Mitig Adapt Strateg Glob Change (2024) 29:14
https://doi.org/10.1007/s11027-024-10108-6

ORIGINAL PAPER

Finding climate smart agriculture in civil-society initiatives

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Received: 31 August 2023 / Accepted: 2 February 2024 / Published online: 20 February 2024

Abstract

International civil society and non-government organisations (NGOs) play a role in implementing agricultural projects, which contribute to the mitigation, adaptation, and food security dimensions of climate-smart agriculture (CSA). Despite the growth of CSA, it remains unclear how CSA is designed, conceptualised, and embedded into agricultural development projects led and implemented by NGOs, creating a lack of clarity as to the direction of future of agricultural development interventions. This paper examines the extent to which development programmes from the NGO sector actively incorporate CSA principles to benefit smallholder farmers under the major pillars of CSA. Drawing from six projects' documentation since 2009, we conducted a thematic analysis to reveal the alignment of projects with the pillars of CSA and discuss the extent to which CSA allows for localised adaptability given the diverse agricultural contexts in which civil society and NGOs work. We find that despite a lack of clarity in CSA definition and focus, the agricultural practices in the six projects make heterogenous contributions to the adoption of CSA principles. We illustrate the diversity of ways in which CSA is 'done' by a global NGO across six areas: greening and forests, practices and knowledge exchange, markets, policy and institutions, nutrition, carbon and climate, and gender. We discuss the need for balance in contextual adaptability across the three pillars of CSA with explicit consideration of trade-offs to reduce unintended outcomes from CSA initiatives. We conclude with reflections on the role of civil society and NGOs as boundary agents in the agricultural development sector.

Keywords Climate smart agriculture · Civil society · Boundary agents · Food security · Agricultural development

1 Introduction

Agricultural activities take place in 38% of the planet's terrestrial surface, use approximately 70% of global freshwater resources, and when combined with the distribution and processing of products in the food system, contribute up to one third of anthropogenic greenhouse gas emissions (Crippa et al. 2021). Global food demand is projected to increase, from 2009 levels, by 102% by 2050 (Fukase and Martin 2020), underscoring the need for urgent acceleration and transformation in agriculture under rapidly changing climate and socio-political contexts (Hellin et al. 2023). Growing food demand will continue

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to shape agricultural practices and will increase the contributions of agriculture to global emissions (Crippa et al. 2021), intensifying future risks and vulnerability in food systems. Agriculture and the broader food system are embedded in the nationally determined contributions under the Paris Agreement and must contribute to emissions reductions to ensure food security (IPCC 2019; Vishnoi and Goel 2024). They must also respond to food demand and environmental changes through transformative adaptation, which includes changing land and cropping practices, and radically new ways of addressing the social differences that exist in CSA interventions (Hellin et al. 2023).

The concept of Climate Smart Agriculture (CSA) has emerged in response to the interrelated dimensions of adaptation and mitigation in food security. There are two interrelated origin stories of CSA. The first is the prioritisation of agriculture as a driver of livelihoods and development, embedded in the World Bank's 2008 global development report (World Bank 2008). The second is the evolution of the agriculture-climate nexus into a more comprehensive articulation of the CSA concept. This was presented in the CSA foundation report developed by the Food and Agriculture Organization (FAO) (Mann et al. 2009) and the subsequent Nature Climate Change publication (Lipper et al. 2014). In 2010, the FAO paper entitled 'Climate-Smart Agriculture, Policies, Practices and Financing for Food Security, Adaptation and Mitigation' was released as a background paper for the Hague Conference on Agriculture, Food Security and Climate Change held in October of that year (Chandra et al. 2018). Since its definition, CSA commitments have been substantial—$8 billion by the World Bank from 2014 to 2018, $2 billion by the US in South Asia, and much larger amounts in Africa, for example, the US$30 billion Adaptation of African Agriculture Initiative, and DFID's £24 million VUNA programme (Dinesh et al. 2017). In 2023, the United States and United Arab Emirates mobilised over $17 billion for the Agriculture Innovation Mission for Climate as part of the 28th Climate Change Conference of the Parties, and over 150 countries signed a joint Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action (United Nations 2023).

Despite the growth in publication and investments in CSA, it remains unclear how CSA is actually designed, conceptualised, and embedded into agricultural development projects (Gardezi et al. 2022). The diversity of climate scenarios for different agricultural regions, coupled with socio-political structures, makes CSA a complex development activity with interacting global drivers and localised operational politics (Newell et al. 2018; Silberberger and Kimengsi 2021). Furthermore, farmers, as the ultimate adopters of climate smart knowledge and practices, face competing challenges of climate threats, finance, and changing trade and consumption patterns (Cohn et al. 2017). These tensions in 'doing' CSA require a more thorough understanding of how it is embodied in ongoing development projects.

In this paper, we explore how CSA is embodied and implemented in agricultural development projects in Asia and Africa. The aim is to critically reflect on the extent to which development programmes, including those by the civil society sector, actively incorporate CSA principles to benefit smallholder farmers and local communities. The paper makes a novel contribution to understanding of CSA is embodied in civil society initiatives in different parts of the world and proposes how these actors can play a role in balancing the science, local knowledge, and politics that influence CSA. We focus on a civil society organisation—World Vision Australia (WVA)—as a member of a larger World Vision International partnership, which has an active interest in addressing climate change in its development programming and projects and is an instrumental technical support group in funding and on-farm activities. This civil society group has the role of 'observer' in the Global Alliance for Climate Smart Agriculture and actively seeks to reflect on the extent to which they form part of the climate-smart discourse (World Vision International 2022). Furthermore, much empirical analysis of CSA has focused on large projects rolled out by public and private institutions and less on civil society groups (Gardezi et al. 2022; Lipper et al. 2017).

We first review critical stages of development in CSA and define the concept in Section 2, to showcase current debates in the literature on CSA development and adoption. In Section 3, we describe the use of keyword search and thematic analysis applied to selected agricultural development projects in Africa, the Middle East, and Southeast Asia. Section 4 presents the results across seven major categories. In Section 5, we discuss how CSA enables localised adaptability given the diverse agricultural contexts in which NGOs work. We conclude in Section 6 with future directions in managing trade-offs and supporting CSA policy development.

2 Critical developments in climate smart agriculture

CSA is broadly defined as a practice to support agricultural innovations that sustainably enhance agricultural productivity to support increases in incomes and food security; adapt and build resilience to climate change; and develop opportunities to reduce greenhouse gas (GHG) emissions from agriculture, otherwise known as the 'three pillars' of CSA (Chandra et al. 2018; Lipper et al. 2017). Climate-smart options include water-smart, energy-smart, nutrient-smart, carbon-smart, and knowledge-smart practices (Khatri-Chhetri et al. 2017). For instance, water-smart technologies (such as rainwater harvesting, drip irrigation, laser land levelling, and drainage management) aim to improve water use efficiency. Energy-smart interventions (such as minimum soil disturbance and conservation agriculture) target improvements in energy use efficiency. Similarly, nutrient-smart practices (such as intercropping and integrated nutrient management) have the potential to improve nutrient use efficiency. In addition, carbon-smart interventions (including agro-forestry, fodder management, and integrated pest management) aim to reduce GHG emissions (Anuga et al. 2020). Moreover, knowledge-smart practices (such as improved crop varieties and crop planning) and climate-resilient services (such as crop insurance and climate information based agro-advisories) assist climate risk management by combining science and local knowledge (McIntyre et al. 2009). The growth in practices associated with CSA has led to an evolution towards 'broad' CSA practices, which relate to on-farm and value chain activities, and 'narrow' CSA practices, which relate to specific production capacity enhancement on farm activities (Li et al. 2023).

