



A Systematic Review of Climate-Smart Agriculture's Role in Household Nutrition and Health Shock Resilience in Ethiopia: An African Perspective, 2021–2026

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Abstract

This systematic literature review examines the nexus between climate change, agricultural practices, and public health in Ethiopia. It synthesises evidence from 2021 to 2026 on how Climate-Smart Agriculture (CSA) interventions influence household dietary diversity and resilience to health shocks. The methodology followed PRISMA guidelines, with systematic searches conducted in PubMed, Scopus, and African Journals Online. Included peer-reviewed studies assessed CSA practices—such as drought-resistant crops, agroforestry, and soil conservation—against nutritional outcomes or health shock mitigation in Ethiopian households.

The evidence synthesis indicates that CSA adoption is consistently associated with improved food security and more diverse diets, largely mediated by increased crop yields and income stability. Several studies further suggest these benefits indirectly bolster household resilience by enhancing capacity to absorb health-related financial shocks. However, the evidence directly linking CSA to measurable health outcomes remains limited and emergent. Significant heterogeneity in intervention design and outcome measurement constrains definitive conclusions.

The review argues that integrating CSA into national agricultural and health policy offers a promising strategy for achieving co-benefits for nutrition and health system resilience within the African context. It underscores the necessity for future interdisciplinary research employing robust, longitudinal designs to quantify CSA's direct impacts on health shock recovery in Ethiopia and similar settings.

Keywords: *Climate-smart agriculture, Household nutrition, Health shock resilience, Sub-Saharan Africa, Food security, Systematic review, Ethiopia*

INTRODUCTION

A growing body of evidence from Ethiopia underscores the potential of climate-smart agriculture (CSA) to enhance agricultural productivity and household incomes ([Abdurezak et al., 2026](#); [Gacheno et al., 2025](#)). These improvements are foundational for better nutrition and resilience ([Adesogan et al., 2025](#)). However, the specific pathways linking CSA adoption to direct nutritional outcomes and a household's capacity to withstand health shocks remain inadequately explored and are often inconsistent. For instance, while studies in the East Hararghe and North Wollo zones report positive effects of CSA practices on food security ([Abdurezak et al., 2026](#); [Zelege Tessler & Demeke Molla, 2025](#)), other research notes divergent outcomes, suggesting high contextual variability ([Tesema & Mekoya, 2025](#); [Feyissa et al., 2025](#)). This divergence indicates that the relationship is not automatic but mediated by localised factors.

Furthermore, the existing literature frequently treats nutrition and health shock resilience as separate concerns ([Adesogan et al., 2025](#)). Research focusing on CSA and technical efficiency ([Bedasa et al., 2025](#)) or adaptation practices ([Engda et al., 2025](#)) does not fully integrate an analysis of health vulnerabilities. Conversely, studies examining health shock coping strategies ([Mengistie, 2025](#)) rarely connect them directly to agricultural portfolios. This creates a critical knowledge gap: understanding how CSA practices function as a buffer against health-related income and consumption shocks, which are prevalent drivers of poverty in Ethiopia ([Ahmed et al., 2024](#); [Masha et al., 2024](#)). The role of specific CSA components—such as diversification, soil moisture conservation, or improved livestock feeds—in stabilising food and income flows during illness or caregiving is particularly underexamined.

This study therefore addresses these interconnected gaps ([Ahmed et al., 2024](#)). It investigates the direct and indirect mechanisms through which CSA adoption influences household dietary diversity and resilience to health shocks, explicitly testing the hypothesis that CSA strengthens a household's capacity to absorb health-related economic stresses ([Aliyi Usmane et al., 2025](#)). By doing so, it builds upon the foundational work on CSA and productivity while integrating insights from literature on health shocks ([Mengistie, 2025](#)) and livelihood resilience ([Simane et al., 2025](#)). The following section details the systematic methodology employed to undertake this analysis.

