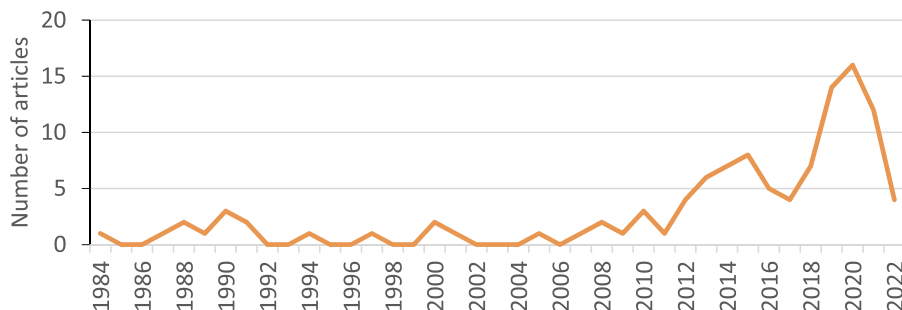


Figure 3. Publication years of the selected 111 articles.

Table 3. Total numbers of different types of studied persons/ interviewees in the 111 articles.

| Farmers | Extension agents | Policy makers | Salespersons | Other persons |
|---------|------------------|---------------|--------------|---------------|
| 61405 | 215 | 46 | 130 | 184 |

the trainings (or advisory services) were to the largest extent crop production (in half of the studies).

Half of the studies had more of generic findings and conclusions while the other half had more specific and practical conclusions. However, just 17 articles were rated as highly relevant in terms of the aim of the review, which means that relatively few studies had the combination of women and access to/use or implementation of extension at the centre of the purpose.

During analysis, the positive (enabling) and negative (disabling) factors were analysed and sorted into different categories outlined earlier (Appendix 3). Most enabling and disabling factors that were mentioned were of extension-related, social or human capital nature such as; gender norms, tailored extension for female smallholders, gender awareness, lack of time and extension, and empowerment. Many studies also pointed out that the current extension purposely avoided women in some cases.

Figure 5 shows the categories and sub-sections along the access and implementation stages in the extension process. Most factors mentioned in the articles were related to the implementation of advice even though many of them were affecting across the three of access, attend and implementation. For example, digitalization of extension through using Information and Communications Technology (ICT) was mentioned mainly in terms of awareness of extension, while mobility was one of the main factors challenging the attendance of extension (Ampaire et al., 2013; Beuchelt & Badstue, 2013; Bui & Do, 2021; Coggins et al., 2022; Izuogu et al., 2023). Access to resources was commonly mentioned regarding implementation of extension advice and access to land was both mentioned as a factor in order to get access to training (be the landowner) and to be able to implement knowledge from the training (be able to take decisions about the land). Experience was only mentioned as a factor enabling at the implementation stage while, e.g. lack of education was seen as disabling for access and attendance in trainings. Gender awareness (for all of men, women, extensionists, policy makers, local leaders

etc.) was important at all stages as well as empowerment and confidence for women.

When looking at which factors were emphasized in literature, it was clear that more enabling factors were brought forward in the extension related category, while all other categories had a majority of disabling factors extracted from the selected papers. However, this systematic review confirmed that research so far has highlighted more barriers than solutions in all other categories, and only 17 of the 111 extracted studies had a clear focus on solutions or had tested ways to overcome the barriers facing female farmers.

The disabling factors (Table 4) mentioned in the largest number of articles were gender norms (mentioned in 50 papers) and lack of time (in 40 papers), while the top enabling factors were tailored extension (in 44 papers) and gender awareness (40). All factors that came up are found in Appendix 3 (but there they are shown several times if they came up in several extension stages).

3.2. Solutions at the level of the individual livelihood capital assets

3.2.1. Human capital

Although the reviewed literature often highlighted a few key skills needed, many of the articles from the solutions-focused analysis emphasized that a focus on the women's' needs in human capital alone was usually insufficient for lasting, sustained female benefit. They noted that skills-only foci (Tsige et al., 2020a) tended to fail if consideration is not also paid to transforming wider societal structures and processes that disempower women (such as gender relations, power, and within-household decision-making) (Theis et al., 2018b). Improving female farmer human capital requires three strategies where the first are those that are more 'standard' training in individual, the second relates to the enabling approaches that have proven effective to boost the impact of such skill trainings (such as building confidence, empowerment and gender awareness), while the third highlights the enabling environment factors that support human capital improvements, such as the time burden, or household division of duties. The next section describes these three approaches in more details.

Female smallholders in the Global South often have lower literacy levels and poorer note-taking abilities than male farmers, situating them at a disadvantage in understanding agricultural information or

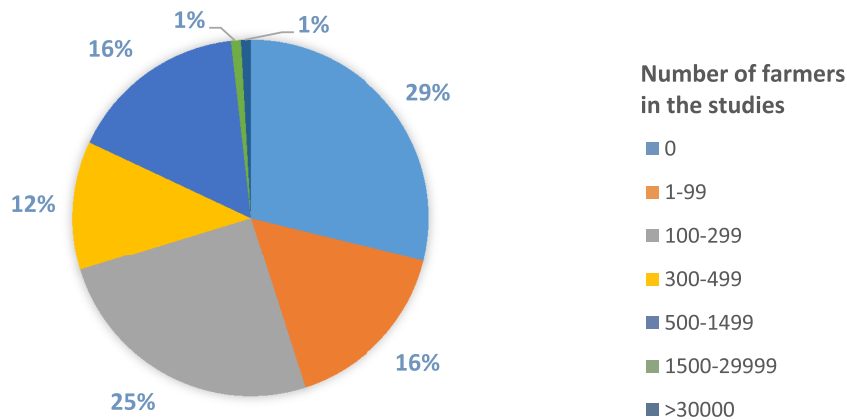


Figure 4. Number of farmers involved in the study, in % of the 111 articles.

when attending trainings (Amran & Abdul Fatah, 2020; Fon, 2015; Misiko & Halm, 2016). Use of local languages could help overcome some of these barriers (Saito, 1991). However, beyond education and literacy, other important skills can help female farmers

including, e.g. farm record-keeping, basic numeracy and accounting, and business-planning. The literature emphasized how interactive/communicative ways of learning that encourages field experimentation, hands-on activities and women's critical thinking

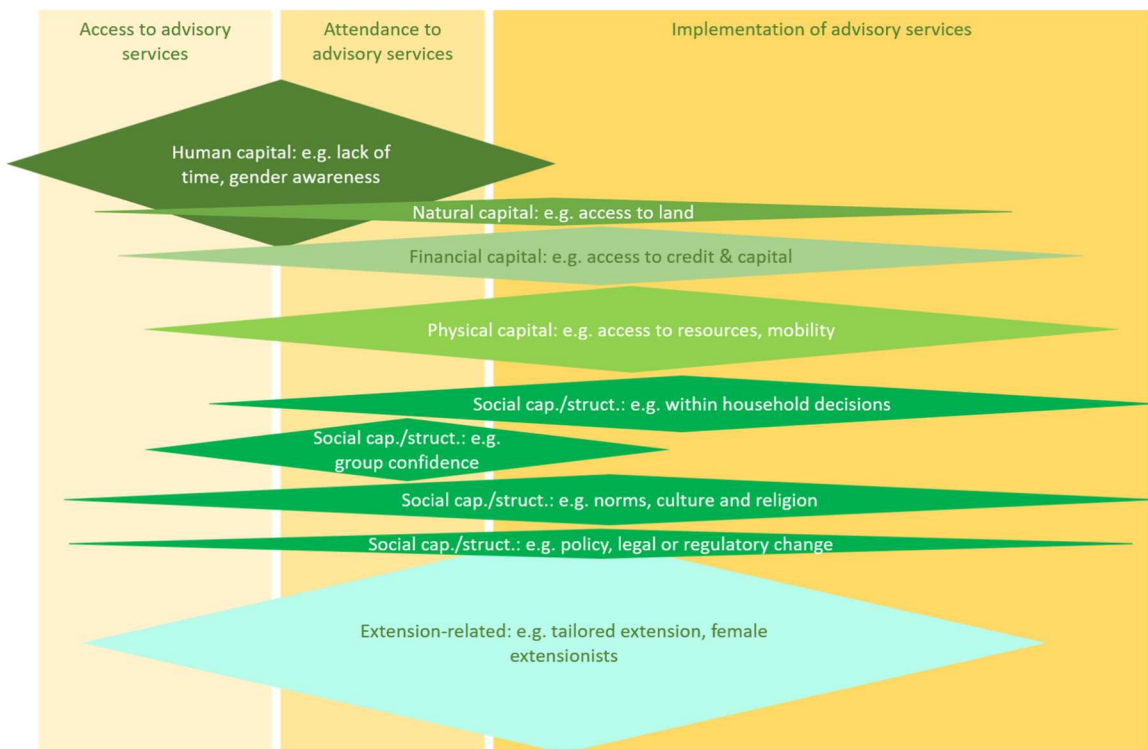


Figure 5. Framework of the major categories of factors analysed and the extension stage they mainly fell under regarding access to advisory services, attendance of advisory services and/or implementation of agricultural advisory services. The height of each category relates to the percentage of factors mentioned during data extraction and the width and centre of each category relates to the spread in the stages respectively where the majority of factors were.

