Economic Incentives for Climate-Smart Agriculture and Ecosystem Conservation in Tanzania: A PRISMA-Based Systematic Review

Isabella L. Mrema[1] and Emmanuel N. Kazuva[2]*
[1]Tanzania Agriculture Research Institute, Mwanza, Tanzania
[2]The Open University of Tanzania, D'Salaam, Tanzania
*Correspondence: ekazuvae@gmail.com/emmanuel.kazuva@out.ac.tz;

Abstract
This study systematically reviews empirical evidence on economic factors associated with the adoption of climate-smart agriculture (CSA) and ecosystem conservation practices in Tanzania. A PRISMA-guided approach was used to identify and synthesise studies published between 2018 and 2025. Ten Tanzania-specific empirical studies were included in the qualitative synthesis. The studies varied in design, setting, economic mechanism and measured outcome. Access to finance was associated with the adoption of some CSA practices, although findings differed by practice. Land-tenure security and extension support also featured in the adoption evidence as institutional and informational conditions, respectively, rather than financial incentives. Evidence on market-based instruments, including payments for ecosystem services, was more limited, and few studies measured sustained adoption or ecosystem outcomes. The available evidence therefore does not establish that financial incentives are more effective than market-based instruments or that combined approaches outperform individual interventions. By bringing these studies together, the review identifies context-specific patterns and gaps in evidence relevant to policy design. Recommendations include addressing locally identified barriers to financial access and piloting payments for ecosystem services (PES) and carbon-market arrangements with careful monitoring of participation, funding and conservation outcomes. Further longitudinal and comparative research is needed to assess the lasting effects of economic instruments on CSA adoption and ecosystem conservation.

Keywords: *Climate-smart agriculture, financial incentives, market-based instruments, ecosystem conservation, Tanzania*

INTRODUCTION

Climate change has persistently put a lot of strain on agricultural systems and natural ecosystems, especially in developing countries where people rely on climate-sensitive resources. In turn, climate-smart agriculture (CSA) has already evolved into a holistic strategy that will help improve productivity, resilience, and reduce greenhouse gas emissions (Ma & Rahut, 2024; Ariom et al., 2022). Meanwhile, ecosystem conservation is necessary to ensure soil quality, the availability of water resources, and biodiversity, which are the basis for agricultural productivity in the long term (Akamani, 2021). More economic arguments, particularly financial incentives and market-based instruments, are needed to influence land-use decisions and to enhance sustainable agriculture (Pineiro et al., 2020; van Asseldonk et al., 2023).

Empirical data from Africa show that CSA practices can increase productivity, adaptation, and mitigation outcomes; however, adoption remains uneven because the practice is constrained by financial, institutional, and market aspects (Mnukwa et al., 2025; Adimassu et al., 2025). Similar trends are observed in Tanzania, where the use of CSA technologies has high potential for enhancing agricultural performance and resilience; however, there has been low adoption due to a lack of access to credit, poor market relations, and high implementation costs (Kurgat et al., 2020; Bai & Magembe, 2025). Studies also indicate that, to make agriculture sustainable in Tanzania, technological and institutional innovations, including precision agriculture and improved resource management methods, will only be possible when combined with economic incentives (Massawe & Mmbando, 2025; Anami, 2026).

The agricultural sector in Tanzania is highly vulnerable to climate change. Despite its potential, there have been persistent issues with productivity and the sustainability of resources. Empirical studies (i.e., Jones et al., 2023; Silas & Ndaki, 2022) have shown that CSA has the potential to increase the resilience of smallholder farmers; however, the adoption rate of CSA is limited due to a lack of financial incentives, insufficient extension services, and access to credit. Despite the increasing focus of policy frameworks on economic tools, including subsidies, rural finance, and market-based conservation mechanisms, a gap persists in the existing studies. Specifically, there is a paucity of systematic evidence that summarises the relative impact of financial incentives and market-based

instruments on CSA and the adoption of ecosystem conservation in Tanzania.

Although limited access to finance and markets can constrain farmers' adoption of climate-smart agriculture in Tanzania, this practical challenge is distinct from the evidence gap addressed by this review. Tanzania-focused studies examine particular practices and economic factors, while broader reviews provide context across countries. This review brings together Tanzania-specific empirical studies to identify which financial and market-related mechanisms have been examined, which adoption and conservation outcomes were measured, and where evidence for comparing instruments remains limited. Regional reviews and other contextual sources inform the background and discussion but are not counted among the ten studies in the synthesis. The contribution is a clearer account of the scope and limits of the Tanzania-specific evidence, rather than an estimate of the relative effectiveness of financial and market-based instruments. This review addresses three questions: (1) Which financial, market-related and institutional economic factors have been examined in Tanzania-specific empirical studies of climate-smart agriculture and ecosystem conservation? (2) What adoption or conservation outcomes do these studies report, and how were those outcomes measured? (3) How do the reported findings vary by practice and setting, and what limits the conclusions that can be drawn about the effects of economic instruments?