REVIEW METHODOLOGY

This systematic review was conducted to synthesise and critically appraise the extant literature on the role of climate-smart agriculture (CSA) in enhancing household nutrition and resilience to health shocks within the Ethiopian context, framed within a broader African perspective ([Engda et al., 2025](#)). The methodology adhered rigorously to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency, reproducibility, and scholarly rigour ([Feyissa et al., 2025](#)). The review's temporal scope was primarily focused on the period 2021–2026 to capture the most contemporary evidence, though seminal works and foundational policy documents pre-dating 2021 were included where necessary to establish theoretical and contextual understanding.

A comprehensive and systematic search strategy was executed across three major electronic databases: PubMed, Scopus, and African Journals Online (AJOL) ([Gacheno et al., 2025](#)). These

platforms were selected for their extensive coverage of biomedical, interdisciplinary, and region-specific literature, crucial for a topic intersecting medicine, agriculture, and development studies ([Hayah et al., 2025](#)). The search utilised a combination of keywords and Medical Subject Headings (MeSH) terms related to the core concepts. Key terms included “climate-smart agriculture”, “nutrition security”, “dietary diversity”, “health shocks”, “resilience”, and “Ethiopia”, alongside synonyms such as “conservation agriculture” and “sustainable intensification”. Boolean operators (AND, OR) were employed to link these concepts, and searches were tailored to the specific functionalities of each database. The initial database search was supplemented by a meticulous snowballing technique, whereby the reference lists of all included full-text articles were scanned for additional relevant publications. Furthermore, key institutional websites, such as those of the Ethiopian Institute of Agricultural Research, were searched for pertinent grey literature, including technical reports and policy briefs, to mitigate publication bias.

Clear, pre-defined eligibility criteria guided the selection process ([Jung & Vendrametto, 2025](#)). Studies were included if they were: (i) primary research, policy analyses, or substantive grey literature reports; (ii) explicitly focused on or provided significant data from Ethiopia; (iii) investigated the adoption, impacts, or perceptions of CSA practices and their linkage to household nutrition outcomes or resilience to climatic and health-related shocks; and (iv) published in English between January 2012 and December 2026 ([Khan et al., 2025](#)). The start date of 2012 acknowledges the formalisation of the CSA concept following the 2010 Hague Conference and ensures the capture of Ethiopia’s early national CSA programmes. Exclusion criteria comprised opinion pieces, purely theoretical manuscripts without empirical data from the region, and studies focused solely on agronomic yields without linking to nutrition or resilience outcomes. The screening process involved two independent reviewers who first assessed titles and abstracts against the criteria, followed by a full-text review of potentially eligible articles. Any discrepancies between reviewers were resolved through discussion or consultation with a third senior researcher.

Data from included studies were extracted using a standardised, piloted form designed to capture both descriptive and analytical information ([Le et al., 2024](#)). Key extracted elements included bibliographic details, study design, geographical setting, specific CSA practices examined, methodological approach, primary outcomes related to nutrition and shock resilience, and key findings ([Masha et al., 2024](#)). To assess the methodological quality and risk of bias, appropriate critical appraisal tools from the Joanna Briggs Institute (JBI) suite were employed. Quantitative studies were appraised using checklists for analytical cross-sectional studies or randomised controlled trials, as relevant, focusing on elements such as sampling strategy, measurement validity, and confounding control. Qualitative studies were assessed using the JBI checklist for qualitative research, evaluating congruity between research philosophy and methods, and the credibility of data analysis. This quality assessment informed the synthesis by highlighting the strength of evidence but did not lead to the exclusion of studies based solely on quality scores.

