

When Hidden Costs Become Actionable: Environmental Management Accounting, Resource-Cost Visibility, and Climate-Smart Agriculture Investment Readiness

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ABSTRACT

Environmental management accounting organizes resource and climate-related cost information, but the decision-level conditions linking this capability to climate-smart investment preparation in agrifood SMEs remain unclear. This study examines environmental resource-cost visibility as such a condition in Trinidad and Tobago. A multiphase mixed-methods design combined qualitative construct development, expert review, cognitive testing, pilot assessment, and a temporally separated two-wave survey of 360 organizations. Standardized composite-score ordinary least squares path analysis showed that environmental management accounting capability was strongly associated with resource-cost visibility, which had the largest direct association with investment readiness. Institutional support accessibility retained an additional positive association, while visibility represented 56.7 percent of the total association between environmental management accounting capability and readiness. Both equations showed positive out-of-sample predictive relevance. The study extends organizational information-processing theory by positioning resource-cost visibility as a decision-level informational outcome associated with investment-specific readiness.

Keywords: Environmental management accounting, Environmental resource-cost visibility, Climate-smart agriculture, Investment readiness, Organizational information-processing theory

1. Introduction

Agrifood small and medium-sized enterprises in Trinidad and Tobago face decisions about adaptation investments intended to reduce inefficient resource use, production losses, and climate-related disruption [1], [2], [3], [4]. Yet recognizing the need to adapt does not, in itself, create investment readiness. A proposed intervention must be supported by a credible investment rationale, evidence of feasibility, and access to suitable finance [2], [3]. The underlying management problem is informational. Organizations must connect physical evidence on resource use and disruption with monetary evidence on costs, losses, savings, and investment implications [4]. When these consequences cannot be identified and compared, a climate-smart agriculture investment may remain

desirable in principle but insufficiently prepared for approval or implementation.

Trinidad and Tobago provides a policy-relevant setting because national adaptation and climate-finance initiatives identify agriculture as a priority while documenting persistent constraints in finance, coordination, technical knowledge, and feasibility evidence [1], [2]. The EcoMicro initiative further illustrates the effort to expand green finance for agricultural enterprises [3]. These conditions make the country useful for examining a firm-level problem that policy availability alone does not resolve, namely how agrifood SMEs convert environmental information into credible preparation for a specific climate-smart investment.

Existing research explains parts of this problem but not the full decision sequence. Environmental management accounting research shows how physical and monetary environmental information can support planning, budgeting, investment appraisal, and strategic sustainability [4], [5]. Climate-smart agriculture research focuses mainly on adoption and identifies information, training, extension, credit, institutional support, and production conditions as important but context-dependent determinants [6]. Investment-readiness research examines organizational preparedness, but it commonly emphasizes equity willingness or readiness as a precursor to technology adoption [7], [8]. Across these streams, the unresolved issue is not whether information and support matter. It is how environmental information becomes sufficiently decision-useful to support preparation of a focal investment.

To address this gap, the study distinguishes four constructs that occupy different analytical roles. Environmental management accounting capability refers to the organizational capacity to collect and integrate physical and monetary environmental information [4], [5]. Environmental resource-cost visibility refers to the decision-level clarity achieved when resource inefficiency, production losses, climate disruption, and hidden environmental costs can be identified, attributed, estimated, and compared [4], [9]. Institutional support accessibility refers to usable access to external information, expertise, training, finance, insurance, and procedural guidance [2], [6], [10], [11]. Climate-smart agriculture investment readiness refers to strategic, analytical, financial, and implementation preparation for one focal investment rather than its adoption or implementation [7], [8]. Environmental resource-cost visibility therefore occupies a distinctive position in the model as the decision-level informational outcome associated with environmental management accounting capability and the proximal informational condition associated with investment-specific readiness.