LITERATURE REVIEW

Theoretical Literature Review

Incentive theory provides a basis for considering how expected costs, returns and risks may enter farmers' adoption decisions (Milgrom & Roberts, 1992). Credit, subsidies and payments may change these considerations, but the existence of a plausible mechanism does not establish that providing an incentive caused adoption. For example, Pamuk et al. (2022) examine savings group support delivered alongside training; the contribution of finance cannot be separated from that of the combined programme. Studies of farmers' resources and practice adoption likewise report associations that may differ across technologies and settings (Erick et al., 2025; Kurgat et al., 2020).

Institutional perspectives draw attention to the conditions under which economic mechanisms operate. Land-tenure security is an institutional

condition, while extension provides information and technical support; neither is itself a financial incentive. Governance and programme arrangements may also matter for market-based instruments. Discussions of Tanzania's REDD+ experience and wider PES arrangements provide context for these issues, but do not establish the effect of a payment on adoption in the studies synthesised here (Scheba, 2018; Osewe et al., 2023; Matekele et al., 2025).

Together, these perspectives guide the review's examination of the economic factors studied, the outcomes reported and differences across settings. They are used to interpret the evidence, not to infer a causal pathway or rank instruments by effectiveness.

Conceptual Framework

Based on the Theory of Incentives and supporting institutional perspectives, this study developed a conceptual framework illustrating the relationship between economic instruments and the adoption of climate-smart agriculture and ecosystem conservation practices (Figure 1).

Figure 1:
Conceptual framework for examining economic mechanisms, contextual conditions and reported adoption and conservation outcomes

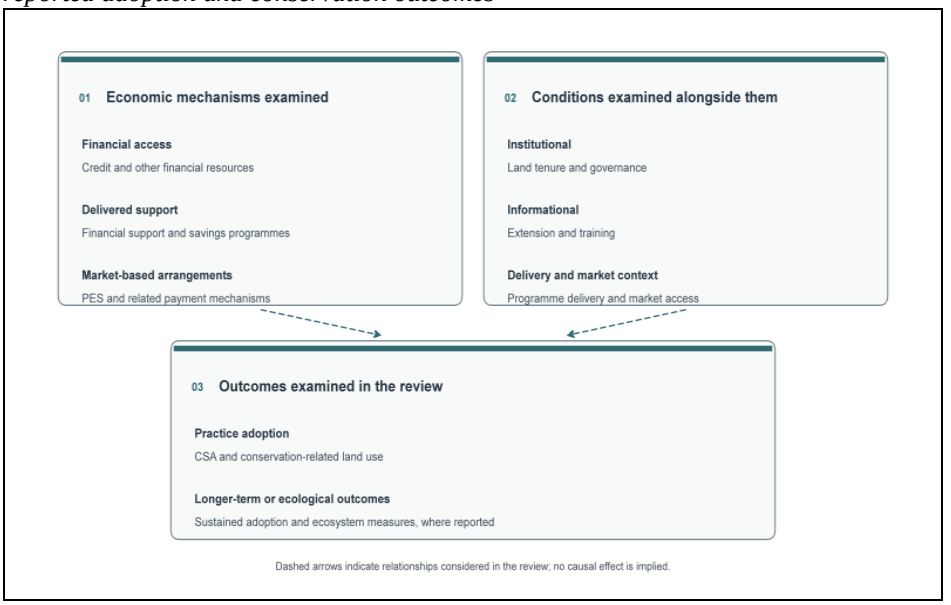


Figure 1 organises the review around the economic mechanisms examined, the institutional and informational conditions reported alongside them, and the adoption or conservation outcomes measured. Its arrows represent relationships to investigate in the included studies, not causal effects established by this review.

Empirical Literature Review

Financial Incentives and Adoption of Climate-Smart Agriculture

The reviewed literature indicates that financial incentives play a role in driving the introduction of climate-smart agriculture (CSA), but they fail due to the institutional context and design. According to Van Asseldonk et al. (2023) and Rurii, M. W., & Nzengya Daniel, M. (2026) tools such as subsidies, credit, and risk-sharing mechanisms decrease barriers to the adoption of CSA in Sub-Saharan Africa. These studies consistently agree that monetary rewards reduce liquidity and financial constraints and perceived risks. However, a study by Van Asseldonk et al. (2023) is not focused on country-specific empirical estimates with regard to Tanzania. On the other hand, Rurii, M. W., & Nzengya Daniel, M. (2026) provide general conclusions for the country, thus falling short of providing country-specific impacts of institutions. Nevertheless, both studies indicate that isolated incentives are likely to be less effective, as they need to be supported and coordinated by institutions. This means that both studies converge on effectiveness, but they also share a common limitation in terms of standalone interventions.