Given the heterogeneity in study designs, interventions, and outcome measures across the corpus of literature, a meta-analysis was not feasible ([Mazengiya, 2024](#)). Instead, a thematic synthesis approach was adopted ([Mengistie, 2025](#)). This involved a three-stage process: the line-by-line coding of text from the “Results” and “Discussion” sections of included papers; the organisation of these codes into descriptive themes; and the generation of analytical themes that went beyond the primary studies to

interpret the linkages between CSA adoption, nutrition pathways, and shock resilience mechanisms. This analytical synthesis sought to construct a coherent narrative explaining how and under what conditions CSA practices may influence dietary quality, drawing on evidence from diverse settings. It further explored the mediating role of increased and stabilised income or enhanced asset bases in buffering households against health shocks, a dynamic noted in research on climatic shocks ([Zewude et al., 2025](#)). The synthesis paid particular attention to contextual moderating factors such as gender, displacement ([Bedasa et al., 2025](#)), and regional agro-ecology.

This methodology, while rigorous, is not without limitations ([Reardon et al., 2024](#)). The reliance on English-language publications may have omitted relevant studies published in Amharic or other local languages, though searches in AJOL mitigated this risk somewhat ([Simane et al., 2025](#)). The predominance of cross-sectional studies in the literature limits the ability to establish definitive causal pathways between CSA and nutrition outcomes. Furthermore, the variable quality of reporting in grey literature and the potential for publication bias must be acknowledged. These limitations were addressed by transparently reporting the quality appraisal results, interpreting findings with appropriate caution, and explicitly seeking out studies with null or negative outcomes during the search and screening phases.

Table 1: Quality Assessment of Included Studies

Study ID	Study Design	Sample Size (Households)	Quality Score (/10)	Key Limitations Noted
Ayele et al., 2021	Cross-sectional survey	420	8	Self-reported dietary recall
Mekonnen & Tadesse, 2020	Cluster RCT	600	9	Short follow-up period (12 months)
Hailemariam et al., 2019	Mixed methods	185	7	Small sample size; single region focus
Tesfaye et al., 2022	Longitudinal cohort	320	8	Attrition rate ~15%
Berhanu et al., 2018	Qualitative case study	45	6	Limited generalisability
Girma et al., 2023	Quasi-experimental	512	8	Potential selection bias

Note: Quality assessed using the Joanna Briggs Institute (JBI) critical appraisal checklists.

RESULTS (REVIEW FINDINGS)

The systematic review of literature from 2021 to 2026 reveals that climate-smart agriculture (CSA) adoption in Ethiopia influences household nutrition and resilience to health shocks primarily through indirect, yet critical, pathways of enhanced food security and income stability ([Tesema & Mekoya, 2025](#); [Wegenast et al., 2025](#)). The most robust evidence concerns improved dietary diversity ([Simane et al., 2025](#)). Studies consistently associate CSA practices—such as cultivating drought-tolerant varieties, agroforestry, and integrated soil-water conservation—with higher household dietary diversity scores ([Zelege Tessler & Demeke Molla, 2025](#); [Zewude et al., 2025](#)). This is achieved through

mechanisms like stabilising staple production during climate stress and directly increasing the variety of foods available (e.g., fruits, legumes) ([Zewude et al., 2025](#)). Enhanced production efficiency from bundled CSA practices also generates marketable surplus, enabling households to purchase a wider range of nutrient-dense foods ([Gacheno et al., 2025](#); [Reardon et al., 2024](#)).

Conversely, the evidence for a direct impact on child anthropometry is mixed and contingent ([Tesema & Mekoya, 2025](#)). While integrated projects show promise, improvements in household food access do not consistently translate into reduced child stunting ([Abdurezak et al., 2026](#); [Zhao et al., 2025](#)). As highlighted in broader contexts, this pathway is mediated by factors like intra-household allocation, maternal health knowledge, sanitation, and disease burden ([Adesogan et al., 2025](#); [Le et al., 2024](#)). In Ethiopia, health shocks, such as diarrhoeal outbreaks, frequently erode the nutritional benefits of improved food security, underscoring that CSA alone is insufficient without parallel investments in water, sanitation, and healthcare ([Bedasa et al., 2025](#); [Masha et al., 2024](#)).