Accordingly, the study examines how environmental management accounting capability, environmental resource-cost visibility, and institutional support accessibility are associated with climate-smart agriculture investment readiness among agrifood SMEs in Trinidad and Tobago. A multiphase mixed-methods design combined qualitative construct development, expert review, cognitive testing, pilot assessment, and a temporally separated two-wave survey of 360 eligible organizations. The model was evaluated using standardized ordinary least squares path analysis, prespecified composite scores, bootstrap inference, out-of-sample predictive assessment, and robustness testing. The study contributes an integrated organizational information-processing framework that shifts analysis from the possession of environmental information and completed

adoption toward the decision-level visibility and organizational preparation that precede a focal climate-smart investment. The specific theoretical contributions are developed in Section 5.7.

2. Theoretical Foundation and Hypothesis Development

2.1 Organizational Information-Processing Theory and Environmental Investment Uncertainty

Organizational information-processing theory explains the study's management problem through the relationship between task uncertainty and information-processing requirements. As uncertainty increases, the gap between the information required for a decision and the information available to organizational actors also increases [9]. Organizations may respond by reducing their information requirements or by strengthening their capacity to collect, interpret, and communicate relevant evidence. The model examines the latter response by positioning environmental management accounting as a domain-specific capability for improving the usefulness of dispersed environmental information for decision-making.

Environmental management accounting provides a domain-specific basis for this argument because it combines physical and monetary forms of information [4]. Physical environmental management accounting records or estimates materials, water, energy, waste, and related environmental flows. Monetary environmental management accounting identifies the costs, savings, expenditure, and financial consequences associated with those flows. Material flow cost accounting illustrates the decision value of this integration by tracing material flows in physical units and evaluating their associated costs [12]. Recent manufacturing-SME evidence similarly shows that material flow cost accounting can visualize negative product costs and identify process-improvement opportunities [13].

Within this framework, environmental management accounting capability represents the organization's internal information-processing capacity, while environmental resource-cost visibility represents its decision-level informational outcome. The distinction rests on transformation rather than information possession. Environmental management accounting capability concerns the routines through which physical and monetary environmental evidence is collected and integrated. Environmental resource-cost visibility concerns whether that evidence has become sufficiently interpretable to identify hidden costs, attribute losses, estimate the consequences of disruption, compare intervention with delay, and judge the organizational relevance of a focal investment [4], [9]. Environmental resource-cost visibility therefore occupies the point at which processed environmental evidence becomes decision-useful for investment preparation. Climate-smart agriculture investment readiness is the focal organizational outcome, while institutional support accessibility represents a separate external antecedent. The following subsections develop the proposed associations.

2.2 Environmental Management Accounting Capability and Environmental Resource-Cost Visibility

Environmental management accounting research increasingly treats environmental information as a strategic decision resource rather than solely as a means of recording environmental expenditure [5]. A systematic review of 89 studies shows that environmental management accounting is used for

legitimacy, organizational efficiency, and strategic sustainable development and is increasingly incorporated into planning, budgeting, investment analysis, and long-term decision-making [5]. This strategic potential is nevertheless conditional. Research on developing-country SMEs identifies limited resources, inadequate environmental knowledge and accounting skills, restricted funding, weak data systems, and low institutional pressure as recurrent implementation barriers [14]. Recent empirical evidence further suggests that environmental management accounting may be associated with broad organizational outcomes through more proximal capabilities rather than through an automatic direct relationship [15].

These findings suggest that the value of environmental management accounting depends on what it makes visible to decision-makers. To capture this condition, the study conceptualizes environmental resource-cost visibility as managers' ability to identify avoidable resource costs, estimate losses associated with waste and unsuccessful production, recognize climate-related expenditure embedded within general accounts, and compare the implications of intervention and delay. Visibility, therefore, differs from the volume of environmental data collected. An organization may record physical resource use or damaged output without being able to attribute the corresponding financial consequences or incorporate them into an investment appraisal.

Environmental resource-cost visibility also differs from the formal sophistication of an accounting system. An agrifood SME may develop useful visibility through systematic records and informed estimates without operating an enterprise-wide environmental accounting system comparable with that of a large corporation. The theoretically relevant issue is whether physical and monetary evidence is sufficiently connected to reduce ambiguity surrounding environmental consequences.