Evidence from Kurgat et al. (2020) and Silas and Ndaki (2022) indicates that this trend is prevalent in Tanzania, where barriers such as financial constraints, insufficient access to credit, and institutional support are singled out. Though these studies confirm that increasing financial access increases the uptake of CSA, they also indicate that most of the interventions are short-term and not well designed to sustain long-term uptake. In this case, the literature reveals agreement in terms of short-term positive impacts but disagreement in the sustainability of uptake in the long term. Quantitative research such as Kurgat et al., (2020) empirically demonstrates a positive correlation between financial incentives and adoption, whereas qualitative research (Silas & Ndaki, 2022) is more contextual and its findings cannot be generalised. However, the gap lies in the fact that researchers such as Kurgat et al. (2020) focus on the determinants of adoption without assessing the sustainability of adoption in the long term or the environmental effects. On the other hand, Silas and

Ndaki (2022) provide little evidence on generalisability or quantitative validation of the financial effects. This is an aspect of the strength of evidence, not the conclusions.

In general, it is widely believed that financial incentives have a positive impact on the adoption of CSA by alleviating liquidity restraints and exposure to risk. Nevertheless, the main gap arises in terms of sustainability over the long term and in terms of its connection to ecosystem conservation outcomes, which have not yet been studied in the context of Tanzania.

Influence of Market-Based Instruments on the Adoption of Climate-Smart Agriculture and Ecosystem Conservation Practices

The evidence for market-based instruments is more varied and context-dependent. At the regional level, Van Asseldonk et al. (2023) and Rurii, M. W., & Nzengya Daniel, M. (2026) highlight that mechanisms such as carbon pricing, payments for ecosystem services (PES), and market integration have the potential of aiding the adoption by increasing expected returns. There is partial agreement on their theoretical potential. Nevertheless, these studies do not measure long-term conservation effects and do not empirically provide evidence in Tanzania, which restricts their policy applicability.

Kurgat et al. (2020) and Silas and Ndaki (2022) show that market access in Tanzania, to a large extent, influences the adoption of CSA, and that more connected farmers choose to engage in better practices. Nevertheless, market incentives are not very reliable due to weak value chains, price volatility, and inefficient cooperative forms. This reflects a clear contradiction: market access promotes adoption, while unstable market systems undermine sustained outcomes.

Notably, the current literature is more concerned with adoption rates, but not with the overall conservation of the ecosystems related to market-based mechanisms. Another significant difference in the literature is the trustworthiness of market-based incentives. Whereas some studies have indicated that better access to the market can trigger adoption, other studies have indicated that structural constraints can undermine their efficacy. This implies that market-based instruments do not necessarily work, but depend on well-established institutions, infrastructure, and

systems of governance. This divergence suggests that outcomes depend heavily on institutional and governance conditions.

The studies examine different economic factors, practices and outcomes. Evidence on access to finance or household resources is more common than direct evaluation of a delivered incentive, while evidence on market-based conservation instruments and measured ecosystem outcomes is limited. These differences guide the qualitative synthesis but do not support a ranking of the instruments' effects.

METHODOLOGY

This study adopted a systematic review design guided by the PRISMA 2020 framework to synthesise empirical evidence on the role of economic incentives in the adoption of climate-smart agriculture (CSA) and ecosystem conservation practices in Tanzania. The four PRISMA stages, identification, screening, eligibility, and inclusion, were followed as recommended by Page et al. (2021). This was chosen in order to improve transparency, decrease selection bias, and improve replicability of the review process.

Searches were conducted in Springer, Google Scholar, ScienceDirect, Emerald and Scopus were searched for studies published between 2018 and 2025. This range defines the publication eligibility period, not the dates on which the searches were conducted. The available records do not establish the exact search dates or complete source-specific queries and result limits. These details cannot therefore be reported or independently reproduced from the present documentation. The review screened titles and abstracts against the predefined eligibility criteria and then assessed potentially eligible articles in full text.

Eligible studies were English-language empirical journal articles published between 2018 and 2025 that reported Tanzania-specific findings on an economic factor or instrument in relation to the adoption of a climate-smart agriculture or ecosystem conservation practice. Articles were excluded if they addressed agronomic outcomes alone, lacked a clear adoption outcome or adequate methodological description, or did not report separately identifiable Tanzanian findings. Reviews, policy reviews and grey literature, including reports, theses and working papers, were excluded from the synthesis. Review and regional sources cited elsewhere in the manuscript provide background context only. While one

reviewer screened titles, abstracts and assessed full-text articles against these criteria, a second reviewer subsequently checked the eligibility decisions and confirmed the final set of included studies.

Methodological quality was considered using the Mixed Methods Appraisal Tool (MMAT), version 2018 (Hong et al., 2018). The tool's criteria differ by study design, so the included studies should be appraised using the criteria appropriate to their respective designs. Item-level appraisal records for the final ten-study set are unavailable; consequently, MMAT scores and a quality-based inclusion threshold are not reported. Table 1 describes each study's design and appraisal status, while methodological limitations are considered in the interpretation of the findings. The Mixed Methods Appraisal Tool (MMAT), version 2018, was identified as a framework for considering methodological quality (Hong et al., 2018). Table 1 describes the studies' designs and limitations relevant to interpreting their findings; it does not present a completed MMAT appraisal.