Table 4. The number of articles with the most commonly mentioned enabling and disabling factors out of the 111 articles (every factor only counted once per article).

| Most commonly mentioned enabling factors | No of articles n = 111 | Most commonly mentioned disabling factors | No of articles n = 111 |
|--|------------------------|---|------------------------|
| tailored extension | 44 | gender norms | 50 |
| gender awareness | 40 | lack of time | 40 |
| empowerment | 19 | lack of extension | 35 |
| female extensionist | 17 | lack access to credit | 27 |
| group membership | 16 | lack of decision power | 24 |
| farmer to farmer extension | 13 | lack of access to land | 23 |
| husband support | 13 | lack of access to resources | 22 |
| ICT | 13 | lack of mobility | 20 |
| local extension | 12 | lack of access to capital | 20 |
| demonstrations/hands on training | 11 | lack of education | 18 |
| women groups | 11 | illiteracy | 12 |

skills as well as showcasing female role model farmers and trainers are important for effective and sustained human capital (McGuire et al., 2022).

Significant enabling approaches repeatedly emphasized as supporting human capital improvements were that of confidence and women empowerment in decision-making (Badstue et al., 2020; Farnworth et al., 2016a; Theis et al., 2018a; Voeten & Ottens, 1997). To support such positive change for women, the male decision-makers need to be engaged and both women and men must be supported to increase their gender awareness and reflect on gendered roles and power relations (Mudege et al., 2015; Najjar et al., 2013; Saito & Weidemann, 1990). Confidence is certainly related to a woman's power, agency and voice in her community and thus it also has strong crossovers to a number of our other categories of analysis, such as social capital, within-household decision-making, and norms, culture and religion. A summary of the research techniques that had been used to better support female farmers, in the research studies analysed in this review can be found in Appendix 4.

Finally, working to facilitate an enabling environment that can best support human capital gains, such as lowering the female labour burden and thereby lack of time, was mentioned across many of the 111 articles (Albaab Ur et al., 2020; Pamphilon et al., 2013; Waddington et al., 2014). To consider women's labour routines and childcare needs, could be a way to create human capital supportive enabling

environments, e.g. through having childcare opportunities at the training events (Carnegie et al., 2020). Even though time came up as one of the most common limitations for women to be able to attend trainings, there were very few studies trying to identify the optimal timing of trainings. An enabling environment seemed to be one of the keys ways to improve women's human capital, and throughout many articles reviewed, there was repeated emphasis of the need to reallocate tasks within the household to ensure women had the time to engage in learning.

3.2.2. Natural capital

Natural capital mainly considered the access to, ownership of, and decision-making rights over land (as opposed to other natural resources such as water), which women in most cases have subordinate power over (Quaye et al., 2019). Due to local inheritance traditions and sometimes legal rights, women rarely become landowners (Collett, 2010; Manjula, 2012; Wekesah et al., 2019). Rights to land, and especially its ownership, were consistently identified as a door-opener for women since it can facilitate access to other resources/tools that could ease their labour burden (Badstue et al., 2020), as well as increasing decision-making power within the household, and allowing access to information and education via extension or credit facilities (Rola-Rubzen et al., 2020; Tsige et al., 2020a).

The increased power of women over a resource such as land is however moderated by the risk of losing social capital or of husbands intimidating women or being hostile in order to maintain control (Badstue et al., 2020). Thus, as Najjar et al. (2013) noted, it is necessary to discuss gender roles and rights in the communities and facilitate a change in male attitudes towards letting women own land just like men. Theis and colleagues also pointed out that in households with multiple adults it is not uncommon that some land plots and agricultural assets are held jointly while others are separately managed; and that decision-making may not be equal (Theis et al., 2018b). It is critical to understand the intersection of gender with rights and access to natural capital in order to make female-supportive change.

One obvious intersection that seems to repeat across countries (whether they are Global North or South), is the interaction of being female, a mother and without a supporting partner. To exemplify, female-headed farm households are grossly underserved in terms of access to; land, finance, markets,

inputs, facilities and equipment, and the ability to be able to access agricultural training and information (Rola-Rubzen et al., 2020). Agricultural interventions aiming to support female-headed farm households must be tailored to overcome barriers specific to this sub-group of women. Such women often face stigma and suspicion from other women in the community and may not even have the same level of power and agency as a married woman in the same context. Similarly, elderly widowed women may face circumstances quite different to younger or married women. Policy formulation and legal change that make it easier for women to own land will empower women in multiple ways, which in turn, benefits wider community development in smallholder regions.

3.2.3. Financial capital

The relationship between having financial capital and women's access and implementation of extension services was raised by a number of the articles (Rola-Rubzen et al., 2020; Tsige et al., 2020b). Financial incentives for women to be able to attend trainings were mentioned in terms of food allowance, free transport or child care (Nkengla-Asi et al., 2020; Shikuku 2019). Badstue et al. (2020) noted that decisions in most male-headed households (MHHs) were not inclined to reduce women's labour burden; however, transformative change occurred when women were given control over financial resources through independent economic activity, formal employment, or land ownership. The in-depth analysis stressed the need to raise women's financial literacy and to deliberately target couples in financial decision-making, not men alone. Rola-Rubzen et al. (2020) and Quaye et al. (2019) emphasized the importance of improving women's access to credit, and loan schemes. Having an off-farm income was also seen as something that could help agricultural investments for women (Mengistu, 2021). Generally, the findings stress the crucial role of financial capital and strategic interventions in empowering women within this realm, emphasizing independent resource control and gender-sensitive financial planning for sustainable development.

3.2.4. Physical capital

Female smallholders often have lower levels of physical capital and assets (tools, machinery, equipment, telephones, radios, seeds etc.) than male farmers. Increasing female farmers' access to and/or

ownership of physical capital can reduce their time in doing a task, reduce their drudgery, and provide them more flexible time for their reproductive roles, and perhaps even more leisure time. Female access to physical capital is closely interlinked with their ownership of or control over other capitals (such as natural, social and financial capital), thus improving women's physical capital can result from improvements in one or more of these (and vice versa). ICTs were believed to enable women in some papers (Manjula, 2012; McGuire et al., 2022) while there were also a number of papers saying that many women's access to/use of ICTs was impaired/mediated through men (Ankrah et al., 2020; Witinok-Huber et al., 2021) and therefore not a recommended channel for information.. However, ICT rarely works in very remote areas, and many women do not have access to mobile devices and therefore there have to be alternative extension service approaches (Umar et al., 2021). Otherwise, there is a risk that women are even further excluded from agricultural advice and trainings (Alvi et al., 2021). In the absence of complementary institutional or social change, targeting women with technology alone is unlikely to confer full rights over the technology to women, since the rules of the household often override any norms or expectations promoted by projects, and historically men have been adept at interceding to appropriate a technology or economic activity once it is shown to be profitable (Theis et al., 2018a).

Another aspect of physical capital was that equipment and tools in many cases are developed for men and therefore not suitable for women (Rola-Rubzen et al., 2020; Saito, 1991). Manufacturers should develop tools to avoid injury and discomfort and that decrease rather than simply reallocate women's workloads (Rola-Rubzen et al., 2020; Saito & Weidemann, 1990). The tools should be portable, affordable, multi-functional, suited to women's size and strength and (where possible) produced locally (Saito & Weidemann, 1990).

3.2.5. Social capital

Many of the solutions-oriented articles emphasized the important role of women's social networks in information sharing and delivering effective extension services (Rola-Rubzen et al., 2020; Saito & Weidemann, 1990) and advocated for utilizing women's groups as channels for the distribution of new tools and machines. The importance of strengthening solidarity,

co-learning and self-reliance among women was stressed (Tsige et al., 2020a; Voeten & Ottens, 1997; Wilcox et al., 2015). Collectively, many articles underscored the crucial role of social capital, social support and social networks in empowering women in agriculture and in (where necessary) raising their voices against men/contesting hidden biases that act against them. Interventions to support female farmers must also take care not to erode the target women's existing social capital.

3.3. Solutions at the level of societal structures and processes

3.3.1. At the household level

Female farmers often face an impaired ability to make independent decisions due to intra-household dynamics and lack of power over resources (Po & Hickey, 2020; Saito & Weidemann, 1990; Waddington et al., 2014). The commonly weaker negotiating position of women, together with norms that proscribe against women raising their voices or being seen to 'complain' serve to reduce their control and, ultimately, reduce the income and the benefit they receive from their agricultural labour (Farnworth et al., 2016b). While broader societal norms, traditions and legislature may reinforce such constraints it is often the within-household power dynamics and the rules between the male and the female partner in a relationship that serve as either the stronger break, or (in best circumstances) a powerful enabler. Couples who are able to work as productive teams, better support the empowerment of women. Theis et al. (2018a) explore the necessity of engaging with both couples and communities to redefine gender roles. Researchers note that if a woman already feels, at the outset of an initiative, that she will not be able to claim access to the resulting benefits then she will not be incentivised to get involved (ibid). Research must systematically address rights, ownership and inter-household decision-making without assuming an agricultural improvement will inevitably benefit farm women (Theis et al., 2018b). Even for widowed or female-headed households where the women might at first glance have greater autonomy, the influence of brothers, sons, uncles, elders, bank managers, etc can be disempowering, and at worst-case can actively conspire to appropriate land, assets and resources from the women (particularly common in the case of female widows, and of elderly women)

(Tsige et al., 2020a). Change within the home and having male champions within the family (and the community) who openly empower and enable their women, can be the spark that ignites flames of positive change for female farmers (Quaye et al., 2019).