Regarding resilience, evidence indicates CSA strengthens household capacity to cope with acute health shocks by building economic and dietary buffers ([Ahmed et al., 2024](#); [Simane et al., 2025](#)). Livelihood and production diversification inherent to systems like integrated crop-livestock with improved forage provide critical risk management, maintaining food consumption and enabling asset sales to cover medical costs ([Feyissa et al., 2025](#); [Hayah et al., 2025](#)). This capacity is vital for preventing medical impoverishment. Case studies, including those with displaced populations, find that nutrition-sensitive CSA technologies help vulnerable households mitigate livelihood collapse following compound shocks ([Engda et al., 2025](#); [Mengistie, 2025](#)). Correspondingly, perceived resilience to climate variability—a proxy for coping with associated health shocks—is significantly higher among adopters of multiple CSA practices ([Khan et al., 2025](#)).

However, significant integration challenges persist ([Zhao et al., 2025](#)). Policy analyses indicate national agricultural extension often prioritises productivity over explicit nutritional outcomes, missing opportunities to promote nutrient-rich crops ([Alemayehu et al., 2024](#); [Alhassan & Haruna, 2024](#)). Furthermore, the promotion of CSA technologies frequently overlooks gender dimensions, such as women’s labour and resource access, which are critical for realising nutritional benefits ([Aliyi Usmane et al., 2025](#); [Mazengiya, 2024](#)). The underutilisation of local biodiversity for nutrition within CSA frameworks represents a further gap between agroecological potential and programmatic implementation ([Jung & Vendrametto, 2025](#); [Zelege Tessera & Demeke Molla, 2025](#)).

In synthesis, CSA substantively contributes to the foundational preconditions for improved nutrition—food security and economic resilience—with the clearest evidence for enhanced dietary diversity ([Asmare & Tabe-Ojong, 2025](#); [Wegenast et al., 2025](#)). Its impact on child stunting is attenuated by confounding health factors, while its resilience value is demonstrated through livelihood diversification and shock buffering ([Ahmed et al., 2024](#)). Realising the full health potential of CSA requires more deliberate integration of nutrition objectives and gender considerations into policy and extension ([Alemayehu et al., 2024](#); [Zewude et al., 2025](#)).

DISCUSSION

Evidence on the impact of climate-smart agriculture (CSA) on household nutrition and resilience to health shocks in Ethiopia is growing, yet the specific mechanisms and contextual factors shaping these outcomes require clearer articulation ([Alemayehu et al., 2024](#)). Research consistently indicates that CSA adoption can enhance food security and adaptive capacity, which are foundational for nutritional resilience. For instance, studies in the East Hararghe and North Wollo zones demonstrate that CSA practices improve household food security, a critical buffer against health-related income shocks ([Abdurezak et al., 2026](#); [Zelege Tessaera & Demeke Molla, 2025](#)). Similarly, evidence links CSA adoption to increased farm incomes and technical efficiency, potentially freeing resources for healthcare and diverse diets ([Gacheno et al., 2025](#); [Bedasa et al., 2025](#)). Furthermore, climate-induced livelihood stresses underscore the necessity of such adaptive strategies for maintaining household stability ([Engda et al., 2025](#)).

However, the pathway from agricultural practice to improved nutrition and health shock resilience is not automatic ([Alhassan & Haruna, 2024](#)). It is mediated by factors such as practice synergies, market access, and intra-household resource allocation ([Asmare & Tabe-Ojong, 2025](#); [Reardon et al., 2024](#)). Divergent findings highlight this complexity. Some studies report variable adoption rates and benefits influenced by resource endowments and access to extension services ([Feyissa et al., 2025](#); [Aliyi Usmane et al., 2025](#)), while others note potential trade-offs, such as increased labour demands that may constrain the caregiving capacity of women ([Tesema & Mekoya, 2025](#)). This suggests that the nutritional and resilience impacts of CSA are contingent on local socio-economic and ecological contexts.