Organizational information-processing theory suggests that environmental management accounting capability should be associated with greater resource-cost visibility. Physical environmental information identifies where resource consumption and losses occur, while monetary information makes their organizational significance more comparable [4], [9]. Integrating these forms of evidence should therefore be associated with greater visibility of costs that would otherwise remain dispersed across operational and accounting records.

H1. Environmental management accounting capability is positively associated with environmental resource-cost visibility.

2.3 Environmental Resource-Cost Visibility and Climate-Smart Agriculture Investment Readiness

Climate-smart agriculture is a context-dependent approach rather than a single technology or production system. It integrates food security, adaptation, and mitigation objectives through policies, programs, and investments selected according to local conditions [16]. This context dependence increases the organizational demands of investment preparation because an enterprise must define its problem, compare feasible responses, and determine whether a proposed intervention is strategically, technically, and financially suitable.

Climate-smart agriculture and investment-readiness research illuminate different parts of this

process. Climate-smart agriculture studies primarily explain adoption and its consequences. Evidence synthesized across 19 studies identifies extension, training, information, land-tenure security, organizational participation, institutional capital, and credit as important determinants, while the effects of several demographic and structural characteristics vary across settings [6]. A systematic review of West African evidence similarly identifies limited user-friendliness, labor demands, restricted credit, weak extension, inadequate government support, and insufficient climate information as adoption barriers [10]. Because adoption is usually treated as the empirical endpoint, this literature provides limited differentiation among the strategic, analytical, financial, and implementation stages that precede it.

General SME investment-readiness research uses a different endpoint. Research on European SMEs primarily examines the willingness to obtain equity capital and identifies entrepreneurial ecosystem quality, regulatory conditions, skilled personnel, market expectations, and firm characteristics as predictors [7]. Green investment research is more closely aligned with the examined concern. Padi and colleagues define green investment readiness as strategic, financial, and operational preparation and position it as an intermediary between internal capabilities or awareness and renewable-energy adoption [8]. This evidence supports treating readiness as analytically distinct from both awareness and completed adoption, although it concerns one technology domain and does not examine environmental accounting information.

Among the studies reviewed, Bouchmel and Omri provide the closest empirical comparison connecting environmental costs with green investment. Using data from Eastern European SMEs, they report that environmental monetary losses associated with extreme weather are positively related to green investment, with financial constraints mediating the relationship and environmental strategy moderating the indirect effect [17]. The model differs by examining managerial visibility across a broader set of resource- and climate-related costs, by positioning environmental management accounting capability as the relevant internal information-processing antecedent, and by focusing on multidimensional readiness for a focal investment rather than completed green investment.

Climate-smart agriculture investment readiness is therefore defined as strategic, analytical, financial, and implementation preparation for one focal investment. Strategic readiness concerns problem definition, investment objectives, and organizational priority. Analytical readiness concerns technical feasibility, alternatives, costs, benefits, and risks. Financial readiness concerns budgeting, affordability, financing sources, and supporting documentation. Implementation readiness concerns approvals, responsibilities, suppliers, scheduling, and operational planning.

Environmental resource-cost visibility should be associated with each dimension. Strategic priority requires an assessment of the organizational significance of the underlying problem. Analytical appraisal requires estimates of current losses and expected benefits. Financial preparation requires an economic rationale that can be communicated to decision-makers and finance providers. Implementation planning requires clarity about the resource inefficiency or climate vulnerability that the proposed intervention is intended to address.

H2. Environmental resource-cost visibility is positively associated with climate-smart

agriculture investment readiness.

2.4 Environmental Management Accounting Capability and Climate-Smart Agriculture Investment Readiness

Environmental resource-cost visibility serves as the proposed proximal informational condition in the indirect association, but it may not capture all the decision-support functions of environmental management accounting. Environmental management accounting can also structure budgeting, capital appraisal, risk assessment, scenario comparison, target setting, and communication between operational and financial decision-makers [5]. These functions may support investment preparation even when the visibility of the underlying resource costs is taken into account.

