EVIDENCE GAP MAP ON IMPACTS OF SOCIO-TECHNICAL INNOVATION BUNDLES (STIBS) ON WOMEN'S EMPOWERMENT AND RESILIENCE FOR GENDER EQUALITY INITIATIVE HER+

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This report includes the background, objectives, methodology and results for the Evidence Gap Map on the impacts of Socio-technical Innovation Bundles (STIBs) on women's empowerment and resilience.

Prepared for HER+ by C4ED

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EXECUTIVE SUMMARY

1. Background

A combination of factors, including policies, technological advancements in response to climate change and social needs, and changes in market demand, have triggered considerable agricultural transformations in recent decades (Timmer, 1988; Viswanathan et al., 2012; Thanh et al., 2021). Yet, technological innovations alone do not necessarily make agricultural transformations sustainable and inclusive over time. Several actors are now focusing on introducing bundled interventions combining technical and/or technological innovations with social innovations. Their aim is to apply a multi-pronged approach to agricultural transformation that simultaneously allows technological advancements, with increased adoption of new methods and tools, and alleviates barriers in access to inputs and credits. Gwynne and Ortiz (1997) provide a clear example from Chile, proving how institutional changes in land ownership, expansion of productive investments, and provision of financial inputs to farmers succeeded in promoting agricultural development, especially increasing agricultural output and labour productivity, among others. Also, Joshi and Joshi (2019) reckon the importance of policies in Nepal and their significance in combination with technology adoption to avoid negative impacts on food production and access and availability of water and energy.

Although these bundled interventions target all farmers in principle, women farmers are often disadvantaged, as the bundle configuration does not consider their preferences, capacities and/or capabilities. This "fits all" approach is particularly problematic as women constitute about half of the agricultural labour force, and if they face greater difficulties in accessing these bundles, and reaping the benefits derived from them, then these bundles fail to empower half of the target population. With the intention to bridge the existing gender gaps, the socio-technical innovation bundles or STIBs need to be gender-responsive and align with women's preferences, attitudes, and capacities.

In order to understand which configurations of STIBs can be most beneficial for women, existing evidence related to STIB interventions and their impact on women's resilience and empowerment needs to be examined. Therefore, this evidence gap map reviews the existing literature on the effect of different STIBs and provides evidence on how and whether these bundles empower women and enhance their resilience. This evidence gap map will guide and inform decision-making about the design and implementation of STIBs in different contexts and how enabling factors can improve or modify their performance.

2. Objectives

The goal of this review was to understand the role of STIB interventions in empowering women and improving their resilience. To accomplish this, all rigorous evidence on bundled interventions that target farmers in rural areas was reviewed and sought to answer the following questions: What types of STIBs are related to women's empowerment and resilience in agriculture? What are the effects of STIBs on women's empowerment? What are the effects of STIBs on women's resilience? Additional questions related to the role of contextual differences, barriers, and facilitators in the success of these STIB interventions in improving women's resilience and empowerment outcomes are elaborated.

3. Search and screening of studies

The evidence gap map relies primarily on creating a conceptual framework which outlines the pathways

through which STIBs improve women's resilience and empowerment. Following this, a systematic search of existing academic databases was conducted. The relevant studies were found in three ways: searching the most comprehensive databases, searching the websites of relevant research institutions or international agencies, and relying on a list of studies provided by experts. The electronic search on databases follows the Population, Intervention, Comparison, Outcomes, and Study (PICOS) model for creating search terms related to agricultural STIB interventions and for women's empowerment and resilience.

The time frame for the search was from 1990 onwards. Through the search, a total of 12,692 studies were found, which were inserted into EPPI Reviewer 4, a specialised software for study screening. During the title and abstract screening, the machine learning algorithm in EPPI Reviewer was implemented, allowing a priority screening of studies, where studies were sorted on their relevance based on the inclusion and exclusion criteria of the screening process. Following the title and abstract screening, the full-text screening was concluded, where 22 studies were retrieved as relevant to answer the research questions posed in this assignment.

Only studies written in English were considered through both screening processes, and, given the large number of studies obtained from the searches, only those published after 2000 were included in the evidence gap map. The studies included were also based on the presence of women in the population under analysis, reporting the impact of STIB intervention on women's empowerment and/or resilience outcomes. These studies were only included if they established the effect through rigorous methods, such as (quasi-)experimental methods. All the other papers were excluded.

4. Results

A review of 22 studies aiming to answer the posited research questions provided positive evidence of the impact of STIBs on women's resilience but not on women's empowerment. A total of 13 studies measured the effects of STIBs on women's resilience outcomes, primarily based on absorptive and adaptive capacities. While several of such indicators showed that STIBs have some impact on resilience, they only seemed to improve the adaptive capacities of women farmers. Similarly, 11 studies reported the effects of STIBs on outcomes related to women's empowerment. However, the impact of STIBs on these outcomes was not conclusive.

First, for resilience, the results suggested that STIBs lead to an improvement in outcomes. Yet, most of this improvement was driven only by the positive impact reported for adaptive capacity, largely measured through improved agricultural productivity and increased assets. Such improvements can be attributed to the nature of the STIB intervention. For regional trends, adaptive capacity showed a stark improvement in the African context, with nearly 70% of reported outcomes showing a positive impact.

Second, the results did not show a clear trend for empowerment outcomes (measured through the WEAI and its sub-domains). Largely driven by one study (Garbero et al., 2018), a large positive impact of STIBs can be observed on the decision-making power of women in rural areas. Contextualising this by continents, the same study, based in Kenya, found high positive results for improvements in empowerment. Excluding this one study, the results did not show any clear evidence of improvement. It may be of interest to consider this study (Bonilla et al., 2017) – and that of Garbero et al. (2018) as prime examples of successful STIB interventions.

It is important to note that the large variety of indicators used, as well as the variation introduced through the methods and contextual factors, imply that no clear trends in a single outcome type emerge for any of the two outcomes. In particular, each intervention is almost unique among the pool of selected studies using their own relevant indicators, making it impossible to draw any statistically relevant conclusion for any of them. Future research in the areas of STIBs and women's resilience and empowerment may benefit from a quantification (after standardisation) that a meta-analysis allows, such that a combined overall estimate for impact can be derived.

However, important lessons learnt on the barriers and facilitators of the intervention and implementation are synthesised and can be informative for policymakers. On this front, it is worth mentioning that features such as facilitating access to additional financial resources, intervention targeting, and size of (farmer) groups can promote the intervention and make it more prone to achieve the desired impacts. In addition, existing (farmer) groups and associations enhance the STIBs implementation. Moreover, it is important that adequate infrastructure, institutional strength and political will is in place to accelerate the success of programme implementation and potential impacts.

Designing programmes where basic needs and basic public services are lacking, or markets do not exist poses important challenges, as these are critical preconditions for programmes to succeed. Under such circumstances, it is important to anticipate difficulties in the implementation and expect less than optimal impacts, especially if those barriers still need to be addressed or modified by the programme. In addition, it is recommended for programme designers to design less labour-intensive interventions/bundles as women farmers are usually more time constrained than men farmers due to household care and domestic responsibilities. Hence, they are less likely to adopt labour-intensive practices, especially women heads of households. Lastly, two significant challenges to programme implementation are the inefficiencies within governmental entities and weak market linkages, which ultimately impede the timeliness and understanding of the initiatives on the ground.

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ABBREVIATIONS

Abbreviation	Name
3ie	International Initiative for Impact Evaluation
AfDB	African Development Bank
AFS	Agri-Food System
ANOVA	Analysis of Variance
ANCOVA	Analysis of Covariance
BCC	Behavioural Communication Campaigns
C4ED	Center for Evaluation and Development
GDV	Gente de Valor
CRCT	Cluster Randomised Control(led) Trials
DID	Difference-In-Difference
DTS	Drought-Tolerant Seed
EBSCO	Elton B. Stephens CO (company)
EconLit	Economics Literature (database service)
EGM	Evidence Gap Map
EPPI	Evidence for Policy and Practice Information
FAO	Food and Agricultural Organization of the United Nations
IDS	Institute of Development Studies
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
GRADE	Grading, Recommendations, Assessment, Development, and Evaluation
IV	Instrumental Variable
JSTOR	Journal Storage (digital library)
LIC(s)	Low-income countries
LMIC(s)	Low- and Middle-Income Countries
NBER	National Bureau of Economic Research
NGO	Non-governmental organizations
NSA	Nutrition sensitive agricultural
OLS	Ordinary Least Squares (regression)
PICOS	Population, Interventions, Comparators, Outcomes, and Study
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RBE	Reach-Benefit-Empower (framework)
RBET	Reach-Benefit-Empower-Transform (framework)
RCT	Randomised Control(led.) Trials
RDD	Regression discontinuity design
STIBs	Socio-Technical Innovation Bundles
ToC	Theory of Change
UN	United Nations
WEAI	Women's Empowerment in Agriculture Index
WoS	Web of Science

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1. BACKGROUND AND RATIONALE

1.1 Background

Technical and technological innovations in agri-food systems (AFSs) have led to considerable transformations in human well-being worldwide and increased farmers' resilience to climate-related shocks (Cacho et al., 2020; Yamano et al., 2018; Shiferaw, et al., 2014).[1] However, the considerable growth in population, as well as the adverse spillover effects of these innovations on climate, natural environment, public health and nutrition, and social justice are making many of the AFSs unsustainable (Barrett, 2021). The question of how communities can innovate further to obtain AFS transformations that sustain and expand has become increasingly pertinent. In recent studies, AFSs are found to be exclusive in their improvement in well-being, with women, indigenous populations, racial and religious minorities, and young people being the most disproportionately disadvantaged (GloPan, 2016, 2020; Diaz et al., 2019; Shukla et al., 2019; Willett et al., 2019). Therefore, technological innovations must increasingly support AFSs to become just, by being able to target vulnerable groups such as women and youth and improve their livelihoods and overall well-being.

Yet, technological innovations alone do not necessarily make AFSs sustainable and inclusive over time. Given the diverse contexts where these technologies are implemented, an interactive and iterative (political and social) innovation process is required to rapidly adapt and align new technologies to the (ever-changing) local context and needs. Thereby, the increasing focus on the development, implementation and scaling-up of bundles combining social, technological, and technical innovations is increasingly pertinent and evident (Timmer, 1988; Viswanathan, et al., 2012; Thanh, et al., 2021; Barrett et al, 2022). Yet, these bundles do not have a similar effect on agricultural transformation everywhere.

Regions and countries with weak institutions and physical infrastructure do not benefit as much from innovations as countries with strong existing institutions and physical infrastructure (Barret, 2021). Moreover, given the heavily decentralised and diverse nature of AFSs, extensive stakeholder participation is indispensable for developing the right bundle for the right context at the right time. An early example of AFS transformation through STIBs can be found in countries where the Green Revolution took place. The success of this movement was not only driven by the availability of technologies, land, and abilities/willingness of farmers to test such technologies, but also by the creation of public infrastructure like irrigation systems as well as making new varieties and agricultural chemicals available to farmers. These efforts, together with several enabling policies, allowed farmers to reap the benefits of the agricultural boom. Similar examples can be found in Gwynne and Ortiz (1997) and in Joshi and Joshi (2019). In the former study, the authors described the Chilean context and emphasise how policies succeeded in promoting agricultural development, especially by increasing the investment in export-oriented agriculture and labour productivity among others. In the latter study, the authors reckoned the importance of policies in Nepal, together with technology adoption, to avoid negative impacts on food production, and access and availability of water and energy.

1 Agricultural *technological innovations* include the provision of improved agricultural inputs such as drought-tolerant seed varieties, fertilizers, irrigation technologies, etc. The *technical innovations* include information provision in the form of training, nudges, and dissemination material, among others.

Besides the contextual differences described above, an important consideration for benefiting from technical and technological innovations is the gender of the household member. Ideally, STIBs should generate employment and income-generating opportunities for rural women on a sustainable basis, thus multiplying contributions to the national income (Singh, 2010). Unfortunately, such benefits have not yet been realised. In LMICS, women constitute a significant proportion (32%) of the agricultural workforce, a figure that increases to 63% in LICs (World Bank data bank, 2021). However, due to different social and economic barriers, and a lack of complementary inputs and services, women still face difficulties in accessing the knowledge and technologies equitably, thereby missing the benefits from these innovations (see review by Ragasa, 2012). Not surprisingly, evidence has shown that women farmers benefitted less from the Green Revolution than men farmers (Pingali, 2012).

Structural constraints in knowledge transfer create difficulties for women in accessing the technologies. Usually, trainers and extension workers are men and hence they are more likely to invite other men farmers to the capacity buildings, leaving female farmers behind (Singh, 2010). Further, several studies have shown that women do not consider training useful because they feel discriminated against by men, have lower literacy levels, and find that most of the trainings are tailored for the benefit of male farmers (Ragasa, 2012; Polar, et al., 2015; Collett and Gale, 2009). These issues impede the diffusion of technology and knowledge, which results in low adoption rates among women and other vulnerable groups, thereby undermining their resilience to climate change. Furthermore, women in rural areas continue to struggle with the dual responsibilities of economic production and domestic labour and are inhibited by poverty, illiteracy, high health risks, inadequate access to technology and productive resources (e.g., land), and lack of credit and market access (Singh, 2010).

Thus, to bridge the existing gender gaps in agriculture and rural economies, STIBs need to be designed and implemented to be inclusive. It is important that these bundles align with women's preferences, needs, priorities, attitudes, and capacities since they are often not considered within the direct target group of agricultural interventions. STIB interventions must, from the onset, attempt to *reach* women, allow them to *benefit*, and actively take steps to *empower* them. Programmes that organise women's only groups or include female extension workers could have a higher chance of reaching women from the onset. In addition, programmes that directly include women in critical decision-making, enhance their resource ownership and thereby increase their overall agency are more likely to empower them (Quisumbing et al., 2019). These strategies are aligned with the new Reach-Benefit-Empower (RBE) framework (Quisumbing et al., 2019).[2] Yet, CGIAR has created a more comprehensive scheme to analyse the effects of an intervention: *the Reach-Benefit-Empower-Transform (RBET) framework*. This different structure allows a more comprehensive view of empowerment and includes structural and gender norm changes derived from the intervention. For instance, it has been shown that women may be more willing to adopt technological bundles that reduce their time trade-offs between agricultural production and domestic labour (e.g., Gouse et al., 2016). Therefore, structural changes such as improvements in roads and electricity could benefit the rural economy, but to especially benefit women they would have to be combined with improved access to cooking fuel or drinking water, thereby reducing their domestic burden.

Tackling the barriers to accessing and benefiting from STIBs is even more critical since women farmers

2 This framework was developed by CGIAR and IFPRI

are more vulnerable than men to climatic shocks and stressors, as they have less diversified livelihoods (Asfaw and Maggio, 2018). The existing evidence on the vital role of women's empowerment in the development of rural areas provides additional incentives to reduce barriers for women farmers to access and benefit from such social and technological innovations. Evidence has suggested that enhancing women's agency or decision-making improves overall agricultural productivity (Mobarok et al., 2021; Diiro et al., 2018), and household welfare (Hoddinott and Haddad, 1995; Duflo, 2003; Gertler, 2004; De Janvry and Sadoulet, 2006; Robinson, 2012; Ibanez et al., 2017). Raising agricultural productivity is expected to improve households' resilience through improved income and asset holdings. Evidence also links gender equality and women's empowerment in AFSs to better food security and nutrition, and increasingly resilient and sustainable food systems for households (Njuki et al., 2022). In view of these advantages, initiatives that aim to improve the inherent gender inequality in AFSs are becoming increasingly prevalent. Social and technical innovations can enhance women's resilience as they focus on increasing anticipative, preventive, absorptive, and transformative capacities. Empirical studies have shown that the establishment of early warning systems, the improvement of roads to access markets, and the provision of training increase household welfare, empower women, and improve efficiency (see Jiri, Mafongoya, Chivenge 2017, Nakamura, Bundervoet and Nuru, 2020, and Patalagsa, et al., 2015). However, the evidence is unclear regarding how resilience within the household, specifically between men and women farmers, might be differently affected by the same innovations.

A review of existing literature undertaken by the Institute of Development Studies (IDS) identified large gaps in the knowledge base around gender integration and equity in AFSs (Harris et al., 2022). These gaps prevent researchers, policymakers, programme implementers and other stakeholders from effectively addressing issues of inequity in rural development. A much-needed partnership between national policymakers and implementers can allow a more gender-equitable agricultural framework that reaches women, and enables them with the right set of infrastructure, information and resources, thereby removing the inherent gender discrimination in access to and benefits from STIBs. Future bundle configurations should thereby address the existing structural gender inequalities in AFSs, realise the considerable promise of emergent technologies, and deliver on multiple objectives that no single innovation can simultaneously satisfy.

1.2 Rationale

A first step towards understanding and augmenting the use of STIBs was to compile and analyse the existing evidence related to STIB interventions and their impacts. In this way, existing evidence may serve to inform policy and any existing research gaps can be filled. The goal of this Evidence Gap Map (EGM) was to ensure that future political engagement on STIBs is strategic and inclusive of all sections of the population, especially women.

In a nutshell, the rationale for this EGM is three-fold:

1. **Structured and systematic review of the literature:** From existing literature, there appears to be an absence of any systematic review of evidence of the impacts of STIBs, in particular, on women's resilience and empowerment. This study served as a systematic review of the literature, to identify

the existing STIBs, and provide insights on the type of outcomes and individuals (gender, age, etc.) they are targeting. The review also proved fruitful in enabling a discussion on what barriers, enablers, and facilitators that have been identified in the implementation of STIBs.

2. **Mapping the existing evidence and gaps:** There are existing systematic reviews on women's resilience and empowerment, but these reviews are not linked with STIBs. Moreover, none of these reviews clearly link specific outcomes to specific STIBs. Based on the systematic search, this evidence gap map (EGM) was produced to highlight where the evidence is abundant versus sparse, the nature of studies/interventions, and the outcomes of interest. This mapping helped to identify areas that require further evidence and STIBS that are more (or less) successful in achieving a gender-equitable impact.

3. **Highlight robust evidence:** By mapping the existing evidence, high-quality evidence (experimental or quasi-experimental impact evaluations) that estimate the causal effect of implementing STIBs was highlighted. The design of these studies can inform future studies including efforts to scale-up evaluations of STIBs.

2. OBJECTIVES OF THE REVIEW

EGMs are evidence collections that map out existing and ongoing systematic reviews or primary studies in particular areas, such as food security, agricultural productivity, or poverty. They present a visual overview of existing evidence using an outcome-intervention framework, where policy-relevant interventions are mapped against outcomes, to provide access to user-friendly summaries of the included studies. EGMs enable policymakers and practitioners to explore the findings and quality of the existing evidence and facilitate informed judgement and evidence-based decision-making in international development policy and practice. The EGM also identifies key "gaps" where little or no evidence from impact evaluations and systematic reviews is available and where future research should be focused (Snilstveit, 2016).

The objective of the review was to produce an EGM that visualises the **impact of STIBs on women's resilience and empowerment.** This EGM was based on a structured literature search, and an appraisal of the evidence to assess whether and how STIBs have had an impact on women's resilience and empowerment in the current AFSs. Intermediate outcomes such as productivity, food security, access to assets and resources, and finance were also examined across the included studies and reviews. The EGM served to illustrate what innovation bundles have been examined in the literature, to what extent they have been adopted (based on adoption and knowledge-based outcomes), and what impact they have had on the population in different geographical contexts. The population of interest were the LMICs, implying that the context is limited to these countries. The EGM enables the reader to understand where the most pertinent gaps in evidence on the impact of STIBs on the outcomes are, thereby paving the way for future research and policy in these areas.