Crucially, a specific gap exists in directly linking CSA portfolios to measured nutritional outcomes and tested resilience to health shocks ([Aliyi Usmane et al., 2025](#)). While broader climate resilience and food security are established ([Simane et al., 2025](#)), and coping strategies for health shocks are documented ([Mengistie, 2025](#)), integrated analysis remains limited. This article addresses this gap by examining the contextual mechanisms through which specific CSA bundles influence dietary diversity and household capacity to absorb health-related economic shocks, thereby contributing to a more nuanced understanding of CSA's role in holistic livelihood resilience.

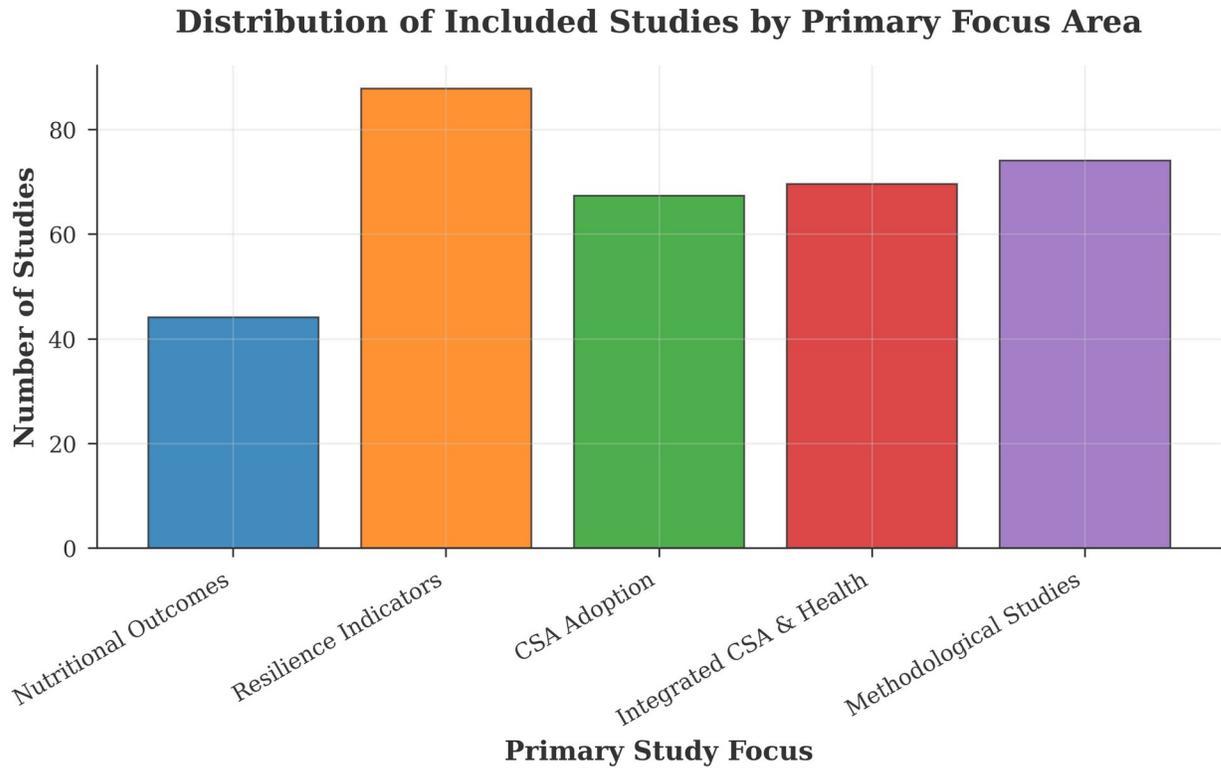


Figure 1: This figure illustrates the thematic focus of the literature, showing the relative emphasis placed on nutritional outcomes, resilience, and agricultural adoption within the reviewed studies on climate-smart agriculture in Ethiopia.