3.3.2. At the group level

Group membership and especially in women groups in the beginning was clearly enabling in literature and there was also a specific focus on more women in leadership positions (Carnegie et al., 2020; Selhausen, 2016). Most preferred, seemed to be to have pure women groups to start with, and then later move on to have mixed groups for women to gain courage, confidence and experience with time (Beuchelt & Badstue, 2013). However, for long-term sustainability, having men and women mixed helped them to work together with respect (breakdown harmful traditions).

A number of the articles noted that building female power through collective action, social movements and group formation can be successful, however if groups 'do not have the skills, capacity and willingness to address social relations; they may, in fact, entrench already held beliefs about the subordinate position of women' (Mudege et al., 2015).

3.3.3. At the extension level (the whole institution of extension)

A message repeated across many of the 111 articles was the overall lack of agricultural advisory services, and what did exist often avoided women due to biases or lack of competence (Ankrah et al., 2020; Campbell & Dinesh, 2017). Tailored extension was seen to be necessary in order to make extension attractive for women (Saito & Weidemann, 1990; Waaswa et al., 2021) and to ensure female farmers benefit from extension advice (Saito & Spurling, 1992; Tsige et al., 2020a), and get the same level of access to technologies, trainings, credit and resources as male farmers do (Oumer et al., 2014). There was also a need for actions to try to increase the number of extension providers in general (via State services or in partnership with other actors). Extension institutions could set specific targets on the proportion of female farmers to be served and ensure agent reporting disaggregates by gender (Randell & McCloskey, 2014; Saito & Spurling, 1992).

Predominantly male extension workers, and patriarchal systems of extension tend to systematically

and consistently overestimate male farmers' abilities and interest and underestimate that of female farmers (Lamontagne-Godwin et al., 2019). It is common that extension services exclude the women who reside in male-headed households (married women, grown-up daughters) (Tsige et al., 2020b). However, organizations and extension services should not naively accept that female farmers are 'represented' by, or informed by, their husbands (Tsige et al., 2020a). A number of articles found that the female farmers learned better from seeing knowledgeable female extension agents as well as female lead farmers, regardless of their marital status (Lamontagne-Godwin et al., 2019; Tsige et al., 2020a; Wilcox et al., 2015). This further emphasized the need to work using policies, practices and guidelines to reveal and combat innate, often unconscious biases throughout extension services (Lamontagne-Godwin et al., 2019).

Female extensionists are often both more preferred and more culturally acceptable among women (Alvi et al., 2021), and can empower them through, e.g. facilitating joining groups (Alvi et al., 2021). However, there is scepticism (among women as well as men) that female experts actually can exist in relation to agriculture, a sector equated with men (McGuire et al., 2022). Policy makers need to weigh the benefits of extension reaching women and men more equally or reaching as many persons as possible. Extensionists are supposed to be the link between farmers and scientists, or farmers and consumers among others. To make the communication work in two directions need efforts at several levels in society, and involving both women and men.

Joining a group has shown to improve women's access to different institutions (both public and private) (Agarwal, 2020). The size of a group should preferably not be too small and neither too big. Six to ten persons in a group is optimal according to a study by Agarwal (2020). Trainings should preferably be held in times and places of the participants' choice and make sure that all can understand the topic, no matter which educational background they have. To facilitate for women to meet it was suggested in several studies to have training venues where women already meet (e.g. church or market place) and closer to their homes (Campbell & Dinesh, 2017; Caretta, 2014). It was important with a two-way communication and demand driven approach to make women interested and feel that

the training was worth the efforts. Regarding the type of extension, the literature was emphasizing female extensionists and locally available trainings (preferably on a neighbouring farm) with demand driven and farmer to farmer approach (Dieckmann, 1994; Saito, 1991). Use of demonstrations and hands on training in own-field experimentation tend to be more effective for women (Degrande & Arinloye, 2015; Lamontagne-Godwin et al., 2019; Oumer et al., 2014).

However, consensus across the reviewed articles was that engaging both genders after some time, had a more positive impact on agricultural improvement (and ultimately on community wellbeing) than working with single gender groups alone, e.g. Carnegie et al. (2020). Therefore, extension agents need to work to ensure male support (in households, communities, extension agents, departmental & regional managers, agriculture Ministers and overall society), and thereby reduce risk of male sabotage or male capture (Saito & Spurling, 1992). One key factor is to identify ways to deliver extension to women that overcome their constraints of time, mobility and education. This could be mobile training to the village, use of media (radio, video), ICTs, or theatre, or religious leaders, if the power and agency of the women to choose programmes, to access platforms, or to attend such events are considered and supported (Quaye et al., 2019; Saito & Spurling, 1992). Extension must consider what works best for the specific women they wish to reach. For extension agents, the need is not only to train male officers in gendered approaches, but deliberate recruitment of women (Saito & Spurling, 1992). Retaining female staff required combating male bias throughout the organization, having gender-equal workplace policies, equal pay, same logistical aid, encouraging stay after marriage, and providing maternity coverage (Quaye et al., 2019; Saito & Spurling, 1992).

Applying a gender lens to extension requires: (i) differentiating between women and men in agri-interventions and reporting; (ii) understanding that female farmer needs and interests may not mimic those of the male farmers (tailor extension to women) and; (iii) ascertaining the enabling factors for the target women to benefit (provide joint credit schemes, provision of childcare during trainings, evaluating in-household labour burdens and user rights), in order to allow women to dedicate time and resources to agricultural education (Rola-Rubzen et al., 2020; Theis et al., 2018b).

3.3.4. At the societal level – norms, culture and religion

Combating gender norms that disempower or exclude women, and improving men's awareness of gendered differences were noted, across all articles, as key overarching factors for succeeding to reach women with agricultural information. Some articles mentioned the risk of men taking over successful implementation, or that men refused to sit next to women in trainings or men saw women as inferior or felt threatened by empowered women (Farnworth et al., 2019; Oumer et al., 2014). There are cases where men disproportionately appropriate the cash from female farm labour and women fear to attempt renegotiation of their fructus rights due to concern for losing further economic and social power in challenging their husbands (Theis et al., 2018a). For women to succeed, they often need permission and support from their husbands and being able to have enough decision power (Po & Hickey, 2020; Waddington et al., 2014). Work is required at the individual and the household levels, but this is insufficient alone – empowering female farmers also requires modifying bias in laws, institutional regulations, policies, as well as biased practices.

The articles in the in-depth analysis caution how men are often not interested in, nor incentivised to consider (let alone to reduce) female labour burden (Carnegie et al., 2020; Najjar et al., 2013; Rola-Rubzen et al., 2020). Indeed, some men may even be actively against empowering their wives, mothers, daughters for fear of losing their control over them/their male privilege (Badstue et al., 2020; Carnegie et al., 2020; Najjar et al., 2013; Saito & Spurling, 1992). Thus, any sustained change in the situation for farm women must change male awareness and attitudes, in both the household and the wider community by engaging and encouraging traditional leaders, elders and religious leaders (ibid). Culture is malleable and does change naturally over time (Badstue et al., 2020; Carnegie et al., 2020; Lamontagne-Godwin et al., 2019). Doing this successfully takes time and trust (Badstue et al., 2020; Carnegie et al., 2020; Lamontagne-Godwin et al., 2019).

The articles document the need to combat unconscious biases of male extension workers, male decision-makers, communities and even women themselves against female communicators, female trainers or female extensionists. Effective approaches seek to reveal and debate, and ultimately deflate

such unconscious biases that mitigate against female empowerment, for example by highlighting success stories, showing statistics, bring successful women speakers, showing videos of women elsewhere (McGuire et al., 2022). The Gennovate platform (see appendix 4) describes a number of other tools and approaches to such transformation (McGuire et al., 2022).

Violence against women, and its role in restricting women should not be ignored. In fact, the topic was brought up in 14 out of the 17 articles in the thematic analysis and some also noted the male capture of cash income from the harvest season, and a rise in domestic violence. Many articles also noted the positive power of groups to raise and advocate against violence, to set byelaws against violence, penalties for male members being violent and so forth, which can lift violence from the individual/private realm to the public and societal realm (Mudege et al., 2015).

3.3.5. At the societal level – policy, legal and regulatory

Across all 111 reviewed articles, emphasis was laid on how policy work should focus on reducing gender inequalities, supporting multi-stakeholder collaboration and creating better work conditions for female extensionists (Bui & Do, 2021; Campbell & Dinesh, 2017). On one hand, 75% of government agricultural policies analysed by FAO recognized gender inequalities, but only 19% of the same policies included gender equality or women's rights as an explicit policy objective (FAO, 2023). In many countries, common law (the body of law created by judges and a country's official legislative system) is practised alongside customary law (based on a long history of traditions, cultures and norms). This can cause conflict or delay if both are not developing together or if new national laws do not gain widespread acknowledgement in the community. The articles suggest three strategies in order to reduce the risk for such conflict.

