

Household Food Security Indicators and Measurement Challenges in Indigenous Rural Areas: A Systematic Literature Review

Nora Fiza^{1*}, Erwin², Novizar Nazir³, Faidil Tanjung⁴

¹Doctoral Programme in Development Studies, Graduate School, Andalas University, Padang, Indonesia

²Department of Anthropology, Faculty of Social and Political Science, Andalas University, Padang, Indonesia

³Department of Food Technology and Agricultural Products, Faculty of Agricultural Technology, Andalas University, Padang, Indonesia

⁴Agribusiness Study Program, Faculty of Agriculture, Andalas University, Padang, Indonesia

Corresponding Author's e-mail : norafiza.sumbar@gmail.com

ARMADA
JURNAL PENELITIAN MULTIDISIPLIN

e-ISSN: 2964-2981

ARMADA : Jurnal Penelitian Multidisiplin

<https://ejournal.45mataram.ac.id/index.php/armada>

Vol. 04, No. 09 September, 2026

Page: 5738-5752

DOI:

<https://doi.org/10.55681/armada.v4i9.4226>

Article History:

Received: Juli 09, 2026

Revised: Agustus 26, 2026

Accepted: September 19, 2026

Abstract : Household food security among Indigenous communities in rural areas faces complex challenges due to limited access, environmental changes, and the inadequacy of measurement approaches in capturing local socio-cultural contexts. This study aimed to analyse household food security indicators, measurement challenges, adaptation strategies, and research gaps among Indigenous communities. A systematic review was conducted following the PRISMA framework by searching literature published between 2021 and 2026 through Scopus, Google Scholar, ScienceDirect, and DOAJ. A total of 25 relevant articles were analysed to identify measurement approaches and factors influencing food security. The findings indicate that standardised quantitative methods often have limitations in representing local cultural values, whereas context-based qualitative approaches provide a more comprehensive understanding of Indigenous communities' food security dynamics. Indigenous communities demonstrate strong adaptive capacity through traditional knowledge, local food resources, and agricultural innovations. However, climate change, weak governance, inequality, and limited policy support remain major barriers. This review highlights the need to develop holistic and culturally sensitive food security assessment tools that incorporate local socio-cultural and ecological dimensions.

Keywords : Food Security, Indigenous Communities, Rural, Indicators, Measurement Challenges

Abstrak : Ketahanan pangan rumah tangga masyarakat adat di wilayah pedesaan menghadapi tantangan kompleks akibat keterbatasan akses, perubahan lingkungan, dan ketidaksesuaian metode pengukuran dengan konteks sosial budaya lokal. Penelitian ini bertujuan menganalisis indikator ketahanan pangan rumah tangga, tantangan pengukuran, strategi adaptasi, serta kesenjangan penelitian pada masyarakat adat. Tinjauan sistematis dilakukan menggunakan pedoman PRISMA dengan pencarian literatur tahun 2021–2026 melalui Scopus, Google Scholar, ScienceDirect, dan DOAJ. Sebanyak 25 artikel relevan dianalisis untuk mengidentifikasi pendekatan pengukuran dan faktor yang memengaruhi ketahanan pangan. Hasil menunjukkan bahwa metode kuantitatif terstandar sering kali memiliki keterbatasan dalam merepresentasikan nilai

budaya lokal, sementara pendekatan kualitatif berbasis konteks mampu menangkap dinamika masyarakat adat secara lebih komprehensif. Masyarakat adat menunjukkan kapasitas adaptasi melalui pemanfaatan pengetahuan tradisional, sumber pangan lokal, dan inovasi pertanian. Namun, perubahan iklim, kelemahan tata kelola, ketimpangan, dan keterbatasan dukungan kebijakan masih menjadi hambatan utama. Penelitian ini menegaskan perlunya pengembangan instrumen pengukuran ketahanan pangan yang holistik dan sensitif terhadap aspek sosial budaya serta ekologi lokal.

Kata Kunci : Ketahanan Pangan, Masyarakat Adat, Pedesaan, Indikator, Tantangan Pengukuran

INTRODUCTION

Global food insecurity represents a persistent and complex challenge, affecting millions of individuals worldwide. Food insecurity, commonly understood as an unstable lack of sufficient and nutritious food access, constitutes a major global public health priority (Jernigan et al., 2021). This condition extends beyond mere hunger, encompassing inadequate dietary quality and quantity necessary for an active, healthy life. Such widespread instability in food access significantly diminishes mental and physical human health across diverse demographics. Understanding this complex challenge requires comprehensive measurement and intervention strategies. Millions worldwide continue to experience varying degrees of food insecurity, highlighting the urgent need for effective global and local responses.

Vulnerable populations, particularly indigenous communities in rural areas, experience severe impacts from this global issue. Indigenous communities worldwide experience disproportionately high rates of food insecurity due to historical and ongoing settler-colonial activities (Jernigan et al., 2021). These activities include forced relocation to rural reservation lands, which often feature degraded environments unsuitable for traditional food practices. Land rights infringements further erode their capacity to maintain customary food systems, limiting access to essential natural resources. Such systemic disadvantages lead to persistent vulnerabilities that undermine food sovereignty and cultural food practices. Consequently, food insecurity among these groups is not merely an economic problem but a profound socio-cultural and historical injustice.