An agrifood SME may, for example, recognize the cost of unreliable water supply while still requiring systematic accounting information to assess affordability, compare financing alternatives, classify expenditure, or prepare documentation for organizational review. The direct path, therefore, represents decision-support functions that are conceptually distinct from resource-cost visibility.

H3. Environmental management accounting capability is positively associated with climate-smart agriculture investment readiness.

The indirect path integrates the preceding arguments into one theoretically ordered association. Environmental management accounting capability is expected to be associated with greater environmental resource-cost visibility, while visibility is expected to be associated with stronger investment readiness. This pathway explains why accounting information may become relevant to investment preparation without assuming that accounting capability mechanically produces an investment decision.

The proposed pathway is consistent with recent SME research, which shows that environmental management accounting is related to distal outcomes through more proximal organizational capabilities. Huy and Phuc identify green innovation complexity management as an intermediary between environmental management accounting and strategic resilience [15]. Padi and colleagues similarly position green investment readiness between financial literacy or environmental awareness and renewable-energy adoption [8]. Although these studies examine different constructs and endpoints, they support the broader proposition that organizational capabilities may become consequential through more proximal informational or preparatory conditions. Accordingly, the model specifies a positive indirect association through environmental resource-cost visibility while retaining the direct relationship proposed in H3.

H4. Environmental management accounting capability has a positive indirect association with climate-smart agriculture investment readiness through environmental resource-cost visibility.

2.5 Institutional Support Accessibility and Climate-Smart Agriculture Investment Readiness

Internal information capability does not address every source of uncertainty surrounding a climate-smart agriculture investment. Agrifood SMEs may also require climate information, technical advice, training, feasibility and business-planning assistance, finance and incentives, insurance, and procedural guidance. Institutional support accessibility refers to the extent to which these resources

can be obtained and used for the focal investment. The domains are treated as constitutive components because an organization may have access to one form of support while lacking another.

Existing evidence generally supports the role of external assistance while showing that support channels operate differently. Climate-smart agriculture research identifies extension, training, information, organizational participation, and credit as important adoption conditions [6], [10]. Recent meta-analytic evidence indicates a positive association between social support and the adoption of climate-smart agriculture. Informational support shows the most consistent association, while the contribution of instrumental support varies across institutional contexts [11]. Although this evidence concerns adoption rather than investment readiness, it supports treating support as multidimensional. When considered alongside the institutional barriers documented in Trinidad and Tobago, the evidence also motivates a distinction between nominal program availability and support that an organization can obtain and use [2], [11].

Accessibility may be constrained even when a support program formally exists. Finance may be unsuitable because of collateral or repayment requirements. Technical advice may be too general for the proposed investment. Training may be poorly timed or geographically inaccessible. Incentive programs may impose unclear eligibility criteria or extensive documentation. The relevant organizational condition is therefore the ability to obtain and apply support, not merely awareness that a program is available.