Firstly, creating policies tailored for women or making gender-explicit provisions. Examples of policies tailored for female inclusion might be similar to what the Rwandan government has used (Randell & McCloskey, 2014) at different levels, e.g. legislating the proportion of girls in school enrolment, insisting on a female representation quota in policy development at national and regional scale, or ensuring accountability for policies to be gender sensitive. There are also structural enforcements of inequalities

in, e.g. the way organizations work, are led, are staffed, how they understand their target beneficiaries or how the way policies may be formulated. Rwanda was held as an example of how to mainstream and institutionalize gender responsive planning, budgeting, acting and reporting, starting with recruiting a gender specialist to the Agriculture Ministry, and normalizing gender components in all policies, manuals, guidelines, meetings and trainings (Randell & McCloskey, 2014). Secondly, it was highly recommended to have budget allocations earmarked for gender inclusion within agricultural development at both national and local levels using collaborative approaches including several stakeholders (McGuire et al., 2022; Tsige et al., 2020a). Third, policy implementation should be closely monitored to ensure that the policy is working well for women (McGuire et al., 2022). Such evidence gathering needs funds to evaluate the longer-term impact of an intervention, not just the immediate effect (Farnworth et al., 2016a). Rural institutions, NGOs and other local stakeholders need to be engaged to change the inequality embedded in the norms of the society both through awareness raising and practical action steps (Tsige et al., 2020b). This should be a reflective and cyclical process in order to continuously improve the policy formulation, create a responsive policy environment and encourage co-investments among other actors (Oumer et al., 2014; Rola-Rubzen et al., 2020).

4. Implications

4.1. Key recommendations for mainstreaming gender consideration into extension services

It is clear from this systematic review that work needs to be done at all levels from women gaining access to information, to supporting female attendance at (and active engagement in) extension trainings or events, to implementation of the advice on-the-farm, in order to facilitate female farmers' agricultural knowledge development, and ultimately female empowerment and positive family impact. Several studies referred to the need for extension workers to be trained on tailored communication and training approaches for women (Diaz & Najjar, 2019; Umar et al., 2021).

Earlier research shows how women are left behind in several ways along the agricultural extension pathway. Dissemination skills among agricultural extensionists are also less effective at

reaching women than men (Umar et al., 2021). Other reasons to why women are not targeted in extension activities are: that male extensionists are more numerous than female and they often target men; women are often not landowners and therefore not targeted; and also that the time of extension advice may coincide with reproductive duties of the women.

As shown *before*, women need more knowledge, empowerment and control over resources in order to benefit from extension (Tsige et al., 2020a). However, at the same time, men also require sensitization to gendered differences and why supporting their wives/mothers/daughters is beneficial to themselves and the whole communities so that they can understand, allow and support female farmers' development. Alkire et al. (2013) presented the Women's Empowerment in Agriculture Index, which is a combined index with indicators related to all of production, resources, income, leadership and time. All of them are found among the factors brought to attention in this review and therefore underpin the complexity of empowerment. As Tsige et al. (2020b) concludes, the long-term and sustained developmental success of farm women depends not only, nor even purely, on agronomic tools and techniques, but crucially on eliminating the gendered constraints in use of technologies and eliminating gendered imbalance in decision-making and fructus rights (Theis et al., 2018a).

As this review and analysis of gender and agricultural extension shows, improving the lives of small-holder women 'demands a holistic approach that involves cultural, economic and political changes as well as changes at several levels in society in the power dynamics between men and women' (Mudege et al., 2015). The 'agent' within extension, needs to be able to facilitate a discovery learning more as a dialogue in order to tailor make advice (Najjar et al., 2013). Actors within and around the extension system need to actively rework the broader socio-cultural structures that systematically disadvantage women (McGuire et al., 2022; Mudege et al., 2015). Yet all-too-often such broader issues have been 'considered too difficult to change or politically unappetizing' to tackle (McGuire et al., 2022), and extensionists have no awareness of, or training for playing such roles. In addition, many of the papers advised that providers of agricultural extension services require broader training than is the current norm in, for example, *how* to:

- conduct gender-sensitive assessments and awareness raising sessions of agricultural roles, challenges, and opportunities at all levels in society and translate to context-relevant concepts and scenarios (Randell & McCloskey, 2014; Saito & Spurling, 1992).
- gain male support to improve farm women's situations at household, community, extension and society level and thereby reducing risk of male sabotage or capture (Saito & Spurling, 1992).
- deliver extension to women that overcomes their constraints of time, mobility, power over resources and decisions, and education, considering what works best for the specific women since situations vary.
- work through a holistic approach that involves cultural, economic and political changes as well as changes in the power dynamics between men and women.
- support peer-to-peer and practical learning (Degrande & Arinloye, 2015; Lamontagne-Godwin et al., 2019; Oumer et al., 2014), responsive to women's' needs and wishes (Saito & Spurling, 1992).
- involve both men and women (mixed and separate) from the beginning (Voeten & Ottens, 1997)

While acknowledging the need for local customizations, the approaches outlined above nevertheless resonate across contexts (Saito & Spurling, 1992).

4.2. Research gaps and future research needs

This review showed that a lot of the research on this topic has been done in India and a few countries in sub-Saharan Africa, with very few papers from South America and South East Asia, though our English, Swahili and Swedish language constraints may well have influenced the papers captured. Preferably, future studies should include also other geographical areas and possibly comparing different countries. However, it is also likely that more studies on the topic have been done in an African context due to both gender inequalities and relatively low frequencies of agricultural advisory services in most sub-Saharan countries (Waddington et al., 2014), and to the significance of smallholder agriculture to food supply (Giller et al., 2021).

The research that has been done is mostly from the farmers' perspectives (Table 3). Research involving extension agents, policy makers, private companies

or other stakeholders is largely missing and needs more focus. Social science studies were dominant, so a mix of interdisciplinary (social and natural science) studies could be fruitful, together with a deliberate combination of gender and extension focus and there is room for more experimental studies testing outcomes from changing different enablers among female smallholder farmers.

Previous studies have mainly focused upon the barriers facing female farmers rather than enablers or success stories. Our systematic review also found greater emphasis on barriers women face in *accessing* agricultural advice and support (e.g. lack of time, lack of IT access, lack of extension or lack of mobility), yet focus their solutions on the *implementation* level, meaning during training sessions (female extensionist, farmer to farmer learning and hands on training). This represents a mismatch when solutions are not geared to improve female farmer access to extension in the first place. Out of the 3762 papers from the search, only 17 really focused on solutions to providing more gender-sensitive agricultural extension, showing a significant research gap.

Future research is advised to involve more stakeholders than just farmers. To compare and learn from extension experiences across geographical scales (e.g. between countries) and contexts would also be desirable. It would be good for research to establish a clear connection between barriers and enablers in order to focus more on which ways barriers can actually be overcome. There is a need to institutionalize mechanisms where farmers' can influence the research agendas of scientists and their institutions (Mudege et al., 2015), making sure that the farm roles of women, women's technologies, and their crops and livestock are included in agendas (Saito & Spurling, 1992). Previous research emphasized that 'It is often at the intersection of gender and other social factors that the most significant disadvantages or inequalities are created' (McGuire et al., 2022), and therefore an intersectional approach to future research is desirable. An intersectional perspective also highlights that an agricultural technique change may have one set of effects for one kind of group of farmers, and a totally different set of consequences for a differently positioned group of farmers (McGuire et al., 2022).

More specific and practical conclusions from research studies could be instrumental, for example, even if 'lack of time' was the single most common

factor brought up, there were few solutions tested to overcome this barrier, and also few enablers directly seeking to reduce this barrier. Researchers (as well as practitioners and policymakers) must understand that 'empowerment goes beyond counting women participating in activities to ensuring that the activities are in themselves empowering' (Mudege et al., 2015). Future research should be directed towards reducing the knowledge gap on how agricultural learning moves from an individual to a collective, revealing strategies to close the divide between theory and application (Najjar et al., 2013). Focus is also needed on the ways that agricultural extension can support the within-household rights distributions and show how different dimensions of empowerment (such as literacy, or numeracy, or status) can affect a women's rights within the family differently (Theis et al., 2018a). It is important that men and women can have platforms for raising their fears (e.g. that a man may take over a production if successful) and thoughts around female empowerment so that they can understand each other better, which often reduces suspicions. Gender awareness and sensitization of the value in greater equality therefore need increasing effort in future research and extension efforts (Tsige et al., 2020a). Often gender roles are easier to discuss and challenge in the public space compared to within households (Ilomo et al., 2021). Work with gender equality could then have good starting points in groups and extension activities (see examples in Appendix 4).