These communities frequently depend on traditional food systems, including subsistence farming, hunting, and gathering, rendering them acutely susceptible to environmental degradation, climate change impacts, economic shifts, and land rights infringements. Traditional food systems, integral to indigenous cultures, often incorporate the production and consumption of fruits and vegetables, which play a potential role in improving household food security (Sithole et al., 2023). Engagement in agricultural production, particularly subsistence farming, often exhibits a positive and significant relationship with household fruit and vegetable consumption. This reliance on local food sources means environmental changes directly impact food availability and quality for these populations. Climate change, for instance, can disrupt seasonal harvests and reduce biodiversity, further exacerbating existing food access challenges. Preserving and strengthening these traditional practices is therefore crucial for enhancing resilience against external shocks.

Accurate assessment of household food security is essential to design effective interventions and policies. Accurate assessment is particularly vital because food insecurity has a significant association with the double burden of malnutrition, characterized by the coexistence of child stunting and maternal overweight or obesity (Sansón-Rosas et al., 2021). Researchers link moderate and severe household food insecurity to this double burden in rural households. Understanding these complex nutritional outcomes necessitates precise measurements of food security status at the household level. Policymakers can tailor intervention strategies to address undernutrition and overnutrition simultaneously. Policy formulation benefits immensely from robust data that reflect the true scope and nature of food insecurity within these specific contexts.

Food security encompasses four dimensions: availability, access, utilization, and stability. Availability means food physically exists in sufficient quantities through local production, markets, or aid. Access means households and individuals can acquire appropriate foods for a nutritious diet. Economic, physical, and socio cultural factors influence this access. Proper utilization of food encompasses the body's ability to absorb and use nutrients effectively, depending on safe water, sanitation, food preparation practices, and health status. The stability dimension highlights the importance of consistent access to these elements over time, preventing fluctuations due to shocks or seasonal variations. Each dimension interacts complexly, necessitating a holistic understanding for effective food security interventions.

Understanding these dimensions within indigenous rural contexts requires careful consideration of cultural practices, traditional knowledge, and unique socio economic structures that influence food access and consumption patterns. Such considerations are paramount because traditional knowledge often dictates food harvesting, preparation, and distribution, which are inherently linked to cultural identity. Socio economic structures, including land tenure systems and community governance, significantly impact access to food resources and market participation. Effective interventions must respectfully integrate these cultural nuances rather than imposing external models that may be incompatible with local traditions. Failing to account for these specific contextual factors risks undermining the sustainability and acceptance of food security initiatives, thereby perpetuating existing vulnerabilities within these communities.

Current literature on food security is growing. However, researchers have not synthesized how to assess and support indigenous rural communities in maintaining food security against these pressures. This study therefore addresses two central questions: (1) what indicators and assessment approaches are currently used to measure household food security among indigenous rural populations, and (2) what measurement challenges and adaptive strategies emerge from the existing literature in these contexts. By systematically reviewing the current evidence, this study aims to synthesize prevailing indicators, identify persistent measurement challenges, and clarify the adaptive strategies indigenous communities employ to sustain food security.

RESEARCH METHOD

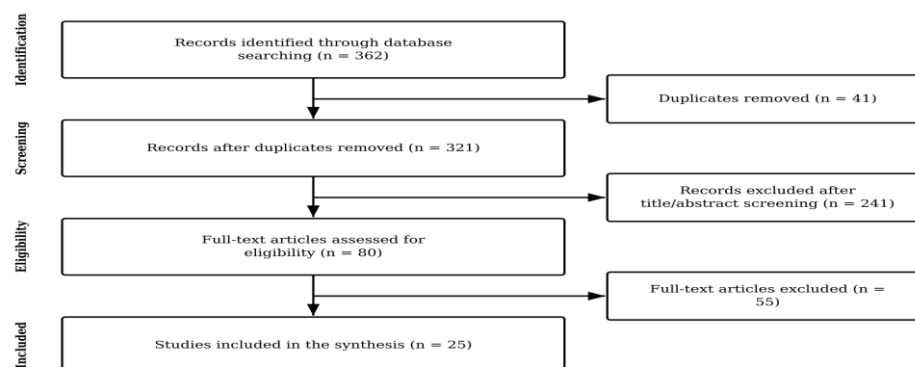
This study applied a systematic literature review (SLR) methodology. The Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) framework guided this research. We structured the review process into four distinct phases: identification, screening, eligibility, and inclusion. We searched Scopus, Google Scholar, ScienceDirect, and DOAJ databases to gather relevant academic literature. The search strategy employed specific Boolean strings to capture pertinent articles, including “household food security” AND indicators AND (“indigenous” OR “rural”); “food security measurement” AND challenges AND (“indigenous areas” OR “rural areas”); “food security indicators” AND “measurement challenges” AND (“indigenous communities” OR “rural communities”); and “household food security” AND (“indigenous population” OR “rural population”) AND (indicators OR challenges). Articles published within the timeframe of 2021 to 2026 were considered for analysis to reflect the most current research trends.