On the road to constructing the EGM the following sub-objectives were reached:

2.1 Sub-Objective 1

To identify the evidence gaps around the impacts of STIBs on women's resilience and empowerment and to examine existing heterogenous impacts across different groups (age, location, socio-economic status).

2.2 Sub-Objective 2

To learn about implementation factors such as the design and implementation strategies associated with programme success and failure.

2.3 Sub-Objective 3

To showcase the evidence, highlighting those STIBs that showed positive impacts on the population of interest. Such programmes can serve as role models for future programmes, and present options for scaling up.

3. CONCEPTUAL FRAMEWORK

3.1 Research questions

The overarching research question that the EGM intended to answer was:

What are the effects of STIBs on women's resilience and empowerment?

To answer this question, more specific questions should be answered, namely:

1. What are the types of the STIBs existing in the literature, in relation to women's empowerment and resilience in agriculture?
2. What are the effects of STIBs on women's resilience?
   a. Do the effects of STIBs differ between different groups of women (according to age, location, or socio-economic status)?
3. What are the effects of STIBs on women's empowerment?
   a. Do the effects of STIBs differ between different groups of women (according to age, location, or socio-economic status)?
4. What intervention and implementation features of STIBs are associated with relative success or failure in improving outcomes of interest?
   a. What are the contextual barriers to enhancing women's resilience and empowerment?
   b. What are the enabling environments of STIBs?
   c. What are the facilitators (actors) of STIBs?

As the EGM only maps interventions and outcomes, it only provided answers to the first three research questions. To be able to answer all the related sub-questions, and question four, narratives were constructed based on robust evidence extracted from the relevant studies (i.e., economically tested results). The results are presented in section 5.

3.2 Theory of Change

Based on the research questions, a Theory of Change (ToC) was developed to understand the linkages between STIBs and the intermediate and final outcomes. The ToC was constructed by investigating examples of STIBs, their implementation, the contextual factors, and most importantly, their impact. To this end, a preliminary screening of the literature was conducted to assess what types of STIBs have already been evaluated, and thereafter to understand the linkages and barriers that facilitate or present detriments to the impact of STIBs. The ToC is up to date taking into consideration the data extracted for the purpose of this assignment.

The theoretical causal chain was defined by several building blocks, two of which are the **inputs** required and **activities** organised as part of the STIBs intervention. Under the main set of inputs, investments by private and public stakeholders are key. This base of capital also needs infrastructural support (such as storage facilities, well-connected road networks, or digital infrastructure) and an existing set of public services within the agricultural sector (availability of trained extension officers, community mobilisers, etc.) at the macro- (national, subnational, or regional), meso- (administrative and legal institutions) and micro- (community and household) levels. With the key resources and structures in place, **activities**

related to the STIBs can be undertaken at all three levels. At the micro-level, along with the introduction of new technologies/innovations, farmer training such as on sustainable agricultural/ agronomic practices and integrated soil management can be organised (Bryan and Garner, 2022; Gugerty and Kremer, 2004), technical assistance such as field demonstration and technical visit (Paolisso et al., 2002), or cash (and/or in-kind) transfer schemes can be set up (Gugerty and Kremer, 2004). Larger information campaigns such as radio or newspapers can be accompanied by smaller and more targeted awareness-raising activities such as video-enabled extension messages (Lecoutere et al., 2020). It is assumed that public services and technological and infrastructural resources are put in place for the target population, markets function well, and strong multi-stakeholder collaboration is present.

In the next level, given the required inputs, the activities are expected to result in the first **outputs** such as more trained, aware, skilled, and informed farmers, especially women. In addition, it is expected that women farmers increase their knowledge of climate-smart practices and acquire access to new types of tools, seeds, and other agricultural implements. The creation of farmer groups (women only or mixed) and other community initiatives may also emerge at this stage.

Under a given set of mediating conditions, especially the adoption of STIBS, these outputs should convert into improvements in household and agricultural **outcomes**, focusing on benefits to women. Gradually, women farmers are expected to adopt more climate-smart agricultural practices, which may lead to higher and/or stable productivity, increase in sales and savings, diversified livelihood options, sustainable agricultural production through the adoption of improved farming practices, efficient utilisation of resources such as water, improvement of ecosystem services, better nutritional status, and an overall improvement in household incomes. Assuming the design of these STIBs are accompanied by reinforcement of positive societal traditions and norms, women farmers enjoy higher access to the outputs, but also enjoy a greater share of the outcomes such as income and savings and control over the utilisation or allocation of the income and savings. These gains should also be visible in improved nutritional options and outcomes for the farmer household. These changes should then lead to the desired **impact**, i.e., more resilient and empowered women farmers.

Empowerment and resilience are important concepts, but they are difficult to define as they encompass multiple notions. Several different indices have been developed to capture these notions. In this assignment, the measure of empowerment utilized the Women's Empowerment in Agriculture Index (WEAI), developed by Alkire et al. (2013). This index incorporates indicators of the five domains of women's empowerment at the individual and household level (production decisions, control over household resources, control over use of household income, leadership, and lastly time use). To measure resilience, the approach utilized by The Food and Agriculture Organization (FAO) where resilience can be enhanced when at least one of five different capacities is improved: anticipative, preventive, absorptive, adaptive, and transformative was followed (United Nations (UN), 2020).[3]

3 The same document defines each of the capacities. *Absorptive capacity* represents the ability to take protective action to "bounce back" after a shock, using predetermined responses to preserve and restore basic structures and functions. *Adaptive capacity* is the ability to make incremental adjustments to the characteristics of systems to moderate potential changes, to be able to function without major qualitative changes in said functions. *Anticipative capacity* is the ability to take early action in anticipation of a potential threat to reduce its negative impacts. *Preventive capacity* implies the ability to implement activities and take measures to reduce existing risks and avoid the creation of new risks. Finally *transformative capacity* is the ability to create a fundamentally new system when ecological, economic or social structures make the existing system untenable. This occurs when there is recognition that ecological, economic or social structures keep people trapped in a vicious circle of poverty, disasters and conflict and make the existing system unsustainable.

A graphical representation of the proposed theoretical causal chain is provided in Figure 1. For the causal chain from outputs to impacts to hold, and to realise the full potential of these STIBs, a large variety of mediating factors need to be in place, such as an adequate regulatory framework, well-functioning governmental institutions, and well-developed preventive systems that prepare farmers against climate shocks. These were also captured within the theoretical framework.

3.3 Linking research questions and key indicators

To answer the above-mentioned research questions, and to facilitate the review, a list of key outcome indicators and interventions are created.

Table 1: Research questions, key outcome indicators, and interventions (not exhaustive)

Research Questions	Key Outcome Indicators and Interventions
What are the effects of STIBs on women's resilience?	• Agricultural productivity/ yield • Asset accumulation / Household income • Food security • Access to cash savings • Access to insurance • Adoption of best practices
What are the effects of STIBs on women empowerment?	• Agency / decision-making power • Financial empowerment (assets and income) • Asset accumulation • Workload/ Leisure time • Membership in groups / Social cohesion/Social capital
What intervention and implementation features of STIBs are associated with relative success and failure in improving outcomes of interest?	Intervention and implementation features: • Implementation modalities, i.e., farmer-led, women-led, community-based, group-based etc • Interlinkages among programme components • Access to credit-loans • Prior existence of farmer groups in the region • Groups size • Number of value chains • Targeting of value chain • Infrastructure status • Resource endowments

Source: Authors' review of the literature

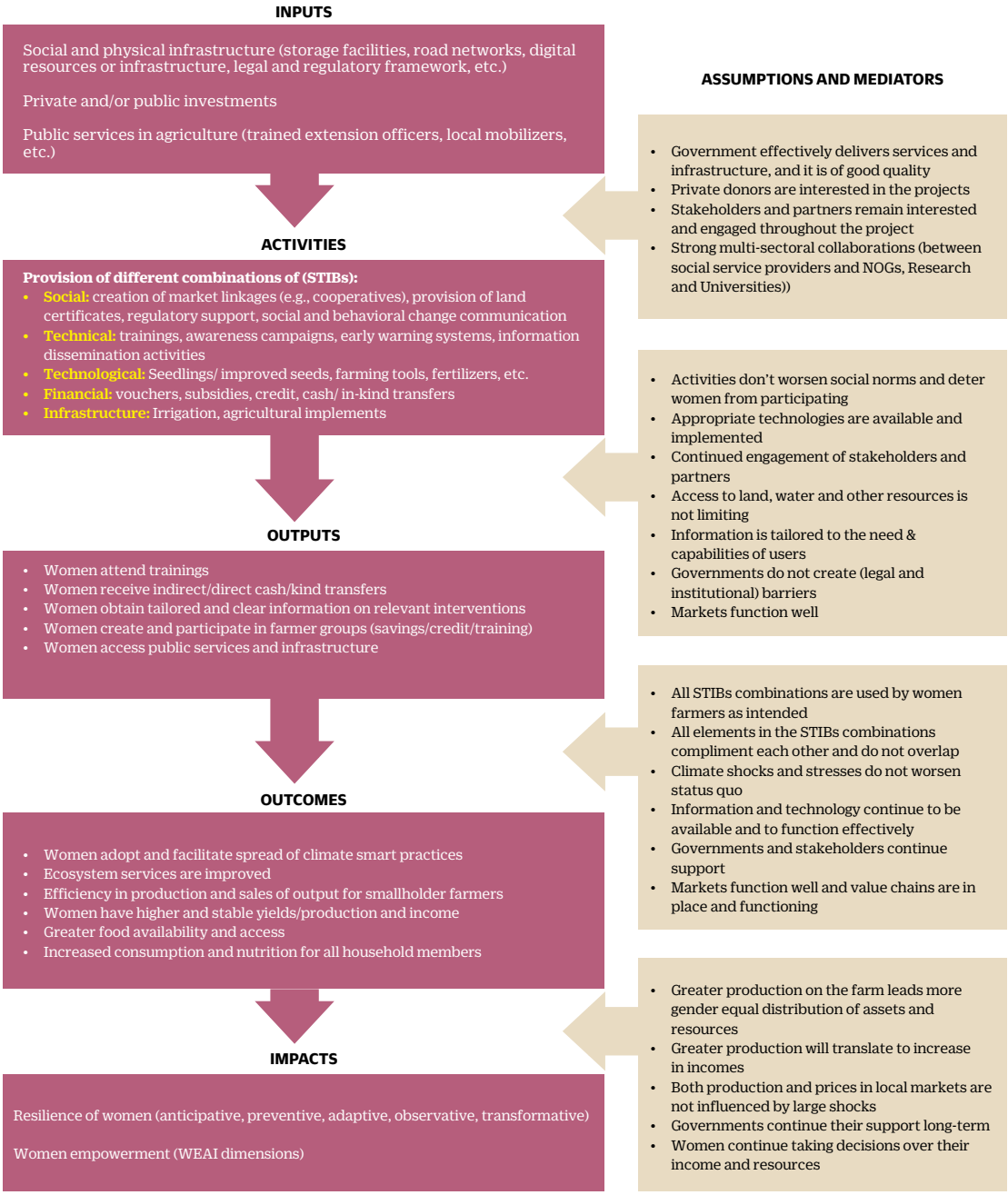

Figure 1. Causal chain between STIBs, intermediate outcomes and final impact on women's resilience and empowerment
Source: Authors' review of the literature. Notes: Under the social component of the STIBs the social, financial, and structural components are included.

4. METHODOLOGY

To identify the evidence that is used to answer the research questions, the PICOS model – namely by defining the Population, Interventions, Comparators, Outcomes, and Study designs to include in this study was applied. The basis of the PICOS was the conceptual framework and the ToC presented above in Section 3. In particular, the assignment focused on interventions conducted in LMICs, on the outcomes outlined, and on the types of interventions presented in the conceptual framework (STIBs). Details of the criteria applied to studies for inclusion as well as exclusion criteria can be found below. Due to the vastness of the literature on resilience and women empowerment, C4ED actively searched for robust quantitative evidence, i.e., evidence that includes a robust econometric model, as defined below. Yet, reports and other systematic reviews were also included in the search.

In Sections 4.1 and 4.2, the PICOS is outlined, thereby defining the inclusion and exclusion criteria. In Section 4.3, the electronic search over multiple databases and websites of key agencies and research institutes is described. Section 4.4 presents the approach to data management, which is the screening process from start to data extraction, as well as the procedure that is used for evaluating the quality of evidence.

4.1 Criteria for inclusion of studies

This assignment followed Snilstveit et al. (2016) to identify which studies are included within the EGM as per the PICOS model. The inclusion criteria for the studies included in the EGM was guided by the Theory of Change and was further refined based on the key research questions. The main **population** of interest for this EGM were women farmers in agriculture in LMICs. Therefore, the EGM used gender and geography (countries, continents, etc.) to categorise the studies such that information is available on the extent to which studies have looked at the differential impacts of the interventions on men and women, and across LMICs. The **interventions** considered are context-specific STIBs that aim to increase the uptake of climate-smart agricultural technology options by women in agriculture, to enhance their resilience and empowerment. The **comparisons** were farmers and, in some cases, women that have not benefited from any of the STIBs. The **outcomes** of interest included broad measures of empowerment of women and measures of resilience in agriculture, such as decision-making, asset ownership, health and nutrition, inclusive value chains, resilience to shocks and environmental sustainability. Finally, there were several types of studies that were considered relevant, but the assignment primarily focused on **study designs** that show robust econometric evidence, rather than narrative reviews, case studies, etc.

4.1.1 Population under study

The EGM includes STIB interventions targeting households and in particular women in agriculture LMICs, as defined by the World Bank categorisation (see list of countries in Appendix III). Studies in high-income country settings were excluded.

4.1.2 Intervention

The EGM includes STIBs that aim at promoting practices that enhance women's resilience and empowerment at the household and community level. However, other intervention types which address the research questions were considered, as long as they are presented as bundles of technical, technological and social interventions among the population of interest. The STIBs included in this

assignment combined the technological, technical and social aspects within single interventions. The interventions can be rolled out as multi-treatment or factorial designs where different groups receive different combinations/ intensities of the interventions. Accordingly, agricultural *technological innovations* included the provision of improved agricultural inputs such as drought-tolerant seed varieties, fertilizers, irrigation technologies, the introduction of biofortification technologies, etc. The *technical innovations* included information on weather, training and adoption of productivity-enhancing technologies/ improved practices, soil and water conservation practices, trainings on integrated pest/weed management and disease control, trainings on livestock and fishery management, and training on storage and tillage practices, among others. To be considered as STIBs, these technical and technological innovations had to be combined with one or more of the following *social, infrastructure and/or financial aspects*, including social awareness programs (information campaigns, market linkages through producer-buyer linkages or provision of market-related information, etc.), and/or infrastructure provision (wells, roads, etc.), and/or, agriculture finance components (microfinance and microcredit programmes, saving group organisations, input subsidies, cash or in-kind grants or transfers such as livestock, agricultural/irrigation tools, etc.).

When a STIB intervention was targeted towards a set of women, then the comparison group would consist of women un-exposed to this intervention. The comparison group could also include women prior to the start of the intervention in studies where there was not a clearly defined counterfactual group (i.e., pre-post evaluation). As some interventions targeted both women and men, the comparison group could also be gender mixed with individuals that were not exposed to the intervention. Lastly, where a study includes more than one intervention/treatment arm, only the treatment and comparison arms that met the eligibility criteria for a combination of social elements with technical or technological elements were considered.

4.1.3 Outcomes

The EGM focuses on the effects of STIB intervention on women's outcomes, particularly on their resilience and empowerment. The outcomes for women's empowerment followed the measures from the WEAI developed by Alkire et al. (2013), which includes indicators of the five domains of women's empowerment at the individual and household level: production decisions (autonomy in decision-making regarding inputs and methods of agricultural production), control over household resources (ownership of assets, having say in decisions regarding purchase/sale/transfer of household assets, access to and participation in decision-making on household credit), control over use of household income (decision-making regarding usage of household income and spending on self and children's schooling/health), leadership (access to/ membership in community and social groups such as agricultural marketing and credit groups, and opportunities of public-speech regarding disputes), and lastly, time-use (availability of leisure activities, distribution of domestic tasks, time allocation between chores and leisure, access to childcare etc.).

The outcomes of women's resilience included the five capacities of resilience discussed above. Measures for improvement in anticipative capacities included income stability, a larger toolbox of coping strategies for climate shocks, access and use of early warning systems, and improved risk management. For measures of improvement in preventive capacities, outcomes on access to technical support, and availability and participation in training programs were considered. Outcomes measuring improvement in absorptive capabilities included increased wealth, asset accumulation and access to household savings, and availability/access to formal and informal safety nets and insurance systems. Outcomes to measure

improvements in adaptive capacities included improvement in measures of household health and food security (increase in caloric intake, improvement in anthropometric measures), crop diversification, and measures of increases in farm income and productivity (improvement in harvests and farm yields for maize, rice, wheat, cassava, manioc, millet, sorghum, banana, beans, coffee, and cocoa, among others). Lastly, outcomes on measures of improvement in transformative capacities included the availability of/ access to information services, access to infrastructure, and availability of/access to agricultural services to increase productivity.

4.1.4 Study design

Only studies that estimated the impact of a programme using an economically robust technique and included a statistically representative sample for the population of interest were considered. The minimum sample size for inclusion in a study was >= 100.

The methods used in the studies had to be appropriate for estimating effects with statistical significance. At the forefront, experimental and quasi-experimental studies were included. The conventional techniques used in the existing literature on programme impact evaluations include regression discontinuity design (RDD), instrumental variable (IV), difference-in-differences (DID), and matching. However, given the limited scope of these methods, it was also decided to include other econometrically common models. Studies that used other regression specifications such as ordinary least squares (OLS) and sample correction methods e.g., the Heckman selection were also included in the review. Panel data studies using fixed and random effects were also included in the screening process. In addition, reports and other systematic reviews were included in the screening, as long as they included statistical models in the study designs.

4.1.5 Language of publication

The EGM only considered studies published in the English language, as the team only had English as a common language. Also, the software employed for data analysis only functioned with one language at a time.

4.1.6 Publication type

This assignment included studies irrespective of whether they were published in journals, or were available as working papers or reports. These had to nevertheless be consistent with a usual research article.

4.1.7 Time criteria

While the search strategy was run considering a time span of 1990-2022, it had to be reduced to narrow the scope of the EGM. Hence, this EGM only includes studies that are conducted within the time span of 2000–2022. Studies published before 2000 were not considered as the intervention designs that are of most interest started being published (using robust econometric models) after the year 2000.

4.2 Criteria for exclusion of studies

The following types of studies were not relevant for the purpose of this review and were excluded from the analysis:

1. Studies that didn't evaluate the impacts of STIBs on relevant outcomes for the study;
2. Studies that didn't evaluate the impacts of some combination of the technical/ technological and social aspects of the STIBs;
3. Studies that presented self-reported findings rather than objectively measured estimates;

4. Reviews and editorials on STIBs that didn't report original study findings.

We defined the types of studies that were excluded at the screening stage in the following subsections.