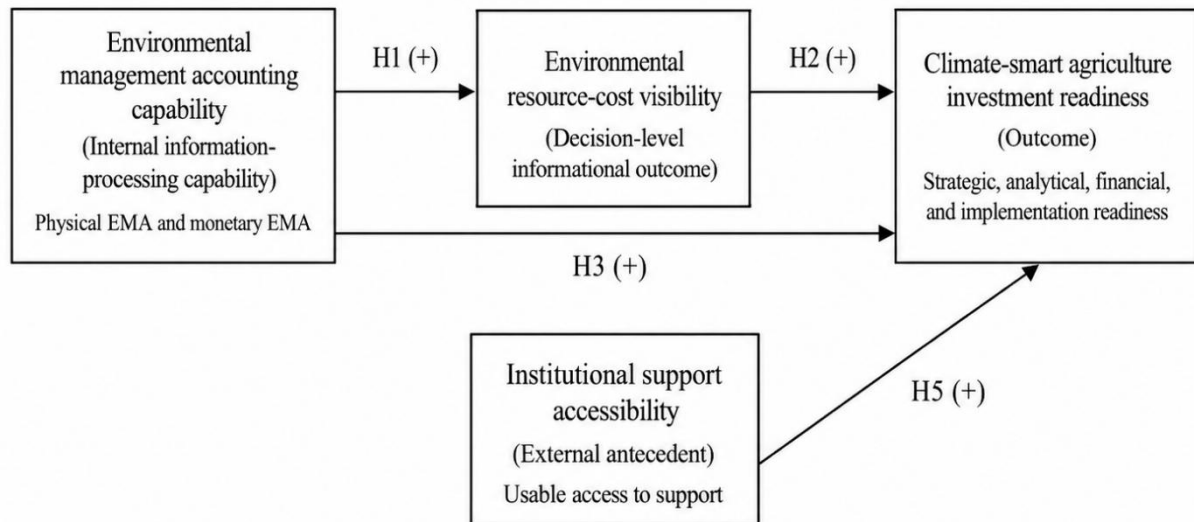
In Trinidad and Tobago, the same distinction is reflected in documented gaps between the support that is formally available and the financial, technical, coordination, and feasibility conditions required to use it [2].

Accessible support should be linked to investment readiness across several channels. Technical guidance can reduce uncertainty surrounding feasibility. Training can improve evaluative and implementation capacity. Business-planning assistance can strengthen costing and documentation. Finance, incentives, and insurance can reduce affordability constraints and risk. Procedural guidance can reduce administrative uncertainty [2], [6], [10], [11]. The model treats institutional support accessibility and internal information capability as separate antecedents rather than assuming that either substitutes for the other.

H5. Institutional support accessibility is positively associated with climate-smart agriculture investment readiness.

2.6 Conceptual Model

Figure 1 presents the hypothesized associations among the four constructs. The model distinguishes the internal informational pathway linking environmental management accounting capability with environmental resource-cost visibility and investment readiness from the separate association of institutional support accessibility with readiness. Readiness represents preparation for a focal investment rather than adoption or implementation.



H4. Positive indirect association through environmental resource-cost visibility

Figure 1. Conceptual model and hypothesized relationships

Source: By the author.

3. Research Design

3.1 Multiphase Mixed-Methods Design and Integration

This study used a multiphase mixed-methods instrument-development design to examine the associations among environmental management accounting capability, environmental resource-cost visibility, institutional support accessibility, and climate-smart agriculture investment readiness among agrifood enterprises in Trinidad and Tobago. The design combined qualitative construct development, expert content review, cognitive testing, pilot assessment, and a temporally separated two-wave survey. The qualitative phase established construct boundaries and contextually appropriate content. Expert review assessed content relevance and clarity. Cognitive testing examined participants' interpretation of the instrument. Pilot evidence informed instrument finalization and administration procedures. The quantitative survey then evaluated the proposed measurement structure and hypothesized associations.

Integration occurred across the study phases. Qualitative findings informed candidate items and response instructions. Expert, cognitive, and pilot evidence informed the documented item-retention and revision decisions. The finalized measures were then used in the quantitative model, and the statistical relationships were interpreted in relation to the construct-development evidence.

Data collection occurred between November 2025 and June 2026. Qualitative interviews, expert review, cognitive testing, and developmental evidence from the 39 pilot cases that had completed both survey waves preceded the February 20, 2026, instrument lock. The broader pilot continued after the lock for administrative and response-stability assessment, while the main two-wave survey began on March 1 and concluded on June 4, 2026. Section 3.6 provides a detailed account of the pilot and

instrument-finalization sequence.

3.2 Research Context, Unit of Analysis, and Eligibility

The study examined agrifood enterprises in Trinidad and Tobago because the setting combines agricultural adaptation priorities, documented technical and financial barriers, and active climate-finance initiatives [1], [2], [3]. The unit of analysis was the agrifood organization. Eligible organizations undertook commercial activity in crop production, livestock, mixed farming, agro-processing, storage and post-harvest operations, aquaculture and fisheries, agricultural services, input supply, or cooperative production and marketing.