Table 1:
Characteristics and methodological considerations of included studies

Study	Design and setting	Consideration for interpretation
Kagata et al. (2018)	Uluguru Mountains; 219 households; survey, interviews and logistic regression	Land-use adoption followed a PES project; the payment effect cannot be isolated.
Kurgat et al. (2020)	Four Tanzanian regions; cross-sectional household analysis	Observational associations; no causal estimate of a delivered incentive.
Jha et al. (2021)	Morogoro and Dodoma; survey of 697 smallholders	Observational survey; adoption associations do not establish causal effects.
Ogada et al. (2021)	Lushoto; survey of 264 households; multivariate probit	Cross-sectional, practice-specific associations; no causal estimate.
Pamuk et al. (2022)	Tanzania; comparison of farmer-group interventions	Savings support and training combined; separate credit effect cannot be isolated.
Bongole (2023)	Mbeya and Songwe; 1,443 households	Plot-ownership association; no incentive payment evaluated.
Selya et al. (2023)	Chamwino; survey of 260 households; logistic regression	Cross-sectional credit association; causation not established.
Utonga et al. (2024)	Dodoma grape farmers; multivariate probit	Cross-sectional analysis; associations differ by practice.
Awoke et al. (2025)	Dodoma; observational study of gender and CSA adoption	Resource-related associations; causal effects not established.
Erick et al. (2025)	Semi-arid central Tanzania; adoption and intensity analysis	Observational associations; no causal incentive estimate.

Data were extracted into a standardised matrix recording each study's authors, publication year, location, design, sample, economic factor or instrument, measured adoption or conservation outcome, and findings. The studies were compared by economic mechanism, distinguishing access to resources from delivered interventions and market-based arrangements. Land tenure, extension and governance were considered institutional or informational conditions rather than financial incentives. The synthesis examined differences across practices and settings and considered the limitations of each study's design and outcome measures.

Meta-analysis was not appropriate because the studies differed in design, economic factors, practices and reported outcomes. Findings were therefore synthesised narratively. Associations were distinguished from evaluations of delivered interventions, and conclusions about effectiveness were limited to what the study designs could support. PRISMA 2020 guided the reporting of study identification and selection. The search and screening totals reported in an earlier draft have not been reconciled with the final study set and are not presented as verified selection counts.

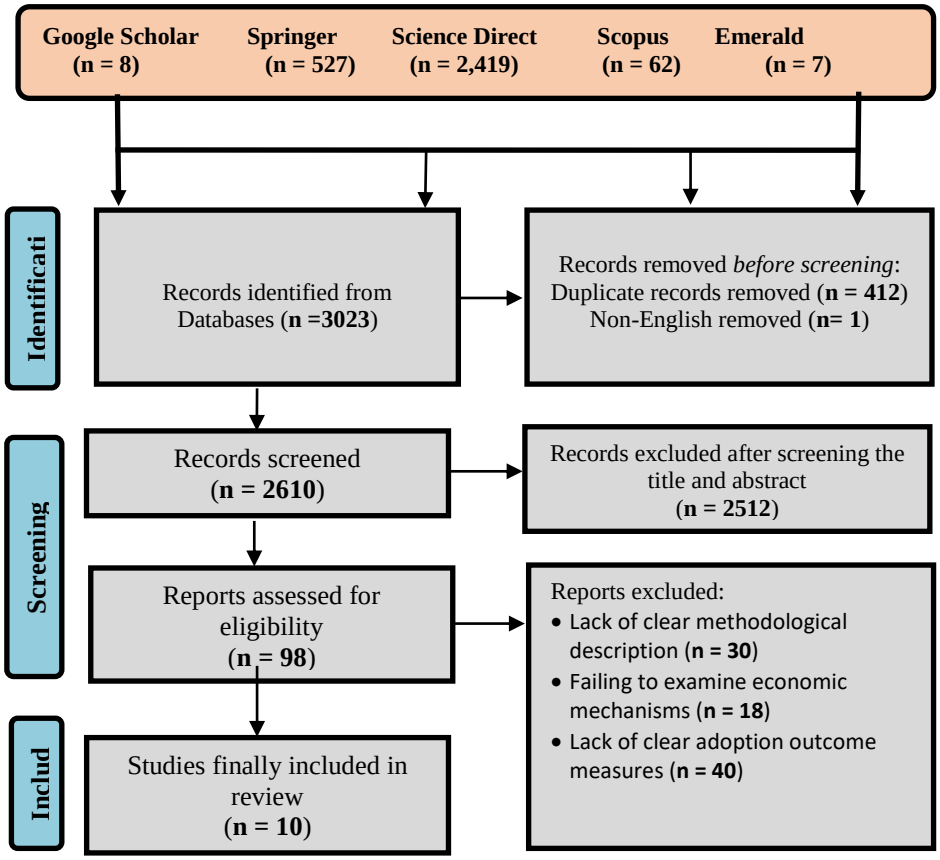
The review has several limitations. Incomplete records of source-specific searches and duplicate removal limit reproducibility. Screening and full-text assessment by one reviewer increase the possibility of selection error. The small and heterogeneous evidence base, together with limited evidence on sustained adoption and measured ecosystem outcomes, prevents a pooled effect estimate or a reliable ranking of financial and market-based instruments. The Tanzania-specific scope also limits the direct applicability of findings to other settings.