Inclusion and exclusion criteria systematically guided the selection of relevant studies, as detailed in Table 1. We included peer reviewed journal articles, conference proceedings, and systematic reviews. The articles must be in English and provide full text access. A primary focus on household food security indicators and/or measurement challenges in indigenous or rural populations formed the core thematic relevance for inclusion. Articles addressing agricultural, ecological, or health-related themes without an explicit indigenous or rural population focus were retained only when their findings had direct applicability to food system components relevant to indigenous rural livelihoods (e.g., alternative protein sources, soil-based food production technologies, or ecosystem services underpinning subsistence food systems), and were excluded otherwise. Conversely, documents such as editorials, opinions, book chapters, news articles, or non-peer-reviewed content were excluded. Irrelevant topics and studies focusing exclusively on urban areas or developed countries without an indigenous context were also systematically filtered out.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Year	Articles published between 2021-2026.	Articles published outside 2021-2026.
Document Type	Peer-reviewed journal articles, conference proceedings, or systematic reviews.	Editorials, opinions, book chapters, news, blogs, or non-peer-reviewed documents.
Language	English language articles.	Articles not in English.
Full Text Availability	Full text of the article is available.	Full text of the article is not available.
Topic Relevance	Directly addresses household food security indicators and/or measurement challenges in indigenous/rural areas.	Does not address household food security, indicators, or measurement challenges in indigenous/rural areas.
Population Focus	Focuses on indigenous or rural populations.	Focuses on urban areas or developed countries without an indigenous context.

We identified 362 records from the specified databases. We removed duplicates and retained 321 unique articles. A rigorous screening of titles and abstracts then led to the exclusion of 241 articles, retaining 80 articles for full text assessment. Subsequently, a comprehensive review of the full texts resulted in the exclusion of an additional 55 articles due to a lack of alignment with the predefined eligibility criteria. A final set of 25 articles was therefore selected for in-depth qualitative analysis, ensuring high relevance to the research questions. We assessed each of the 25 selected articles using five key criteria : topic relevance, methodological clarity, data and sample clarity, results clarity, and overall contribution to the field. We applied a scale of 1 to 3 for this assessment. excluded articles scoring below the acceptable threshold The final corpus of articles demonstrated high methodological rigor and thematic relevance. Data extraction involved systematically recording key information from each article, including study objectives, methodologies, indicators identified, measurement challenges, and findings specific to indigenous and rural contexts. We employed thematic synthesis as our analytical technique. This technique allows us to identify recurring themes, patterns, and gaps concerning household food security indicators and their measurement in the target populations.

**Figure 1.** PRISMA flow diagram of the study selection process

RESULT AND DISCUSSION

Our initial search identified 362 articles. We removed duplicates and retained 321 unique articles. Screening excluded 241 articles by title and abstract, and a further 55 during full text review, resulting in 25 articles for final analysis.

Article Characteristics

Table 2. *Summary of Article Characteristics*

Aspect	Finding
Final articles analyzed	25
Year range	2021-2026
Dominant countries	Global, Africa, Pakistan, Uganda
Dominant methods	Literature review, Quantitative, Qualitative, Systematic review
Dominant themes	Positive Outcomes and Adaptive Capacities, Enabling Factors and Sustainable Solutions, Challenges and Barriers to Food Security

Publication Trend

Research on household food security in indigenous rural areas shows a concentrated trend in recent years, with a notable peak in 2021 (13 articles). Subsequent years included 6 publications in 2022, 2 in 2023, 1 in 2024, 1 in 2025, and 2 in 2026 (in press/early access), indicating sustained but fluctuating scholarly interest.

Data Extraction Table

Table 3. *Data Extraction Summary of Included Articles*

No	Author (Year)	Country	Method	Main Findings
1	(Owen et al., 2023)	Global	Quantitative	More than half of the global energy transition mineral (ETM) resource base is located on or near the lands of Indigenous and peasant peoples, highlighting a high level of intersectionality with territories less impacted by industrialization.
2	(Rahman et al., 2022)	Pakistan	Case study	Climate models predict significant yield reductions for rice (15.2-17.2%) and wheat (12-14.1%) in Pakistan by mid-century due to climate change, highlighting the need for optimized climate-smart agricultural practices.
3	(Atube et al., 2021)	Uganda	Quantitative	The most widely practiced adaptation strategies by smallholder farmers in northern Uganda include planting different crop varieties, drought-resistant varieties, and fallowing, with factors like marital status, access to credit, extension services, and farm income influencing their adoption.

No	Author (Year)	Country	Method	Main Findings
4	(Dewa et al., 2022)	Malawi	Quantitative	A multidimensional construct of community flood resilience in rural Malawi, defined by purpose-built infrastructure, early warning systems, and local human capacity, is significantly associated with access to health and psychosocial well-being services, and a strong sense of place.
5	(Gallois et al., 2021)	Cameroon	Mixed	In situ methods (walk in the woods) are more effective than ex-situ methods (freelisting and dietary recalls) for collecting detailed information on wild food plant knowledge and use frequency among the Baka people in Cameroon, yielding significantly more species.
6	(Oza et al., 2025)	Fiji and Indonesia	Quantitative	Analysis supported a one factor model for economic resilience and a four factor model for social resilience (inclusion, social cohesion, collective efficacy and action, and preparedness), demonstrating internal construct validity and reliability for these scales in coastal urban informal settlements.
7	(Prieto et al., 2026)	Canada	Qualitative	Intergenerational learning on the land within Inuvialuit families fosters holistic nourishment, harvesting skills, and “living a good life,” but systemic and climatic changes constrain these opportunities, with sharing, environmental stewardship, and adaptability identified as key guiding principles for future generations’ wellbeing.
8	(Dar et al., 2026)	Global	Qualitative	Global health security experts critiqued existing assessment tools (WHO JEE and WOAHS PVS) for narrowly framing sustainability, focusing on short term processes and compliance rather than long term outcomes, equity, or resilience, with sectoral differences in emphasis.
9	(Sekaran et al., 2021)	Global	Literature review	Integrated crop-livestock systems (ICLS) can improve productivity, enhance food security, and contribute to environmental sustainability, but face adoption challenges due to lack of investment, awareness, skills, and market competition, especially in low and medium income countries (LMICs).
10	(Atukunda et al., 2021)	Africa	Literature review	Africa is off track to reach SDG 2 (“Zero Hunger”) by 2030, with slow progress or