4.2.1 Intervention

Interventions that were in the form of bundles of social (including infrastructure and financial innovations), technical, and technological innovations were included. Technological innovations, such as improved seed, fertilizer, improved agronomic practices, and precision agriculture, were included when they were implemented in conjunction with one or more social or technical aspects, such as trainings, on-the-field technical or financial support, subsidy, or transfer. Studies that addressed only one aspect of these types of interventions were excluded from the review. Moreover, such interventions had been implemented together or with factorial design, but had not been analysed as random factors. For example, studies that combined drought-tolerant seed (DTS) distribution with training on their agronomic practices to encourage adoption and increase impact were included, but studies that evaluated training as one of the several factors associated with the adoption of DTS by farmers were excluded.

4.2.2 Population

Studies that only used high-income countries or studies that used aggregated data from low/middle-income countries with high-income countries were excluded. Studies that used data on multiple countries for cross-country time series or panel analysis but did not allow the disaggregation between high-income countries and LMICs were also excluded.

4.2.3 Outcome

Outcomes that do not directly measure women's empowerment or resilience components were not considered in the analysis. Studies that did not explicitly report effects for women were excluded. Therefore, studies only measuring men's empowerment or those that focus on the impact of the STIBs on education of the children were not relevant, since the focus is on women's empowerment. Similarly, studies measuring changes in economic growth and more macro-level outcomes were also excluded from this review.

4.2.4 Study design

Any qualitative study or report that has purely descriptive analysis was excluded. Therefore, expert opinion pieces, editorials, narrative reviews, and case series/case study reports were all excluded from this review. Moreover, studies that only include correlation analysis, ANOVA, ANCOVA and other simple statistical techniques were also excluded.

4.3 Search strategy

The search strategy followed a two-step approach. In the first stage, the literature search was conducted using various databases and search engines, such as EconLit, Web of Science (WoS), The National Bureau of Economic Research (NBER), Scopus, JSTOR, Google Scholar, Campbell Systematic Reviews, and Systematic Reviews (International Initiative for Impact Evaluation (3ie) repository). In the second stage, a snowball technique was used to collect relevant studies that did not turn up in the searches, through forward snowballing.

In addition to published and peer-reviewed literature, it was also considered relevant to add grey literature, especially given that many systematic reviews and EGMs are only published as reports. To access the reports, the team relied on guidance from key experts and checked the websites of relevant institutions. The following was set as the starting criteria to include studies (both systematic reviews and primary adoption and impact evaluations) to populate the EGM.

- Reports that document new innovations that have been developed and introduced.
- Published primary studies that document the adoption and scaling of the interventions, classified by gender and geographic locations (specifically those conducted in LMICs).
- Published studies, reports, primary studies, or systematic reviews that use quantitative methods (see section 4.1.4).
- Published primary studies that investigate the impact of the interventions on relevant outcomes (such as resilience, empowerment, etc.)
- Published systematic reviews on the innovations produced and promoted, their adoption, and their impacts.
- Both primary studies and systematic reviews that are currently working papers.
- Reports, primary studies, and systematic reviews written in English.

4.3.1 Electronic Search

The search for relevant evidence on databases was based on the PICOS model described in further detail via the inclusion and exclusion criteria in the previous sections (Sections 4.1 and 4.2). Multiple search terms were combined using Boolean logic: "OR" is used between different terms within the same category, and "AND" is used to combine different categories of search terms to form a single query. In order to acquire the relevant literature while ensuring that the scope of the review is manageable, these searches were tested iteratively. The full preliminary search strategy for the EBSCO (Academic Search Premier, EconLit and GreenFILE) can be found in the appendix (Append–x IV - Search strategy).

4.3.2 Information sources

Databases:

- Academic search premier (via EBSCO)
- EconLit (via EBSCO)
- GreenFILE (via EBSCO)
- WoS (Social Sciences Citation Index)
- World Bank eLibrary

Websites of agencies and research institutes:

- International Food Policy Research Institute (IFPRI)
- Food and Agriculture Organisation (FAO)
- International Fund for Agricultural Development (IFAD)
- African Development Bank (AfDB)
- Asian Development Bank (ADB)
- 3ie Development Evidence Portal
- National Bureau of Economic Research (NBER)
- World Bank eLibrary

4.3.3 Limitations of Search Terms

Search terms were customised according to the requirements of each search engine. Therefore, there is no consistent list of search phrases. For example, Google Scholar allows less than 300 characters, including bullion operators. Other search engines such as 3ie and EconLit allow for more detailed search terms with a wide selection of Boolean operators and restrictors. Moreover, some search engines do not have a user-friendly interface that allows for quick saving and exporting of metadata. In such cases, only the first 200 search results were considered and manually exported. For the website search instead, all the results were included in the analysis without retrieving the metadata. Given these limitations, the search terms were optimised for each search engine.

Moreover, the search was limited by language (English) and by time period (after 1990).

4.4 Data management

4.4.1 Screening, Coding, and abstraction

After retrieving the final sample of studies from the systematic search of the databases, the studies were screened and coded. The PICOS model outlines the exact criterion for the inclusion (and thereby exclusion) of studies. Two stages of review were used, where the first stage is a title and abstract screening and only studies whose title or abstract (or both) seemed to be relevant to the research question continued into the next stage. All studies that were included in the next stage then undergo a full-text screening in the second stage. At this second stage all studies were read, to ensure that all PICOS criteria was satisfied and that the paper was suitable for inclusion into the final set of studies for the EGM. The screening was done by two pairs of reviewers (four in total) based on the inclusion criteria in EPPI (Evidence for Policy and Practice Information) Reviewer 4—a specialised software for managing and analysing literature.

The website search followed a similar procedure where first the studies were excluded at title or abstract level (without reporting the different exclusion reasons), and then they were analysed based on the same full text screening framework of the studies in the databases. The first step for the website search followed the pilot stage at title-abstract level in EPPI, to ensure that the reviewer applied uniform inclusion-exclusion criteria to all studies. For the list of papers coming from the experts, we did not deem a two-stage procedure necessary (first title and abstract, and then full-text screening), as the reviewer team was already trained in the screening process and the source ensured relevant studies for the topic of women empowerment and resilience in agriculture. For these reasons, those papers were screened in one round. In this case each study was excluded at abstract or full-text level or included if it fitted the PICOS criteria stated above.

4.4.1.1 Stage 1: Pilot phase

After the finalisation of the conceptual and methodological approach, the next step was to implement the searches using the iteratively revised search strings. This was used to develop and refine the screening protocol, which was used to exclude all irrelevant studies, based on the PICOS. A version of this screening protocol is provided within Appendix V. Finally, a short pilot was conducted to test the tool on a sample of studies (100). The piloting stage was also important for achieving standardisation in inclusion and exclusion standards across the reviewers. At this stage, if the

disagreement rate among reviewers was below 20%, an additional pilot needed to be conducted.

Stage 2: Title and abstract screening

All studies beyond the pilot ones were screened with the help of the screening tool in the EPPI reviewer. EPPI allowed the sorting of studies by relevance, such that studies lower in relevance appeared later in the searches. The algorithm took the coded studies as input and presented the studies it believed were most likely to be included using the words from the title and abstract. The screening stopped after reaching saturation level, meaning that the inclusion rate of studies dropped so far that despite screening over 100 studies, no new studies were included.

The screening process involved quality checks in the form of double-screening 10% of studies. After the first 10% of studies were double-screened (by the two teams of reviewers), the remaining 90% were single-screened to complete the screening and inclusion stage in a timely manner. Disagreements in coding were resolved through discussion and the involvement of an independent team member.

Stage 3: Full-text screening

The full texts of the titles and abstracts included in the previous stage were thereafter retrieved and uploaded to EPPI Reviewer 4. At this stage, two piloting rounds were conducted where a total of 18 studies were double-screened. This exercise was relevant to align the full-text screening process among reviewers as well as to standardise their inclusion/exclusion criteria. All differences between reviewers were resolved by discussion and, if necessary, third-member involvement. All further studies after the piloting are single-screened, i.e., by one reviewer per paper. The final screening results are presented in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram in the result section.

Stage 4: Full-text coding and data extraction

The final studies that were included after the full-text screening were then coded into the intervention-outcome framework mentioned earlier. During the full-text screening, the reviewers used a (pre-piloted) extraction form to extract all the relevant outcomes, information on the kind of intervention, the geographical information, the study type, etc. The forms used to extract data for the EGM were created in Kobo Toolbox.

In the piloting phase of this data extraction form, three of the included studies were tested by the team. The data extracted was used for this report and to populate the EGM. The data extraction form is provided in Appendix VI - Data extraction form.

4.4.2 Assessment of overall quality of evidence

The confidence in the evidence from a particular study was assessed by a modified GRADE (Grading, Recommendations, Assessment, Development, and Evaluation) criteria (Guyatt et al., 2011). This framework serves as a transparent and reproducible method to evaluate a body of evidence. Depending on the study design, a study is initially classed as high, medium, low, or very low quality. Then, this rating is increased or decreased according to factors such as the risk of bias, imprecision, large effect size, or inconsistency. As previously, differences in GRADE assessments between reviewers are resolved by consensus or, if needed, by a third-party resolution. The assessment of studies can be found in Appendix A.7.

5. RESULTS

5.1 Search and screening

The results of the search are presented in the form of a PRISMA flow diagram (Figure 2). Overall, the search identified a total of 12,692 studies across all sources, of which 10,972 were retrieved via an electronic search based on the PICOS model across all databases and 1,720 via searches on websites or through the list of papers from experts presented in section 4.3.1. The studies from the PICOS search were extracted from the databases and added to the software EPPI Reviewer 4 for screening, while the less-easily extractable website results and expert list were screened directly on the websites at title-abstract level and thereafter inserted in EPPI Reviewer to better present the results via the EGM.

For the database results, 349 studies were selected during the title and abstract screening from a total of 4,475 studies screened. Not all studies were screened, as a machine learning algorithm embedded in EPPI Reviewer 4 that allows for priority screening was implemented. From the 349 studies identified, seven studies were not retrieved, leaving a sample of 342 full-text studies to screen. Of these, 12 studies were included across a range of interventions and outcomes, more details of which will follow later in this report.

The website searches resulted in a total of 1,574 studies, all of which were screened at title-abstract level. Since screening was conducted directly at the website, no statistics on the reason for exclusion at this stage was included. Of the 1,574 studies, only 76 were included and reviewed at full-text. These studies were retrieved of which only 9 were included for this review. Table 2 presents the frequencies of exclusion reason and inclusion for the 76 studies included after title-abstract screening of the websites.

The 146 studies from the experts' list were screened in one round looking at the title, abstract, and (if needed) full text level. Since each paper was screened directly, there is no separate statistics for the title-abstract and full text exclusion at this stage. Of the 146 studies, only one was included. Table 3 presents the frequencies of exclusion reason and inclusion for the 146 papers from the experts' list.

Therefore, in total, 22 studies across the three sources of data were found within the reviewed studies. Overall, one of the studies is a meta-analysis and 21 others were quantitative studies or impact evaluations.

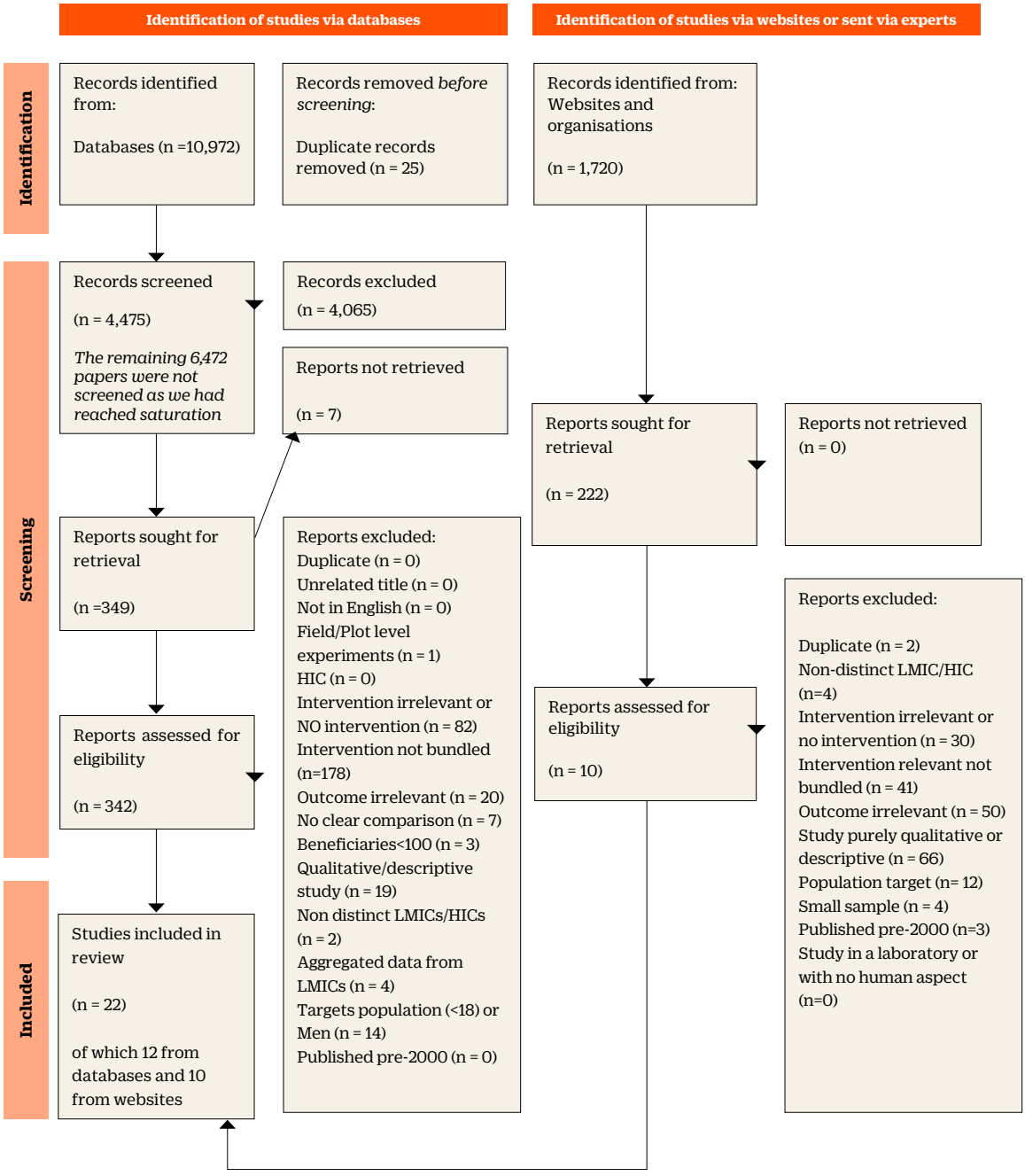

Figure 2. PRISMA flow diagram. From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. Doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/.

Table 2. Full-text screening stage of Websites (76 studies)

Decision code	Count (Studies at Full Text)
INCLUDE Quantitative	9
EXCLUDE–Qual - no causal method, study purely descriptive or qualitative	21
EXCLUDE Duplicate in EPPI	1
EXCLUDE on Not English	0
EXCLUDE HIC	0
EXCLUDE Non-distinct LMICs-HICs	0
EXCLUDE Targets children (<18) or men	12
EXCLUDE Intervention irrelevant	1
EXCLUDE Intervention relevant but not bundled	14
EXCLUDE Outcome irrelevant	17
EXCLUDE if Number of beneficiaries <100 HHs	1
EXCLUDE Full Text not available	0
Total	**76**

Table 3. Single screening stage of expert studies (146 studies)

Decision code	Count (Studies at Full Text)
INCLUDE Quantitative	1
EXCLUDE–Qual - no causal method, study purely descriptive or qualitative	45
EXCLUDE Studies field/plot-level experiments or pilot-only related outcomes (no human component)	0
EXCLUDE Duplicate not identified at TiAb	1
EXCLUDE on Not English	0
EXCLUDE HIC	0
EXCLUDE Non-distinct LMICs-HICs	4
EXCLUDE Targets children (<18) or men	0
EXCLUDE Intervention irrelevant	29
EXCLUDE Intervention relevant but not bundled	27
EXCLUDE Outcome irrelevant	33
EXCLUDE: Published pre-2000	3
EXCLUDE if Number of beneficiaries <100 HHs	3
EXCLUDE Full Text not available	0
Total	**146**

Table 4 and Table 5 present the results of the screening of the search results from the databases. Specifically, Table 4 shows the results of the screening of the titles and abstracts, while Table 5 shows the screening results of those studies screened at full text. In both cases, each of the studies is marked by exactly one code indicating either inclusion (first row) or the reason for exclusion.

Table 4. Title and Abstracts screening stage from databases (10972 studies, of which 25 duplicates and 4475 screened)

Decision code	Count (Studies at Title & Abstract)
INCLUDE on Title and Abstract	349
EXCLUDE: Duplicate not found by EPPI	0
EXCLUDE: Unrelated title	2,174
EXCLUDE: Not English	2
EXCLUDE: Intervention irrelevant or NO intervention	856
EXCLUDE: Interventions relevant but not bundle	537
EXCLUDE Studies field/plot-level experiments or pilot-only related outcomes (no human component)	320
EXCLUDE Studies purely qualitative or descriptive	128
EXCLUDE: HIC	9
EXCLUDE: Outcome irrelevant	56
EXCLUDE: Non-distinct LMICs and HICs results	8
EXCLUDE: Use aggregated data from LMICs	15
EXCLUDE: Targets population (< 18) or Men	9
EXCLUDE: Published pre-2000	0
EXCLUDE if Number of beneficiaries <100 HHs	12
Not screened	6,472
Total	**10,957**

Table 5. Full-text screening stage from databases (349 studies, of which 342 screened)

Decision code	Count (Studies at Full Text)
INCLUDE Quantitative	22
EXCLUDE: Duplicate not found by EPPI	0
EXCLUDE: Unrelated title	0
EXCLUDE: Not English	0
EXCLUDE: Studies field/plot-level experiments or pilot-only related outcomes (no human component)	1
EXCLUDE: HIC	0
EXCLUDE: Intervention irrelevant or NO intervention	82
EXCLUDE: Interventions relevant but not bundle	178
EXCLUDE: Outcome irrelevant	20
EXCLUDE: No (unclear) comparison	7
EXCLUDE if Number of beneficiaries <100 HHs	3
EXCLUDE: Studies purely qualitative or descriptive	19
EXCLUDE: Non-distinct LMICs and HICs results	2
EXCLUDE: Use aggregated data from LMICs	4
EXCLUDE: Targets population (< 18) or Men	14
EXCLUDE: Published pre-2000	0
Total	**342**

5.1.1 Quality of the studies- GRADE assessment

A GRADE based assessment tool was used to assess the quality of the 21 evaluation studies considered in the evidence map (the assessment criteria are provided in Appendix A.7). Of the included studies, only

10% are evaluated as low quality (scoring lower than 2), while 33% were marked as high-quality evidence on the impact of STIBs on women's resilience and empowerment (scoring more than 3). Around 57% of the studies score between 2 and 3, therefore scoring a medium rating in terms of quality. As part of the assessment, all outcome types were aggregated as best as possible, to derive an average grade for each outcome type. Table 6 depicts the average score for women's resilience and empowerment outcomes. The overall average GRADE score for women's resilience and empowerment outcomes across the 21 studies was 2.7, implying an overall medium quality of studies in the sample.