FINDINGS

The searches identified 3,023 records: 527 from Springer, 8 from Google Scholar, 2,419 from ScienceDirect, 7 from Emerald and 62 from Scopus. After duplicates and one non-English record were removed, 2,610 records remained for title and abstract screening. Of these, 2,512 were excluded because they did not meet the review's objectives. Most focused solely on agronomic performance, examined climate change without considering economic instruments, or were outside Tanzania. The remaining 98 reports were assessed in full text. Eighty-eight were excluded: 30 did not adequately describe their methods, 18 did not examine financial incentives or market-based instruments, and 40 did not report a clear

adoption outcome. The remaining 10 articles were included in the qualitative synthesis. Their differences in design, incentives and outcomes limit confidence in comparing the relative effectiveness of financial and market-based instruments. The findings are therefore presented as patterns in the available evidence, rather than firm estimates of comparative effectiveness. Bibliographic details, study characteristics and findings were organised in Microsoft Excel. The study-selection process is shown in the PRISMA flow diagram.

Figure 2:
PRISMA flow diagram of study identification and selection



Financial Incentives and the Adoption of Climate-Smart Agriculture

In a quasi-experimental study, Pamuk et al. (2022) compared the effects of Farmer Field Business Schools (FFBS) and Village Savings and Loan Associations (VSLAs) on CSA adoption in Iringa, Tanzania. The researcher found that farmer training, access to microfinance, and

women's empowerment positively contributed to increased use of mulching, composting manure, crop rotation, and rhizobium inoculation. VSLAs provided greater liquidity, which lowered financial barriers to adoption. This suggests that community-based financial mechanisms are highly influential in CSA adoption when paired with capacity building.

Van Asseldonk et al. (2023) conducted a policy review and found that subsidies, rural finance, land rights security, and training are important tools for influencing adoption. Moreover, the study also emphasises that single policy instruments are less effective when used alone, and that integrated and well-timed incentives are more effective than individual measures.

Bongole (2023), using multivariate and ordered probit models, revealed that climate-smart agriculture (CSA) practices are complementary rather than substitutionary, with plot ownership and gender playing critical roles in adoption decisions. Although the study did not directly examine financial incentives, the findings suggest that institutional and economic conditions moderately influence the level of adoption.

Erick et al. (2025) conducted a study using a double-hurdle model and found that land tenure security, extension services, and access to markets have a strong positive effect on both the probability of adoption and intensity. But not all the practices were very common because capital requirements were high. Thus, while financial incentives may lessen risk, they might not be sufficient to overcome the cost barrier, which implies a high but conditional effect.

Rurii, M. W., & Nzengya Daniel, M. (2026) found that poor access to credit and financial constraints are major hurdles in Africa. They note that credit schemes and subsidies enhance adoption in combination with extension services, and thus support the observation that integrated financial and informational support systems have more effective results.

Kurgat et al. (2020) showed that financial capital, information accessibility, and institutional support have a positive influence on the adoption of CSA by reducing the cost of transactions and uncertainty; it also suggested that the impact of financial resources is moderate to high.

In cases where farmers are willing despite the inadequacy or poorly designed financial incentives, a study by Silas and Ndaki (2022) found that the lack of capital, the lack of extension services, and the high prices of inputs were limitations to this willingness to adopt.

There is overall agreement that financial incentives have a significant impact on the adoption of CSA, particularly in the reduction of liquidity and risk. Their effectiveness, however, needs to be combined with institutional support; however, there is a lack of evidence on long-term effectiveness.

Market-Based Instruments and Adoption of CSA and Ecosystem Conservation

Scheba (2018) critically evaluated the application of REDD+ in Tanzania and found that income instability, governance issues, and institutional misfits compromised the effectiveness of REDD+. This indicates that carbon market incentives are weak and conditional in weak institutional settings. According to Osewe et al. (2023), Payments for Ecosystem Services (PES) are more efficient in long-term financing, bundling ecosystem services, and the involvement of both state and non-state actors. The mixed transaction model (cash and in-kind) showed better livelihood and conservation outcomes, thus suggesting a moderate to high impact under organised conditions.

A study by Matekele et al. (2025) found that carbon trading increases income where there is good community-level institutional integration. However, poor institutional anchoring reduces trust and sustainability, which means that it has a conditional effect that depends on institutional strength.

Market-based instruments are shown to be conditional in the sense that they will have more effects when there are stable institutions, trusted markets, and long-term funding, but they perform worse when there are governance and market constraints. To further generalise these findings, Table 2 provides a comparative analysis of economic tools, their observed outcomes, and their comparative level of impact in the reviewed literature.