There has been a substantial uptake of the term CSA since the development of the FAO's original technical report and journal publication (Lipper et al. 2014; Mann et al. 2009). These foundational documents have led to literature focusing on approaches for meeting the three pillars of CSA. Technological and scientific understandings of CSA were the focal priorities of studies published between 2011 and 2016, following the expansion of CSA as a dominant framing (Chandra et al. 2018). Among the top 10 most cited 'climate smart agriculture' journal publications over the last 10 years (2013–2022, based on Scopus search March 2022), eight describe technology adoption, interventions, or themes to change and intensify agriculture (Campbell et al. 2014; Dawson et al. 2015; Giller et al. 2015; Harvey et al. 2014; Khatri-Chhetri et al. 2017; Long et al. 2016; Raza et al. 2019; Steenwerth et al. 2014); one is conceptual (Lipper et al. 2014); and one focuses on the gendered dimensions of localised CSA (Jost et al. 2016). Long et al. (2016) focus on the demand side (end-users) and supply side (technology providers) barriers that inhibit adoption of CSA technological innovations. Khatri-Chhetri et al. (2017) assess technological adoption at local scales based on farmers' preferences and willingness to pay for new technologies. Others, such as Giller et al. (2015), examine localised agronomic knowledge production by suggesting a 'systems agronomy' approach which demands a shift from adapting principles or technologies to local circumstances, towards co-learning and local agronomic knowledge production. This approach seeks to understand farming households and farming systems and to propose a suite of pathways for changing agricultural systems at local scales (Giller et al. 2015). The Consultative Group on International Agricultural Research (CGIAR) links CSA with the concept of sustainable intensification, with a focus on changes to farm practices that intensify production while addressing CSA's three pillars (Campbell et al. 2014). The CGIAR and FAO publications emphasise the need to support climate-resilient pathways through a combination of evidence, strengthening national and local institutions, developing coordinated policies, and acknowledging trade-offs in interventions (Lipper et al. 2014). A comprehensive review of progress in planning for and assessing CSA across regions (Lipper et al. 2017) concluded that CSA remains an evolving concept that has been implemented in different ways, yet the approach is ultimately unified by a focus on diversity of solutions, markets and supply chains, innovation and learning, and trade-offs and risk management towards climate change.

The heterogeneous and adaptive nature of CSA means assessment is complex and context specific (Zilberman 2017). For example, van Wijk et al. (2020) critique CSA for lacking clear indicators of progress and for the ad hoc nature of CSA projects. They conclude that improvements in understanding of CSA will come through a more comprehensive monitoring of productivity gains for food security and of the environmental contributions of changes in practices at the farm and landscape levels. Analysis into the overall progress in thinking and practice of CSA has largely focused on the discourse and policy of CSA (Chandra et al. 2018) or the adoption and testing of CSA largely in developing country contexts (Lipper et al. 2017). More recent scholarship in social science and political economy has critiqued the technocratic focus of CSA, which fails to acknowledge the underlying structural power dynamics and drivers of vulnerability that affect smallholder farmers (Clay 2023; Newell and Taylor 2017). Civil society groups criticised CSA as a discourse in the lead-up to the formal definitions, noting that it excludes the knowledge of millions of smallholders and perpetuates business-as-usual agriculture through top-down mechanisms (Ewbank 2015). In a critique of the top-down, globally driven discourse of CSA, Taylor (2017) argues that it fails to address the systemic inequalities in food production and consumption that create vulnerability and food insecurities. Furthermore, the focus on agriculture alone limits CSA's ability to address climate change to one part of a wider food system, which includes distribution, consumption, and waste management, and which contribute to up to one third of greenhouse gas emissions (Crippa et al. 2021). Taylor (2017) argues that the growing push for CSA by multilateral agencies and corporations inhibits its ability to radically move food systems in more sustainable and equitable directions and rather perpetuates the technocratic focus of agricultural development. Newell et al. (2018) explore the place-based challenges of CSA through examining how agricultural development projects in Kenya fail to adapt to the pressures of 'solutions' to align with global Sustainable Development Goals and the localised realities of smallholder farming systems. Institutional pressures to 'do' CSA risk further amplifying the underlying structural inequalities that perpetuate food insecurity, such as market dependence for basic food, inadequate commodity prices for smallholders, and poor access to social protection and institutional support (Taylor 2017). Analysis of ten years of research led by the CGIAR in Tanzania indicates consistent positive impacts on productivity, mixed impacts on resilience, short-term negative impacts on emissions intensity, and highly variable impacts on socioeconomic characteristics (Jones et al. 2023). Much CSA discourse and implementation are also silent on gender relations, existing power imbalances and norms, as well understood drivers of equity in agriculture. Jost et al. (2016) explore women's limited adaptive capacity within male dominated decision making systems, leading to their exclusion from CSA extension services. Gender lenses on CSA indicate that there is a risk the same agricultural practices, asset and land ownership, and knowledge exchange processes will be perpetuated (Collins 2017).

Despite the growing criticism, CSA remains dominant in sustainable development reporting and among its advocates. The most recent United Nations Food Systems Summit saw the World Economy Forum and the World Bank explicitly advocate for CSA. To understand how CSA has permeated global institutions, Gardezi et al. (2022) analysed documents from major international organisations at the forefront of CSA research and financing in developing countries. Their analysis indicates, as others have indicated, a continuous alignment between 2010–2020 of CSA with techno-managerial interventions, and an absence of attention to CSA governance and effectiveness to address its core aims. They also found a notable absence of gender mainstreaming in CSA documentation over a 10-year period. While this analysis is useful and encompasses important actors in the global architecture of CSA (Newell and Taylor 2017), there is a notably limited analysis of how civil society actors influence CSA. This is surprising given the potentially transformative role such actors play in shaping global discourse on agriculture, for example, through normalising agroecology and food sovereignty principles in global fora (Brem-Wilson 2015). In 2014, civil society groups coalesced around the ‘Climate Smart Agriculture Concerns’ group, which included La Via Campesina, Oxfam, Greenpeace, and Action Aid International. Additional organisations, including Caritas International, and the CIDSE (Coopération Internationale pour le Développement et la Solidarité), have raised concerns with the biotechnology and genetic engineering biases of CSA. Newell and Taylor (2017) argue that the wide heterogeneity of international NGOs makes it difficult to determine how they fit within the CSA global implementation system.