Table 6. GRADE assessment for outcome categories under women's resilience and empowerment

Outcome	Count	Average grade
Women's resilience		
Agricultural productivity/ yield	1	2.94
Asset accumulation	9	2.63
Household income	13	2.62
Food security	9	2.60
Access to cash savings	0	N/A
Access to insurance	0	N/A
Resilience to shocks	8	2.59
Adoption of best practices	3	2.64
Women's empowerment		
Agency / decision-making power	8	2.73
Financial empowerment (assets and income)	1	3.90
Asset accumulation	9	2.63
Workload/ Leisure time	1	3.90
Membership in groups	2	2.23
Social cohesion/Social capital	4	2.90

5.2 Description of included studies in the review

Figure 3 presents the geographical distribution of studies included in the review. The interventions are dispersed across South and Southeast Asia, sub-Saharan Africa, Latin America and the Caribbean. The Asian countries included India (two studies), Bangladesh, Nepal, Tajikistan, and the Philippines (one study each). The African countries included three studies in Ethiopia, two in Zambia, and one study each in Burkina Faso, Chad, Kenya, Madagascar, Malawi, Sao Tome and Principe, Senegal, and Uganda. The Latin America and Caribbean countries included one study each in Brazil and Mexico. A systematic review with six studies from Bangladesh, Zambia, Burkina Faso (two studies), Malawi, and Ethiopia was also included.[4] As can be seen in Figure 3, there is a dearth of available evidence in the Middle East and North Africa, and Southeast Asia-Pacific regions. In the latter, only one study in the Philippines was included in the review.

Sharma et al. (2021) conducted a systematic review of the evidence on the impact of nutrition-sensitive agricultural (NSA) interventions on nutritional outcomes. As a result, the inclusion criteria were met by 43 studies, which were retrieved and synthesised across impact and pathway analysis. The effect of the

4 One of the six studies overlap with the 21 studies we included. This is the Kumar et al. (2018) paper in Zambia.

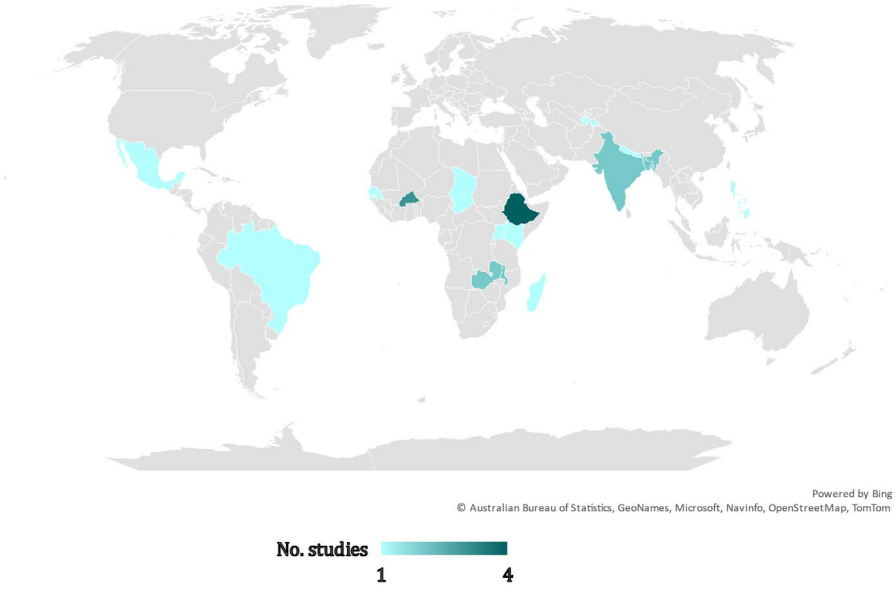

Figure 3. Geographical distribution of studies included in the review.

NSA interventions on nutritional outcomes are synthesised while pathways are constructed by mapping evidence at each temporal stage from treatments to the outcomes. One of the five pathways the authors found is women's empowerment. In general, they found that NSA interventions can address many causes of undernutrition, such as unhealthy dietary patterns, inadequate care practices, and illness recurrence, but have less impact on nutritional status. From these 43 papers, six overlap with the set objective and meet the criteria. Four of the six related papers focus on the direct impact of NSA intervention on women's empowerment and nutrition, while two papers focus more on the pathways to increase the outcomes through women's empowerment. All these overlapping papers were found to have significant effects on improving women's empowerment.

Studies were separated into different intervention and outcome types following the structure of the ToC presented in Section 3.2 In practice, three intervention types were differentiated: social interventions presented in Figure 4, technical interventions presented in Figure 5, and technological interventions presented in Figure 6. Within social intervention, four categories were included: agricultural finance, awareness programmes, market frameworks, and others. Agricultural finance programmes include access to credit, microcredit programs, cash and in-kind grants, and input subsidies. Awareness programmes provide nutritional information, promotion of optimal child feeding knowledge and practices, health-seeking behaviours and hygiene, along with awareness of social inclusion and gender balances. Market frameworks include programmes for market linkages, access to irrigation facilities and physical infrastructure, land rights, contractual agreements between producer groups and agribusinesses, and farmer organisations. There were also three programmes around capacity building and women's groups, which were included under 'others'. As for technical interventions, different types of training programmes were covered, including interventions on organisational and managerial skills, farmer participatory trainings, agricultural information trainings, farmer field schools, field training, information dissemination activities, provision

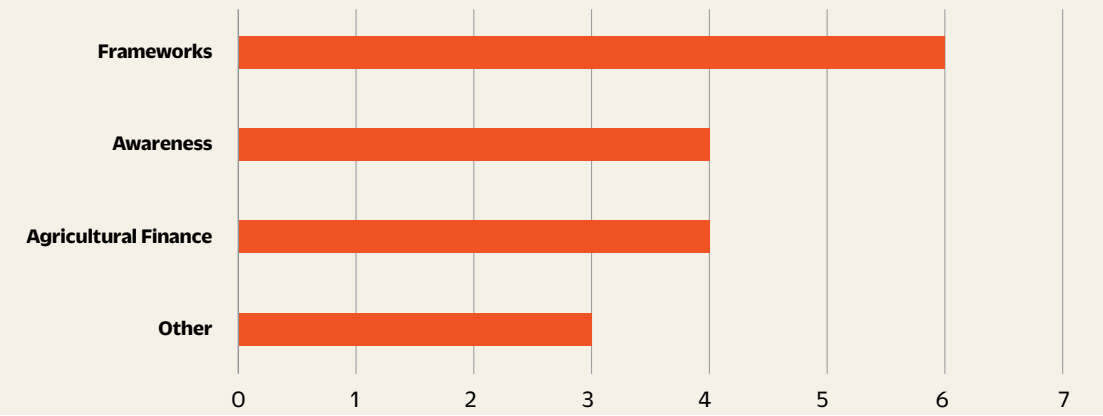

Figure 4. Number of studies by social intervention categories.

of market-related information, online training, agricultural advisory, extension services, among others. Regarding technological intervention, six categories were considered: improved conservation practices, improved seed varieties, improved soil management practices, irrigation technologies, livestock interventions, and others. Livestock interventions include the provision of poultry and cattle, along with training on animal husbandry. There were also several interventions which provided agricultural tools and aid such as seed bags, cereal banks, farming equipment, solar conduction driers, cooking stoves etc, which were included in "others".

Most of the studies included a combination of interventions (34 studies), where 19 out of 21 studies included a training component as technical interventions, and 12 studies included the provision of seeds of improved varieties as a technological intervention component. Within technical interventions, agricultural information training was the most common, and it was implemented in 14 studies. The agricultural information training was the sole technical intervention in one of the 14 studies, and it was combined with other types of training in the other 13 studies. There were eight studies that combined two different training and six studies that combined three types of training. There were nine studies that combined technical intervention with social interventions. As shown in Figure 4, the framework was implemented in six studies as a social intervention while eight studies included agricultural finance (both access and use of finance)[5] or awareness programmes[6]. Improved varieties were usually provided with a combination of other technological components, primarily improved soil management practices and irrigation technologies. Improved conservation practices were provided in six studies. About half of the studies provided a combination of two or more technological components.

5 For example, Bahru and Zeller (2021) analyse the impact of the Productive Safety Net Programme (PSNP) in Ethiopia that include cash transfers in its STIB intervention, and Karamba and Winters (2015), that look at the Farm Input Subsidy Program (FISP) in Malawi that have within the intervention bundle vouchers that offers access to inputs at a subsidized price (here they also check how many of these vouchers are used).

6 An awareness program comprises information dissemination programs and campaigns aimed at a larger amount of people. These can be community schemes that provide information, information centres (e.g., Bonilla, et al., 2017, has a Dairy Information Centre), and so on. The modalities can be various, like brochures, posters, radio, or any other platform. The difference between training activities and awareness programs lies in the targeting and modality through which they are carried on. Training activities are related to smaller group activities where there is an expert explaining concepts related to the type of training to a smaller group. It can be theoretical and/or practical.

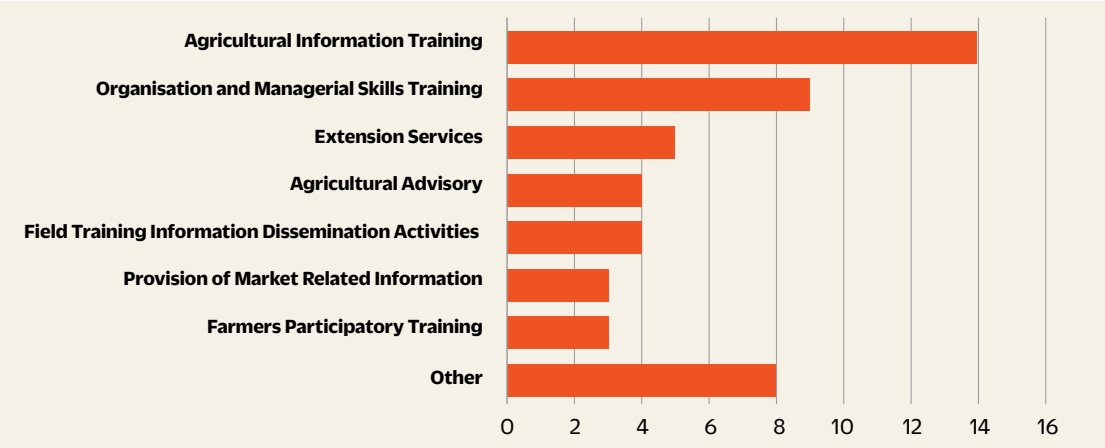

Figure 5. **Number of studies by technical intervention categories.**

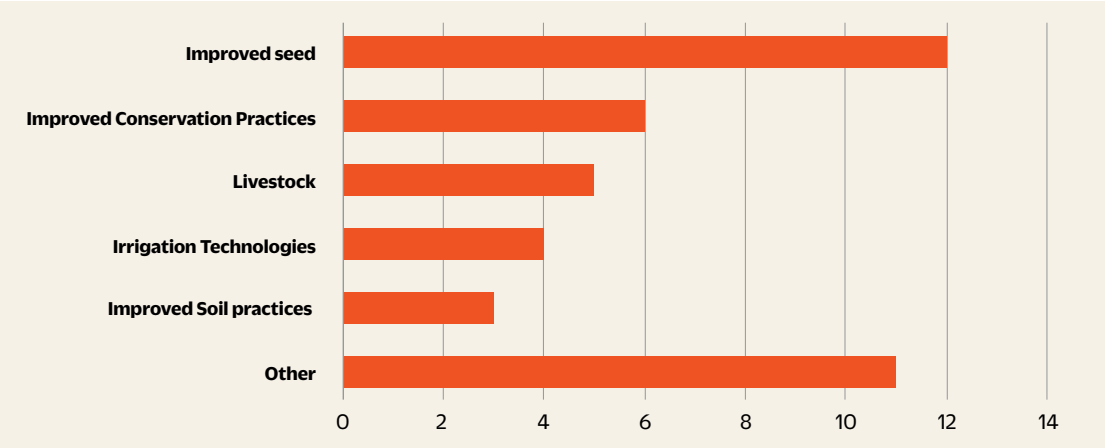

Figure 6. **Number of studies by technological intervention categories.**

The equivalent of the above in terms of outcomes can be seen in Figure 7. A total of 13 studies had women's resilience outcomes, mostly measuring women's absorptive and adaptive capacities, making this the most frequent outcome category. The second most common outcome category included measures of women's empowerment, which is covered by 11 papers, and these were evenly distributed in the WEAI measures of empowerment, including decision-making regarding inputs and methods of production, control over household resources, control over the use of household income, leadership, and others. Only three studies had measures for both women's resilience and empowerment. Figure 8 and Figure 9 break down the outcomes by empowerment and resilience indicators. Only one study with empowerment outcomes included the five indicators of empowerment from the WEAI. The rest only used one or two outcomes from the WEAI. As for resilience outcomes, most of the studies had outcomes for only adaptive capacities. About five studies looked at outcomes using a combination of adaptive, absorptive, and anticipative capacities.

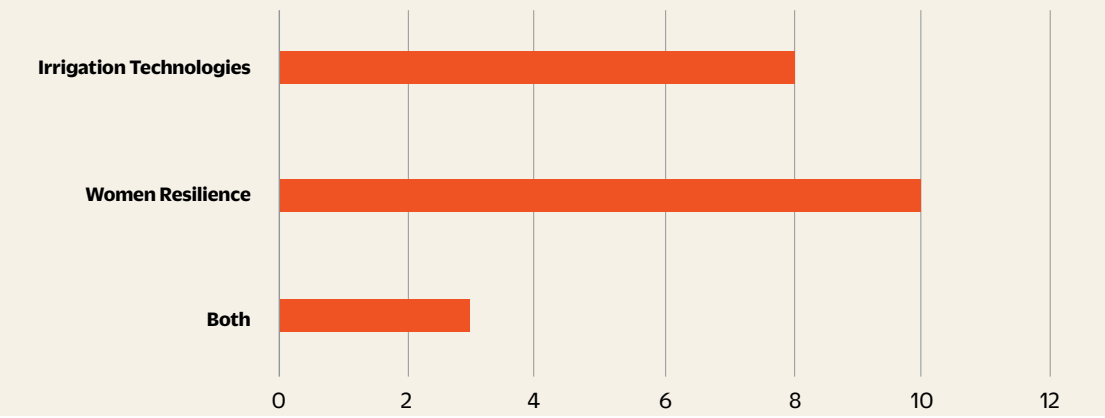

Figure 7. Number of studies by outcome categories.

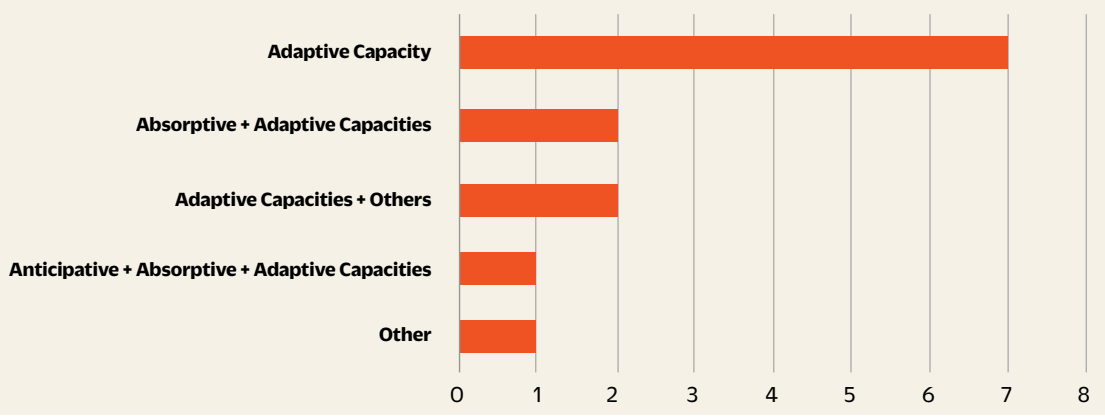

Figure 8. Number of studies by women's resilience outcome categories.

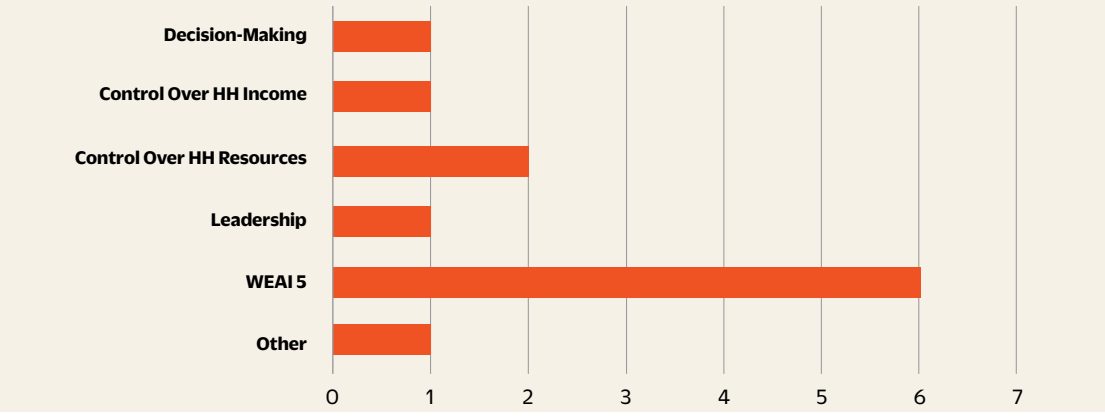

Figure 9. Number of studies by women's empowerment outcome categories.

Figure 10 presents the actors and facilitators of the interventions in the sample. Most interventions were implemented by multiple actors (called "Multi" in Figure 9 when they are more than two) that can be national governments, occasionally in collaboration with an international government and/or an international agency and local NGOs. Two of the interventions were implemented by local governments collaborating with a foreign government together with a local NGO and an international agency. Six studies were implemented by local governments working with a local and a foreign NGO. Only two interventions were implemented unilaterally by an NGO and only two by an international agency.