Table 2:
Characteristics and Findings of Included Tanzanian Studies

Study	Design and setting	Economic mechanism and outcome	Interpretation and limits	Outcome category
Kagata et al. (2018)	Uluguru Mountains; 219 households; survey, interviews and logistic regression	PES payments, land rights; adoption of promoted land-use interventions	Adoption observed after a PES project; payment effect not isolated.	Land-use adoption
Kurgat et al. (2020)	Four Tanzanian regions; cross-sectional household analysis	Tenure, household resources; adoption of specific CSA technologies	Technology-specific associations; no delivered incentive effect estimated.	Practice adoption
Jha et al. (2021)	Morogoro and Dodoma; survey of 697 smallholders	Land access, project-related factors; agroforestry uptake	Observational evidence; directions of individual economic predictors require full-text check.	Practice adoption
Ogada et al. (2021)	Lushoto; survey of 264 households; multivariate probit	Credit, off-farm income and landholding; CSA technology uptake	Practice-specific associations; causal effects not established.	Practice adoption
Pamuk et al. (2022)	Tanzania; comparison of farmer-group interventions	Village savings and loan associations plus training; CSA uptake	Combined programme; independent credit effect not isolated.	Practice adoption
Bongole (2023)	Mbeya and Songwe; 1,443 households	Plot ownership; adoption of multiple CSA practices	Tenure-related association; no payment assessed.	Practice adoption
Selya et al. (2023)	Chamwino; survey of 260 households; logistic regression	Agricultural credit; conservation-agriculture adoption	Credit associated with adoption; causal effect not established.	Practice adoption

Study	Design and setting	Economic mechanism and outcome	Interpretation and limits	Outcome category
Utonga et al. (2024)	Dodoma grape farmers; multivariate probit	Finance access; rotation and diversification uptake	Positive association for rotation, negative for diversification.	Practice adoption
Awoke et al. (2025)	Dodoma; empirical study of gender and CSA adoption	Land and livelihood resources; practice adoption	Gendered resource associations; observational design.	Practice adoption
Erick et al. (2025)	Semi-arid central Tanzania; adoption/intensity analysis	Tenure and market access; leafy-vegetable CSA uptake	Associations with adoption and intensity; no causal effect established.	Practice adoption

The studies differed in location, design, economic mechanism and measured outcome (Table 2). Most examined associations between farmers' resources or access to finance and adoption of specific agricultural practices; fewer evaluated an implemented incentive or measured a conservation outcome. The direction of association varied by practice. For example, access to finance was positively associated with crop rotation but negatively associated with crop diversification in the Dodoma grape-farming study (Utonga et al., 2024). The evidence does not support a single estimate of how economic incentives affect adoption across Tanzania.

DISCUSSION

The ten studies examine different crops, farming systems, regions and economic factors. They also measure different outcomes, from the adoption of a particular practice to the intensity of its use. These differences limit direct comparison. For example, studies of land tenure, household resources and market access identify factors associated with adoption, but they do not show what would happen if farmers were given a loan, subsidy or payment (Bongole, 2023; Kurgat et al., 2020; Erick et al., 2025). Evidence from agroforestry and other CSA technologies likewise shows that adoption depends on the practice and the circumstances of the household (Jha et al., 2021; Ogada et al., 2021; Awoke et al., 2025). The findings are therefore better understood as context-specific associations than as estimates of the effectiveness of financial incentives.

The evidence on access to finance illustrates why the type of practice matters. Pamuk et al. (2022) examined a programme combining farmer training with village savings and loan associations. Although the programme supported CSA uptake, its design does not allow the contribution of finance to be separated from that of training and other support. In Chamwino, access to agricultural credit was associated with conservation-agriculture adoption (Selya et al., 2023). Among grape farmers in Dodoma, however, access to finance was positively associated with crop rotation and negatively associated with crop diversification (Utonga et al., 2024). These findings do not justify a general claim that credit increases adoption of all CSA practices. They suggest that the costs, risks and practical requirements of each practice should be considered when designing financial support. A broader African review also describes variation in adoption conditions (Rurii et al. 2026); it provides

context only, as it was published outside this review's 2018–2025 eligibility period.

The evidence on market-based conservation instruments is narrower. Kagata et al. (2018) observed adoption of promoted land-use interventions following a payment for ecosystem services (PES) project in the Uluguru Mountains. Because the study could not separate payments from other aspects of the project, it does not establish the effect of PES payments alone. The other sources discussed here address related, but different, questions: Scheba (2018) examines governance challenges in Tanzania's REDD+ experience; Osewe et al. (2023) compares PES arrangements across Kenya, Uganda and Tanzania; and Matekele et al. (2025) examines carbon trading in relation to community income. These studies help explain why governance, participation and reliable returns may matter, but they cannot establish whether PES or carbon trading increases CSA adoption or improves ecosystem outcomes more effectively than financial support.

These findings can be interpreted through incentive and institutional perspectives. Expected costs, returns and risks may influence a farmer's decision to adopt a practice (Milgrom & Roberts, 1992). Whether an incentive can be used as intended may also depend on land rights, access to services and programme governance. The reviewed studies are consistent with these possible relationships, but they do not test a common causal model. In particular, evidence from a combined programme should not be taken to mean that combining interventions is necessarily more effective than providing any one component separately.