No	Author (Year)	Country	Method	Main Findings
				deterioration in hunger indicators, driven by factors like poor governance, conflicts, inequality, weak economic development, climate change, and the Covid-19 pandemic.
11	(Marengo et al., 2022)	Brazil	Literature review	While some government proposed short-term drought adaptation strategies in Northeast Brazil may help survival, they often act as post disaster mitigation and can foster maladaptation and dependency, highlighting the need for a more holistic, integrated risk management approach.
12	(Grote et al., 2021)	Africa and Asia	Literature review	Wheat and maize production in Africa and Asia was increasingly impaired by ecological drivers, affecting all four dimensions of food security, particularly availability and stability, despite promising innovations that face adoption constraints.
13	(Lu et al., 2022)	Global	Literature review	Black Soldier Fly Larvae (BSFL) are rich in nutrients and show potential as an alternative protein source in animal diets, with supplementation of less than 20% having no negative impact on poultry, but more research is needed for pigs and ruminants, and challenges exist regarding cost, availability, and acceptance.
14	(Akram et al., 2023)	Global	Literature review	Mangroves provide critical ecosystem services but face major threats from coastal development, aquaculture, deforestation, and climate change, compounded by challenges like land use conflict, weak regulations, and lack of awareness, necessitating inclusive and coordinated management approaches.
15	(Hassan et al., 2021)	Global	Literature review	Millet grain, particularly finger and pearl millet, is a nutrient dense and health beneficial food source rich in phenolic compounds, showing positive impacts when substituted for maize in animal diets and offering potential for diverse food and feed applications.
16	(Farooq et al., 2022)	Global	Literature review	Climate change is hypothesized to bring substantial negative impacts on food production systems and food security globally, particularly in vulnerable regions, necessitating huge focused investments in

No	Author (Year)	Country	Method	Main Findings
				mitigation and adaptation measures to achieve sustainable, climate smart, and eco friendly food systems.
17	(Ortiz et al., 2022)	Central America	Literature review	Central America is highly vulnerable to the emergence or resurgence of mosquito-borne and tick-borne diseases, with deforestation driven urbanization and forest degradation being key anthropogenic drivers whose complex biocultural interactions are not well understood.
18	(Ayanlade et al., 2022)	Sub-Saharan Africa	Systematic review	Extreme climate events in Sub-Saharan Africa (SSA) lead to reductions in crop yield and negatively impact smallholder farmers' livelihoods, indicating a strong need for greater agricultural technological transfer from developed countries to facilitate better adaptation.
19	(Zerssa et al., 2021)	Ethiopia	Literature review	While climate-smart agriculture (CSA) practices offer opportunities for smallholder farming in Ethiopia, their adoption is limited by factors such as small land size, land tenure issues, lack of knowledge, slow return on investment, and insufficient policy support.
20	(Kirkbride et al., 2024)	Global North	Literature review	People exposed to unfavorable social circumstances are more vulnerable to poor mental health, with structural factors perpetuating disadvantage, and the review identifies pervasive social determinants across the life course, particularly affecting marginalized groups, primarily based on evidence from the Global North.
21	(Muluneh, 2021)	Global	Literature review	Climate change significantly alters biodiversity and food security globally, causing species distribution shifts and potential extinction rates of 21-52%, and adversely affecting food security, especially in rain-fed agricultural communities where crop growth and yield are compromised.
22	(Williams et al., 2021)	Africa	Systematic review	Over half of adaptation actions in Africa are in the food sector, with sustainable water management being most reported, and while 95% of options showed medium or high effectiveness, technological and institutional factors present major

No	Author (Year)	Country	Method	Main Findings
				implementation barriers, and no options had high feasibility across all dimensions.
23	(Koskey et al., 2021)	Global	Literature review	Plant growth-promoting microorganisms (PGPMs) offer an eco-friendly solution for sustainable crop production in smallholder agroecosystems by playing critical roles in soil nutrient amelioration, crop improvement, plant stress tolerance, and biocontrol of pests and diseases.
24	(Kappes et al., 2023)	Global	Scoping review	A significant knowledge gap exists in evaluating the global burdens of animal diseases and their distribution throughout value chains, necessitating an analytical framework to guide future evaluations and improve access to information on animal health impacts.
25	(Kumar et al., 2022)	Global	Literature review	Plant-associated microbes, used as biofertilizers, offer an eco-friendly technology with enormous potential to enhance plant biomass and crop yield, maintain soil fertility, and address challenges posed by modern intensive agricultural practices, thereby contributing to nutrient recycling and environmental sustainability.

Thematic Findings

Thematic analysis of the 25 included articles identified four recurring dimensions relevant to household food security in indigenous rural areas: the positive outcomes and adaptive capacities communities demonstrate, the enabling factors that support sustainable food solutions, the persistent challenges and barriers they face, and the research gaps and methodological limitations evident across the current literature. Each of these themes is elaborated in the following subsections.