Civil society is broadly defined as actors or groups that pursue particular interests but are not affiliated with official government entities (Böhmelt 2013). In the climate change domain, civil society has been highly active in mobilising advocacy for mitigation and adaptation (Böhmelt 2013). Similarly, in food security advocacy, civil society groups cover a wide spectrum of issues ranging from influencing formal policy to radically transforming agri-food systems structure (Canfield et al. 2021). For this paper, we focus on civil society in the form of an international non-government organisation (NGO),[1] with sub-offices in countries in which it operates. As a major international civil society actor, World Vision (WV) continues to advocate for sustainable development dedicated to working with children, families, and communities to overcome poverty and injustice. WV actively links issues of poverty reduction and inequality with the climate crisis and increasingly focuses on embedding climate action into its programme. World Vision and its associate country offices play crucial roles in both acquiring funding and designing projects and in providing technical support to farmers and communities involved in projects. This dual-role makes them an important agent in linking development finance with on-farm practices. A 2022

[1] We use NGO and civil society interchangeably in this article.

review by WV was undertaken to understand how its programmes address environmental and climate change challenges (World Vision International 2022). From a total of 1100 projects across 46 countries, the review found WV contributes to climate change adaptation and mitigation across eight areas of action. One of these was explicitly CSA, framed as agroecological and conservation agriculture, which was separate to investments in natural resource management, agroforestry, and water management—all in theory contributors to making agriculture more climate resilient. This fragmentation of CSA within the NGO indicates a need to further understand the nuances of what lies within the framings and approaches to agriculture that could be labelled CSA. Furthermore, exploring how a civil society group has undertaken interventions in agriculture allows opportunities for learning and identifying strategies to ensure that design of future CSA-based programs is systemic and cognisant of the well-established limitations and critiques of globally framed CSA interventions.

3 Methods

We selected six development projects focused on smallholder agri-food systems that claimed linkage to CSA themes and used available documentation covering both project inception (including design of approaches) and implementation (outcome-focused reporting at mid-term or end of project) phases. These projects were selected on the basis that they represented a range of geographical regions (East Africa, South and Southeast Asia), had sufficient documentation to allow analysis, and included both single country projects and multi-country programs (Table 1). While the World Vision partnership has an extensive portfolio of projects, the regions and projects selected are illustrative of the scale and type of projects the partnership delivers in the context of sustainable agriculture and food security. While further projects and programs had to be omitted due to research scope, we expect similar characteristics of CSA to be embedded in them. Five projects were implemented after the 2009 definition of CSA, and one (Humbo, Ethiopia), which began in 2006, is a unique long-term 30-year initiative to support carbon sequestration through the carbon market. All projects were financed by a range of donor organisations, in partnership with country-level implementation agencies such as WV. WVA and the associated offices in-country were core to the projects and involved in both the conceptualisation and implementation. For multi-country programs, one location was selected on the basis that it best satisfied the other selection criteria (e.g. Kenya within the Regreening Africa and DryDev projects). These six projects were considered by the research and NGO author team to be a reasonable representation (rather than a comprehensive survey) of what WV, or any other international development agency supporting food security or climate-resilient livelihoods programming, might be actively engaged in. This is because the projects were often funded by Organisation for Economic Co-operation and Development (OECD) donors, had a combination of local and international partners, and targeted smallholders as the beneficiaries of the work. The selection was also intended to be heterogeneous to cover a diverse range of contexts and applications. Expansion of the set to consider additional projects could be considered for future analysis.

Document review analysis was applied to each report, which consisted of extraction of project objectives and theory of change (where available) followed by keyword search and manual thematic analysis (Bowen 2009). Document review is a valid methodological approach for understanding the underlying foundations of a particular research or policy

Table 1 Attributes of projects shortlisted for document analysis

Project	Implementing partner	Country focus	Funding amount and source	Number of household/ farmers targeted	Timeframe	Documents reviewed
Humbo Assisted Natural Regeneration Project (Humbo)	World Vision Ethiopia (WVE); World Vision Australia (WVA)	Ethiopia	US$ 1,157,413[1] WVA, carbon finance through commercial sale of carbon credits	41,529 persons direct beneficiaries	2006–ongoing	Baseline, project design, evaluation final report
Regreening Africa (Kenya)	World Agroforestry Centre (ICRAF), Oxfam, Care International, Catholic Relief Services, and Sahel Eco, World Vision Australia (WVA)	Ethiopia, Ghana, Kenya, Mali, Niger, Rwanda, Senegal, and Somalia	European Commission's financial contribution: EUR 21,736,113.95 (87%) Implementing partners' contribution: EUR 3,247,925 (13%)[2]	500,000 households	2017–ongoing	Design document, end of year 3 progress report
Australia Afghanistan Community Resilience Scheme (AACRS)	World Vision Afghanistan, Voice of Women Organisation (VWO), World Vision Australia (WVA)	Afghanistan	$5,576,353[3] Australian Government Department of Foreign Affairs and Trade (DFAT)	115,000 individuals	2014–2018	Baseline, mid-term review, theory of change, endline report
Better Food, Better Health (BFBH)	World Vision Timor-Leste, Government National level Ministries and Private Sector partners, World Vision Australia (WVA)	Timor-Leste	USD 6,772,995[4] DFAT (ANCP)	31,806 direct beneficiaries	2017–2021	Design document, endline report, M&E strategy

Table 1 (continued)

Project	Implementing partner	Country focus	Funding amount and source	Number of household/ farmers targeted	Timeframe	Documents reviewed
Accelerating Health Agriculture and Nutrition (AHAN)	World Vision International (World Vision Australia, and World Vision Lao PDR), Agronomes et Vétérinaries Sans Frontières (AVSF), Burnet Institute and Green Community Development Association	Laos	USD 3,809,467[5] European Union, DFAT (ANCP)	31,673 direct beneficiaries	2018–ongoing	Design document, theory of change, log framework
Drylands Development Programme (DryDev), Kenya	World Vision Kenya, Stichting Nederlandse Vrijwilligers (SNV), Caritas, Adventist Development & Relief Agency (ADRA), World Vision Australia (WVA)	Kenya, Ethiopia, Burkina Faso, Mali, Niger	USD 6,875,720 (DryDev Kenya total budget)[6] (DGIS funding USD 5,177,500 and World Vision Australia funding USD 1,698,220) Directorate-General for International Cooperation (DGIS) of the Netherlands' Ministry of Foreign Affairs, World Vision Australia (WVA)	282,719 farmers	2013–2019	Programme implementation plan, end of project report

[1]Evidence of Impact: FMNR 2019, World Vision Australia

[2]Total project budget across 7 countries, as per Regreening Africa Consolidated Annual Report Year 4 (2021)

[3]Mid Term Review of the Australia Afghanistan Community Resilience Scheme (AACRS), Final Report 2017

[4]Project Endline Report 2022, World Vision Timor-Leste

[5]Project Design Document 2019, World Vision Australia, World Vision International

[6]Final Report, The Dryland Development Programme (DryDev) p 9- PIP, 2020, The World Agroforestry Centre (ICRAF)

topic (Grant and Booth 2009; Snyder 2019) and has been applied in other climate smart agriculture discourse analyses (Chandra et al. 2018; Gardezi et al. 2022). We first coded project objectives and change theories against the three major pillars of the FAO framework to determine the extent of alignment with CSA principles. Following this, we coded documents for the six selected projects. We used the functionality within MS Word or Adobe Acrobat software (depending on the source file) to search for a pre-defined set of keywords within each document related to pillars of CSA.