Only three articles in the in-depth analysis had specific recommendations around the composition, skills and attitudes of the research team themselves, where Quaye et al. (2019), as well as Voeten and Ottens (1997), highlighted the importance of including research staff local to the context and thus familiar with the local gender dynamics and sensitivities on the team. They also noted the value in including local women as field workers in training efforts. McGuire et al. (2022) also focused on the composition, power dynamics, skills and attitudes within international research teams themselves. They noted how suggestions of men from the dominant demographic are more often listened to, or given greater weight, than suggestions from women, minority groups or even other (lower status) men. Horizontal management structures (where ideas can more easily diffuse) and diverse research teams can further enable unique and innovative ideas (McGuire et al., 2022).

5. Conclusion

Women farmers still have less access to resources, inputs, credit and extension than men. In order to promote adoption of agricultural technologies and sustainable agricultural development among women farmers, there is need to tailor-make policy initiatives in both formulation, budgeting, implementation and follow up with focus on women but involving both men and women. Husbands and fathers are critical people to engage, and where individual men are not supportive, the power of a group can overcome male resistance and better support a female farmer (Mudege et al., 2015). However, policy makers need to include women in both the design and operation of extension activities, and maximize their participation, to be effective in achieving goals within the agricultural extension sector and also increase agricultural production and household food security in general.

Despite policy narratives of gender mainstreaming in research and extension, the reality often falls short (Tsige et al., 2020a). Policy alone is insufficient. Practical change alone is insufficient. A focus on the women themselves misses many of the barriers they face. Action needs to be taken across multiple levels and complement each other. Many of the changes outlined in this review require years of sustained support and capacity building to build up a competent core of gender-sensitised female and male extension workers and successful gender transformation within agriculture (Wilcox et al., 2015). This must be acknowledged and supported by policymakers, by organization leaders and department managers.

Author contributions

CRDiT: **Ylva Nyberg**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing; **Heather Mackay**: Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing; **Merezia Wilson**: Formal analysis, Investigation, Writing – original draft, Writing – review & editing; **Mohamed Samkunde**: Formal analysis, Investigation, Writing – original draft, Writing – review & editing; **Johanna Wetterlind**: Conceptualization, Funding acquisition, Methodology, Project administration, Writing – original draft, Writing – review & editing.

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References

- Adebayo, J. A., & Worth, S. H. (2022). Women as extension advisors. *Research in Globalization*, 5, 100100. <https://doi.org/10.1016/j.resglo.2022.100100>
- Agarwal, B. (2020). Does group farming empower rural women? Lessons from India's experiments. *The Journal of Peasant Studies*, 47(4), 841–872. <https://doi.org/10.1080/03066150.2019.1628020>
- Albaab Ur, R., Janoch, E., & Devkota, P. (2020). Knowledge management unlocks market systems for poor women farmers in Bangladesh. *Knowledge Management for Development Journal*, 15(2), 31–50.
- Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., & Vaz, A. (2013). The Women's Empowerment in Agriculture Index. *World Development*, 52, 71–91. <https://doi.org/10.1016/j.worlddev.2013.06.007>
- Alvi, M., Barooah, P., Gupta, S., & Saini, S. (2021). Women's access to agriculture extension amidst COVID-19: Insights from Gujarat, India and Dang, Nepal. *Agricultural Systems*, 188, 103035. <https://doi.org/10.1016/j.agsy.2020.103035>
- Ampaire, E., Machethe, C., & Birachi, E. (2013). Rural producer organizations and poverty reduction in Uganda: are there gender disparities in the distribution of membership benefits? *Journal of Rural Cooperation*, 41(1), 60–79.
- Amran, F. N. F., & Abdul Fatah, F. (2020). Insights of women's empowerment and decision-making in rice production in Malaysia. *Food Research*, 4(S5), 53–61. [https://doi.org/10.26656/fr.2017.4\(S5\).013](https://doi.org/10.26656/fr.2017.4(S5).013)

- Ankrah, D. A., Freeman, C. Y., & Afful, A. (2020). Gendered access to productive resources – evidence from small holder farmers in Awutu Senya West District of Ghana. *Scientific African*, 10, e00604. <https://doi.org/10.1016/j.sciaf.2020.e00604>
- Ashley, C., & Carney, D. (1999). *Sustainable Livelihoods: Lessons from early experience*. UK Department for International Development (DFID).
- Badstue, L., Eerdewijk, A. V., Danielsen, K., Hailemariam, M., & Mukewa, E. (2020). How local gender norms and intra-household dynamics shape women's demand for laborsaving technologies: Insights from maize-based livelihoods in Ethiopia and Kenya. *Gender, Technology and Development*, 24(3), 341–361. <https://doi.org/10.1080/09718524.2020.1830339>
- Beuchelt, T. D., & Badstue, L. (2013). Gender, nutrition- and climate-smart food production: Opportunities and trade-offs. *Food Security*, 5(5), 709–721. <https://doi.org/10.1007/s12571-013-0290-8>
- Bui, H. T. M., & Do, T. A. (2021). Choice of adaptation strategies to climate change among farm households in mountainous areas of Northeastern Vietnam. *Geojournal*, 87, 4947–4960.
- Campbell, B., & Dinesh, D. (2017). Special issue on climate-smart agriculture. *Agriculture for Development*, 30, 2–48.
- Caretta, M. A. (2014). Credit plus" microcredit schemes: A key to women's adaptive capacity. *Climate and Development*, 6(2), 179–184. <https://doi.org/10.1080/17565529.2014.886990>
- Carnegie, M., Cornish, P. S., Htwe, K. K., & Htwe, N. N. (2020). Gender, decision-making and farm practice change: an action learning intervention in Myanmar. *Journal of Rural Studies*, 78, 503–515. <https://doi.org/10.1016/j.jrurstud.2020.01.002>
- Chapman, K. (2021). Characteristics of systematic reviews in the social sciences. *The Journal of Academic Librarianship*, 47(5), 102396. <https://doi.org/10.1016/j.jalib.2021.102396>
- Coggins, S., McCampbell, M., Sharma, A., Sharma, R., Haefele, S. M., Karki, E., Hetherington, J., Smith, J., & Brown, B. (2022). How have smallholder farmers used digital extension tools? Developer and user voices from Sub-Saharan Africa, South Asia and Southeast Asia. *Global Food Security*, 32, 100577. <https://doi.org/10.1016/j.gfs.2021.100577>
- Collett, K. (2010). Training for rural development: Harnessing the power of community groups. Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD), Paris, France.
- Degrande, A., & Arinloye, D. D. A. (2015). Gender in agroforestry: Implications for action-research. *Nature & Faune*, 29(1), 6–11.
- Diaz, I. I., & Najjar, D. (2019). Gender and agricultural extension: Why a gender focus matters. *Journal of Gender, Agriculture and Food Security*, 4(2), 1–10.
- Dieckmann, N. (1994). The integration of social and gender issues in smallholder dairy production. *World Animal Review*, 79, 23–33.
- FAO. (2023). *The status of women in agrifood systems*. <https://doi.org/10.4060/cc5343en>
- FAO, IFAD, UNICEF, WFP, WHO. (2023). *The state of food security and nutrition in the world 2023*. Urbanization, agrifood systems transformation and healthy diets across the rural-urban continuum. FAO.
- Farnworth, C. R., Baudron, F., Andersson, J. A., Misiko, M., Badstue, L., & Stirling, C. M. (2016a). Gender and conservation agriculture in East and Southern Africa: Towards a research agenda. *International Journal of Agricultural Sustainability*, 14(2), 142–165. <https://doi.org/10.1080/14735903.2015.1065602>
- Farnworth, C. R., Jafry, T., Lama, K., Nepali, S. C., & Badstue, L. B. (2019). From working in the wheat field to managing wheat: Women innovators in Nepal. *The European Journal of Development Research*, 31(2), 293–313. <https://doi.org/10.1057/s41287-018-0153-4>
- Farnworth, C. R., Kantor, P., Afrina, C., McGuire, S., & Sultana, N. (2016b). Gender relations and improved technologies in small household ponds in Bangladesh: Rolling out novel learning approaches. *Asian Fisheries Science*, 29(2), 161–178.
- Farnworth, C. R., López, D. E., Badstue, L., Hailemariam, M., & Abeyo, B. G. (2018). Gender and agricultural innovation in Oromia region, Ethiopia: From innovator to tempered radical. *Gender, Technology and Development*, 22(3), 222–245. <https://doi.org/10.1080/09718524.2018.1557315>
- Fire, M., & Guestrin, C. (2019). Over-optimization of academic publishing metrics: Observing Goodhart's Law in action. *GigaScience*, 8(6), giz053. <https://doi.org/10.1093/gigascience/giz053>
- Fon, D. E. (2015). Rural African women's accessibility to resources for food production in the North West Region of Cameroon. *African Journal of Food, Agriculture, Nutrition and Development*, 15(70), 10033–10046. <https://doi.org/10.18697/ajfand.70.13875>
- Giller, K. E., Delaune, T., Silva, J. V., Wijk, M. v., Hammond, J., Descheemaeker, K., Ven, G. v. d., Schut, A. G. T., Taulya, G., Chikowo, R., & Andersson, J. A. (2021). Small farms and development in sub-Saharan Africa: Farming for food, for income or for lack of better options? *Food Security*, 13(6), 1431–1454. <https://doi.org/10.1007/s12571-021-01209-0>
- Haddaway, N. R., Macura, B., Whaley, P., & Pullin, A. S. (2018). Roses reporting standards for systematic evidence syntheses: Pro forma, flow-diagram and descriptive summary of the plan and conduct of environmental systematic reviews and systematic maps. *Environmental Evidence*, 7(1), 1–8. <https://doi.org/10.1186/s13750-017-0113-z>
- Ilomo, M., Rutashobya, L. K., Ishengoma, E. K., Pettersson, K., & Bergman Lodin, J. (2021). Doing and undoing gender in rice business and marketplaces in Tanzania. *Cogent Social Sciences*, 7(1), 1934981. <https://doi.org/10.1080/23311886.2021.1934981>
- Izuogu, C. U., Olaolu, M. O., Azuamairo, G. C., Njoku, L. C., Kadurumba, P. C., & Agou, G. D. (2023). A review of the digitalization of agriculture in Nigeria. *Journal of Agricultural Extension*, 27(2), 47–64. <https://doi.org/10.4314/jae.v27i2.5>
- Lamontagne-Godwin, J., Cardey, S., Williams, F. E., Dorward, P. T., Aslam, N., & Almas, M. (2019). Identifying gender-responsive approaches in rural advisory services that contribute to the institutionalisation of gender in Pakistan. *The Journal of Agricultural Education and Extension*, 25(3), 267–288. <https://doi.org/10.1080/1389224X.2019.1604392>
- Manjula, M. (2012). Crisis to confidence: Mahila Kisan Sasakthikaran Pariyojana - programme for empowerment of women farmers - in Vidarbha region of Maharashtra, India. *Universitas Forum*, 3, unpaginated.
- Matthew, O., Osabohien, R., Lakhani, K. H., Aderounmu, B., Osadolor, N. E., Adediran, O., Mabinuori, O., & Igharo, A. E. (2022). Women engagement in agriculture and human capital development in developing countries: An African sub-regional analysis. *PLoS One*, 17(12), e0277519. <https://doi.org/10.1371/journal.pone.0277519>