For policy, the clearest implication is to identify the local barrier and the specific practice before choosing an instrument. Access to appropriate finance, secure land tenure and extension support are reasonable priorities where the evidence identifies these as constraints. Their expected benefits should nevertheless be assessed in the settings where they are introduced. The ten studies do not establish that financial incentives are generally superior to market-based instruments, nor do they identify a national sequence for introducing them. PES and carbon-market programmes may be considered for monitored pilots that record who participates, how benefits are distributed, whether funding and governance remain reliable, and whether adoption and ecosystem conditions improve over time. Expanding such programmes would require stronger evidence on those outcomes.

The small number of studies, their predominantly observational designs and the variation in measured outcomes limit confidence in comparisons between instruments. Evidence on sustained adoption and directly measured conservation outcomes is particularly scarce. Future research should compare clearly defined interventions over time and measure both farmers continued use of practices and changes in ecosystem conditions. Until then, the review supports context-sensitive policy design and identifies evidence gaps; it does not provide a causal ranking of economic instruments.

CONCLUSION

This review identifies context-specific associations between economic conditions and the adoption of climate-smart agriculture and conservation practices in Tanzania. Access to finance, land tenure and extension support recur in the adoption studies, while evidence on payments for ecosystem services and carbon trading is limited and addresses different outcomes. The ten-study qualitative synthesis cannot determine whether one type of instrument is more effective than another.

The findings are consistent with incentive theory and institutional economics: farmers' decisions appear to depend on available resources as well as the institutions through which support is delivered. Evidence-informed policy priorities are to identify local barriers to adoption and improve access to appropriate finance, secure land tenure and extension services. The review does not establish the effect of any single intervention or combined policy package. Expansion of PES and carbon-market programmes should therefore proceed through monitored pilots that assess governance, equitable participation, funding reliability and measurable conservation outcomes.

Confidence in broader conclusions is limited by the small evidence base, differences in study design and outcome measures, and the predominance of observational studies. Evidence on sustained adoption and ecosystem outcomes remains particularly scarce. Longitudinal and comparative studies are needed to assess whether specific economic mechanisms produce lasting changes in practice and conservation outcomes.

REFERENCES

Adimassu, Z., Tibebe, D., Tamene, L., & Abera, W. (2025). Evaluating the effects of Climate Smart Agricultural (CSA) practices on productivity, adaptation, and mitigation indicators in Ethiopia: A

meta-analysis approach. *Heliyon*, 11(4). https://doi.org/10.1016/j.heliyon.2025.e42796

Akamani, K. (2021). An ecosystem-based approach to climate-smart agriculture with some considerations for social equity. *Agronomy*, 11(8), 1564. https://doi.org/10.3390/agronomy11081564

Anami, A. K. (2026). Agricultural productivity and economic transformation in Tanzania: A review of challenges and strategic interventions. *African Research Reports*, 2(2), 108-118. https://doi.org/10.65221/0174

Ariom, T. O., Dimon, E., Nambeye, E., Diouf, N. S., Adelusi, O. O., & Boudalia, S. (2022). Climate-smart agriculture in African countries: A Review of strategies and impacts on smallholder farmers. *Sustainability*, 14(18), 11370. https://doi.org/10.3390/su141811370

Awoke, M. D., Löhr, K., Kimaro, A. A., Lana, M., Soh Wenda, B. D., Buabeng, K., Hafner, J. M., & Sieber, S. (2025). Exploring gender dynamics in climate-smart agriculture adoption: A study in semi-arid Dodoma, Tanzania. *Frontiers in Sustainable Food Systems*, 8, 1507540. https://doi.org/10.3389/fsufs.2024.1507540

Bai, M., & Magembe, Y. K. (2025). Advancing agriculture in Tanzania through climate-smart technologies. African *Journal of Agricultural & Resource Economics*, 20(2). 2025.20(2).8 https://doi.org/10.53936/afjare.

Bongole, A. (2023). Adoption of multiple climate smart agricultural practices in Mbeya and Songwe regions in Tanzania. *Journal of African Economic Perspectives*, 1(1), 41–60. https://doi.org/10.58548/2023jaep11.4160

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). SAGE Publications.

Erick, S. B., Mbwambo, J. S., & Salanga, R. J. (2025). Determinants of adoption and intensity of use of climate-smart agriculture (CSA) practices among smallholder leafy vegetable agripreneurs in semi-arid central Tanzania. *International Journal of Development and Management Review*, 20(1), 56–78. https://doi.org/10.4314/ijdmr.v20i1.4

Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M.-P., Griffiths, F., Nicolau, B., O'Cathain, A., Rousseau, M.-C., Vedel, I., & Pluye, P. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information

professionals and researchers. *Education for Information*, 34(4), 285–291. https://doi.org/10.3233/EFI-180221

Jha, S., Kaechele, H., & Sieber, S. (2021). Factors influencing the adoption of agroforestry by smallholder farmer households in Tanzania: Case studies from Morogoro and Dodoma. *Land Use Policy*, 103, 105308. https://doi.org/10.1016/j.landusepol.2021.105308