To overcome the potential limitation of using the overarching terms from the CSA framework (*adaptation*, *mitigation*, and/or *food and nutrition*), we developed an expanded set of keywords (or word stems) that are implicitly associated with these broad areas of CSA and its implementation. For example, project documentation more frequently used terms related to practices or outcomes associated with the CSA pillars than to the pillars themselves. Furthermore, we sought to distinguish between the meaning in English of terms such as mitigation (i.e. the act of reducing how harmful, unpleasant, or bad something is, Cambridge 2023) from its specific application to climate change in CSA. Word stem searches used a wildcard (i.e. '*') to identify alternate spellings and variations on a root word. The set of keywords included: adopt*, practice, tech*, and input (for adaptation); carbon, forest and green* (for mitigation); hunger, nutri*, and market (for food and nutrition); and climate, efficien*, resource, institution, policy, knowledge, and gender (general terms associated with development projects that also could be linked to CSA). The frequency of appearance of the keyword in each document was recorded, and the phrase in which it appeared was extracted to a spreadsheet. Documents for projects from inception and design, implementation, and outcomes phases were analysed and results pooled for each project. Where keywords appeared in document headings, tables, captions, names of organisations, or administrative details of projects, they were excluded from the analysis. For each keyword, extracted phrases were examined to identify recurrent themes and repeated associations with other keywords. The relative frequencies of keywords for each project were visualised as a series of tree-maps (MS Excel), which are used to display hierarchical data in colour-coded rectangles proportionally sized according to the amount of data in each category.

4 Results

Here, we present results from the application of a CSA-based framework across six WV projects in several geographical regions. We first present the objectives of the projects in the context of the three pillars of CSA. We then present the major dimensions of CSA represented in project reporting documents and focus on the most common issues covered. Throughout, we illustrate how the framing of the projects led to the implicit recognition and focus of categories of CSA.

4.1 Project objectives in the context of CSA

None of the projects analysed were explicitly designed as CSA projects (Table 2). All three Africa activities had a strong focus on smallholder farm systems and the regeneration of landscapes through the re-establishment of traditional tree species. The Africa activities, plus BFBH Timor-Leste, promoted Farmer Managed Natural Regeneration (FMNR) as the agricultural practice of focus. FMNR was featured as a major contributor to addressing

Table 2 Agricultural development projects included in the CSA analysis

Project	Objectives (as per project documents)	Initial screening of CSA focus	Agricultural practice in the project
Humbo	1. The regeneration of native forest, utilizing the farmer managed natural regeneration (FMNR) and traditional forest establishment techniques 2. The enhancement of GHG removals by sinks in the project area 3. The promotion of native vegetation and biodiversity in the project area, which can be utilized as a refuge for local and migratory species and to improve the connectivity of fragmented forest resources 4. The reduction in soil erosion and flooding, and help maintain supply of the subterranean streams to support the regions water supply 5. The provision of income stream for communities through sustainable harvesting of forest resources	This project focuses on the regeneration of 2724 hectares to generate 29,000 t of CO_2e per year. The project explicitly mentions addressing 'climate change mitigation objectives by contributing to greenhouse gas removals by sinks through assisted natural regeneration'. The project gives specific focus to endemic indigenous species While not explicit, an unintended impact of the project may be the adaptation potential of reforesting landscapes and reducing soil erosion and flooding risk No clear FNS contribution, besides assumption that reduction in flash flooding will improve incomes, and that incomes will be used to purchase nutritious food	Practices as FMNR (planting seedlings, cultivate seedlings, protect seedlings with fence, diversion ditch/soil conservation, watering seedlings, pruning seedlings, forest preservation) Diversity of tree species (Eucalyptus, Grevillia, Cordia, Mango, Moringa, Coffee, Avocado, *Azadirachta indica*, Balanites, Acacia)
Regreening Africa	1. To equip partner countries with the tools they need to accurately understand land degradation dynamics to influence policies and interventions 2. To reverse land degradation across those countries through interventions that promote a re-greening of the landscapes	This project focuses on landscape surveying and monitoring, with the aim of reforesting (i.e. regreening) the landscape through farmer managed natural regeneration (FMNR) Project objectives and subject matter relate to mitigation, with possibility of linking to long-term adaptation. These terms, however, are not core to the objectives There is no direct focus on FNS	Regreening options (FMNR, agroforestry tree nursery establishment and seedlings production, tree planting, enrichment planting, fruit tree farming, landscape restoration) Water harvesting, soil, and water conservation Value chains strengthened (honey/bee keeping, pawpaw, medicinal products, avocado, mango, Moringa)

Table 2 (continued)

Project	Objectives (as per project documents)	Initial screening of CSA focus	Agricultural practice in the project
AACRS	1. Ensure families are more food secure 2. Producers sell more produce in existing and new markets 3. The vulnerable including women headed households are benefiting from project initiatives	It is too difficult to ascertain any detail from these high-level objectives related to CSA. Specific outputs in the project theory of change focus on a number of agriculture activities such as high yielding wheat varieties, integrated pest management, afforestation, and reduction of erosion A very strong focus is given to market access and income generation. Food security is associated with a combination of higher production and income generation There is no clear climate change focus	Improving agricultural production through adoption of techniques and technologies by targeting crops of soybeans, wheat, potato, pistachios, and honey Focused agricultural practices include irrigation practices (drip irrigation, water harvesting, basin irrigation, furrow irrigation) and crop management practices (row planting, weeding, disease management, pesticides, fertilizers, improved seed procedures)
BFBH	1. Caregivers of under 5 children have improved nutrition, hygiene, and health-seeking practices 2. Households have improved access to superfoods 3. Households have increased income from superfood production 4. Improved sustainability of health and agriculture services	The project objectives are most closely associated with the FNS dimensions of CSA. 'Superfoods' in the objectives are assumed to lead to improve consumption of healthier food No clear links to climate change or adaptation or mitigation pillars of CSA	Adoption to nutritionally diverse 'Superfoods' crops, i.e. soybeans, mung beans, red kidney beans, orange sweet potato, Moringa Agricultural techniques such as FMNR, perennial kitchen gardens supporting 'superfoods' production
AHAN	1. Improve dietary and care practices among women of reproductive age and children under five 2. Reduced incidence of selected water, sanitation, and hygiene (WASH) related diseases/illness linked to malnutrition 3. Improved gender relations at household level, particularly in decision-making and distribution of workload	The objectives have explicit gender focus on household relations and gender dynamics—a core contributor to long-term FNS. WASH focus can also improve nutrition outcomes through improved health No clear links to climate change or adaptation or mitigation pillars of CSA	Training, supporting households to improve their crop production (through home gardening and rice cultivation) Land use mapping and participatory natural resource management (NRM) planning

Table 2 (continued)

Project	Objectives (as per project documents)	Initial screening of CSA focus	Agricultural practice in the project
DryDev Kenya	1. Increased water capture and soil conservation/fertility at sub-catchment and farm levels 2. Increased production of profitable, climate-smart commodities and food crops 3. Increased sales of targeted value chain commodities by male, female, and vulnerable farmers 4. Improved local governance and farmer organization functioning 5. Critical mass of development actors motivated, able, and resourced to support/directly implement evidenced options 6. More supportive/appropriate policies and wider institutional environment conducive for wide uptake of evidence	Objectives explicitly mention 'climate smart' commodities and farm practices associated with supporting adaptation of farm systems Focus on productivity and markets is an element of FNS; however, explicit FNS focus is unclear Mitigation is unclear from project objectives	Water-efficient land management Practices/technology promoted (drip irrigation, measured irrigation, two-wheel tractor, capillary wick irrigation system, seeding of denuded land using seed balls) Land restoration commodities (green grams, honey, indigenous chickens, mango, cowpeas and pigeon peas) Increased yield productivity and livestock