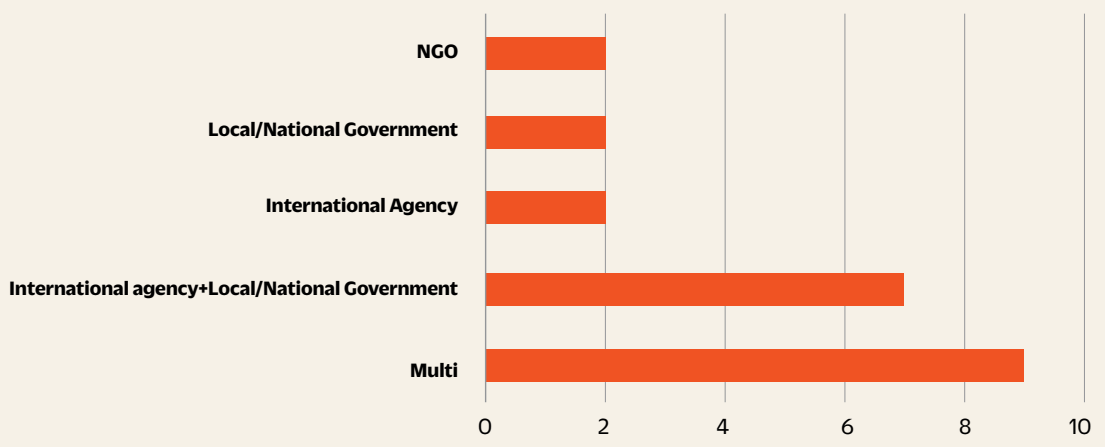

Figure 10. **Number of studies by actors/facilitators of the intervention.**

Table 7. **Cross-frequencies of studies by social intervention and outcome categories**

Intervention	Outcome categories		
	Women Empowerment	Women Resilience	Both
Agricultural Finance	2	2	0
Awareness	2	1	1
Market frameworks1	1	3	2
Total	8	10	3

Table 8. **Cross-frequencies of studies by technical intervention and outcome categories**

Intervention	Outcome categories		
	Women Empowerment	Women Resilience	Both
Organisational And Managerial Skills Training	5	4	0
Farmers Participatory Training	2	1	0
Agricultural Information Training	5	8	1
Field Training Information Dissemination Activities	2	2	0
Provision Of Market Related Information	2	0	1
Agricultural Advisory	3	1	0
Extension Services	3	1	1
Other	3	4	1
Total	**8**	**10**	**3**

Table 9. Cross-frequencies of studies by technological intervention and outcome categories

Intervention	Outcome categories		
	Women Empowerment	Women Resilience	Both
Improved seed	3	7	2
Improved soil practices	1	1	1
Improved Conservation Practices	3	2	1
Irrigation Technologies	2	2	0
Livestock	2	2	1
Other	5	4	2
Total	**8**	**10**	**3**

Tables 7, 8 and 9 provide cross-frequencies of studies by intervention and outcome types. The three types of interventions were categorised by empowerment and resilience outcomes, or both. Most of the technical interventions targeted women empowerment outcomes except of agricultural information training, where the highest number of studies (eight) were focused on women's resilience outcomes. Five of the agricultural information training papers targeted empowerment outcomes. For technological interventions, there was mostly minor or no difference between the different outcome categories for most interventions except in the case of improved seeds, which was also the most common technological intervention. Seven of the 12 studies on improved seeds (as part of the STIBs) focused on women's resilience outcomes and two studies measured both outcome categories. There are 11 studies that included social interventions and nine of them had a technical component as well. In terms of outcome categories, social and technical interventions focused on both types equally. The interventions with technological components also provided a good mix of both empowerment and resilience outcomes.

5.3 Effects of STIBs on womens' resilience and empowerment

Based on the evidence derived from the included studies, the effect of STIBs on women's resilience and empowerment is intended to be understood. To answer this question, the results are analysed based on the research questions outlined in Section 3.1.

With a total of 21 included studies, various EGMs that illustrate the multiple intervention bundles against the outcomes for women's empowerment and resilience can be populated.[7] Although the EGMs are interactive (link in Appendix A.1), some of the main results were highlighted with the help of screenshots in the following subsections.

As can be seen in Figure 11, there are three types of bundles: the social and technological bundle (bundle1), the technical and technological bundle (bundle2), and the social, technical and technological bundle (bundle3). The most popular types of bundles in the studies were bundle2 (10 studies) and bundle3 (nine studies). The social and technological bundle (bundle1) was evaluated only in two studies.[8] International agencies implemented most studies that included bundle 2 (8 out of 10 studies).

7 The papers in the EGM are 21, as the data extraction form does not allow a uniform coding framework for single studies and systematic reviews. For this reason, the one paper part of the latter category is left out of the EGM.

8 A larger bubble implies a larger number of studies in that cell. It should be considered that all cells in this EGM are not exclusive, and therefore the rows and column numbers may exceed the total number of studies.

Foreign governments (bilateral donors) were only involved in studies related to bundle3.[9] It is interesting that, whenever a bilateral donor is involved, all other actors also take part in the implementation.

Across the empirical studies, the largest set of evidence was found for adaptive capacity outcomes (12 studies), while the other resilience indicators measured were in very few or no studies (one and three studies for anticipative and absorptive capacity, respectively, and no studies including preventive and transformative capacities indicators). Noticeably, there were large gaps in the literature for a more varied definition of resilience, as discussed later in Section 5.3. In comparison, for empowerment, the categories of decision-making, household resources ownership and use of household income had a similar distribution of (few) studies (between four and six).

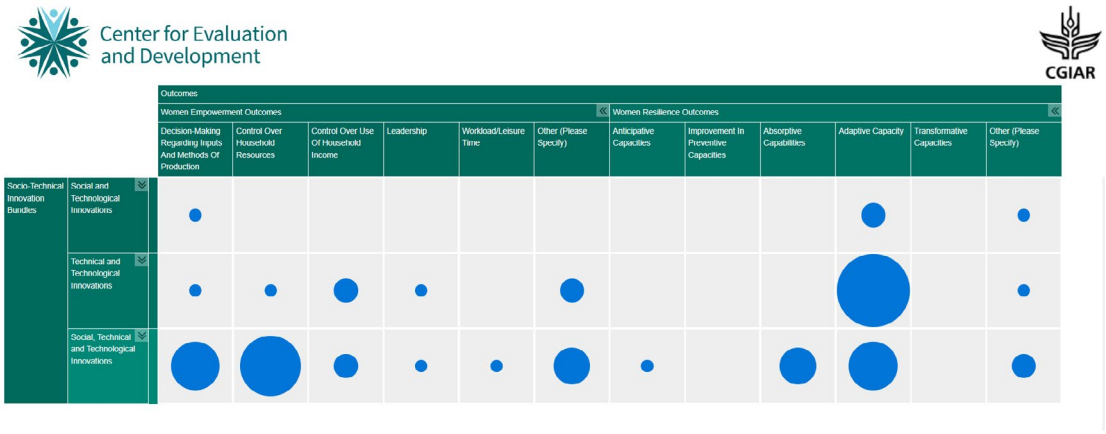

Figure 11. Screenshot of the EGM aggregating bundles against outcomes categories. ***The dots in this figure are scaled based on the number of studies included that have that specific type of bundled intervention and outcome. Cells with no dots indicate no studies in that combination of intervention and outcome.***

In addition to the EGMs in Figure 11 and Figure 12, two additional EGMs, one where the actors of the intervention are depicted as sub-categories, and another where each intervention type (not bundled) is mapped against the outcomes, were also generated. Again, the largest bundles here were those in adaptive capacity, with the most frequency in records being for technological and technical interventions. For bundle3, there were also a relevant number of studies concerned with empowerment outcomes like decision-making regarding inputs and methods of production, and control over household resources. The final type of EGM reports bundled interventions against the resilience and empowerment outcomes by GRADE assessment that gives an overview of the quality of the included studies. (Figure 12).

9 There are two papers with a foreign government involved: Kumar et al. (2018) and Rosenberg et al. (2018). Both these studies talk about the RAIN programme in Zambia, which was funded by the Irish Aid and Kerry Group, with support from the Bank of Ireland. Additional support for the evaluation was from the UK Government's Department for International Development (DFID).

Figure 12. Screenshot of the EGM for bundled interventions against outcome categories by GRADE assessment.10

5.3.1 What are the effects of STIBs on women's resilience?

The studies reviewed provide suggestive evidence for a positive effect of STIB's on women's resilience. Among the 13 total studies that measure women's resilience, including *"Absorptive Capabilities", "Adaptive Capacity" and "Anticipative Capacities"* (see Section 4.1.3), a total of 64 outcomes were reported.[11] By examining the measured effects in each of these studies, across the various indicators, an improvement in women's resilience was observed in 39 cases, compared to four cases where a negative effect was reported. However, in 22 indicators no impacts on women's resilience outcomes were observed. **Based on these numbers, cautiously, one might conclude that bundled interventions may lead to an improvement in women's resilience, with nearly 61% reporting positive impact on outcomes.** However, this result is tenuously based on the larger number of instances where positive effects are found, and it is unclear how many of the insignificant results were not reported in the included studies.

Moreover, the number of indicators per category differs, where most of the reporting focussed on *Adaptive capacity* (47 outcomes, as opposed to one, 12 and four outcomes in the other categories).[12] **Consequently, it can be concluded that a large part of the results in resilience is driven by the reporting in adaptive capacity.** Eyeballing the distribution of effects within the adaptive capacity indicators it can be evidenced that mostly positive effects were observed (or reported) - 32 positive effects compared to 13 insignificant results and two negative results. That is, 68% of the reported outcomes showed a positive impact as a result of STIBs**.** For the category of adaptive capacity, given the much higher instance of positive results, one may conclude that STIBs may enhance rural households' adaptive capacities. When looking at the various indicators a large number of the positive results were within the agricultural and crop productivity outcome, which is often targeted within STIBs in the first place. However, it is important to note, that

10 Please refer to section 5.1.1 for details about the low/medium/high GRADE assessment level. For further information on how the GRADE assessment is evaluated, please look at Appendix A.7.

11 No indicator is reported for transformative or preventive capacity. This can be due to the nature of transformative capacities, which are usually not measured at the individual level (as these often transcend individual systems). These are often falling under the scope of the intervention itself (such as the creation of more equitable distribution systems, universal education, etc.) Preventive capacities, on the other hand, fall under disaster risk reduction strategies and are not necessarily captured in STIBs already. Additionally, these strategies fall more under the support provided by the stakeholders and not necessarily those of the farmers and their households.

12 The division of indicators is also provided within the header of each table, next to the name of the indicator category.

14 of the positive reported outcomes were included in a single study (Garbero et al, 2018).[13] By combining these 14 outcomes into two broad categories (yield and value of yield) a total of 21 positive outcomes were obtained out of the overall 32 positive outcomes, which is similarly high at 66% of positive outcomes for this resilience category.[14]

The list of indicators used to measure resilience, as well as the direction of effects, can be found in the last four columns of Table 9. All text written in red indicates a negative effect, while those marked in green indicate a positive effect of the intervention on said outcome. All cells with normal (black) text indicate no effect of the intervention on the outcome.

In addition to the significant effects, it is important to understand what types of samples these effects captured. Does age, the geographical location of these women, or their socio-economic status make a difference? Surprisingly, in many of the studies the population was not clearly specified, making a population-specific comparison infeasible. In studies where it was specified, there is no comparison shown between age groups for particular outcomes. Only in the case of adaptive capacity there are two types of age groups present (adults aged 35-65 versus all ages), but no distinctive patterns emerged. Both age groups were equally prevalent in the categories of positive and negative effects, implying that the age of the targeted population was not a facilitator or hindrance towards an improvement in resilience.

When considering the location of the targeted population, as most STIB interventions are targeted at rural populations, there is no evidence to report for differences between rural and urban populations. Moreover, considering that most such interventions (and studies) also included selection criteria that prefer more vulnerable populations, evidence on higher socio-economic status population is limited.

With regard to geographical patterns, only studies in Asia and Africa included outcomes for resilience. When comparing the two regions, the share of positive, negative and no result outcomes were dispersed in both regions. However, overall, 37 outcomes for resilience were reported in African countries, and 26 in Asia. Of these, 73% of the resilience outcomes reported a positive effect in African countries, whereas only half of the outcomes reported a positive impact in Asian countries. Again, this positive result in African studies is driven by the reporting of outcomes under adaptive capacity (31 outcomes with 25 being positive), particularly from the Garbero et al. study in Senegal. However, even after removing 11 outcomes from each total, it is still found that 70% reported positive impact of STIBs on adaptive capacity in Africa.[15] Therefore, STIBs appeared to improve adaptive capacity in at least some context in rural African households.

13 For differentiates crop yield and value of yields.

14 Removing 11 of the 14 outcomes from the 47 overall and 32 positive outcomes, we get 36 overall and 21 positive outcomes.

15 Removing 11 outcomes from 31 overall and 25 positive outcomes, we get 20 and 14 outcomes, respectively.

Table 9. List of indicators, as well as direction of effect for resilience indicators

#	Author	Year	Country	Target population gender	Anticipative Capacities (1/0-0-1)	Absorptive Capabilities (12/5-1-6)	Adaptive Capacity (47/32-2-13)	Other (4/2-0-2)
					Indicator			
1	Abate at al.	2018	Ethiopia	Women and Men			Wheat yield based on crop-cut estimates	
2	Bahru and Zeller	2018	Ethiopia	Women and Men				Welfare: per capita household consumption (based on women respondents)
3	Cavatassi and Mallia	2018	Tajikistan	Women and Men			Increase in income from livestock	
4	Dar et al.	2020	India	Women and Men			Adoption of improved agricultural practices	
5	Dillon et al.	2020	Burkina Faso	Women			Total production by women (kg) - also measured by crop type.	Manure use - women (%)
6	Garbero et al.	2018	Senegal	Women and Men			Productivity: Yields (kg/ha, log) of Niebe; Bissap; Peanut; Horticulture; Pulses; Oilseeds; Production indicators: Harvest (kg, log) and Value (XOF, log) of niebe; Bissap; horticulture; pulses; Income: Total gross income (XOF, log); Crop income (XOF, log); Livestock income (XOF, log); Transfer income (XOF, log)	
7	Kafle et al.	2018	Nepal	Women and Men	Ability to recover from shocks	Asset indicators: Housing quality index (MCA); Durable asset index (PCA); Livestock asset (TLU); Productive asset index (PCA); Poverty reduction indicators: Above the 40th poverty line, durable asset; Above the 40th poverty line, productive asset; Above the 60th poverty line, productive asset; Above the 60th poverty line, durable asset	Income indicators: Wage income (Log, Rs.); Self-employment and self-enterprise income (Log, Rs.); Sales of products, goods, and service income (Log, Rs.); Remittance income (Log, Rs.); Transfer and pension income (Log, Rs.); Total household income (Log, Rs.); Crop income (Log, Rs.); Livestock income (Log, Rs.) Agricultural production indicators: Share of farmers selling crops to traders during dry season; Number of crop rotations wet & dry season, Post-harvest losses (kg.) wet & dry season, Share of farmers selling crops to traders wet season	Dietary diversity score
8	Karamba and Winters	2015	Malawi	Women and Men			Productivity: log value of output per hectare - log (MK/HA)	Adoption: Incidence of inorganic fertilizer use
9	Karim et al.	2016	Bangladesh	Women			Productivity: log of the quantity of fish produced per hectare of pond area (kg/ha)	
10	Nagwekar et al.	2020	India	Women			Annual income scores	
11	Pan et al.	2018	Uganda	Women		Shock-coping methods	Food security	
12	Ring et al.	2017	Madagascar	Women and Men			Crop production	
13	Rosenberg et al.	2018	Zambia	Women and Men		Economic well-being: Housing characteristics index score; Home assets index score; Economic well-being: Productive assets index score	Gross revenue: All crops and animal products; Non-food agriculture; Food-based agriculture; Agricultural production diversity: Number of agricultural activities (of 4 groups of activities); Number of agricultural activities (of 7 groups of activities); Total number of food crops grown; Agricultural diversity family of outcomes (Z-score); Economic well-being: Productive assets index score	

5.3.2 What are the effects of STIBs on women empowerment?

As indicated in Section 5.2, eleven studies estimated the effect of STIBs on outcomes related to women's empowerment. The categories included "control over household resources", "control over the use of household income", "decision-making regarding inputs and methods of production", and "Leadership", which are further measured using a variety of indicators. The list of indicators used to measure empowerment, as well as the direction of effects, can be found in Table 2. All cells marked in red indicate a negative effect, those marked in green indicate a positive effect of the intervention and cells with normal text indicate no effect of the intervention on the given outcome.

Within the number of studies reviewed, no strong evidence indicating that STIBs improve empowerment for women was found. The results showed that, of the 43 total reported outcomes, 21 had a positive effect of STIBs on women's empowerment, and only in three cases there is a negative effect on empowerment. However, in nearly as many cases (19 coded outcomes), there is no significant effect of STIBs on women's empowerment. Therefore, with the limited number of studies, even considering the larger number of indicators within, no clear answer on the role of STIBs in improving empowerment outcomes for women can be given.

Comparing the effects of indicators within each category yielded similar results. In most cases, the number of indicators within a category was small. For the income category, there were only four indicators for women's access and agency, and for the resource category, there were only five indicators. For the category of leadership, two studies reported indicators for group membership. The reported effects were positive, but it is not possible to draw any conclusions from such a small sample. For the category of decision-making, a positive effect was reported for eight indicators compared to no significant effect for five indicators but six of the positive indicators were from the same paper (Bonilla et. al. 2017) which drives the ponderance of positive effects.

As in the case of resilience, the effects on empowerment, when the women's age, location and socio-economic status vary were examined. Here, the results were similarly few and therefore hard to derive clear conclusions against. There appears to be no great difference between age groups when it comes to empowerment of women through STIBs. Comparing the regions, all reported negative impacts are from the African sample and none are from the Asian and South American country samples. However, these results might be driven by the high number of studies in the review that are conducted in African countries (six out of the total nine studies for empowerment). Simultaneously, the largest number of positive results were found in the African country sample. The positive results in the African sample may again be an indication of a large number of studies in that region (or driven by the Bonilla et al. paper) or of higher effectiveness of bundles there (by showing an improvement across the board for all outcomes).

The results on differentiation by regions or populations were not surprising (for resilience or empowerment), since the sample itself is limited, where the outcome is captured through a variety of indicators and includes a large selection of covariates. Therefore, future studies may strive to quantify and standardise these differences (as with a meta-analysis) in order to estimate clearer impacts. Moreover, with added evidence on the impact of STIBs on both outcomes, a greater heterogeneity in results will allow a better examination of the variation in results for sub-populations.

Table 10. List of indicators, as well as direction of effect for empowerment indicators

#	Author	Year	Country	Population gender	Decision-making (14/8-1-5)	Resources (9/3-1-5)	Income (6/3-1-2)	Leadership (3/2-0-1)	Other (11/5-0-6)
					Indicator				
1	Arslan et al.	2018	Philippines	Women and Men					
2	Bahru and Zeller	2021	Ethiopia	Women and Men		Land and livestock ownership			
3	Bonilla et al.	2017	Kenya	Women and Men	Women decide own bull service provider; AI service provider; use of anthelmintic; use of tick control service; use of vaccination service; and use of vaccination service	Women manage money from fresh milk sold			Women requested livestock best practices training
4	Cavatassi (a)	2018	Mexico	Women and Men					Participation in women's group
5	Cavatassi (b)	2018	Chad	Women and Men	Input choice and methods		Income from crop sale		Non-agricultural activities
6	Cavatassi and Mallia	2018	Tajikistan	Women and Men	Livestock production decisions				
7	Dillon	2020	Burkina Faso	Women		Number of plots - women			
8	Garbero and Paliwal	2019	Brazil	Women and Men	Input in Productive Decisions	Ownership of Land and Assets; Access and Decisions on Credit	Control over Income Use; Autonomy in Income	Visiting important location; Membership in Influential Groups	Pro-WEAI; Attitudes on Domestic Violence; Respecting among Household Members; Group Membership; Self-Efficacy
9	Garbero et al.	2019	São Tomé e Príncipe	Women and Men			Women's control of income (binary)		
10	Kafle et al.	2018	Nepal	Women and Men	Decision-making of women about crop cultivation; Decision-making of women about crop livestock rearing of large animals; Decision-making of women about crop livestock rearing of small animals	Decision-making of women about crop sales; Decision-making of women about crop livestock sales			
11	Kumar et al.	2018	Zambia	Women and Men	Decision-making power Agriculture empowerment score	Assess selling score; Asset access score	Financial empowerment score; Buying power score	Membership in irrigation association	Spouse relationship score; Perception of equality score; Social capital score

5.4 Intervention and implementation features and facilitators

Intervention and implementation features

Overall, an important implementation feature of STIBs is the **use of existing (farmer) groups** which not only eases field implementation but also is a cost-efficient feature to disseminate information. On these lines, studies that describe programmes where (farmer) groups are used for the implementation report an increase in social cohesion among beneficiaries and at the village level (see e.g., Bonilla et al., 2017, Cavatassi et al. 2018a, Cavatassi et al. 2018b, and Garbero & Paliwal, 2018). Several of these studies also report positive impacts on women's empowerment. Furthermore, a feature that is mentioned in two of the included studies is the importance of **interlinkages among programme components**. In particular, the authors mention that focused interventions can be more effective in achieving the desired impacts compared to large, diversified interventions (see Cavatassi & Mallia, 2018 and Cavatassi et al., 2018a). Similarly, the authors mention that interventions focused and designed based on the local needs of vulnerable populations (i.e., women), context characteristics, and the availability of natural and capital endowments are important features.