Jones, K., Nowak, A., Berglund, E., Grinnell, W., Temu, E., Paul, B., ... & Kimaro, A. A. (2023). Evidence supports the potential for climate-smart agriculture in Tanzania. *Global Food Security*, 36, 100666. https://doi.org/10.1016/j.gfs.2022.100666

Kagata, L., Mombo, F., & Massawe, F. A. (2018). Payments for ecosystem services incentives and adoption of land use interventions in Uluguru Mountains, Tanzania. *Agricultural Sciences*, 9(3), 299–316. https://doi.org/10.4236/as.2018.93022

Kurgat, B. K., Lamanna, C., Kimaro, A., Namoi, N., Manda, L., & Rosenstock, T. S. (2020). Adoption of climate-smart agriculture technologies in Tanzania. *Frontiers in Sustainable Food Systems*, 4, 55. https://doi.org/10.3389/fsufs.2020.00055

Ma, W., & Rahut, D. B. (2024). Climate-smart agriculture: adoption, impacts, and implications for sustainable development. *Mitigation and Adaptation Strategies for Global Change*, 29(5), 44. https://doi.org/10.1007/s11027-024-10139-z

Massawe, J. I., & Mmbando, G. S. (2025). The Potential Role of Precision Agriculture in Enhancing Sustainable Agriculture in Tanzania. *Advances in Agriculture*, 2025(1), 6705876. https://doi.org/10.1155/aia/6705876

Matekele, C. K., Mambosho, J. S., Rutatola, P. P., & Chongela, J. M. (2025). Carbon trading and local communities' income: does social enterprise embeddedness moderate? Evidence from Tanzania. *Cogent Social Sciences*, 11(1), 2456503. https://doi.org/10.1080/23311886.2025.2456503

Milgrom, P., & Roberts, J. (1992). Economics, organization, and management. Prentice Hall.

Mnukwa, M. L., Mdoda, L., & Mudhara, M. (2025). Assessing the adoption and impact of climate-smart agricultural practices on smallholder maize farmers' livelihoods in Sub-Saharan Africa: A systematic review. *Frontiers in Sustainable Food Systems*, 9, 1543805. https://doi.org/10.3389/fsufs.2025.1543805

Ogada, M. J., Radeny, M., Recha, J., & Dawit, S. (2021). Adoption of complementary climate-smart agricultural technologies: Lessons

from Lushoto in Tanzania. *Agriculture & Food Security*, 10, 55. https://doi.org/10.1186/s40066-021-00321-w

Osewe, I., Hălălișan, A. F., Talpă, N., & Popa, B. (2023). Critical analysis of payments for ecosystem services: case studies in Kenya, Uganda and Tanzania. *Forests*, 14(6), 1209. https://doi.org/10.3390/f14061209

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372, n71. https://doi.org/10.1136/bmj.n71

Pamuk, H., van Asseldonk, M., Wattel, C., Ng'ang'a, S. K., Hella, J. P., & Ruben, R. (2022). Community-based approaches to support the anchoring of climate-smart agriculture in Tanzania. *Frontiers in Climate*, 4, 1016164. https://doi.org/10.3389/fclim.2022.1016164

Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A. M., Kinengyere, A., & Torero, M. (2020). A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. *Nature Sustainability*, 3(10), 809-820. https://doi.org/10.1038/s41893-020-00617-y

Rurii, M. W., & Nzengya Daniel, M. (2026). A scoping review of literature on adoption and impact of climate smart agricultural technologies by smallholder farmers in Africa. Frontiers in Climate, 7, Article 1692929. https://doi.org/10.3389/fclim.2025.1692929

Scheba, A. (2018). Market-based conservation for better livelihoods? The promises and fallacies of REDD+ in Tanzania. *Land*, 7(4), 119. https://doi.org/10.3390/land7040119

Selya, N. Y., Dimoso, P., & Mgale, Y. J. (2023). Exploring the adoption and impact of conservation agriculture among smallholder farmers in semi-arid areas: Evidence from Chamwino District, Tanzania. *Research on World Agricultural Economy*, 4(2), 47–61. https://doi.org/10.36956/rwae.v4i2.801

Silas, Z. S., & Ndaki, P. M. (2022). Opportunities and challenges experienced by smallholder farmers in using climate smart agriculture to adapt to climate variability and change in Kilosa District, Tanzania. *Tanzania Journal of Development Studies*, 20(1), 136–156. https://journals.udsm.ac.tz/index.php/tjds/article/view/5498/4607

Utonga, D., Mundilege, S. A., Masigazwa, T. E., & Kihungwe, V. M. (2024). Adoption of climate-smart agricultural practices by grape-producing smallholder farmers in Dodoma, Tanzania. *Journal of*

Agriculture and Environmental Sciences, 9(2), 93–110. https://doi.org/10.20372/jaes.v9i2.10644

van Asseldonk, M., Girvetz, E., Pamuk, H., Wattel, C., & Ruben, R. (2023). Policy incentives for smallholder adoption of climate-smart agricultural practices. *Frontiers in Political Science*, 5, 1112311. https://doi.org/10.3389/fpos.2023.1112311.