Positive Outcomes and Adaptive Capacities

The literature highlights substantial positive outcomes and adaptive capacities in indigenous rural food security. Local infrastructure and human capacity build community resilience. This resilience mitigates adverse impacts and fosters food stability during environmental shocks like floods (Dewa et al., 2022). Traditional knowledge systems are foundational, promoting holistic nourishment, harvesting skills, and sustainable living across generations (Prieto et al., 2026). Careful selection of culturally grounded, in-situ research methods further reveals the depth of indigenous knowledge regarding diverse wild food sources (Gallois et al., 2021). Innovative agricultural practices are also prominent.

Integrated Crop-Livestock Systems (ICLS) optimize resource utilization and productivity while contributing to environmental sustainability (Sekaran et al., 2021). Bio fertilizers derived from plant associated microbes enhance soil fertility and crop yields sustainably (Kumar et al., 2022). Nutritional benefits of traditional grains like millet are emphasized for their resilience and dietary value (Hassan et al., 2021). Alternative proteins, such as Black Soldier Fly Larvae, further illustrate a proactive search for diverse and sustainable food solutions in changing climates (Lu et al., 2022).

Enabling Factors and Sustainable Solutions

Several enabling factors and sustainable solutions foster resilient food systems in indigenous rural areas. For smallholder farmers, access to credit, effective extension services, and sufficient farm income empower investments in improved inputs and technologies, mitigating risks and stabilizing household food security (Atube *et al.*, 2021). At the community level, robust infrastructure and human capacity are vital for resilience against environmental threats, particularly floods, ensuring continued access to health and psychosocial support services (Dewa *et al.*, 2022). Cultural principles such as sharing, environmental stewardship, and adaptability are fundamental to enduring food security strategies, functioning as informal governance mechanisms that promote equitable distribution and sustainable resource management (Prieto *et al.*, 2026). Furthermore, eco-friendly technologies, such as Plant Growth-Promoting Microorganisms (PGPMs) and biofertilizers, offer promising avenues for sustainable crop production and soil fertility (Koskey *et al.*, 2021; Kumar *et al.*, 2022). These biotechnological innovations align with agroecological principles, reducing ecological footprints and supporting long-term ecosystem health and food security.

Challenges and Barriers to Food Security

Indigenous rural areas face numerous challenges hindering household food security. Climate change is a primary barrier, directly impacting crop yields, agricultural cycles, and biodiversity, with global assessments projecting substantial disruption to food production systems in vulnerable regions (Ayanlade *et al.*, 2022; Farooq *et al.*, 2022). Socio economic factors such as poor governance, conflict, inequality, and weak economic development create unstable environments that undermine food security efforts (Atukunda *et al.*, 2021). Structural disadvantage and unfavorable social circumstances further limit access to resources and increase vulnerability among marginalized groups (Kirkbride *et al.*, 2024). Farmers face significant barriers when implementing sustainable practices. These barriers include insufficient investment, limited awareness, poor skills, market competition, insecure land tenure, and inadequate policy support. (Sekaran *et al.*, 2021; Zerssa *et al.*, 2021). Experts critique existing food security assessment tools for their narrow, compliance-oriented focus. These tools overlook the complex socio cultural dimensions of indigenous food systems and fail to capture holistic measures of well being (Dar *et al.*, 2026). Escalating pressure from resource extraction activities on indigenous lands poses an additional threat to traditional food systems and territorial integrity, compounding existing vulnerabilities (Owen *et al.*, 2023).

Research Gaps and Methodological Limitations

The literature reveals critical research gaps and methodological limitations. A significant gap exists in understanding the complex biocultural interactions driving environmental degradation and disease emergence in landscapes undergoing rapid land use change, which carries implications for indigenous food systems (Ortiz *et al.*, 2022). Similarly, more extensive research is needed on the global burdens and distribution of animal diseases across value chains, an area directly relevant to livestock-dependent food systems in indigenous communities (Kappes *et al.*, 2023). Specific alternative food sources, such as Black Soldier Fly Larvae, also require targeted studies to determine optimal application across different livestock categories, given the current scarcity of evidence for ruminants (Lu *et al.*, 2022).

Researchers frequently note methodological limitations. Existing assessment tools use a narrow framing of sustainability. They prioritize short term compliance processes over long term resilience, equity, or broader socio-ecological dimensions (Dar *et al.*, 2026). Efforts to develop context specific resilience measurement scales illustrate emerging attempts to address this gap, though such tools remain limited in geographic and cultural scope (Oza *et al.*, 2025). A more holistic and culturally sensitive assessment approach is imperative to accurately capture the complexities of food security in indigenous rural areas.

Discussion

Household food security in indigenous rural areas involves complex ecological, socio-economic, and cultural factors. This systematic literature review synthesizes current understanding regarding indicators, measurement challenges, and adaptive strategies prevalent in these distinct contexts. While global efforts towards food security often employ standardized metrics, this review

reveals the necessity of context specific approaches, acknowledging the unique vulnerabilities and capacities of indigenous populations.

Positive Outcomes and Adaptive Capacities

Indigenous rural communities frequently demonstrate remarkable adaptive capacities and positive outcomes concerning food security, often rooted in their deep connection to local ecosystems. Communities develop resilience through robust local infrastructure and enhanced human capacity, notably in areas prone to environmental stressors like flooding (Dewa et al., 2022). Indigenous people pass traditional knowledge systems through generations. These systems contribute to holistic nourishment and practical harvesting skills. They ensure the sustained availability of diverse food sources. They also link cultural practices with food system stability (Prieto et al., 2026).