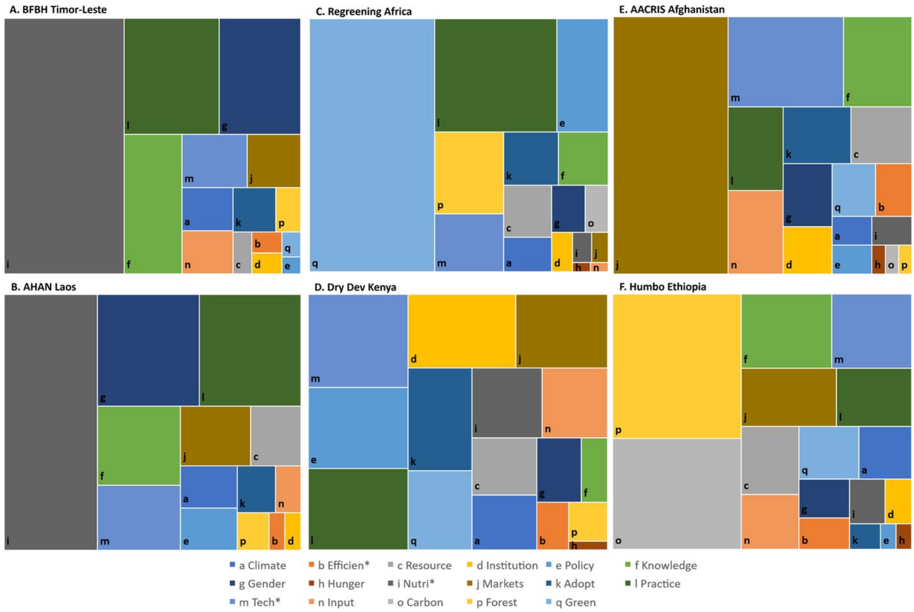

Fig. 1 Thematic map of frequency of keywords associated with CSA extracted from reports on selected agricultural development projects

climate change in the review by World Vision International (2022). This review states that 'FMNR has an immediate positive effect on the environment and micro-climate in the respective area under practice, while it can easily be integrated with additional measures such as CSA in order to tap its full potential'. Mitigation was considered in the Africa projects through the carbon sequestration delivered in FMNR. However, mitigation through carbon sequestration and generation of carbon credits was a core component of Humbo Ethiopia, with the most recent project design document indicating that 863,183 tonnes of CO_2e is expected to be sequestered over the project's lifetime. Food and nutrition security (FNS) featured in BFBN Timor-Leste associated with the aim of promoting the production of high nutritive-value crops, or 'superfoods', for consumption and sale—perpetuating the notion that food security is achieved through increasing productivity. Only AHAN Laos explicitly considered gender, seeking to improve dietary (i.e. malnutrition reduction) and care practices (e.g. hygiene) among younger women and children to integrate gender and food security concerns. Other projects did not explicitly mention gender as an objective; however, sub-activities did focus on women's health and development. There was no explicit mention of adaptation or related concepts in the SE Asia projects' objectives.

4.2 Key terms and their connections to climate smart agriculture

4.2.1 Greening and forest

The keywords *green** and *forest* appeared most frequently in projects that incorporated objectives to reverse land degradation through FMNR (Table 2). Of the six projects analysed, Regreening Africa and Humbo Ethiopia used the dissemination of FMNR practices as the preferred approach to promote land remediation among smallholder farmers. In these projects, visualisations of the relative frequencies of appearance of CSA keywords were dominated by these terms (Fig. 1C and F). The term *green** was most frequently used in Regreening Africa. Thematic analysis indicated that it was associated with two related concepts: *green*ing practices and re*green*ing. Although we initially considered *green** to be part of the mitigation pillar of CSA, in the context of Regreening Africa, it was more closely aligned with adaptation action than with carbon sequestration. In Humbo Ethiopia, while it appeared with reduced frequency, *green** was mainly associated with the role of vegetation in carbon sinks and carbon credit schemes. Keyword *forest* replaced *green** in Humbo Ethiopia as the most frequently used CSA-related term (it was the third highest in Regreening Africa). However, as with *green**, use of *forest* in Humbo Ethiopia was related mainly to mitigation through carbon sequestration, while in Regreening Africa, it was more aligned with adaptation through the adoption of agro*forest*ry practices to improve land use sustainability, expand livelihood options, and develop alternative value chains.

In other projects, both terms appeared less often, or not at all (e.g. *green** in AHAN Laos). The exception was DryDev Kenya, where *green** was associated with the successful adoption of a new better adapted crop, green gram. While BFBH Timor-Leste incorporated FMNR principles, regreening or agroforestry themes rarely appeared in the context of the aim to increase superfood production (discussed in the Nutrition theme below).

4.2.2 Practice, technology, adoption, knowledge

These keywords appeared with varying frequency in all projects (Fig. 1). We associated the terms *practice*, *tech**, and *adopt* primarily with the adaptation pillar of CSA, and thematic analysis indicated that they were used in that context in the project reports. *Knowledge* was generally used in relation to knowledge sharing and agricultural extension (e.g. Regreening Africa and DryDev Kenya). These often appeared together in phrases such as ‘adoption of new practices and technology’. In particular, DryDev Kenya, which was the only project that directly referenced in documentation ‘CSA production practices’ and ‘knowledge of CSA’, listed sets of practices that were promoted through the project, including: ‘(a) rainwater harvesting (e.g. zai pits); (b) agroforestry; (c) on-farm FMNR; (d) soil conservation (e.g. contour bunds) and fertility enhancement (e.g. micro-dosing); and € small-scale irrigation’. However, while not explicitly linked with CSA through the thematic analysis, the implication was that they defined CSA within the project.

Adoption of technologies and practices was also present in projects focused on markets and nutrition. In BFBH Timor-Leste, a major component was the extension of superfood crops (such as pulses and orange sweet potato). Knowledge and practices were associated with changes in habits in the establishment of superfood production and changing practices related to hygiene, notably in water use and sanitation. AHAN Laos also had a strong focus on supporting the growing and consumption of high-nutrition foods and their sale to markets as a way of commercialising agriculture.

4.2.3 Markets

In AACRS Afghanistan, *markets* was the most frequently used keyword (Fig. 1E). In other projects, the term appeared less frequently. Thematically, the term was used in two contrasting ways. In all projects, except AHAN Laos, the word was linked to food security through increased productivity that enabled sale of excess produce into new and existing markets. To achieve this, smallholder farmers required improvements in market access, demand, linkages and prices for the surplus produce. The concept of sustainable intensification was occasionally explicitly associated with *markets*, as in Regreening Africa, ‘access to profitable markets for agricultural produce is a major driver for sustainable intensification’. However, in AHAN Laos, this keyword was associated with ‘creating a supply chain to strengthen the market for sanitation products, linking with small, local concrete or hardware businesses to assist with poverty reduction through development of sanitation within villages.’ That is, creating market linkages to allow communities to purchase products rather than to sell them. Although the aim of Humbo Ethiopia was to create an income stream from carbon sequestration, this activity was not closely associated with the need for access to carbon markets in project documents.