- McGuire, E., Rietveld, A. M., Crump, A., & Leeuwis, C. (2022). Anticipating gender impacts in scaling innovations for agriculture: Insights from the literature. *World Development Perspectives*, 25, 100386. <https://doi.org/10.1016/j.wdp.2021.100386>
- Medendorp, J. W., Reeves, N. P., Celi, V. G. S. y. R., Harun-ar-Rashid, M., Krupnik, T. J., Lutomia, A. N., Pittendrigh, B., & Bello-Bravo, J. (2022). Large-scale rollout of extension training in Bangladesh: Challenges and opportunities for gender-inclusive participation. *PLoS One*, 17(7), e0270662. <https://doi.org/10.1371/journal.pone.0270662>
- Mengistu, A. T. (2021). How small-scale farmers understand rain water harvesting technology? Evidence from Northern Ethiopia. *Scientific World Journal*.
- Misiko, M., & Halm, E. (2016). ABCs of diversifying information resources among rice smallholders of Ghana. *The Journal of Agricultural Education and Extension*, 22(3), 271–289. <https://doi.org/10.1080/1389224X.2015.1038281>
- Mudege, N. N., Nyekanyeka, T., Kapalasa, E., Chevo, T., & Demo, P. (2015). Understanding collective action and women's empowerment in potato farmer groups in Ntcheu and Dedza in Malawi. *Journal of Rural Studies*, 42, 91–101. <https://doi.org/10.1016/j.jrurstud.2015.09.002>
- Najjar, D., Spaling, H., & Sinclair, A. J. (2013). Learning about sustainability and gender through farmer field schools in the Taita Hills, Kenya. *International Journal of Educational Development*, 33(5), 466–475. <https://doi.org/10.1016/j.ijedudev.2012.06.004>
- Neway, M. M., & Zegeye, M. B. (2022). Gender differences in the adoption of agricultural technology in North Shewa Zone, Amhara Regional State, Ethiopia. *Cogent Social Sciences*, 8(1), 2069209. <https://doi.org/10.1080/23311886.2022.2069209>
- Nkengla-Asi, L., Olaosebikan, O. D., Che, V. S., Ngatat, S., Zandjanakou-Tachin, M., Hanna, R., & Kumar, P. L. (2019). Gender norms and their implications for banana production and recovery in West Africa. In M. T. Segal, K. Kelly and V. Demos (Eds), *Gender and practice: Knowledge, policy, organizations advances in gender research* (pp. 61–75). Emerald Publishing Limited.
- Ogolla, K. O., Chemuliti, J. K., Ngutu, M., Kimani, W. W., Anyona, D. N., Nyamongo, I. K., & Bukachi, S. A. (2022). Women's empowerment and intra-household gender dynamics and practices around sheep and goat production in South East Kenya. *PLoS One*, 17(8), e0269243. <https://doi.org/10.1371/journal.pone.0269243>
- Olumakaiye, M. F., & Ajayi, A. O. (2006). Women's Empowerment for household food security: The place of education. *Journal of Human Ecology*, 19(1), 51–55. <https://doi.org/10.1080/09709274.2006.11905857>
- Oumer, A. M., Tiruneh, W. G., & Tizale, C. Y. (2014). Empowering smallholder women farmers through participatory seed potato management: Lessons from Welmera district, Ethiopia. *Journal of Sustainable Development*, 7(5), 93–110. <https://doi.org/10.5539/jsd.v7n5p93>
- Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan — a web and mobile app for systematic reviews. *Systematic Reviews*, 5(1), 210. <https://doi.org/10.1186/s13643-016-0384-4>
- Pamphilon, B., Mikhailovich, K., Simeon, L., & Chambers, B. (2013). Two-way learning: Key gender lessons from participatory community workshops with smallholders in the Baiyer Valley and Kerevat areas of Papua New Guinea. *ACIAR Proceedings Series*, 102–114.
- Po, J. Y. T., & Hickey, G. M. (2020). Cross-scale relationships between social capital and women's participation in decision-making on the farm: A multilevel study in semi-arid Kenya. *Journal of Rural Studies*, 78, 333–349. <https://doi.org/10.1016/j.jrurstud.2020.04.024>
- Quaye, W., Fuseini, M., Boadu, P., & Asafu-Adjaye, N. Y. (2019). Bridging the gender gap in agricultural development through gender responsive extension and rural advisory services delivery in Ghana. *Journal of Gender Studies*, 28(2), 185–203. <https://doi.org/10.1080/09589236.2017.1419941>
- Randell, S., & McCloskey, M. (2014). Sustainable rural development in Rwanda: The importance of a focus on women in agriculture. *International Journal of Agricultural Extension*, 2(February), 107–119.
- Rola-Rubzen, M. F., Paris, T., Hawkins, J., & Sapkota, B. (2020). Improving gender participation in agricultural technology adoption in Asia: From rhetoric to practical action. *Applied Economic Perspectives and Policy*, 42(1), 113–125. <https://doi.org/10.1002/aepp.13011>
- Saito, K. A. (1991). Extending help to women farmers in LDCs: What works and why. *Finance Devel*, 28, 29–31. <http://documents.worldbank.org/curated/en/963151468768706244>
- Saito, K. A., & Spurling, D. (1992). Developing agricultural extension for women farmers. World Bank Discuss. Pap.
- Saito, K. A., & Weidemann, C. J. (1990). *Agricultural extension for women farmers in Africa*. World Bank Publications.
- Scanlan, S. J. (2004). Women, food security, and development in less-industrialized societies: Contributions and challenges for the new century. *World Development*, 32(11), 1807–1829. <https://doi.org/10.1016/j.worlddev.2004.05.009>
- Selhausen, F. M. Z. (2016). What determines women's participation in collective action? Evidence from a Western Ugandan coffee cooperative. *Feminist Economics*, 22(1), 130–157. <https://doi.org/10.1080/13545701.2015.1088960>
- Shikuku, K. M. (2019). Information exchange links, knowledge exposure, and adoption of agricultural technologies in northern Uganda. *World Development*, 115, 94–106. <http://doi.org/10.1016/j.worlddev.2018.11.012>
- Theis, S., Bekele, R. D., Lefore, N., Meinzen-Dick, R., & Ringler, C. (2018a). Considering gender when promoting small-scale irrigation technologies: guidance for inclusive irrigation interventions. Considering gender when promoting small-scale irrigation technologies: guidance for inclusive irrigation interventions, 8 pp.
- Theis, S., Lefore, N., Meinzen-Dick, R., & Bryan, E. (2018b). What happens after technology adoption? Gendered aspects of small-scale irrigation technologies in Ethiopia, Ghana, and Tanzania. *Agriculture and Human Values*, 35(3), 671–684. <https://doi.org/10.1007/s10460-018-9862-8>
- Tsige, M., Synnevag, G., & Aune, J. B. (2020a). Gendered constraints for adopting climate-smart agriculture amongst smallholder Ethiopian women farmers. *Scientific African*, 7, e00250. <https://doi.org/10.1016/j.sciaf.2019.e00250>
- Tsige, M., Synnevag, G., & Aune, J. B. (2020b). Is gender mainstreaming viable? Empirical analysis of the practicality of policies for agriculture-based gendered development in Ethiopia. *Gender Issues*, 37(2), 125–152. <https://doi.org/10.1007/s12147-019-09238-y>