Innovative agricultural practices further bolster food security and productivity. Integrated Crop Livestock Systems (ICLS) enhance agricultural output and promote ecological sustainability, fostering more resilient food production in challenging environments (Sekaran et al., 2021). The nutritional benefits derived from traditional food sources, such as drought resistant millet varieties, offer crucial dietary diversity and resilience against food shortages (Hassan et al., 2021). Alternative protein sources, like Black Soldier Fly Larvae, present promising opportunities for sustainable feed production, indicating a proactive search for solutions to protein scarcity in the face of climate pressure (Lu et al., 2022). These adaptive measures collectively represent vital indicators of successful household food security strategies, illustrating how indigenous populations leverage traditional wisdom alongside modern innovations to maintain nutritional well-being.

Enabling Factors and Sustainable Solutions

Effective food security strategies in indigenous rural areas rely heavily on specific enabling factors and the adoption of sustainable solutions. Smallholder farmers significantly benefit from improved access to credit, comprehensive extension services, and sufficient farm income, which collectively empower them to invest in productive resources and adopt advanced agricultural practices (Atube et al., 2021). Community level infrastructure development, coupled with enhanced human capacity building, strengthens the resilience of food systems against external shocks and climatic variability, while also supporting broader psychosocial well being (Dewa et al., 2022). Cultural principles within indigenous societies serve as powerful enablers for sustainable food practices. Values such as sharing, environmental stewardship, and inherent adaptability foster community-based resource management and collective responses to food insecurity, functioning as guiding principles passed across generations (Prieto et al., 2026). Furthermore, modern eco friendly technologies, including Plant Growth Promoting Microorganisms (PGPMs) and biofertilizers, offer sustainable solutions for improving crop production and soil fertility without relying on synthetic inputs (Koskey et al., 2021; Kumar et al., 2022). Their application reduces environmental impact while increasing yields, presenting a viable path toward ecologically sound and productive food systems in these regions.

Challenges and Barriers to Food Security

Household food security in indigenous rural areas confronts multifaceted challenges and persistent barriers that complicate assessment and intervention. Climate change represents a dominant threat, severely impacting crop yields, reducing biodiversity, and disrupting traditional agricultural calendars, consequently undermining the foundation of local food systems (Ayanlade et al., 2022; Farooq et al., 2022). Socio economic factors, including poor governance, pervasive conflict, deep-seated inequality, and weak economic development, exacerbate food insecurity by limiting access to resources, markets, and essential services (Atukunda et al., 2021). Structural disadvantages and unfavorable social circumstances further marginalize indigenous communities, making them disproportionately vulnerable to food crises (Kirkbride et al., 2024). Implementing sustainable practices also faces significant hurdles. Common impediments include insufficient investment in agricultural technologies, limited awareness, and a lack of essential skills among farmers to adopt new methods effectively, compounded by land tenure insecurity that disincentivizes long-term investment (Sekaran et al., 2021; Zerssa et al., 2021). Existing assessment tools for food security are critiqued for their narrow, compliance-oriented focus, overlooking the complex socio cultural dimensions of indigenous food systems and failing to capture holistic

measures of well being (Dar et al., 2026). The intersection of resource extraction activities with indigenous lands also poses a significant threat, displacing communities and degrading the ecological resources crucial to their food security (Owen et al., 2023).

Research Gaps and Methodological Limitations

Current scholarship reveals critical areas requiring further investigation regarding household food security in indigenous rural contexts, alongside notable methodological limitations in existing studies. Significant knowledge gaps persist in understanding the intricate biocultural interactions that drive both environmental degradation and the emergence of disease risks in transitioning landscapes, which directly impact food safety and availability (Ortiz et al., 2022). Similarly, comprehensive evaluations of the global burdens and distribution of animal diseases across value chains remain scarce, hindering targeted interventions aimed at protecting livestock, a critical component of food security in many indigenous communities (Kappes et al., 2023). Research on specific alternative food sources, such as Black Soldier Fly Larvae, also requires targeted studies to determine optimal application across different livestock categories, given the current scarcity of evidence for ruminants (Lu et al., 2022).

Methodological limitations frequently impede a holistic understanding of food security in these settings. Many existing assessment tools are criticized for their overly narrow framing of sustainability, often prioritizing short-term processes and compliance metrics over long-term ecological health, social equity, or systemic resilience (Dar et al., 2026). Emerging efforts to construct context specific resilience scales represent a step toward addressing this gap, though such instruments remain limited in cultural and geographic transferability (Oza et al., 2025). A more comprehensive methodological framework is needed to accurately measure multi dimensional aspects of food security, including access to traditional foods, cultural appropriateness, and community self-determination in food governance.

CONCLUSIONS AND RECOMMENDATIONS

This systematic literature review examined household food security indicators and their measurement challenges within indigenous rural areas, alongside existing adaptive strategies and persistent research gaps. Regarding indicators, the reviewed literature shows that assessment of household food security in these contexts draws on a combination of quantitative resilience and adaptation measures, traditional knowledge based indicators such as harvesting skills and dietary diversity from wild and traditional food sources, and emerging locally adapted resilience scales. Standardized tools complicate these assessments. These tools use narrow and compliance oriented framing. They lack cultural sensitivity. They also fail to integrate the specific socio cultural and biocultural dimensions of indigenous food systems. These findings extend the conceptual understanding of food security by underscoring the interplay between traditional knowledge, adaptive capacity, and external structural challenges. Theoretically, the review suggests that food security frameworks should move beyond caloric and access based metrics to incorporate cultural appropriateness and self determination as core dimensions. Practically, the findings point to the need for policy and program design that integrates local infrastructure investment, credit and extension access, and culturally grounded assessment instruments. Language and database choices limit this review. We only included English language and peer reviewed sources from Scopus, Google Scholar, ScienceDirect, and DOAJ. This strategy may exclude significant regional grey literature and non English scholarship. The thematic synthesis approach, while suited to capturing cross context patterns, also limits the ability to draw statistically generalizable conclusions. Future research should prioritize the development and psychometric validation of culturally grounded food security assessment tools, alongside longitudinal studies capturing the dynamic interplay between climate change, socio-economic shocks, and indigenous adaptive strategies over time.