An additional effective feature of STIBs that is repetitively mentioned in the studies is the **access to financial sources** for beneficiaries, including micro-finance, local savings, and loan clubs.[16] Given that adopting some interventions can be costly to farmers, especially women farmers, facilitating the access to financial resources can alleviate their economic pressures and motivate them to adopt the innovations (see discussions in Ring et al., 2017 and Pan et al., 2018). Kafle et al. (2018) highlighted an intervention that includes credit mobilisation. In the study, the authors reported significant increases in women's resilience. However, this important and potentially effective feature should be considered with caution. Even when loans or other financial resources can be facilitated, sometimes this financial support is not large enough as the target group are usually vulnerable women farmers who face high financial constraints (see e.g., Ring et al., 2017 and Bahru & Zeller, 2021). Moreover, it is important to consider that while women farmers can be given financial support they are also constrained by time.

The paper by Karamba and Winters, 2015 reported that women farmers face additional constraints to productivity compared to men and these constraints are likely to be related to labour input use. In such cases, teaching labour-saving farming techniques can be more useful than facilitating access to financial sources. On this front, the paper by Nagwekar et al., 2020 provided a good example as the technological intervention (Domestic Solar Conduction Dryer – DSCD) saves labour time for women farmers and allows them to earn additional income through the sale of dehydrated products (besides being a comfortable technology that is not competing with home tasks as women farmers can use it while they are at home). Yet, this example is largely based on anecdotal evidence, as the authors did not find significant positive effects on women's empowerment or resilience, possibly due to the small sample size (500 observations). Another interesting feature is the **targeting of interventions**. For instance, the study by Dar et al., 2020 showed that women farmers performed relatively better than men when it comes to agro-based household goods (i.e., quality seed production). Hence, targeting women farmers for this type of programmes could potentially be more beneficial.

16 This is different from the financial innovation component.

Studies also emphasize the importance in the **number of members that belong to cooperatives or (farmer) groups**. According to the study by Kafle et al. (2018), groups of 25-40 farmers ease the monitoring of activities. Related to group size, the study by Arslan et al., (2018) also showed that small groups were more effective in achieving the desired impacts. By conducting a heterogeneity analysis, the authors find that smaller irrigation systems are perceived as easier to organise and more efficient. Given that both papers reported significant increases in women's resilience and empowerment, it is important to highlight this potential enabling intervention feature.

In addition, a feature worth highlighting is the inclusion of different types of value chain development activities within the interventions. In principle, value chain interventions try to facilitate market access and make production profitable for smallholder farmers. Yet, how value chains are developed or integrated can have differential impacts. One observed feature is the targeting strategy which can make a difference when it comes to generating impacts on the most vulnerable populations. For instance, the paper by Garbero et al. (2018) showed that targeting women and youth populations and integrating them at the early stages of the value chain development brings financial benefits for such groups. A second feature is the number of value chains that the intervention targets. Kafle et al. (2018) found that promoting specifically tailored activities related to the production and marketing of high-value commodities to serve a **small number of commodity value chains** (which are interlinked) brings positive impacts to farmers in terms of income. In the paper, they evaluate the "High-Value Agriculture Project in Hill and Mountain Areas (HVAP)" which links different actors in the agricultural value chain (e.g., producers, retailers, wholesalers, input suppliers, technical service providers, credit and commerce groups, and government line ministries and agencies). The reason behind targeting a small number of value chains is that each of them can be closely monitored and supported at each node when necessary. While no other paper where value chains are put in place discussed this feature, it is an interesting approach and, based on the positive impacts that are observed on women's resilience, this is a feature that could be taken into consideration.

A last feature observed in the included papers concerns the **type of communicators for the dissemination campaigns**. In particular, the study by Dillon et al. (2020) argued that the Behavioural Communication Campaigns (BCC) put in place were successful in increasing nutrition outcomes because they used older women leaders to disseminate the information. The authors commented that the characteristics of the communicator (gender and "perceived" as experienced) matter for achieving the desired effects with BCC interventions. Besides the positive effects on nutrition outcomes, the authors also report positive effects on women's empowerment.

Facilitators

Implementation features matter in the success of a programme, but an intervention cannot happen without individual actors or organisations that facilitate the programme implementation. In this regard, a facilitator mentioned in the studies is the presence of groups and associations prior to the programme implementation. This is mentioned in the studies by Ring et al. (2017), Cavatassi et al. (2018b), and Garbero et al. (2019). In particular, the study by Cavatassi et al. (2018) explicitly mentioned the presence of women's groups as a facilitator for programme implementation and future success in achieving the desired impacts.

5.5 Enabling environments

Even when an intervention is well planned and fits the needs of the target population, the effectiveness of an intervention can be either enabled or inhibited by political will or by the political climate in the region or location of interest. While this is not often mentioned in the reviewed studies, the study by Garbero and Paliwal (2018) addressed and discussed this issue. In the case of the programme "Gente de Valor (GDV)" in Brazil, the authors mentioned that without the implementation of sister programmes, GDV would probably not have been successful. In the district of Bahia in Brazil, GDV was not the only government initiative taking place. Parallel to the GDV implementation, alternative government initiatives were also in place to provide cash, access to electricity, water, and roads to the population.[17] Because of this, it is critical to understand and weigh, although difficult to measure, the relative impact of a programme against the implementation of other development efforts. Another study, reporting the positive effects of a decentralised irrigation programme on women's empowerment (Arslan and Higgins, 2018), suggested that well-established institutions (in this case irrigation associations) are key in achieving the desired effects. In this intervention, the institutions put in place encouraged women to become irrigation officers which helped to achieve the observed impacts on women empowerment.

A critical issue that can affect the programme implementation and that harms the sustainability of the invested efforts in the medium to long term is that individuals have access to land. While in some studies it is observed that land certificates are distributed to beneficiaries, it is important that under a shortage of land, governments promote land rehabilitation or land-sharing programmes so that vulnerable landless populations can engage in agriculture.

Another enabling factor for the success of interventions is the existence of a well-structured and trained (farmer) group or cooperative that provides professional assistance and mentoring to other farmers, and that this group is also financially and administratively autonomous. This is mentioned in the paper by Garbero et al., (2019) which studies a programme in São Tomé and Príncipe that promotes certified organic farming. In the study, the authors mentioned the important role of cooperatives in generating gains for the members. In addition, the paper by Ring et al., 2017 suggested that the irrigation programme worked well because the new community structures created by the programme replaced existing, functioning farmers' associations.

5.6 Contextual barriers

There are two contextual barriers that can be drawn from this review. The first one is that donors, agencies, and governments should consider the context before designing a particular programme and setting specific goals. In a context where basic needs and basic public services are lacking, or where markets are not existing, programme implementation is difficult and hence it is difficult to achieve the desired impacts. This barrier was found in the studies by Garbero et al. (2019) and Dillon et al. (2020) where beneficiaries had difficulties in accessing water, which complicated the adoption of agricultural practices, and hence inhibited the intended impacts. A second contextual barrier refers to the gender responsiveness of programmes. Implementers have to be careful in how they tailor the programme within specific contexts such that both women and men can equally benefit and partake in the programme activities.

17 Initiatives such as Bolsa Familia (cash transfers for families with vaccinated children attending school), Luz para Todos (electrification), Agua para Todos, Um Milhão de Cisternas (programmes that provide household cisterns), etc., were taking place and aimed directly at rural transformation.

5.7 Intervention and implementation barriers or failures

Given the vulnerable settings where agricultural interventions usually take place, it is important that the design of the interventions fit the needs and characteristics of the target population. For instance, as mentioned above, women farmers are less likely to adopt labour-intensive practices due to several barriers they face. If women are unable to adopt technical practices, their agricultural output is negatively affected which impacts empowerment and resilience. In several of the included papers, women failed to realise the benefits of the intervention because they did not have the time to adopt the practices that were suggested by the programme implementers or extension workers (see for example Karamba & Winters, 2015 and Dillon et al., 2020). This issue is exacerbated when the interventions target households headed by women, who have even less time in comparison to biparental households (see Bahru & Zeller, 2021).

While studies report positive effects of interventions that establish (farmer) groups/cooperatives on social capital/social cohesion, it is observed that these efforts do not necessarily translate into higher participation of women in economic activities and business enterprises (see for example, Cavatassi et al., 2018a and Cavatassi et al., 2018b). Another failure of the implementation of such groups is that community asset creation does not guarantee that all community members can benefit from them. Hence, it is important to consider disparities of initial endowments, such as land and livestock, within the target population so that the interventions do not simply exacerbate disparities.

A major challenge to programme implementation mentioned by Bonilla et al. (2017) is the inefficiencies within governmental entities that deter the timely implementation of initiatives on the ground. Other challenges at the implementation level that do not exclusively affect women are related to the establishment of weak market linkages. Given that farmers have a weak understanding of markets, they are not linked to markets, or they have limited access, they heavily rely on third parties for product commercialisation. When such linkages are weak then farmers fail in reaping the benefits from the existing structures. Hence, it is important to provide guidance and monitor the commercialisation process which is equally important as the production process.

6. LIMITATIONS

Given the scope of the present evidence review, there are two limitations that should be considered when reviewing or generalising the results of this report.

The first is the limitation to evidence published from 2000 onwards. While this can create a selection bias in the types of programmes covered (as research in particular areas has a time trend), it is important to note that programmes implemented prior to 2000 are still included in the review when published in the timeframe under analysis. Regarding the language limitation, since one of the exclusion criteria is that the evidence is not presented in English, there is a risk to miss relevant information being published in other languages.

7. CONCLUSION

There are large gaps in the existing literature on gender integration and equity in agriculture. These gaps prevent researchers, policymakers, programme implementers and other stakeholders from effectively addressing issues of inequity in rural development. Specifically, systematic evidence on the causal impact of STIBs on women's resilience and empowerment is lacking. Specifically, STIBS are defined as a combination of social (awareness campaigns, agricultural subsidies or finance), technical (agricultural information training, extension services, provision of market-related information, etc.) and technological (improved seed or livestock distribution, irrigation technology, etc.) innovations. By conducting a systematic search in different databases and websites, this report provides robust evidence on the gender-equitable and integrative nature of the existing STIB interventions. This assignment focuses on women's empowerment (based on WEAI measurement and indicators included therein such as decision-making, ownership of resources, leadership, etc.) and resilience in agriculture (based on the five dimensions of resilience defined by the UN), with the majority of studies reporting on adaptive absorptive and anticipative capacity as key favourable outcomes of STIB interventions.

This review is the first to map the current set of STIB interventions implemented by governments, international agencies, and/or NGOs, against a set of women's empowerment and resilience indicators. Through a review of these interventions, key insights into the barriers and facilitators of the different STIBs, including what contextual factors may enable their reach and benefits to women, are presented. Consequently, this EGM aims to inform researchers, development practitioners, governments, donors, and other policymakers on the role of (various types of) STIBs in improving women's empowerment and resilience in LMICs, thereby improving their future design and implementation.

The evidence captured within this review is acquired using the PICOS model, based on a theory of change developed as part of this study. After a careful screening process, a total of 21 relevant studies and 1 systematic review with STIB interventions are included in the review. As shown in the result section, most of the studies included report the effects of innovation bundles that combine technical and technological components (10 out of 22 studies) followed by social, technical and technological bundles (nine studies) and finally social and technical bundles (two studies). None of the studies that are included in the EGM combine social bundles and technological bundles. Especially, a large proportion of the technical-technological interventions include a training component (technical innovation) in combination with improved seeds and/or livestock provision (technological innovation). An example of social-technical-technological bundles can be found in Garbero & Paliwal (2018) where community groups are established (social), provided access to improved seed and irrigation technologies and are trained on agricultural information (technical). The latter bundles often include the distribution of land rights, the establishment of market linkages and unions, implying a change in the social and infrastructural framework within which rural households are operating. Across a wide diversity of interventions and intervention combinations, the 22 studies included in the review have a similar mix of empowerment and resilience outcomes, with 11 and 13 studies, respectively.

Analysing the information extracted from 21 studies, some evidence for the positive effect of STIBs on women's resilience is found**.** Resilience is measured through 64 types of outcomes, where 39, i.e. 61% of the reported outcomes, show a positive impact on resilience. The 13 studies measuring women's resilience

mostly focus on the adaptive capacities of women, a majority of which indicate a positive impact on this outcome. However, since adaptive capacity is measured through the increase in agricultural productivity, a direct outcome of STIBs in agriculture, the result is not entirely surprising. For the other types of capacities, the results are inconclusive, since a large majority of the indicators report non-effects, as opposed to positive effects. Of the five capacities, transformative and preventive, are not measured within the 21 papers. When measuring the effects across sub-populations, positive effects are found in Africa, with 73% positive results for resilience, driven entirely by the positive results in adaptive capacity. However, readers must interpret these results cautiously, since we cannot ignore the possibility of reporting biases where insignificant and negative results are deliberately not reported, and since a few papers may be carrying a large number of (positively) reported indicators. The latter, found in the Garbero et al (2019) paper may be an indication of a particularly successful programme model, which can be replicated in other contexts.

From the 11 papers measuring the effect of STIBs on outcomes related to women's empowerment, no clear positive (or negative) impact of STIBs on empowerment outcomes. About half of the outcomes show positive effects (21 out of the 43 reported outcomes), while nearly the same number of indicators (22) report no effect of STIBs on women's empowerment. The estimates within each indicator of empowerment also do not present any striking impact, although some suggestive trends do present themselves. In terms of decision-making, 57% of the 14 reported outcomes show a positive impact. Leadership is measured in 3 cases, where two show an improvement as a result of access to group membership. However, the small sample of studies (six for decision-making and two for leadership) does imply a cautious interpretation of these trends. About half of the outcomes show positive effects, while nearly the same number of indicators report no effect of STIBs on women's empowerment. Regionally, empowerment outcomes only show a positive effect in the African sample. Overall, studies from South America do not show significant effects for empowerment or resilience outcomes, although this may be the consequence of a very small sample of studies from this region. Other sub-populations, such as age or location being urban or rural do not depict any clear trends in either set of outcomes.

It is important to note that the large variety of indicators used, as well as the variation introduced through the methods and contextual factors, imply that no clear trends in a single outcome type emerge for any of the two outcomes. In particular, each intervention is almost unique among the pool of selected papers using their own relevant indicators, making it impossible to draw any statistically relevant conclusion for any of them. Future research in the areas of STIBs and women's resilience and empowerment may benefit from a quantification (after standardisation) that a meta-analysis and synthesis allows, such that a combined overall estimate for impact can be derived.

While some patterns in women's resilience or empowerment can be drawn from this review, important lessons learnt on the barriers and facilitators of the intervention and implementation are synthesised and hope to be informative for policymakers. On this front, it is worth mentioning that features such as facilitating access to additional financial resources, intervention targeting, and size of (farmer) groups can enhance the intervention and make it more prone to achieve the desired impacts. Targeted interventions could empower women by introducing technology that does not inhibit their domestic chores (rather complements them) and can be utilised in spaces where social norms impede their presence, i.e. in their homes. In a similar vein, one study highlights the importance of targeting women and youth popu-

lations and integrating them at the early stages of the value chain development, bringing greater financial benefits for such groups. Not only do implementation features matter in the success of a programme but also facilitators or actors enhance the programme implementation. In this regard, a common facilitator mentioned in the studies is the presence of groups and associations prior to the programme implementation. The existence of these groups facilitates the diffusion of information and activity implementation. In addition, it is important that adequate infrastructure, institutional strength and political will is in place to facilitate the success of programme implementation and potential impacts. As highlighted within the RBE framework, enabling environments do matter. Programmes working in environments where the gender of the (irrigation) officer is female (thereby improving the reach to women in general), or focus on structural improvements that particularly affect women, such as access to water and roads, may reduce their domestic burden.

Furthermore, this review highlights that the design of programmes in contexts where basic needs and basic public services are lacking, or where markets are not existing, should not be too ambitious as they would likely face many difficulties in implementation. In addition, programme design should account for the fact that women farmers are more averse to adopting labour-intensive practices, especially women heading households solely. Hence focusing on labour-saving techniques in domestic and farming tasks could work best when aiming for this group. Two major challenges to programme implementation are the inefficiencies within governmental entities that deter timely implementation of initiatives on the ground and the weak market linkages that are not properly established or understood by farmers.