Organization size was classified based on self-reported full-time employee headcount, including the owner-manager, where applicable. Micro organizations employed 1 to 5 people, and small organizations employed 6 to 25 people, consistent with the national thresholds for micro and small enterprises [18]. For this study, organizations employing 26 to 50 people were classified as medium, retaining the upper employment boundary of 50 used for the combined national SME category [19]. Cooperatives and other organized commercial activities were included only when they exercised autonomous operational and investment decision-making and met the same employee-headcount rule.

Each organization was represented by one informed decision-maker with direct knowledge of resource use, accounting arrangements, operating costs, climate exposure, budgeting, or investment preparation. Eligible roles included owner-managers, finance or operations managers, senior operational managers, directors, and cooperative managers. Respondents were required to possess relevant organizational knowledge and decision authority. Records that did not satisfy these requirements were excluded.

3.3 Qualitative Construct Development

The qualitative phase comprised 24 participants. Sixteen were decision-makers from agrifood enterprises, and eight were institutional or professional key informants with experience in agricultural extension, finance, accounting, technical support, climate adaptation, or agrifood investment. Purposive selection sought variation in geography, organizational size, agrifood activity, accounting arrangements, resource and climate exposure, and previous investment experience.

Qualitative participants were recruited purposively through producer associations and agricultural cooperatives, agricultural extension and technical service contacts, agribusiness and SME support networks, and professional contacts in accounting, agricultural finance, climate adaptation, and agricultural risk management. The initial recruitment was supplemented by limited participant referral to improve representation of underrepresented agrifood activities and Tobago-based organizations. Every referred participant was independently screened against the study's organizational-knowledge and decision-authority criteria.

Sixteen interviews were conducted through secure Microsoft Teams video calls. Five interviews were conducted by telephone because of connectivity or accessibility constraints, and three were conducted in person in private meeting rooms at neutral locations. Participants joined remote interviews from locations where they could discuss organizational practices confidentially. No

financial, material, or gift-based incentive was offered for participation.

The interviewer prepared contemporaneous notes during each session and completed a structured post-interview summary within 24 hours. The summaries recorded relevant contextual observations, emerging concepts, negative or contradictory evidence, methodological reflections, and potential implications for construct boundaries and item development. These records were linked to anonymized transcript references and incorporated into the qualitative audit trail.

Full transcripts were not routinely returned because of participant burden and the commercially sensitive nature of some organizational accounts. Instead, a concise interpretive summary was sent to all 24 participants for optional confirmation. Twenty participants responded. Seventeen confirmed the summary without revision, while three provided minor factual or wording clarifications that were incorporated into the relevant case summaries and coding records. Four participants did not respond to the validation request. No respondent requested the removal of substantive evidence, and the participant-validation process did not identify an additional construct dimension.

Coding and case-by-theme organization were managed through a structured Microsoft Excel analytical matrix designed around the Framework Method. The matrix linked anonymized case identifiers, transcript references, initial codes, final themes, construct domains, negative or divergent evidence, analytic memoranda, and instrument-development decisions.

The sample was designed to provide sufficient information for focused construct development rather than statistical representation. Sample adequacy was evaluated in relation to participant specificity, the focused study aim, the quality of the interview dialogue, the use of an established theoretical framework, and the case-by-theme analytical strategy [20]. Review of the chronological coding record indicated that the final four interviews reinforced or refined existing themes and did not introduce a materially new construct dimension.

Semi-structured interviews lasted between 49 and 72 minutes. Interviews focused on actual organizational decision episodes involving a recent, planned, postponed, rejected, or implemented environmental or climate-smart investment. The interview guide examined the environmental information used by decision-makers, the recording or estimation of physical resources, the identification of monetary environmental costs, resource losses that remained hidden within general expenses, investment appraisal practices, financing preparation, implementation planning, and the accessibility of external support. Interview guides were developed through a staged process involving prior evidence, preliminary formulation, testing, and refinement, consistent with established methodological guidance for semi-structured interviewing [21].