ACKNOWLEDGEMENTS

The authors would like to thank those who provided both moral and material support for the implementation of this event.

REFERENCES

- Akram, H., Hussain, S., Mazumdar, P., Chua, K. O., Butt, T. E., & Harikrishna, J. A. (2023). Mangrove Health: A Review of Functions, Threats, and Challenges Associated with Mangrove Management Practices. *Forests*, 14(9), 1–38. <https://doi.org/10.3390/f14091698>
- Atube, F., Malinga, G. M., Nyeko, M., Okello, D. M., Alarakol, S. P., & Okello-Uma, I. (2021). Determinants of smallholder farmers' adaptation strategies to the effects of climate change: Evidence from northern Uganda. *Agriculture and Food Security*, 10(1), 1–14. <https://doi.org/10.1186/s40066-020-00279-1>
- Atukunda, P., Eide, W. B., Kardel, K. R., Iversen, P. O., & Westerberg, A. C. (2021). Unlocking the potential for achievement of the un sustainable development goal 2 – ‘zero hunger’ – in Africa: Targets, strategies, synergies and challenges. *Food and Nutrition Research*, 65, 1–11. <https://doi.org/10.29219/fnr.v65.7686>
- Ayanlade, A., Oluwaranti, A., Ayanlade, O. S., Borderon, M., Sterly, H., Sakdapolrak, P., Jegede, M. O., Weldemariam, L. F., & Ayinde, A. F. O. (2022). Extreme climate events in sub-Saharan Africa: A call for improving agricultural technology transfer to enhance adaptive capacity. *Climate Services*, 27(December 2021), 100311. <https://doi.org/10.1016/j.cliser.2022.100311>
- Dar, O. A., Claron, M., Zahid, H., Khan, M., & Spicer, N. (2026). Exploring measures of sustainability in the WHO Joint External Evaluation and the WOA performance of veterinary services tools—A qualitative assessment of perceived usefulness and acceptability to one health and global health security experts. *Plos One*, 21(3 March), 1–19. <https://doi.org/10.1371/journal.pone.0343801>
- Dewa, O., Makoka, D., & Ayo-Yusuf, O. A. (2022). Measuring community flood resilience and associated factors in rural Malawi. *Journal of Flood Risk Management*, 16(1), 1–21. <https://doi.org/10.1111/jfr3.12874>
- Farooq, M. S., Uzair, M., Raza, A., Habib, M., Xu, Y., Yousuf, M., Yang, S. H., & Ramzan Khan, M. (2022). Uncovering the Research Gaps to Alleviate the Negative Impacts of Climate Change on Food Security: A Review. *Frontiers in Plant Science*, 13(July), 1–39. <https://doi.org/10.3389/fpls.2022.927535>
- Gallois, S., Heger, T., Henry, A. G., & van Andel, T. (2021). The importance of choosing appropriate methods for assessing wild food plant knowledge and use: A case study among the Baka in Cameroon. *PLoS ONE*, 16(2 February), 1–19. <https://doi.org/10.1371/journal.pone.0247108>
- Grote, U., Fasse, A., Nguyen, T. T., & Erenstein, O. (2021). Food Security and the Dynamics of Wheat and Maize Value Chains in Africa and Asia. *Frontiers in Sustainable Food Systems*, 4(February), 1–17. <https://doi.org/10.3389/fsufs.2020.617009>
- Hassan, Z. M., Sebola, N. A., & Mabelebele, M. (2021). The nutritional use of millet grain for food and feed: a review. *Agriculture and Food Security*, 10(1), 1–14. <https://doi.org/10.1186/s40066-020-00282-6>
- Jernigan, V. B. B., Maudrie, T. L., Nikolaus, C. J., Benally, T., Johnson, S., Teague, T., Mayes, M., Jacob, T., & Taniguchi, T. (2021). Food Sovereignty Indicators for Indigenous Community Capacity Building and Health. *Frontiers in Sustainable Food Systems*, 5(August), 1–9. <https://doi.org/10.3389/fsufs.2021.704750>
- Kappes, A., Tozooneyi, T., Shakil, G., Railey, A. F., McIntyre, K. M., Mayberry, D. E., Rushton, J., Pendell, D. L., & Marsh, T. L. (2023). Livestock health and disease economics: a scoping review of selected literature. *Frontiers in Veterinary Science*, 10(September), 1–15. <https://doi.org/10.3389/fvets.2023.1168649>
- Kirkbride, J. B., Anglin, D. M., Colman, I., Dykxhoorn, J., Jones, P. B., Patalay, P., Pitman, A., Soneson, E., Steare, T., Wright, T., & Griffiths, S. L. (2024). The social determinants of mental health and disorder: evidence, prevention and recommendations. *World Psychiatry*, 23(1), 58–90. <https://doi.org/10.1002/wps.21160>
- Koskey, G., Mburu, S. W., Awino, R., Njeru, E. M., & Maingi, J. M. (2021). Potential Use of Beneficial