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APPENDIX

A.1 Appendix I – EGM

The four interactive EGMs are included as links below:


EGM_bundle_intervention_Updated.html


EGM_bundle_interventions_w_actors_Updat


EGM_single_bundles_Updated.html


EGM_single_intervention_w_bundles_Update


EGM_bundle_intervention_grade.html

A.1 Appendix II – Description of studies

Author	Year	Implementation country	Involved partners	Empirical Strategy	Total sample	Target population	Target population age	STIBs
Abate et al.	2018	Ethiopia	Local/National Government: Ethiopia's Ministry of Agriculture and Ethiopia's Agricultural Transformation Agency (ATA)	Experimental Design – Randomised Control Trial (RCT)	0-500	Women and Men	Adults (35-65)	Technical (Provision of agricultural information training and purchase of output) + Technological (Provision of improved seeds and soil practices)
Arslan et al.	2018	Philippines	Local/National Government: Government of the Philippines; International agency: International Fund for Agricultural Development (IFAD)	Quasi-Experimental Design – Matching	1001-3000	Women and Men	Adults (35-65)	Technical (Provision of organisational and managerial skills training and market related information) + Infrastructure (Improvement of irrigation technologies)
Bahru & Zeller	2021	Ethiopia	Local/National Government: Government of Ethiopia	Doubly robust maximum likelihood-based estimation method (TMLE)	Larger than 5001	Women and Men	Adults (35-65)	Technical (Provision of extension services) + Financial (Implementation of microcredit programme and provision of cash or In-Kind grants) + Technological (Improved of seed, soil practices, and conservation practices)
Bonilla et al.	2017	Kenya	Local/National Government: Government of Kenya International agency: International Fund for Agricultural Development (IFAD) and International Initiative for Impact Evaluation (3ie)	Quasi-Experimental Design – Matching	1001-3000	Women and Men	Not Specified	Technical (Provision of training in organisational and managerial skills, agricultural information training, field training, information dissemination activities, market related information, agricultural advisory and extension services) + Social (establishment of farmer groups to disseminate information and create market linkages) + Technological (Provision of improved practices for milk production)
Cavatassi & Mallia	2018	Tajikistan	Local/National Government: Government of Tajikistan International agency: International Fund for Agricultural Development (IFAD)	Quasi-Experimental Design – Matching	1001-3000	Women and Men	Adults (35-65)	Social (Distribution of land rights, establishment of Pasture User Unions) + Technical (training on livestock husbandry practices) + Technological (Provision of improved seed and soil practices, and livestock packages for women, provision of inputs - tractors)

Author	Year	Implementation country	Involved partners	Empirical Strategy	Total sample	Target population	Target population age	STIBs
Cavatassi et al.(a)	2018	Mexico	Local/National Government: Government of Mexico; International agency: International Fund for Agricultural Development (IFAD) and Global Environment Facility (GEF)	Quasi-Experimental Design – Matching	1001-3000	Women and Men	Adults (35-65)	Technical (Provision of agricultural information, training and agricultural advisory on climate change effects and the adoption of good agricultural/environmental practices) + Social (information dissemination programs, information campaigns, and market linkages) + Technological (Improved conservation practices and provision of livestock)
Cavatassi et al.(b)	2018	Chad	Local: Community committees; International agency: International Fund for Agricultural Development (IFAD)	Quasi-Experimental Design – Propensity Score Matching	1001-3000	Women and Men	Adults (35-65)	Technical (Provision of organisation and managerial skills training) + Infrastructure (Construction of cereal banks)
Dar et al.	2020	India	National/Government: National Systems of Indian Agriculture	Experimental Design – Randomised Control Trial (RCT)	1001-3000	Women and Men	Adults (35-65)	Technical (Provision of agricultural information training) + Technological (Provision of improved seed and bags for seed storage)
Dillon et al.	2020	Burkina Faso	International agency: Helen Keller International (HKI)	Experimental Design – Cluster-Randomised Control Trial (CRCT)	0-500	Women only (Women with children 3–12 months of age)	Not Specified	Technical (Provision of agricultural information training) + Technological (Provision of improved seed, saplings, chicks, and small gardening tools)
Garbero & Paliwal	2018	Brazil	National/Government: Government of Brazil; Local: Government from the state of Bahia; International agency: World Bank (WB) and International Fund for Agricultural Development (IFAD)	Quasi-Experimental Design – Matching	3001-5000	Women and Men	All Ages	Technical (Provision of organisational and managerial skills training, agricultural information training, field training, information dissemination activities, extension services and agricultural advisory) + Social (Establishing and obtaining buy-in community groups) + Technological (Provision of improved seed and irrigation technologies)
Garbero et al.	2018	Senegal	Local: Local Producer Organisations (POs), as well a selected Regional Approval Committee (RAC); International Agency: International Fund for Agricultural Development (IFAD)	Quasi-Experimental Design – Regression Discontinuity and Matching	1001-3000	Women and Men	All Ages	Technical (Provision of organisational and managerial skills training, agricultural information training and agricultural advisory) + Social (Establish market linkages) + Financial (Supply of input subsidy) + Infrastructure (Access to irrigation facility or infrastructure) + Technological (Access to quality inputs, provision of improved conservation practices)
Garbero et al.	2019	São Tomé and Príncipe	National/Government: Government from São Tomé and Príncipe; Local: Local Cooperatives; International agency: International Fund for Agricultural Development (IFAD)	Quasi-Experimental Design – Matching	1001-3000	Women and Men	Not Specified	Technical (Provision of organisational and managerial skills and agricultural information training) + Social (Creation of export-oriented cooperatives) + Infrastructure (Investments in rural infrastructure) + Technological (Creation of rehabilitation and densification of plantations as well as provision of equipment and materials)

Author	Year	Implementation country	Involved partners	Empirical Strategy	Total sample	Target population	Target population age	STIBs
Kafle et al.	2018	Nepal	National/Government: Government of Nepal; International agency: International Fund for Agricultural Development (IFAD); NGO: SNV Netherlands Development Organization	Quasi-Experimental Design – Matching	3001-5000	Women and Men	Not Specified	Technical (Provision of market related information and extension services) +Social (Information campaigns and awareness trainings on social inclusion and gender balance as well as market linkages) + Infrastructure (infrastructure development such as storage facilities, roads, and irrigation) + Technological (Provision of improved conversation practices)
Karamba & Winters	2015	Malawi	National/Government: Government of Malawi	Standard regressions (Ordinary Least Squares - OLS), weighted regressions, and weighted regressions with the inclusion of spatial fixed effects	Larger than 5001	Women and Men	Not Specified	Financial (Distribution of input subsidy) + Technological (Provision of improved seeds)
Karim et al.	2016	Bangladesh	International agency: USAID	Cobb Douglas production function with treatment dummies.	1001-3000	Women only	Other (Please Specify)	Technical (Provision of organisational and managerial skills and training on improved aquaculture technologies, gender, and nutrition) + Technological (Provision of improved seed)
Kumar et al.	2018	Zambia	National/Government: Ministries; International agency: Concern Worldwide; Local: local implementing NGOs	Quasi-Experimental Design – Difference-In-Difference	3001-5000	Women and Men	All Ages	Technical (Provision of farmers participatory and agricultural information training) + Social (Gender awareness and women's empowerment intervention) +Technological (Provision of improved seed and livestock)
Nagwekar et al.	2020	India	NGO	Quasi-Experimental Design – Difference-In-Difference	0-500	Women only	All Ages	Technical (Provision of agricultural information and field training as well as information dissemination activities) + Technological (Supply of solar conduction dryer)
Pan et al.	2018	Uganda	NGO: BRAC	Quasi-Experimental Design – Regression Discontinuity	3001-5000	Women only	All Ages	Technical (Provision of agricultural information, field training, dissemination activities, extension services) + Social (Market Linkages - network of Model Farmers and Community Agriculture Promoters) + Technological (Provision of improved seeds)
Ring et al.	2017	Madagascar	Local: NGOs, private companies, de-concentrated technical service providers from the regions; International agency: International Initiative for Impact Evaluation (3ie)	Quasi-Experimental Design – Matching	1001-3000	Women and Men	All Ages	Technical (Provision of organisational and managerial skills and agricultural information training) + Technological (Provision of improved seeds) + Infrastructure (Creation of new irrigation infrastructure) + Social (trainings on land administration and legal rights, provision of land tenure certificates)

Author	Year	Implementation country	Involved partners	Empirical Strategy	Total sample	Target population	Target population age	STIBs
Rosenberg et al.	2018	Zambia	International agency: International Food Policy Research Institute (IFPRI), NGO: Concern International	Quasi-Experimental Design – Difference-In-Difference	Larger than 5001	Women and Men	All Ages	Technical (Provision of farmers participatory and agricultural information training, and nutrition behaviour change communication - BCC) + Social (Gender awareness and women's empowerment intervention, formation of women groups) + Technological (Provision of improved seeds and livestock)
Gelo et al.	2018	Ethiopia	National/Government: Government of Ethiopia; International agency: Local: NGOs; World Food Programme (WFP); African Economic Research Consortium (AERC)	Quasi-Experimental Design – Semi-parametric Difference-In-Difference and Matching	1001-3000	Women and Men	Not Specified	Technical (Provision of training in organisation management, farming techniques, quality control, and postharvest handling) + Infrastructure (Equips FOs with storage infrastructure) + Technological (Improved conservation practices) + Financial (Facilitating access to credit)
Sharma et al.	2021	Bangladesh, Zambia, Burkina Faso (2 studies), Malawi, Ethiopia	Multiple partners involved	Systematic Review	6 papers are included in this review	Women and Men	All Ages	Mix of bundles

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A.3 Appendix III – List of low and middle income countries by the world bank

Table 11: List of LMICS

Afghanistan	Albania	Algeria	American Samoa
Angola	Argentina	Armenia	Azerbaijan
Bangladesh	Belarus	Belize	Benin
Bhutan	Bolivia	Bosnia and Herzegovina	Botswana
Burkina Faso	Bulgaria	Brazil	Burundi
Cabo Verde	Cambodia	Cameroon	Central African Republic
Chad	China	Colombia	Comoros
Congo, Democratic Republic	Congo, Republic	Costa Rica	Cote d'Ivoire
Cuba	Djibouti	Dominica	Dominican Republic
Ecuador	Egypt, Arab Republic	El Salvador	Equatorial Guinea
Eritrea	Eswatini	Ethiopia	Fiji
Gabon	Gambia	Georgia	Ghana
Grenada	Guatemala	Guinea	Guinea-Bissau
Guyana	Haiti	Honduras	India
Indonesia	Iran, Islamic Republic	Iraq	Jamaica
Jordan	Kazakhstan	Kenya	Kiribati
Korea, Democratic People's Republic	Kosovo	Kyrgyz Republic	Lao People's Democratic Republic
Lebanon	Lesotho	Liberia	Libya
Madagascar	Malawi	Malaysia	Maldives
Mali	Marshall Islands	Mauritania	Mauritius
Mexico	Micronesia, Federated States	Moldova	Mongolia
Montenegro	Morocco	Mozambique	Myanmar
Namibia	Nepal	Nicaragua	Niger
Nigeria	North Macedonia	Pakistan	Palau
Peru	Paraguay	Papua New Guinea	Philippines
Russian Federation	Rwanda	Samoa	Sao Tome Principe
Senegal	Solomon Islands	Sierra Leone	Serbia
Somalia	South Africa	South Sudan	Sri Lanka
St Lucia	St Vincent and the Grenadines	Sudan	Suriname
Syrian Arab Republic	Tajikistan	Tanzania	Thailand
Timor-Leste	Togo	Tonga	Tunisia
Turkey	Turkmenistan	Tuvalu	Uganda
Ukraine	Uzbekistan	Vanuatu	Vietnam
West Bank and Gaza	Yemen, Republic	Zambia	Zimbabwe

A.4 Appendix IV - Search strategy

1. Search String for EBSCOHost (Academic Search Premier, EconLit and GreenFILE)

The following terms were used in the search strings. The database was always restricted to English language and after 1990.[18]

1.1 R1- Interventions (all combined with OR Boolean operator) – 289665 results

Agricultural technology and practice innovation	fertiliz* OR fertilis* OR pesticid* or herbicid* OR insecticid* OR manure OR irrigation OR cultivat* OR biotech* OR GMO OR GMOs OR ((“genetically modified” OR “genetically-modified” OR hybrid OR hybrid* OR improved) N1 (seed* OR produc* OR crop*)) OR agroforestry OR “agro-forestry” OR “IPM” OR “integrated pest management” OR “SRI” OR “system of rice intensification” OR irrigat* OR “water management” OR “organic agricultur*” OR “conservation agricultur*” OR “agricultur* innovat*” OR “crop intensif*” OR “soil management” OR “biofortification” OR “drip-irrigat*” OR “drip irrigat*” OR “seed*” OR “livestock” OR “lifestock” OR “small ruminant*” OR ((agricultur* OR crop* OR pastoral OR horticult?r* OR agronomic* OR agric* OR farm* OR livestock OR lifestock OR plant OR fisheries OR weed OR irrigat*) N1 (innovat* OR technolog* OR revolution OR management OR tool* OR implements OR practice*)) OR “green revolution” OR “white revolution” OR “agro-pastoral*” OR “agropastoral*” OR “post harvest technolog* and value addition” OR ((water) N2 (management OR conserv* OR harvest*)) OR “maize storage” OR “seed storage” OR “tillage practices” OR “crop* pattern*” OR “pest control” OR “weed control” OR “disease control” OR “export horticulture” OR biofortificat* OR “early warning system*” OR “EWS” OR “early warning infrastructure” OR ((“post-harvest” OR postharvest OR “post harvest”) N2 (technolog* OR method*)) OR “precision agriculture” OR “sustainable agric* mechani*” OR “sustainable agric* practice*” OR “sustainable farm* mechani*” OR “sustainable farm* practice*” OR “Integrated Soil Fertility Management” OR “ISFM” OR
Training	“farmer field schools” OR FFS OR “farmer training” OR “farmer field visit*” OR “online training*” OR “extension service*” OR “extension office*” OR “extension program*” OR “extention service*” OR “extention office*” OR “extention program*” OR “agricultur* advisory” OR “agricultur* knowledge” OR “agri-information” OR “informati* training*” OR “farmer participatory training*” OR “participatory training*” OR “Farmer Trainer*” OR “farmer-to-farmer” OR
Agricultural finance	(agri* N1 (credit* OR loan* OR financ* OR insurance* OR microfinance OR microcredit* OR saving* OR bank*)) OR “saving* group*” OR “credit group*” OR “savings and credit group*” OR voucher* OR subsid* OR subsidiz* OR subsidis* OR “cash transfer*” OR “credit transfer*” OR “safety net*” OR “agricultur* support*” OR “contract farm*” OR “contract-farm*” OR
Awareness	(“awareness” OR information OR dissemination OR diffusion) N1 (campaign OR activit* OR transfer) OR “market information” OR “video intervention*” OR

18 Please keep in mind that while in the inclusion/exclusion criteria we have a different time period (from 2000 onwards), the search strategy was conducted taking studies from 1990 onwards.

Framework	"market linkage*" OR (agri OR agricultural OR rural OR agrimarket) N1 ("regulation" OR "policy" OR framework) OR
Bundle	"agricultural bundle*" "socio-technological bundle*" OR "socio-technic* bundle*" OR "STIB" OR "STIBS" OR "STIBs" OR agri-technologic* bundle*" OR "agricutural innovation bundle*" "farm* innovation bundle*" OR "wholesome approach*"

1.2 R2- Outcomes of interest (all combined with OR Boolean operator) – 225491 results

Empowerment of women	("wom?n" OR female OR girl) N2 ("empower* OR "dependen*" OR "independen*" OR agency OR access OR income OR asset OR wealth or financ* OR autonomy OR decision-making OR "decision making" OR "make decision" OR "time-use" or "time use" OR "control" OR "voice" OR network* OR enable* OR skill* OR "skill develop*" OR "participat*" OR mobility) OR "gender equity" or "gender-equity" or "gender-equit*" or "gender equit*" OR "economic* empower*" OR "monetar* autonomy" OR "decision-making" Or "decision making" OR "asset ownership" OR "livestock ownership" OR "WEAI" OR "women's empowerment in agriculture index" OR "I-WEAI" Or Pro-WEAI" OR "dual responsibilities" OR ((domestic OR spous*) N1 (labor OR labour OR responsibilit* OR violence OR abuse)) OR
Productivity	((farm OR farm* OR agricultur* OR crop OR plot) N2 (yield OR produc* OR harvest* OR profit* OR output)) OR maize OR rice OR wheat OR cassava OR manioc OR millet OR sorghum OR banana OR bean OR coffee OR cocoa OR cacao OR "production value" OR "value of production" OR "harvest" OR
Income, savings and expenditure	"*farm income" OR "*farm asset" OR welfare OR "economic better*" OR "economic gain" OR (household N1 (income OR saving OR wealth OR profit OR asset) OR "asset accumulation" OR ((health OR food OR education) N1 (spending OR expenditure)) OR
Resilience	(food OR income) N1 (secur*" OR shock OR risk OR consumption OR insecur* OR access*) OR resilien* OR "calorific intake" OR "food intake" OR "crop diversif*" OR "crop-diversif*" OR malnourish* OR vulnerability OR "income stability" OR "climate shock" OR "market shock" OR ((anticipative OR preventive OR absorptive OR adaptive OR transformative) N1 capacities) OR
Other	((climate OR climate-smart OR "climate smart" OR "climate change" OR " N1 (knowledge OR awareness or practice* OR training* OR participat* OR adopt*))

1.3 R3- Country list (185315 results)

((Africa* OR sub-sahara* OR MENA OR Caribbean OR "West Indies" OR "Middle East" OR "Central America" OR "Pacific Islands" OR Micronesia OR Polynesia OR Melanesia) OR (Asia NOT (Japan OR Korea OR "Hong Kong" OR Hong-Kong)) OR ("South America" OR "Latin America") OR (Afghanistan OR Albania OR Algeria OR "American Samoa" OR Angola OR Argentina OR Armenia OR Armenian OR Azerbaijan OR Bangladesh OR Byelarus OR Byelorussian OR Belarus OR Belorussian OR Belorussia OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia OR Herzegovina OR Hercegovina OR Botswana OR Brazil OR Bulgaria OR "Burkina

Faso" OR "Burkina Fasso" OR "Upper Volta" OR Burundi OR Urundi OR "Cabo Verde" OR Cambodia OR "Khmer Republic" OR Kampuchea OR Cameroon OR Cameroons OR Cameron OR Camerons OR "Cape Verde" OR "Central African Republic" OR Chad OR China OR Colombia OR Comoros OR "Comoro Islands" OR Comores OR Mayotte OR Congo OR Zaire OR "Costa Rica" OR "Cote d'Ivoire" OR "Côte d'Ivoire" OR "Ivory Coast" OR Cuba OR Djibouti OR "French Somaliland" OR Dominica OR "Dominican Republic" OR "East Timor" OR "East Timur" OR "Timor Leste" OR Ecuador OR Egypt OR "United Arab Republic" OR "El Salvador" OR "Equatorial Guinea" OR Eritrea OR "Eswatini" OR Ethiopia OR Fiji OR Gabon OR "Gabonese Republic" OR Gambia OR Gaza OR Georgia OR "Georgia Republic" OR "Georgian Republic" OR Ghana OR Grenada OR Guatemala OR Guinea OR Guiana OR Guyana OR "Guinea-Bissau" OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kazakh OR Kenya OR Kiribati OR Kosovo OR Kyrgyzstan OR Kirghizia OR "Kyrgyz Republic" OR Kirghiz OR Kirgizstan OR "Lao PDR" OR Laos OR Lebanon OR Lesotho OR Basutoland OR Liberia OR Libya OR Macedonia OR Madagascar OR "Malagasy Republic" OR Malaysia OR Malaya OR Malay OR Sabah OR Sarawak OR Malawi OR Maldives OR Mali OR "Marshall Islands" OR Mauritania OR Mauritius OR "Agalega Islands" OR Mexico OR Micronesia OR Moldova OR Moldovia OR Moldovian OR Mongolia OR Montenegro OR Morocco OR Ifni OR Mozambique OR Myanmar OR Myanma OR Burma OR Namibia OR Nauru OR Nepal OR "Netherlands Antilles" OR Nicaragua OR Niger OR Nigeria OR Muscat OR Pakistan OR Palestine OR Paraguay OR Peru OR Philippines OR Philipines OR Phillipines OR Phillippines OR "Papua New Guinea" OR Romania OR Rumania OR Roumania OR Russia OR Russian OR Rwanda OR Ruanda OR "Saint Lucia" OR "St Lucia" OR "St. Lucia" OR "Saint Vincent" OR "St Vincent" OR "St. Vincent" OR Grenadines OR Samoa OR "Samoan Islands" OR "Navigator Island*" OR "Sao Tome" OR "São Tomé and Principe" OR Senegal OR Serbia OR "Sierra Leone" OR "Sri Lanka" OR "Solomon Islands" OR Somalia OR Sudan OR Suriname OR Surinam OR Swaziland OR "South Africa" OR Syria OR Syrian OR Tajikistan OR Tadzhikistan OR Tadjikistan OR Tadzhik OR Tanzania OR Thailand OR Togo OR "Togolese Republic" OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Turkmen OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Uzbek OR Vanuatu OR "New Hebrides" OR Venezuela OR Vietnam OR "Viet Nam" OR "West Bank" OR Gaza OR Yemen OR Zambia OR Zimbabwe) OR ((developing OR "less* developed" OR "less-developed" OR "under developed" OR underdeveloped OR "middle income" OR "middle-income" OR "low* income" OR "low*-income" OR underserved OR "under served" OR deprived OR poor*) N0 (countr* OR nation OR nations OR population* OR world OR state*)) OR ((developing OR "less* developed" OR "under developed" OR underdeveloped OR "middle income" OR "low*-income" OR "low* income" OR underserved OR "under served" OR deprived OR poor*) N0 (economy OR economies)) OR (low* N0 (gdp OR gnp OR "gross domestic" OR "gross national")) OR (low N3 middle N3 countr*) OR (lmic OR lmics OR "third world" OR "lami countr*" OR "global south") OR "former soviet" OR "post-soviet" OR "commonwealth of independent states" OR "non-OECD" OR ((transition* OR cis) N0 (countr* OR state* OR economy OR economies)))