4.2.4 Policy and institutions

The use of *policy* and *institutions* varied among the projects. In BFBH Timor-Leste, there was a focus on local and community-based institutions. For example, the project sought to use Tara Bandu, a local form of community law, to encourage the reduction of harmful agricultural practices, including tree-cutting, over-grazing, and slash and burn agriculture to restore the landscape. In contrast, in Regreening Africa, *policy* and *institutions* most often related to engaging government agencies, policy makers, and processes to ensure support for FMNR practice adoption.

While examination of changes in frequency of use of keywords between project stages was not the focus of this study, nevertheless, the analysis did suggest subtle shifts in emphasis from initial to outcome phases of projects (not shown). Initial documents generally covered a much broader range of issues/concepts than outcomes, which involved reporting on metrics, uptake, and dissemination of practices. For example, in DryDev Kenya, *policy* and *institutions* appeared more frequently in outcome reporting than in implementation. Thematically, this change signalled the need for altered local governance to sediment and expand successful practice adoption in communities.

4.2.5 Nutrition

The use of *nutri** related terms was limited in all three Africa projects (bottom right quadrant, Fig. 1C, D, and F). While human nutrition was not the focus of these projects, there was recognition that, through adoption of FMNR, the ‘selection and planting of appropriate trees can complement naturally regenerating ones, for example to improve nutritional outcomes, enhance household incomes, or to provide a perennial fodder, fruit or timber source’. The role of trees in nitrogen fixation and nutrient cycling was also a minor theme in these projects, aligning their aims more closely to the themes in the FAO framework.

Themes in BFBH and AHAN were explicitly aligned with human dimensions of nutrition. These projects targeted activities related to changing practices and building knowledge around hygiene, breastfeeding, and consumption of healthier foods. Improvements in nutrition from agriculture were largely related to food grown at household level—a common aspect of smallholder farming systems.

4.2.6 Carbon and climate

Carbon rarely featured in keyword searches of project documents with the exception of Humbo Ethiopia where it was frequently related to development of 'cooperatives to manage the forest and the revenues generated through carbon credit sales'. Where carbon appeared in Regreening Africa, it was associated with improvements to soil health.

While all project documents contained the keyword *climate*, it was primarily associated with climate change as an underlying driver of local community vulnerability and the need for NGO intervention. For example, *climate* appeared in AACRS Afghanistan; thus, 'the overall mission is to enable vulnerable Afghan farmers to adapt to climate change and support them to mitigate the impacts'.

4.2.7 Gender

Gender appeared with relatively greater frequency in the projects situated in Southeast Asia (BFBH Timor-Leste and AHAN Laos), as these were more focused on human nutrition (of women and children), than those in Africa, which aimed to remediate land degradation. In Regreening Africa, although a minor theme, *gender* was strongly linked with *resources* and related to the recognition of women's roles and the need for their inclusion in decision making on natural resource management.

5 Discussion

Agriculture urgently needs to address its substantial contributions to GHG emissions, and adapt to the increasing impacts of climate change (IPCC 2019). CSA continues to be promoted as a set of techniques and strategies able to balance adaptation and mitigation, while also supporting food security. Three major pillars of CSA—mitigation, adaptation, and food and nutrition security—remain core to the conceptualisation of trade-offs in agricultural research and development. Our study sought to explore the expression of CSA in agricultural development projects implemented by a large NGO in Asia and Africa. We found that WV activities in different countries have specific design and implementation elements that contribute to the three pillars of CSA. None of the projects analysed were explicitly designed using CSA as a guiding concept; however, we found that depending on the project context and theory of change, CSA was manifested in different ways. Here, we discuss the results within the three original pillars of CSA as presented by the FAO's leading documents on CSA (Mann et al. 2009). We provide insights into the adaptative nature of CSA and offer avenues for NGOs in addressing the challenges in explicitly taking a CSA approach to development projects.

5.1 Climate framings in agricultural development projects

All projects showed alignment with at least one of the three pillars of CSA, although this was usually implied from project aims and activities rather than explicit design and mention in the projects' theory of change. There were often connections between two of the pillars, but very few linking the three pillars. This was unsurprising, given that CSA literature frequently emphasises trade-offs and complementarity between pillars, notably mitigation and food security. For example, DryDev was the only project to link climate-smart practices with the production of commodities (World Vision Australia 2018). Siloed focus on individual pillars was, however, the most common approach, for example, AHAN's detailed emphasis on nutrition sensitive value chains, or AACRS's focus on increasing yields of cash commodities. Neither of the projects built-in short-term climate contexts nor long-term projections of stressors affecting either country.

The definition of 'climate change' and climate was notably absent from the six projects but is a fundamental contextual concept in designing CSA interventions. Where climate change was present, it was contextual as a driver of vulnerability to the rural communities, rather than an overarching systemic driver of long-term agricultural productivity and food security. Only one project included CSA as an aim (DryDev), but it did not explicitly define which of the practices promoted in the project constituted CSA. Rather, the project documents assumed that the practices were in aggregate contributing towards aspects of climate-smartness. In the literature, CSA is frequently presented and critiqued as a largely technology-driven scientific process to improve productivity, ranging from agroforestry to biotechnology implementation (Kombat et al. 2021), aligning with the traditional approaches proposed in the CSA conceptual document. Project interventions were often described in generic terms, and there was no evidence that they were guided by local or regional climate projections. Without explicit focus on climatic contexts, the projects analysed indicate a need to be more adaptive and flexible to the local conditions. For example, the FMNR practices in three projects (DryDev, Humbo, and BFBH) are largely focused on agroforestry practices and crop-livestock integration systems. These systems are likely more aligned with traditional land management in the countries of implementation (Ndegwa et al. 2017). It is possible that the local implementation of interventions varied with the required level of climate response that our analysis was unable to detect. The use of climate projections and future models in planning for agriculture is an essential element of building food systems capable of managing projected climate futures (Caron et al. 2018). Overall, designing explicit CSA projects will require some basic contextualisation of the short-term, long-term, and extreme climate risks to agricultural systems and communities. Developing countries, where most smallholder farm systems doing CSA receive international funds, are increasingly incorporating CSA into their agricultural policy as a pathway towards meeting their national determined contributions under the Paris Agreement (Hrabanski and Le Coq 2022). These globally driven CSA discourses and policies, however, require increasing use of local solutions and domestic policy coherence that supports the local knowledges and contextual understandings of the agricultural systems adapting to climate change (Carter et al. 2018; McIntyre et al. 2009).

5.2 Mitigation

Mitigation of GHG emissions from agriculture has been a major priority of CSA activities. The urgency to mitigate emissions from agriculture is undisputed. The most recent IPCC synthesis indicates that emissions from crop and livestock will increase by 30–40% by 2050 under business-as-usual practices, translating to agricultural emissions of 8–9 Gt CO_2e per year by 2050 (IPCC 2019). The IPCC further notes that emissions can be reduced by increasing carbon sequestration in soils and biomass. Agroforestry, reforestation, and associated regreening practices can play a role in building such soil stocks (Lasco et al. 2014). Previous analysis of CSA narratives in Africa has found that building soil organic carbon and agroforestry are dominant in Southern and Eastern Africa CSA projects (Anuga et al.