Interviews were recorded with participant consent and linked to anonymized transcript references. The records did not retain identifying organizational names in the analytical workbook. Commercially sensitive matters could be discussed using approximate amounts, relative costs, or descriptions of decision-making processes rather than requiring the disclosure of exact financial values. The interviewer was the lead researcher, with postgraduate training in environmental management and research methods, and had completed formal training in qualitative interviewing, mixed-methods research, and research ethics. The interviewer had no prior supervisory, financial,

employment, or commercial relationship with the participants. Interviews were conducted in English. Participants were permitted to use Trinidadian or Tobagonian Creole expressions where these conveyed their experiences more naturally. Recordings were transcribed verbatim in English, with locally specific expressions retained and clarified in brackets where necessary.

Qualitative evidence was analyzed using a structured case-by-theme process informed by the Framework Method [22]. Initial coding remained open to participants' accounts before the framework was refined to compare evidence across organizations, activities, locations, accounting arrangements, and investment experiences. Particular attention was given to negative and contradictory evidence, as well as to differences between formal organizational records and informed managerial estimates. The final matrix linked case-level evidence, themes, divergent evidence, analytic memoranda, and instrument-development decisions. Primary coding was conducted by the lead researcher. A second researcher independently reviewed six transcripts and all evidence classified as negative or contradictory. Differences were resolved through discussion and recorded in a coding-decision log.

The qualitative phase informed five principal measurement decisions. Physical environmental management accounting retained wording that recognized both systematic records and informed estimates. Monetary environmental management accounting distinguished environmental and climate-related costs from general operating expenses. Environmental resource-cost visibility was specified to capture the managerial clarity created when hidden or dispersed resource costs become identifiable. Investment readiness was separated from general interest or adoption intention and anchored to a single focal investment. Institutional support was defined in terms of practical accessibility and usability rather than the formal existence of programs or services.

Qualitative trustworthiness was supported through anonymized transcript references, a documented coding framework, structured case-by-theme comparisons, explicit examination of negative and contradictory evidence, independent review of six transcripts, and an audit trail linking qualitative evidence to construct development and item design decisions. Interviewer credentials, prior relationships with participants, recruitment and interview procedures, recording and transcription practices, coding responsibilities, participant validation procedures, and the resolution of interpretive differences were documented in accordance with recognized qualitative reporting domains [23].

3.4 Expert Content Review

Seven experts reviewed the provisional instrument. Their disciplinary and professional coverage included environmental management accounting, agrifood SME management, climate-smart agriculture, survey methodology, agricultural finance, natural capital and environmental management, and SME accounting and investment. Reviewers represented university research, business support practice, technical and development practice, finance, policy, and professional accounting contexts. Their experience ranged from 12 to 18 years.

Experts rated each candidate item for relevance and clarity using separate four-point scales. The item-level content validity index was calculated as the proportion of experts who assigned a relevance rating of 3 or 4, with a retention criterion of .857 [24]. The scale-level average content-validity index

was calculated as the arithmetic mean of the item-level content-validity indices across the substantive candidate items. Qualitative comments were considered alongside the index values when determining whether an item should be retained, revised, or removed. Item flow and the substantive content-review findings are reported in Section 4.1.

3.5 Cognitive Testing

Cognitive testing was conducted with 12 eligible agrifood SME decision-makers. Participants represented different organizational roles, agrifood activities, and operating locations. Each participant completed a think-aloud procedure that examined how item wording, response categories, and construct instructions were interpreted. Sessions lasted between 41 and 57 minutes.

The think-aloud evidence was reviewed for comprehension problems, response-scale interpretation, focal-investment anchoring, and possible construct contamination. Wording revisions and item-retention decisions arising from cognitive testing are reported in Section 4.1. Cognitive testing was treated as evidence of comprehensibility and contextual relevance rather than psychometric validation.

3.6 Pilot Assessment and Instrument Finalization

The pilot involved 60 eligible agrifood organizations, separate from the main analytical sample. Organizational identifiers and retained response profiles were compared to detect overlap, and no exact pilot-to-main duplicate was identified. The pilot assessed item variation, response-scale functionality, completion time, missingness, preliminary reliability, construct separation, focal-investment anchoring, survey routing, attention checking, and response-quality thresholds.