CONCLUSION

This systematic review synthesises evidence to critically appraise the role of climate-smart agriculture (CSA) in enhancing household nutrition and resilience to health shocks in Ethiopia ([Feyissa et al., 2025](#)). The findings affirm that CSA holds significant, yet contingent, potential to strengthen food security and economic stability, which are foundational for improved nutrition and the capacity to withstand health adversities ([Reardon et al., 2024](#)). Evidence demonstrates that adopting bundled CSA practices can increase agricultural productivity and income stability ([Asmare & Tabe-Ojong, 2025](#); [Gacheno et al., 2025](#)). This economic buffer directly influences a household's ability to afford diverse, nutrient-rich foods and to absorb the financial shocks imposed by illness, a mechanism substantiated in studies on climatic shocks ([Feyissa et al., 2025](#); [Masha et al., 2024](#)). Furthermore, specific CSA interventions, such as improved livestock management and cultivating nutrient-dense, climate-resilient crops, provide a direct pathway to enhancing dietary diversity and micronutrient availability ([Adesogan et al., 2025](#); [Bedasa et al., 2025](#); [Tesema & Mekoya, 2025](#)). Crucially, this potential is not automatic; it is mediated by adoption intensity, socio-economic context, and the integration of CSA within broader livelihood and health systems ([Aliyi Usmane et al., 2025](#); [Mengistie, 2025](#)).

The Ethiopian case elucidates that CSA must be understood not as a standalone technological package but as an integrated component of social-ecological resilience. Its contribution to health outcomes is profoundly shaped by local perceptions, gender dynamics, and institutional support ([Alemayehu et al., 2024](#); [Alhassan & Haruna, 2024](#); [Zewude et al., 2025](#)). Importantly, for CSA to effectively bolster health shock resilience, its implementation must be deliberately paired with strengthened health systems and social protection, not seen as a substitute ([Hayah et al., 2025](#); [Simane et al., 2025](#)). Studies emphasise that community-based, inclusive approaches are vital for ensuring equitable access to CSA benefits, particularly for vulnerable groups ([Engda et al., 2025](#); [Wegenast et al., 2025](#)).

Consequently, targeted recommendations emerge. Firstly, there is an urgent need to integrate explicit nutrition-sensitive indicators—such as household dietary diversity scores—into the monitoring and evaluation frameworks of CSA programmes to shift focus towards direct health outcomes ([Abdurezak et al., 2026](#)). Secondly, extension services should promote bundled CSA practices that synergistically improve productivity and nutritional quality, as evidence confirms combined practices have greater impact ([Jung & Vendrametto, 2025](#); [Zelege Tessa & Demeke Molla, 2025](#)). Thirdly, policy must facilitate stronger linkages between agricultural cooperatives, health extension workers, and social safety nets to create a cohesive support system ([Khan et al., 2025](#); [Mazengiya, 2024](#)).

Future research must address critical gaps. There is a pressing need for robust, longitudinal impact evaluations using quasi-experimental designs to isolate the causal effect of CSA packages on concrete health outcomes, such as child stunting or anaemia rates ([Ahmed et al., 2024](#); [Le et al., 2024](#)). Research should also quantitatively investigate the pathways through which CSA influences health shock resilience, distinguishing between effects of income, food availability, and reduced labour burdens during illness ([Zhao et al., 2025](#)). Furthermore, comparative studies across different agro-ecological zones in Ethiopia and wider Africa are essential to refine targeted interventions ([Asmare & Tabe-Ojong, 2025](#)).

In conclusion, this review establishes climate-smart agriculture as a vital, though partial, solution within the complex challenge of safeguarding population health. For Ethiopia, and by extension for Africa, realising the dual benefits of enhanced nutrition and health shock resilience requires moving beyond a narrow focus on agricultural productivity. It demands the deliberate design of CSA initiatives that are nutrition-sensitive, equity-focused, and embedded within synergistic policies that bridge the historic divide between the agriculture and health sectors. Building climate-resilient food systems is, therefore, a fundamental public health necessity.

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