2020). In alignment, our analysis shows that soil carbon and reforesting landscapes were core approaches aligning with CSA in Africa WV projects. The results pointed towards different framings of land-based restoration and carbon sequestration—offering diversity of pathways for CSA design. For example, Dry-Dev had an explicit orientation towards adaptation and climate-smart commodity production, while Humbo focused on carbon markets for income generation. Framing of the purpose of reforestation illustrates how CSA can take different forms. Humbo, as a multi-decade initiative, has an explicit project design to work towards sequestering carbon and contributing to carbon markets (Murugan and Israel 2017). Carbon markets may offer long-term incentives for land restoration, but concerns remain as to the extent to which they can truly benefit the rural poor (Siedenburg et al. 2016), and whether mitigation efforts seek to perpetuate business-as-usual inequalities in energy consumption (Hickel and Slamersak 2022). Critically examining how agricultural transformations may generate a burden for the rural poor remains a core element of managing food systems under climate change (Davis et al. 2022).

Mitigation potential of agricultural practices in the Asian projects was unclear, and determining their agricultural contributions to emissions reduction would require specific analysis. Projects in Afghanistan, Timor-Leste, and Laos had a focus on food production but with the ultimate intention of enabling market access (Afghanistan) or diversifying household nutrition (Laos, Timor-Leste). AACRS (Afghanistan) had a major focus on cash commodities, such as potatoes, wheat, and soy. The project's objectives on poverty reduction and food security diluted any possible focus on the contribution of these commodities to greenhouse gas mitigation. The same occurred in Asia; however, the focus there was smallholder plots for subsistence crops, so any mitigation potential would be marginal. The interaction between the crop being promoted through development projects and its associated contributions to emissions would thus require planning in the initial design stages of an explicit CSA project.

5.3 Adaptation

Adaptation to climate change in agricultural systems is defined broadly as the decision-making process and actions implemented to improve the management of agricultural risks from long-term (decadal) incremental changes (e.g. rising temperatures, declining precipitation), enhanced climate variability (causing seasonal weather conditions), and extreme events (such as droughts) (Nelson et al. 2007; Vermeulen et al. 2012). In common with the development projects we analysed, the FAO source document is not explicit about which aspects of climate change CSA should address, although it does reference changes in precipitation and temperature and climate shocks (presumably incremental and extreme events respectively) as drivers of food system vulnerability.

Development projects often target smallholder farmers because of their importance to local food supply and their high degree of vulnerability to climate impacts (FAO 2014; IFAD and UNEP 2013). While a range of initiatives has been identified to assist smallholder farmers manage climate risks (Smit and Skinner 2002), the need for responses in the short-term and a lack of local institutional capacity means that interventions most often target adaption in farm management practices (Vignola et al. 2015). With this observation, the FAO source document on CSA frames adaptation in terms of technology adoption and practice change. Among the development projects we examined, although adaptation was rarely mentioned explicitly, change in farm management was generally promoted to smallholder farmers through technology transfer under traditional models of agricultural extension. One development project, DryDev Kenya, listed practices associated with CSA that included rainwater harvesting, agroforestry, on-farm FMNR, soil conservation and fertility enhancement, and small-scale irrigation (Abegunde et al. 2019). Considered as a package of climate change adaptations, these practices form more immediate responses to seasonal variations in rainfall (e.g. rainwater harvesting) and contribute to longer-term resilience of the agricultural system to shocks and stresses (e.g. soil conservation measures) (Abegunde et al. 2019). In particular, on-farm FMNR and agroforestry are considered 'ecosystem-based adaptation' practices because they regenerate ecosystems, help maintain agricultural yields under climate change, and may buffer the biophysical impacts of seasonal weather variations and extreme events (Vignola et al. 2015). Some practices (e.g. FMNR) have been recognised as also contributing to the mitigation pillar of CSA through carbon sequestration (Anuga et al. 2020). Most of the development projects also sought to contribute through practice change to improvements in food security (the third pillar of CSA) and income generation through the sale of excess produce.

While adaptation to climate change is well represented in project documents, the measure of 'smartness' lies not only in the extent to which an intervention contributes to all of the three CSA pillars, but rather in the avoidance of maladaptation (Barnett and O'Neill 2010), that is, an increase rather than reduction in aspects of future vulnerability (Schipper 2020). While numerous examples of maladaptive outcomes from development interventions have been reported previously (Bruna 2022; Ranjan 2021), including risks in CSA maladaptive outcomes (Hellin et al. 2023), only one of the development projects we examined mentioned maladaptation (Regreening Africa) in relation to the reliance of agricultural intensification on 'expensive external inputs and a conventional agronomic wisdom which often proves to be maladapted to their (smallholder farmers) circumstances'.

5.4 Food and nutrition security

FNS outcomes remain associated with farmers' incomes and production of nutritious foods. The focus on productivity is unsurprising given the powerful narrative of doubling food production by 2050 embedded in the Sustainable Development Goals (Gil et al. 2018) and in original conceptualisations of CSA. FNS is unclear in some projects, as it was not a main outcome of the Theory of Change. For example, projects focused on carbon credits or climate smart commodity production did not have explicit design of food security outcomes. We found that projects in Asia and Southeast Asia had a much stronger focus on supporting food security through generating incomes and accessing food via markets, whereas the Africa projects focused on landscapes and ecosystems. Alternative food security is also supported in the establishment of home gardens and planting superfoods (Laos and Timor-Leste projects). While we did not analyse the range of manifestations of food security, the FAO's four dimensions of food security were evident throughout the projects (FAO 2020). Accessibility, which is often associated with both financial and physical access, was embedded throughout all the projects. Food availability was represented through the production of superfoods[2] and enhanced home gardens. Food stability and utilization were less evident; however, training to maintain the establishment of crops through FMNR or local institutions in Timor-Leste shows attempts to provide stable food supplies.

[2] Superfoods were associated with vegetables and nutrient-dense crops. It was not associated with the market focused export crops labelled 'superfoods' such as chia.

In Timor-Leste, efforts to help establish high-nutrition foods aimed to expand production of sweet potato, beans, and legumes. While orange sweet potato has been proven to be a highly robust and resilient crop to climate extremes, the exposure of Timor-Leste to extreme events such as drought or sudden onset flooding creates a major risk. Given that project beneficiaries of BFBH are smallholder farmers producing food in small gardens, the long-term vulnerability and adaptive capacity enabled by the project are unclear. While a major development outcome such as food security may be the priority of a project, there are risks of agriculture projects perpetuating or amplifying vulnerabilities if the local climate context is not embedded into project implementation.