1.4 R4- Study design 1 (255589 results)

"quasi experiment*" OR quasi-experiment* OR quasiexperiment* OR "random* control* trial*" OR "random* trial*" OR RCT OR randomi* OR (matching N2 (study OR procedure OR "using" OR use* OR observable*)) OR ("control*" N2 (study OR trial OR region OR area)) OR ("cluster* random*" N2 (study OR trial)) OR ("cluster-random*" N2 (study OR trial)) OR "propensity score" OR psm OR "regression discontinuity" OR "regression kink" OR "fuzzy regression" OR "sharp regression" OR "discontinuous design" OR rdd OR "difference in difference*" OR "difference-in-difference*" OR "diff in diff" OR "diff-in-diff" OR (random* N1 (allocat* OR assign* OR select*)) OR "research synthesis" OR "fixed effect*" OR "synthetic control" OR "rapid evi-

dence assessment*" OR "systematic literature review*" OR "systematic* review*" OR metaanaly* OR "meta analy*" OR meta-analy* OR "control* evaluation" OR "control* treatment" OR "instrumental variable*" OR (as N2 instrument) OR (heckit N2 (model* OR estimat* OR procedure OR method)) OR (heckman* N5 (sample OR selection OR model OR correction)) OR ((treatment OR intervention OR comparison OR control OR subsidy) N0 group) OR ((counterfactual OR "counter factual" OR "counter-factual" OR random*) N2 (stud* OR analysis OR experiment*)) OR ((counterfactual OR "counter factual" OR "counter-factual" OR random*) N2 (outcome*)) OR causal* OR "control group*" OR "comparison group*" OR ((control OR treatment) N0 (communit* OR village*)) OR (experiment* N1 (stud* OR analysis OR design*)) OR IV OR ITT OR ((treatment OR intervention) N2 effect*) OR "intention-to-treat" OR "intention to treat" OR ("econometric analysis") OR (impact* N1 (evaluation OR stud*)) OR "controlled before and after" OR "controlled before-and-after" OR "controlled before after" OR "controlled before-after" OR "quasi experimental time series" OR "quasi-experimental time series" OR "interrupted time series") OR "regression" OR "ordinary least square*" OR ("panel" N1 (data OR analysis OR study OR cohort)

1.5 R5- Study design 2 (8304 results)

("rapid evidence assessment*" OR "systematic literature review*" OR "systematic* review*" OR metaanaly* OR "meta analy*" OR meta-analy*)

1.6 Other criterion (included with R1 AND R2 AND R3 AND (R4 OR R5))

Published Date: 1990101-;
Publication Type: Educational Report; Document Type: Article, Book Chapter, Proceeding, Report; Language: English; Publication Type: Collective Volume Article, Dissertation, Journal Article, Working Paper; Publication Type: Academic Journal; Document Type: Article, Book Chapter, Proceeding, Report
Language: English;

2. Search terms by website

Here is a list of the terms searched within each website in the period from 2000 on, except for the NBER papers that are from the 1st of July 2022 until the 1st of December 2022, as the previous period is covered by the database search.

1. **World Bank eLibrary**
   Title: *innovation OR technolog* OR sociotechnical OR socio-technical OR bundle* OR GMO* OR revolution OR "sustainable agriculture" OR "precision agriculture" OR agro-chemical* OR fertilizer* OR pesticide* OR finance OR microfinance*

   Abstract: *women OR woman**

2. **African Development Bank (AfDB)**
   Separate single term searches: *innovation, technology, bundles*

3. **Asian Development Bank**
   We restricted our search to evaluation documents, and project results or case studies.

Separate single term searches: *innovation, technology, bundles, agriculture women empowerment, agriculture women resilience, farming women empowerment, farming women resilience.*

4. **International Initiative for Impact Evaluation: 3ie Development Evidence Portal**
   Title: *innovation OR technolog* OR sociotechnical OR socio-technical OR bundle* OR GMO* OR revolution OR "sustainable agriculture" OR "precision agriculture" OR agro-chemical* OR fertilizer* OR pesticide* OR finance OR microfinance*

   Abstract: *women OR woman**

5. **National Bureau of Economic Research Working Papers**
   Separate single term searches: *agriculture, farming*

6. **Food and Research Policy Institute (IFPRI)**
   Separate searches: *innovation women empowerment, innovation women resilient, bundles women*

7. **Food and Agriculture Organisation (FAO)**

   Document: *(woman OR women) AND (empowerment OR resilience)*

   Title: *(technology OR innovation OR revolution OR GMO OR socio-technical OR training OR extension OR finance OR credit OR microfinance OR information OR dissemination OR linkage OR STIB OR STIBs OR bundle)*

8. **International Fund for Agricultural Development (IFAD)**
   Given the activity of the international agency, the search terms are left blank and the document type is limited to "*Impact Assessment*".

A.5 Appendix V - Search protocol for the screening of papers

Protocol for Selection of Studies

Title and abstract screening (4 steps):

1. Read title first, get first impression of what the text is about
   a. If title is clear and study is **not relevant**: *EXCLUDE* from full text screening
   b. If title is relevant or unclear or does not give enough information to exclude: proceed to step 2

2. Is the publication in English?
   Yes OR unclear: proceed to step 3
   No: *EXCLUDE* from full text screening

3. For the next step, **scan** the abstract
   a. Aim of the study: Is the research question **relevant** for our topic?

i. Is there an intervention of interest COMBINED with at least another intervention of interest *(see below)*?

Yes (bundled) OR unclear: proceed to step 3 (a)(ii)
No (not bundled)*: EXCLUDE* from full text screening

Examples:

Agriculture Technological and practice innovations

1. Water management
2. Biofortification
3. Soil fertility management
4. ...

Training programs

5. Farmers field schools
6. Online training
7. Extension services
8. Agricultural advisory
9. Farmers participatory training
10. Agricultural information training
11. ...

Agriculture Finance

12. Microfinance/Microcredit program
13. Savings/Credit groups
14. Cash transfer program
15. Voucher/Subsidy program
16. Bank instrument
17. ...

Awareness programs

18. Information dissemination programs
19. Information campaigns
20. ...

Framework

21. Market linkages
22. Market-based regulations
23. Market-based policy

ii. Are there outcomes of interest *(see below)*?

Yes OR unclear: proceed to step 3 (b)
No*: EXCLUDE* from full text screening

Women's empowerment

1. Asset/livestock ownership and control

2. Household decision-making
3. Time use
4. Mobility
5. WEAI outcomes
6. Skill development
7. Domestic violence
8. Mental health

Productivity

9. Farm productivity
10. Maize/rice/wheat/cassava/cocoa/sorghum/banana/coffee yields
11.
12.

Income, savings and expenditure

13. Farm income
14. Farm profits
15. Household welfare
16. Household savings
17. Asset Accumulation

Resilience

18. Crop diversification
19. Caloric intake
20. Climate shock resilience
21. Income stability
22. Malnourishment
23. Market shocks resilience
24. Food security

Other

25. Climate-smart practices adoption
26. Climate smart practice training
27. Knowledge of climate smart practices

b. Method used

i. Econometric studies (including regression analysis of some sort) and systematic reviews?

Yes: proceed to step 3(c)

No: proceed to step 3(b)(ii)

ii. Is the method unclear?

Yes: ***EXCLUDE*** from full text screening

No: proceed to step 3(c)

c. Country of analysis

The study relates to interventions in any of low- and middle-income countries and NOT ONLY in high-income countries *(consult the list of LMIC)*?

Yes: proceed to step 4
No: *EXCLUDE* from full text screening

4. Is the publication date within the specified interval (from 2000)?
   Yes OR unclear: *INCLUDE* into full text screening
   No: *EXCLUDE* from full text screening

DECISION RULE (SUMMARY):
If the paper has met all the above criteria (outcomes, interventions, methods, country, time of publication, and language): INCLUDE
If the paper has met some criteria and the rest are unclear: INCLUDE
If the paper has NOT met one or more criteria, even if it has met others: EXCLUDE

Full Text Screening:

Step 1. General observation

1. Language. Is the publication language English?
Yes: proceed to Step 2
No: *EXCLUDE* from full text review

2. Country of analysis. Does the study present evidence either only from LMIC or if not only, then disaggregated so it is possible to separate effects measured for LMIC from aggregated effects?
Yes: proceed to Step 3
No: *EXCLUDE* from full text review

Step 2. Review of the RESULTS section of the paper (the table of results)

3. Outcomes and interventions.

a. The interventions can be put into one of the predefined categories:
Yes: proceed to 3(b)
Not clear: Consult the **METHODS** section and the **DESCRIPTION** of the study
No: *EXCLUDE* from full text review

Agriculture Technological and practice innovations

1. Water management
2. Biofortification
3. Soil fertility management

Training programs

4. Farmers field schools
5. Online training
6. Extension services
7. Agricultural advisory
8. Farmers participatory training
9. Agricultural information training
10.

Agriculture Finance

11. Microfinance/Microcredit program
12. Savings/Credit groups
13. Cash transfer program
14. Voucher/Subsidy program
15. Bank instrument

Awareness programs

16. Information dissemination programs
17. Information campaigns
18. ...

Framework

19. Market linkages
20. Market-based regulations
21. Market-based policy
22.

b. The outcomes can be put into one of the predefined categories:

Yes: proceed to 3(c)
Not clear: Consult the **METHODS** section and the **DESCRIPTION** of the study
No*: EXCLUDE* from full text review

Women's empowerment

1. Asset/livestock ownership and control
2. Household decision-making
3. Time use
4. Mobility
5. WEAI outcomes
6. Skill development
7. Domestic violence
8. Mental health

Productivity

9. Farm productivity
10. Maize/rice/wheat/cassava/cocoa/sorghum/banana/coffee yields

Income

11. Farm income
12. Farm profits
13. Household welfare
14. Household savings
15. Asset Accumulatio

Resilience

16. Crop diversification

17. Caloric intake
18. Climate shock resilience
19. Income stability
20. Malnourishment
21. Market shocks resilience
22. Food security

Other

1. Climate-smart practices adoption
2. Climate smart practice training
3. Knowledge of climate smart practices

c. Is the intervention exactly targeting any of the outcomes mentioned above?

Yes: proceed to 3(d)
Not clear: Consult the **METHODS** section and the **DESCRIPTION** of the study
No: *EXCLUDE* from full text review

4. Comparison / Study Design / Non-Causal or Qualitative Studies

a. There is an attempt to evaluate the effect of an intervention on the outcome (using a large enough sample and at the very least, a simple econometric model) or the study is a systematic review with meta-analysis

Yes: proceed to 4(b)
Not clear: Consult the **METHODS** section and the **DESCRIPTION** of the study
No: **Go to 5**

b. There is a clearly defined unit of observation (AND there are >= 30 observations in the control and >= 30 observations in each treatment arm/ sample if above 1000 observations)

Yes: *INCLUDE* into full text review
Not clear: Consult the **METHODS** section and the **DESCRIPTION** of the study
No: EXCLUDE from review

DECISION RULE (SUMMARY):

If the study satisfies ALL of the criteria (language, outcomes and interventions, study design, sample size) [i.e., the answer is "Yes" to 1, 2, 3(a)-(d), and 4(a)-(b)]: INCLUDE into full text review

If the paper has met some criteria and the rest are still somehow unclear: *START READING FROM THE START OF THE PAPER TO FIGURE WHICH STEP YOU NEED TO START FROM*

If the paper has NOT met some criteria, even if it has met others: EXCLUDE

A6. Appendix VI - Data extraction form

General Information

Name of person extracting data		
Publication ID (from EPPI)		
Full name of first author (Surname, First name)		
Publication Year		
Publication type	An article published in the journal	☐
	Working paper	☐
	Report / Grey Literature	☐
	Thesis (Bachelor, Master, or PhD)	☐
	Other (Please Specify)	☐
Target county		
Target population gender	Male	
	Female	
	All genders	
Who are the implementers?	NGO	☐
	Local/National Government	☐
	Foreign Government	☐
	International agency	☐
	Other (please specify)	☐
	Can't tell	☐

Methodology

Empirical strategy	Experimental Design – RCT or CRCT	☐
	Quasi-Experimental Design – Difference-In-Difference	☐
	Quasi-Experimental Design – Instrumental Variable	☐
	Quasi-Experimental Design – Regression Discontinuity	☐
	Quasi-Experimental Design – Propensity Score Matching	☐
	Quasi-Experimental Design – Synthetic Control Method	☐
	Synthesis - Systematic Review or Meta-Analysis	☐
	Other (Please Specify)	☐
Unit of assignment to treatment or control	Individual	☐
	Cluster	☐
	Can't Tell	☐

Timeframe of intervention	One Time	☐
	1 To 12 Months	☐
	1 To 3 Years	☐
	More Than 3 Years	☐
	Can't Tell	☐
Sample level	Individual	☐
	Household	☐
	Village/Community	☐
	City/Town	☐
	Subnational (District, Province, County, Region, Etc.)	☐
	National	☐
	Other (Please Specify)	☐
Total sample size	0-500	☐
	501-1000	☐
	1001-3000	☐
	3001-5000	☐
	Larger than 5001	☐
Target population level	Individual	☐
	Household	☐
	Village/Community	☐
	City/Town	☐
	Subnational (District, Province, County, Region, Etc.)	☐
	National	☐
	Other (Please Specify)	☐
Target population age	Young Adults (18-35)	☐
	Adults (35-65)	☐
	Elderly (65+)	☐
	Adults (18-65)	☐
	All Ages	☐
	Not Specified	☐
	Other (Please Specify)	☐
Target population living environment	Rural And Urban	☐
	Rural	☐
	Urban	☐
	Can't Tell	☐
	Other (Please Specify)	☐
Are there covariates?	Yes	☐
	No	☐

The paper has only gender as a covariate *If yes, paper has to be excluded*	Yes	☐
	No	☐

Intervention

Social interventions	A. Training	☐
	B. Agricultural Finance	☐
	C. Awareness Programs	☐
	D. Frameworks	☐
	E. Other (Please Specify)	☐
Intervention type (depending on intervention category)	A1. Organisational And Managerial Skills Training	☐
	A2. Farmers Participatory Training	☐
	A3. Agricultural Information Training	☐
	A4. Farmers Field School	☐
	A5. Field Training Information Dissemination Activities	☐
	A6. Provision Of Market Related Information	☐
	A7. Online Training	☐
	A8. Agricultural Advisory	☐
	A9. Extension Services	☐
	A10. Other (Please Specify)	☐
	B1. Microfinance	☐
	B2. Microcredit Programs	☐
	B3. Savings Groups	☐
	B4. Input Subsidies	☐
	B5. Cash Or In-Kind Grants	☐
	B6. Other (Please Specify)	☐
	C1. Information Dissemination Programs	☐
	C2. Information Campaigns	☐
	C3. Other (Please Specify)	☐
	D1. Market Linkages	☐
	D2. Market-Based Regulations	☐
	D3. Market-Based Policy	☐
	D4. Access To Irrigation Facility/ Infrastructure	☐
	D5. Other (Please Specify)	☐

Technological interventions	Improved Seed	☐
	Drought-Tolerant Seed Varieties	☐
	Information On Weather	☐
	Improved Soil Practices	☐
	Improved Conservation Practices	☐
	Irrigation Technologies	☐
	Biofortification Technologies	☐
	Integrated Pest/Weed Management	☐
	Disease Control	☐
	Livestock	☐
	Fishery Management	☐
	Other (Please Specify)	☐
Comparison group	Control Group	☐
	Pre-Treatment	☐
	Other (Please Specify)	☐

OUTCOMES

Outcome timing	Less than a year	☐
	1 To 3 Years (13-36 Months)	☐
	3 To 5 Years (37- 60 Months)	☐
	More Than 5 Years	☐
	Can't Tell	☐
Outcome	A. Women Empowerment	☐
	B. Women Resilience	☐
Outcome type (depending on outcome category)	A1. Decision-Making Regarding Inputs and Methods of Production	☐
	A2. Control Over Household Resources	☐
	A3. Control Over Use of Household Income	☐
	A4. Leadership	☐
	A5. Workload/Leisure Time	☐
	A6. Other (Please Specify)	☐
	B1. Anticipative Capacities	☐
	B2. Improvement In Preventive Capacities	☐
	B3. Absorptive Capabilities	☐
	B4. Adaptive Capacity	☐
	B5. Transformative Capacities	☐
	B6. Other (Please Specify)	☐

Outcome description (repeated for each outcome)		
Impact of intervention or Direction of the effect (repeated for each outcome)	Positive Effect Favours Treatment	☐
	Positive Effect Favours Comparison	☐
	Can't Tell	☐
Target population age of outcome (Repeated for each outcome)	Young Adults (18-35)	☐
	Adults (35-65)	☐
	Elderly (65+)	☐
	Adults (18-65)	☐
	All Ages	☐
	Not Specified	☐
	Other (Please Specify)	☐
The paper should be included	Yes	☐
	No	☐
Notes about study in general		

A.7 Appendix VII – GRADE Assessment form

	Argument	Rating
Study design	RCT	4
	Quasi-experimental design	3
	Quasi-experimental design with limitations	2
	Quasi-experimental design with severe limitations	1
	RCT with multiple methods	4
	RCT with one method	3
Limitations or expansion of study design	Multiple methods: e.g., DiD + Matching (e.g. PSM)	3
	Only one method: e.g. just DiD or PSM	2
Risk of Bias	Biased checked and controlled	0
	Less clear bias noticed (no self-selection controlled, small sample size)	-1
	More clear bias (with uncontrolled self-selection, small sample size)	-2
Inconsistency of results within study	If authors verify heterogeneity of results and it's well explained	0
	If authors didn't verify heterogeneity of results	-1
	If authors verify heterogeneity of results and it's badly explained	-2
Indirectness of evidence	Clear that overarching question of our EGM gets answered less directly by investigating the outcome	-1
	Not clear whether the outcome is directly aligned with overarching question	0
Imprecision within study	If point estimates and confidence intervals differ widely across model specifications/outcome measures	-1
	If point estimates and confidence intervals differ widely across model specifications/outcome measures and results insignificant	-2
Large effect size	Don't grade if effect size is reported as 'small' or 'moderate' or (economically) insignificant/close to 0 (while being statistically significant)	0
	Grade up if authors consider this as 'high' or 'strong' evidence	1
More intense intervention leads to stronger effect	If treatment intensity doesn't vary (1, 0 dummy)	0
	If higher treatment intensity leads to stronger effect	1

All confounding would reduce strength of result	If the absolute value of beta without controls is smaller than with controls	0
	If the absolute value of beta without controls is higher than with controls	1
Publication bias	Study funded by industry that benefits from results provided/other conflicts of interest reported	-1
	Unclear if publication bias exists/study is in form of report or grey literature that (usually) is not subject to publication bias incentives	0

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(Footnotes)

1 Reminder to the reader: Market frameworks include programmes for market linkages, access to irrigation facilities and physical infrastructure, land-rights, contractual agreements between producer groups and agribusinesses, and farmer organisations.