- Microorganisms for Soil Amelioration, Phytopathogen Biocontrol, and Sustainable Crop Production in Smallholder Agroecosystems. *Frontiers in Sustainable Food Systems*, 5(April), 1–20. <https://doi.org/10.3389/fsufs.2021.606308>
- Kumar, S., Diksha, Sindhu, S. S., & Kumar, R. (2022). Biofertilizers: An ecofriendly technology for nutrient recycling and environmental sustainability. *Current Research in Microbial Sciences*, 3(December 2021), 100094. <https://doi.org/10.1016/j.crmicr.2021.100094>
- Lu, S., Taethaisong, N., Meethip, W., Surakhunthod, J., Sinpru, B., Sroichak, T., Archa, P., Thongpea, S., Paengkoum, S., Purba, R. A. P., & Paengkoum, P. (2022). Nutritional Composition of Black Soldier Fly Larvae (*Hermetia illucens* L.) and Its Potential Uses as Alternative Protein Sources in Animal Diets: A Review. *Insects*, 13(9), 1–17. <https://doi.org/10.3390/insects13090831>
- Marengo, J. A., Galdos, M. V., Challinor, A., Cunha, A. P., Marin, F. R., Vianna, M. dos S., Alvala, R. C. S., Alves, L. M., Moraes, O. L., & Bender, F. (2022). Drought in Northeast Brazil: A review of agricultural and policy adaptation options for food security. *Climate Resilience and Sustainability*, 1(1), 1–20. <https://doi.org/10.1002/cli2.17>
- Muluneh, M. G. (2021). Impact of climate change on biodiversity and food security: a global perspective—a review article. *Agriculture and Food Security*, 10(1), 1–25. <https://doi.org/10.1186/s40066-021-00318-5>
- Ortiz, D. I., Piche-Ovares, M., Romero-Vega, L. M., Wagman, J., & Troyo, A. (2022). The impact of deforestation, urbanization, and changing land use patterns on the ecology of mosquito and tick-borne diseases in central America. *Insects*, 13(1). <https://doi.org/10.3390/insects13010020>
- Owen, J. R., Kemp, D., Lechner, A. M., Harris, J., Zhang, R., & Lèbre, É. (2023). Energy transition minerals and their intersection with land-connected peoples. *Nature Sustainability*, 6(2), 203–211. <https://doi.org/10.1038/s41893-022-00994-6>
- Oza, H. H., Salinger, A. P., Taruc, R., Tela, A., Barker, S. F., Leder, K., Freeman, M. C., Clasen, T., & Sinharoy, S. S. (2025). Resilience measurement for environmental shocks and stressors: scale development and psychometric assessment for coastal urban informal settlements in Fiji and Indonesia. *BMC Global and Public Health*, 3(1). <https://doi.org/10.1186/s44263-025-00177-3>
- Prieto, M. R., Ostertag, S., Donnelly, T., Wolki-Ruben, C., Arey, S., Memogana, S., Slack, C., & Skinner, K. (2026). Exploring intergenerational knowledge transfer within Inuvialuit families: connecting wellbeing, food security, and climate resiliency. *Frontiers in Climate*, 7(January), 1–13. <https://doi.org/10.3389/fclim.2025.1694926>
- Rahman, M., Ahmad, A., Raza, A., Hasnain, M. U., Alharby, H. F., Alzahrani, Y. M., Bamagoos, A. A., Hakeem, K. R., Ahmad, S., Nasim, W., Ali, S., Mansour, F., & EL Sabagh, A. (2022). Impact of climate change on agricultural production; Issues, challenges, and opportunities in Asia. *Frontiers in Plant Science*, 13. <https://doi.org/10.3389/fpls.2022.925548>
- Sansón-Rosas, A. M., Bernal-Rivas, J., Kubow, S., Suarez-Molina, A., & Melgar-Quinonez, H. (2021). Food insecurity and the double burden of malnutrition in Colombian rural households. *Public Health Nutrition*, 24(14), 4417–4429. <https://doi.org/10.1017/S1368980021002895>
- Sekaran, U., Lai, L., Ussiri, D. A. N., Kumar, S., & Clay, S. (2021). Role of integrated crop-livestock systems in improving agriculture production and addressing food security – A review. *Journal of Agriculture and Food Research*, 5, 100190. <https://doi.org/10.1016/j.jafr.2021.100190>
- Sithole, Z., Siwela, M., Ojo, T. O., Hlatshwayo, S. I., Kajombo, R. J., & Ngidi, M. S. C. (2023). Contribution of Fruits and Vegetables to the Household Food Security Situation of Rural Households in Limpopo. *Nutrients*, 15(11), 1–14. <https://doi.org/10.3390/nu15112539>
- Williams, P. A., Simpson, N. P., Totin, E., North, M. A., & Trisos, C. H. (2021). Feasibility assessment of climate change adaptation options across Africa: An evidence-based review. *Environmental Research Letters*, 16(7). <https://doi.org/10.1088/1748-9326/ac092d>
- Zerssa, G., Feyssa, D., Kim, D. G., & Eichler-Löbermann, B. (2021). Challenges of smallholder

farming in Ethiopia and opportunities by adopting climate-smart agriculture. *Agriculture (Switzerland)*, 11(3), 1–26. <https://doi.org/10.3390/agriculture11030192>