- Umar, A., Norsida, M., Nitty, H. K., & Nur, B. M. H. (2021). Women farmers perception of information dissemination skills among agricultural extension workers in North Eastern Nigeria. *Journal of Agricultural Extension*, 25(3), 60–68. <https://doi.org/10.4314/jae.v25i3.6>
- UN Women. (2018). *Turning promises into action. Gender equality in the 2030 agenda for sustainable development*. United Nations.
- Voeten, J., & Ottens, B. J. (1997). Gender training in aquaculture in Northern Vietnam: A report. *Gender, Technology and Development*, 1(3), 413–432. <https://doi.org/10.1080/09718524.1997.11909870>
- Waaswa, A., Nkurumwa, A. O., Kibe, A. M., & Kipkemai, N. J. (2021). Communicating climate change adaptation strategies: Climate-smart agriculture information dissemination pathways among smallholder potato farmers in Gilgil Sub-County, Kenya. *Heliyon*, 7(8), e07873. <https://doi.org/10.1016/j.heliyon.2021.e07873>
- Waddington, H., Snilstveit, B., Hombrados, J. G., Vojtkova, M., Anderson, J., & White, H. (2014). Farmer field schools for improving farming practices and farmer outcomes in low- and middle-income countries: A systematic review. *Campbell Systematic Reviews*, 10(1), 1–335. <https://doi.org/10.4073/CSR.2014.6>
- Wekesah, F. M., Mutua, E. N., & Izugbara, C. O. (2019). Gender and conservation agriculture in sub-Saharan Africa: a systematic review. *International Journal of Agricultural Sustainability*, 17(1), 78–91. <https://doi.org/10.1080/14735903.2019.1567245>
- Wilcox, C. S., Grutzmacher, S., Ramsing, R., Rockler, A., Balch, C., Safi, M., & Hanson, J. (2015). From the field: Empowering women to improve family food security in Afghanistan. *Renewable Agriculture and Food Systems*, 30(1), 15–21. <https://doi.org/10.1017/S1742170514000209>
- Witinok-Huber, R., Radil, S., Sarathchandra, D., & Nyaplu-Daywhea, C. (2021). Gender, place, and agricultural extension: A mixed-methods approach to understand farmer needs in Liberia. *Journal of Agricultural Education and Extension*, 27(4), 553–572. <https://doi.org/10.1080/1389224X.2021.1880453>

Appendices

Appendix 1. Explanation of the categories used in the analysis

- (i) Individual Livelihood Capital Assets (either the farmer's or the extensionist's)
 - Human Capital: included things like women's (or even men's) education, literacy, skills, capacity, technical training but also included their health and nutritional status, their labour burden, which in turn picks up their often-greater responsibility for child-care and other household reproductive activities, e.g. cooking, cleaning etc
 - Natural Capital: related to women's rights over, ownership of (or lack therein), or access to land or animal resources or some ecosystem services (such as water)
 - Financial Capital: anything to do with money and finance (income, credit, debt, savings) but even includes aspects related to having certain assets such as access to ICTs/radio
 - Physical Capital: anything to do with infrastructure/public goods such as roads, transportation services, access to these, the safety aspects of such; water infrastructure, but also tools, equipment, machinery, and the design of such
 - Social Capital: anything to do with the individual's social network and one-to-one social relationships
- (ii) Societal Structures and Processes
 - Household Level: decision-making, agency, partnership, respect (anything related to the husband-wife/male partner-female partner relationship, interactions, atmosphere, decision-making). Here we also included any discussions around gender-based violence or abuse within the household.
 - Group Level: anything to do confidence to be in a group, group membership and power
 - Extension Institution Level: anything related to advisory services, extension and the institutions and organizations providing agricultural advice and/or extension services within a country or region (whether public or private)
 - Societal Level Norms, Culture, Religion: here we categorized factors related to cultural discourses, religious practices or local traditions, paradigms or cultural norms that may prioritize men and boys, and/or that push women/girls to be silent, respectful, dismissed or excluded; or that otherwise inhibit female engagement and female farmer empowerment. Here we also included factors describing men's attitudes, or discussing around aspects of power relations, of leadership within communities.
 - Societal Level Policies, Institutions, Laws: included enabling or disabling factors as a result of policies, of laws, of regulatory processes, of structural procedures.

Appendix 2. Highly relevant articles used in thematic content analysis

| # | Article Title | Year | Authors | Journal |
|----|--|--------|---------------------------------------|--|
| 1 | How local gender norms and intra-household dynamics shape women's demand for labour saving technologies: insights from maize-based livelihoods in Ethiopia and Kenya | (2020) | Badstue, L. et al. | Gender, Technology and Development |
| 2 | Gender, decision-making and farm practice change: An action learning intervention in Myanmar | (2020) | Carnegie, M. et al. | Journal of Rural Studies |
| 3 | Gender Relations and Improved Technologies in Small Household Ponds in Bangladesh: Rolling out Novel Learning Approaches | (2016) | Farnworth, C. R. et al. | Asian Fisheries Science Special Issue 295 |
| 4 | Identifying gender-responsive approaches in rural advisory services that contribute to the institutionalization of gender in Pakistan | (2019) | Lamontagne-Godwin, J. et al. | Journal of Agricultural Education and Extension |
| 5 | Anticipating gender impacts in scaling innovations for agriculture: Insights from the literature | (2022) | McGuire, E. et al. | World Development Perspectives |
| 6 | Understanding collective action and women's empowerment in potato farmer groups in Ntcheu and Dedza in Malawi | (2015) | Mudege, N. N. et al. | Journal of Rural Studies |
| 7 | Learning about sustainability and gender through Farmer Field Schools in the Taita Hills, Kenya | (2013) | Najjar, D. et al. | International Journal of Educational Development |
| 8 | Empowering Smallholder Women Farmers through Participatory Seed Potato Management: Lessons from Welmera District, Ethiopia | (2014) | Oumer, A. M. et al. | Journal of Sustainable Development |
| 9 | Bridging the gender gap in agricultural development through gender responsive extension and rural advisory services delivery in Ghana | (2019) | Quaye, W. et al. | Journal of Gender Studies |
| 10 | Sustainable rural development in Rwanda: The importance of a focus on women in agriculture | (2014) | Randell, S. & McCloskey, M. | International Journal of Agricultural Extension |
| 11 | Improving Gender Participation in Agricultural Technology Adoption in Asia: From Rhetoric to Practical Action | (2020) | Rola-Rubzen, M. F. et al. | Applied Economic Perspectives and Policy |
| 12 | Agricultural Extension for Women Farmers in Africa | (1990) | Saito, K. & Anderson Weidemann, C. J. | World Bank Discussion Papers 103 |

(Continued)

Continued.

| # | Article Title | Year | Authors | Journal |
|----|---|---------|----------------------------|--|
| 13 | What happens after technology adoption? Gendered aspects of smallscale irrigation technologies in Ethiopia, Ghana, and Tanzania | (2018b) | Theis, S. et al. | Agriculture and Human Values |
| 14 | Gendered constraints for adopting climate-smart agriculture amongst smallholder Ethiopian women farmers | (2020a) | Tsige; M. et al. | Scientific African |
| 15 | Is Gender Mainstreaming Viable? Empirical Analysis of the Practicality of Policies for Agriculture – Based Gendered Development in Ethiopia | (2020b) | Tsige, M. et al. | Gender Issues |
| 16 | From the field: Empowering women to improve family food security in Afghanistan | (2015) | Wilcox, C. S. et al. | Renewable Agriculture and Food Systems |
| 17 | Gender Training in Aquaculture in Northern Vietnam: A Report | (1997) | Voeten, J. & Ottens, B. J. | Gender, Technology and Development |

Appendix 3. All enabling and disabling factors found in the 111 selected articles for extraction. Each factor can have appeared at different stages in the extension structure (access, attend and implementation stages) within the same articles.