5.5 Social dimensions of agriculture

Social dimensions of CSA, such as gender and institutional support, were present but relatively scarce in our analysis. WV, as a socially oriented institution, had an explicit focus on gender and institutional approaches to the types of practices and technologies put forward in projects. Gender is core to transformative climate-agriculture processes, yet multiple CSA investments risk perpetuating gender inequalities and vulnerability of women to climate impacts through a focus on technologies and business as usual institutional mechanisms (Taylor 2017). Addressing gender as pillar of climate change work is a major challenge requiring transformative approaches that get to the root causes of inequality and vulnerability. For example, land continues to be largely tied to patrilineal traditional land tenure systems, preventing women from having agency over their food production (Manlosa et al. 2019). Climate adaptation is also gendered. Climate impacts in rural landscapes can amplify existing gender inequalities and create new structures of inequality (Pearse 2017). Adaptation strategies that ultimately seek to diversify livelihoods may have the maladaptive outcome of creating further time burdens on women or further feminization of food security pillars in already inequitable societies (Asadullah and Kambhampati 2021; Pearse 2017). Gender was addressed but varied in focus within the projects—from resources focus in Africa (recognised but minor theme and no obvious intervention) to household and food choices in the Asia projects. The extent to which gender in projects engaged men and the institutions that can support gender development was unclear. Some projects may unintentionally perpetuate gender inequalities. For example, the AHAN Laos project found women had to travel less time to collect food through now managing home gardens. Yet at its core, the project continues to frame women as the main source of labour for acquiring food. Broader factors, such as diversified livelihoods where men may no longer be at home, may be influencing the continued framing of women as main contributors of food security in Laos. Gender discourses in climate change are more recent than the focus on agricultural mitigation and adaptation, offering opportunities for future CSA design to be explicit in its gender assumptions and risks of perpetuating vulnerabilities.

5.6 Implications for development policy

CSA, as an applied development activity, aims to address synergies and trade-offs between production, climate change, and nutrition outcomes. The fields of adaptation and food security both have extensive evidence of successes and failures through decades of research and policy experimentation. For example, the extensive analysis and planning for the dimensions of food availability, access, utilization and stability, and more recently agency and sustainability, make specific planning for the food security pillar of CSA a rich area.

Integrating this into the smallholder context in which much CSA development projects take place can benefit, for example, from the insights provided by the literature of transformative adaptation (Rickards and Howden 2012) and adaptive capacity building and community-based adaptation processes (Armitage 2005). Some mitigation work as evidenced in our analysis can also draw from the long history of agroforestry experimentation as a source of livelihoods with the co-benefit of mitigating emissions (Lasco et al. 2014). Drawing linkages between these complementary bodies of work can benefit from the insights offered by broader food systems narratives dominating development research and discussions (Béné et al. 2019). Taking a systems principles approach to the co-design of the CSA pillars within the specific implementing contexts provides an avenue for specifying what CSA is, for who, by who, and within which climate context. These questions on process and benefits can ultimately reduce the risk of perpetuating the inequalities and politics that may lead to mal-adaptive outcomes from transformation processes (Blythe et al. 2018).

Analysis of WVA projects indicates the malleable nature of CSA in the specific agricultural development context in which it is applied. This has been found in recent studies also looking at similar projects to our study, indicating the importance of contextual interventions and leveraging smallholders' farm systems knowledge (Kandel et al. 2022). This points towards a need to balance the donor-led requirements for CSA, for example, following metrics-based monitoring frameworks, with the non-quantifiable nature of local and indigenous knowledge in smallholder farm systems. The approach raises a question about the types of knowledge used in CSA implementation. With CSA research and discourse being led by FAO, World Bank, and other international research organizations (Li et al. 2022), there is a risk that local governments and donors may push farmers to adopt 'proven' CSA options without fully situating the technology within local knowledge. NGOs, which focus on communities and the poor, can play a strategic role in agricultural development (Kaimowitz 1993). Their mandate to focus on sustainability, equity, and human development enables an explicit interest in local knowledges and consideration of family, social, and communal relationships. The 'knowledge smart' aspect of CSA seeks to combine science-based agricultural techniques with local knowledge that smallholder farmers have traditionally applied on the ground. Previous global assessments of agriculture point towards a need to balance traditional and scientific knowledge in agriculture (McIntyre et al. 2009), and focus on local knowledge can improve adoption of adaptation strategies (Makate 2020). Diversifying the knowledge base of development can support broader pathways needed to transform food systems under a changing climate.

Policy development to support CSA requires the ongoing balancing of the trade-offs between mitigation, adaptation, and food security and can be a highly complex and messy process requiring coordination across policy sectors (Rodríguez-Barillas et al. 2024). Managing trade-offs will require careful negotiation between the actors involved in designing and implementing CSA. While the design may occur among professional and technical staff, the implementation in developing countries is likely to be done by farmers with varying levels of education and resources. This requires policy processes that can maximise expertise from both technical and community groups. NGOs like WV, which operate at the interface of communities, donors, and increasingly science (Kandel et al. 2022), play a role as boundary organisations in agricultural development. Agricultural extension and knowledge exchange have always been at the boundary of science-society interfaces (Cash 2001), and CSA is a more current demonstration of such boundary work by different agencies. As boundary-spanning practitioners (Bednarek et al. 2018), NGOs can help navigate the framings of different CSA pillars and how they can be situated within traditional knowledges. Such knowledge interface work allows NGOs to actively balance the trade-offs in

CSA and seek to ensure that actions in one pillar do not amplify and create unintended consequences for the other pillars. While much more explicit framings of CSA will be required given the diversity of framings found in this study, focusing on the trade-offs and types of knowledges that are relevant to specific contexts puts NGOs in a position to facilitate future agricultural development interventions.

6 Conclusions

Climate smart agriculture continues to grow and its application can support changes towards improving climate adaptation, mitigation, and food security. Civil society, as major recipients of international aid and as actors blending technical expertise with rural communities, are major influencers on the performance of CSA. We found considerable diversity in how CSA is expressed through the design and implementation of the six large scale investments analysed. This illustrates the continually evolving nature of CSA in development implementation, and its increasing need to include local understandings of climate change. We conclude that the technocratic original framings of CSA continue to dominate critiques of CSA; however, the reality of agricultural development indicates the need for a highly place-based and adaptive approach to technologies and agricultural development. We recommend a more explicit recognition of local vulnerability to climate change in planning, for CSA interventions is needed to improve project outcomes. In addition, civil society groups can play crucial roles in balancing the scientific and technical components of CSA with the localised practices that align with farm and value chain systems diversity throughout the world.

There is a need to ensure that the implementation of CSA acknowledges the boundaries and trade-offs that exist in the diverse farm practices that form part of CSA. This study indicates that civil society groups tasked with implementing donor-funded projects have opportunities to clearly articulate how they will balance trade-offs in future CSA interventions. The future of agricultural interventions requires careful mapping of trade-offs from initial concept design to reduce the risk of unintended impacts across different pillars of CSA. These non-state actors, which have ethical commitments to social and environmental development, can further facilitate the science-development knowledge base. Given the substantial role civil society plays in social, economic, and environmental development, they can present novel pathways for advancing the performance and implementation of CSA to maximise sustainability and equitable development outcomes. Further research requires complementary analysis of how other civil society groups are implementing CSA and, more broadly, how private sector and government actors frame CSA. Such analysis will provide important synthesis into how CSA trade-offs and characteristics can be embedded in future funding and development policy.

Acknowledgements We thank the various World Vision staff for their support in discussing the manuscript drafts and sourcing project documentation for this study.

Funding Open Access funding enabled and organized by CAUL and its Member Institutions. This study was funded through the Australian NGO Cooperation Program supported by the Department of Foreign Affairs and Trade, Australia.

Data availability The data analysed during this study are not publicly available due to confidentiality of materials from civil-society organisations and protection of identity of some project beneficiaries; reports may be made available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare no competing interests.

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