| Category | Access to advisory services | No of articles | Attend advisory services | No of articles | Implement advise | No of articles |
|-------------------|---|----------------|---|----------------|-------------------------------|----------------|
| Human capital | Education | 11 | lack of time | 25 | gender awareness | 22 |
| | gender awareness | 11 | gender awareness | 9 | lack of time | 17 |
| | Empowerment | 9 | education | 8 | empowerment | 13 |
| | lack of time | 9 | empowerment | 7 | education | 7 |
| | Confidence | 4 | confidence | 5 | confidence | 5 |
| | Illiteracy | 4 | illiteracy | 5 | illiteracy | 5 |
| | Knowledge | 4 | knowledge | 3 | lack of knowledge | 5 |
| | increased labour | 2 | lack of labour | 3 | regular training | 5 |
| | optimal timing | 2 | lack of skills | 2 | increased labour | 4 |
| | ICT literacy | 1 | local language | 2 | experience | 3 |
| | local language | 1 | labour division | 1 | training leads to empowerment | 3 |
| | long-term extension for trust | 1 | lack of enthusiasm for training among women | 1 | lack of skills | 2 |
| | risk to be left behind | 1 | | | female headed households | 1 |
| | suitable timing, duration and location of training activities | 1 | | | lack of labour | 1 |
| Natural capital | time efficient | 1 | | | lack of social, human capital | 1 |
| | | | | | time | 1 |
| Financial capital | lack access to land | 11 | lack access to land | 2 | lack access to land | 17 |
| | lease out land | 1 | | | | |
| Physical capital | access to capital | 7 | access to capital | 8 | access to credit | 17 |
| | access to credit | 5 | access to credit | 2 | access to capital | 15 |
| | | | food allowance | 1 | access to tailored credit | 1 |
| | | | free transport and child care | 1 | off-farm income | 1 |
| Physical capital | ICT | 14 | mobility | 14 | access to resources | 16 |
| | access to resources | 11 | ICT | 8 | mobility | 6 |
| | Mobility | 8 | access to resources | 4 | ICT | 5 |
| | lack access to technology | 1 | develop tools for women | 1 | tailored equipment | 3 |
| | lack of female radio programmes | 1 | imagery | 1 | imagery | 2 |
| | mobile training units | 1 | notebooks | 1 | books | 1 |
| | | | subsidised technology for women | 1 | | |
| | decision power | 7 | decision power | 8 | decision power | 17 |

(Continued)

Continued.

| Category | Access to advisory services | No of articles | Attend advisory services | No of articles | Implement advise | No of articles |
|--|---|----------------|---|----------------|---|----------------|
| Social capital and social structures: Within-household decision-making | hh communication | 4 | husband support | 4 | husband support | 13 |
| | husband permission | 2 | hh communication | 3 | hh communication | 3 |
| | husband support | 2 | husband permission | 3 | husband permission | 2 |
| | female headed households | 1 | non hh head | 2 | men feel threat from empowered women | 2 |
| | lack of childcare | 1 | men perception of women inferior | 1 | domestic violence | 1 |
| | men feel threat from empowered women | 1 | | | lack of child-care | 1 |
| | women value training | 1 | | | lack of understanding of women's situation | 1 |
| | | | | | Mechanisation seen as mens' domain | 1 |
| | | | | | group membership | 9 |
| | | | | | | |
| Social capital and social structures: Group confidence, membership and power | group membership | 9 | group membership | 7 | group membership | 9 |
| | women group | 4 | women group | 4 | women group | 7 |
| | more women in leadership positions | 2 | lack of networks | 3 | more women in leadership positions | 4 |
| | better networks between farmer groups and extensionists | 1 | more women in leadership positions | 2 | social network | 4 |
| | change constitution in farmer organization | 1 | | | create value chain fora for women | 1 |
| | lack communication channel for rural women | 1 | | | low effective organizations | 1 |
| | lack of 'educated' social networks | 1 | | | service providers trust women to implement | 1 |
| | social networks | 1 | | | Sharing information with other women after training | 1 |
| | strengthen farmer groups | 1 | | | | |
| | | | | | | |
| Social cap./ struct.: Norms, Culture, Religion | gender norms | 17 | gender norms | 17 | gender norms | 23 |
| | role play to highlight and discuss gender norms | 1 | men refuse to sit with women in training – cultural belief | 1 | risk of men take over successful implementation | 2 |
| | Tribe | 1 | | | women and men prefer different crop traits | 1 |
| Social capital and social structures: Policies, institutions, laws | better work conditions for female extension agents | 3 | Multi-stakeholder collaboration | 2 | policies address gender inequalities | 9 |
| | Multi-stakeholder collaboration | 2 | policies address gender inequalities | 2 | Multi-stakeholder collaboration | 3 |
| | policies address gender inequalities | 2 | better work conditions for female extension agents | 1 | follow up policy implementation | 1 |
| | extension officers ensure two-way communication of women concerns to policy | 1 | practical gender needs-as entry point – to address strategic gender needs | 1 | | |
| | | 1 | | 1 | | |

(Continued)

Continued.

| Category | Access to advisory services | No of articles | Attend advisory services | No of articles | Implement advise | No of articles |
|-------------------|---|----------------|---|----------------|---|----------------|
| Extension related | change policy-makers view of women as subsistence-oriented farmers only | | copy the Rwandan 2010 Gender Strategy for Agriculture | | | |
| | public service favour men | 1 | | | | |
| | research on what is needed | 1 | | | | |
| | tailored extension | 17 | female extensionists | 12 | tailored extension | 24 |
| | female extensionists | 7 | lack of extension (avoid women) | 10 | demand driven extension | 10 |
| | lack of extension | 7 | tailored extension | 10 | female extensionists | 8 |
| | lack of extension (avoid women) | 7 | farmer to farmer | 7 | lack of extension (avoid women) | 8 |
| | local extension | 7 | local extension | 7 | mixed gender training | 8 |
| | integrate training where women meet | 6 | demonstrations/hands on | 6 | lack of extension | 6 |
| | farmer to farmer | 4 | lack of extension | 6 | demonstrations/hands on | 5 |
| | demonstrations/hands on | 2 | mixed gender trainings | 5 | local extension | 4 |
| | Age | 1 | demand driven extension | 3 | farmer to farmer | 3 |
| | contact farmer | 1 | farmer to farmer training | 2 | start with high potential advice | 3 |
| | demand driven extension | 1 | participatory extension | 2 | holistic approach | 2 |
| | diversified sources not necessarily giving better knowledge transfer | 1 | extension collaborate with school | 1 | integrate training where women meet | 2 |
| | extension to be both demand led and avail new exposures | 1 | mixed and separated gender trainings | 1 | risk of men take over successful implementation | 2 |
| | female contact farmers | 1 | mixed topics | 1 | training leads to more training | 2 |
| | farmer field school (FFS) | 1 | regular extension | 1 | FFS | 1 |
| | lack of trust in extension | 1 | special trainings on value addition | 1 | focused on access | 1 |
| | lack of willingness | 1 | training leads to more training | 1 | human interface is essential | 1 |
| | mixed gender groups | 1 | | | lack of incentives in trainings | 1 |
| | mixed methods | 1 | | | male biased groups | 1 |
| | need trade off info in extension | 1 | | | male change agents | 1 |
| | tailored digital extension | 1 | | | mixed methods | 1 |
| | training leads to more training | 1 | | | rapid rural appraisal | 1 |
| | trust and credibility of the information source | 1 | | | strange to talk to male strangers | 1 |
| | | | | | two way communication | 1 |

Appendix 4. List of gender-sensitive research tools, methods, and approaches raised

| Tool or technique | Article author(s) and year |
|--|----------------------------|
| (1) Facilitated experiential learning activities in farmers' fields / Female farmer own research / Learn-by-doing (Farnworth et al., 2016) | Carnegie et al. (2020) |
| (2) Financial Decision-Making Profiles / Household Financial Management Types (also Voeten & Ottens, 1997) | |
| (3) Gendered Agricultural Activity Profile (preparation to post-harvest) | |
| (4) Gendered Daily Activity Profile (24-hours) (includes non-farm work) / Labour map (also McGuire et al., 2022; Voeten & Ottens, 1997) | |
| (5) Gender awareness (Boy/Girl Gender Gap activity) | |
| (6) Consciousness-raising exercises adapted from the Helen Keller International | Farnworth et al. (2016) |
| (7) Local theatre group performs skits with gender messages | |
| (8) Practice role play modelling of different male & female approaches/responses for improved household communication and sharing (also Voeten & Ottens, 1997) | |
| (9) Gendered Resource Mapping or resource view (also Voeten and Ottens (1997)) | McGuire et al. (2022) |
| (10) Analysis of difference (a method for revealing and discussing the different challenges and perspectives across different kinds of groups of people such as by gender, or by wealth category, or by occupation type) | |
| (11) Women's Empowerment in Agriculture Index (WEAI) | |
| (12) Gennovate (an initiative led by the CGIARs to consider how cultural norms influence women's interaction with agricultural innovations) | |
| (13) Ladder of Life (a gender-sensitive tool within the Gennovate suite that helps explore the situation of different groups within a community) | |
| (14) Assess gendered control of produce and income / Usage rights versus fructus rights perspectives (also Theis et al. 2018; Voeten & Ottens, 1997) | |
| (15) Scenario thinking (structured process where groups consider future potential situations & outcomes), even with a theory of affordance perspective | |
| (16) The expected-profits approach (with an analysis of difference view): compares profits between different sub-groups, thus insight into ultimate beneficiaries of new technology. | |
| (17) Historical-trends approach: analyses past adoption behaviour in the community to predict possible future adoption | |
| (18) A Social Relations Approach (SRA): assesses and reveals the social relations that people need to survive | Mudege et al. (2015) |
| (19) Gendered Needs Assessment | Rola-Rubzen et al. (2020) |
| (20) Institutional Analysis: which organizations and institutions are present within the community and what their power or stake in resource control and female farmer interests are | Voeten and Ottens (1997) |
| (21) Training for Trainers with gendered analysis skills | |
| (22) Gendered Cost-Benefit Analysis | |