The developmental assessment used the 39 pilot cases that had completed both survey waves by February 20, 2026. Review of these cases and the cognitive testing findings informed the finalization of TT-EMA-CSAIR Version 3.0. All 60 pilot cases received the same broader pilot form, which was not altered during pilot fieldwork. The remaining 21 cases were not used for further item-selection decisions. Version 3.0, administered to all main-survey respondents, incorporated the retained wording refinements and excluded the four candidates whose removal had been identified during expert review and confirmed during cognitive testing. Because Version 3.0 was not administered during the pilot, the pilot statistics were interpreted as preliminary evidence regarding the retained item domains, response behavior, and administrative feasibility rather than as final psychometric validation of the main-survey instrument.

The pilot evidence was examined for completion time, missingness, item variation, preliminary reliability, response-scale functioning, routing, and response-quality thresholds. Detailed pilot results and the final item composition are reported in Section 4.1.

3.7 Main Survey Procedure and Participant Flow

The main survey used two temporally separated waves. Respondents were recruited through farmers' associations and producer groups, agricultural cooperatives, agro-processing and agribusiness networks, agricultural extension and technical service contacts, agricultural finance and SME support networks, and food security and agribusiness contacts in Tobago. Invitations were

distributed through organizational email lists, producer-group mailing lists, professional and extension contacts, closed WhatsApp groups administered by participating organizations, and direct invitations to eligible enterprise decision-makers. Limited participant referral was permitted to improve coverage of underrepresented agrifood activities, but each referred participant was screened independently. The survey was administered primarily through individualized Qualtrics XM links. Researcher-assisted completion by telephone or tablet was available only to eligible respondents experiencing connectivity or accessibility constraints.

Wave 1 measured physical and monetary environmental management accounting, institutional support accessibility, and organizational characteristics. It also collected respondent role, decision authority, organization size, accounting arrangement, climate exposure, and previous environmental or climate-smart investment experience. Before completing the institutional-support items, respondents were instructed to select one realistic climate-smart agriculture investment that the organization had identified, was appraising, had budgeted for, was seeking financing for, or planned to implement within the next 24 months. They were asked to retain the same investment when answering all technical, financial, informational, and institutional support questions, and to reconfirm it during Wave 2. Wave 1 and Wave 2 investment descriptions were compared before analysis. Alternative labels referring to the same prespecified investment category were harmonized after review. The prespecified rule required exclusion when the two waves referred to substantively different organizational investments. No completed Wave 2 record was excluded because the two waves referred to substantively different focal investments.

Wave 2 measured environmental resource-cost visibility and climate-smart agriculture investment readiness. Respondents identified the focal climate-smart investment used to answer the readiness questions and reported its current preparation stage. Recorded investment categories included efficient irrigation, protected agriculture, rainwater harvesting, climate-controlled storage, solar or renewable energy, drainage and flood protection, resilient planting material, soil-management systems, integrated pest management, livestock cooling or water systems, and other context-specific investments, including waste-reduction equipment.

The observed interval between Wave 1 and Wave 2 ranged from 21 to 35 days, with a median of approximately 28 days. Records were matched through anonymized study identifiers. Each eligible Wave 1 respondent received an individualized Wave 2 invitation 21 days after the first survey, with up to 2 reminders during the 14-day response window. Contact details and identifier keys were stored separately from the analytical data. Temporal separation reduced immediate consistency effects between the principal predictor and outcome modules but did not establish causal ordering because environmental resource-cost visibility and investment readiness were both measured during Wave 2. Eligibility and response-quality screening were applied after the two survey waves. Participant disposition and the numbers excluded under each prespecified rule are reported in Table 2.

Duplicate records were identified through repeated anonymized respondent-contact and organization hashes. The earliest eligible complete record was retained. The attention check required the instructed response value of four. Speeding thresholds were prespecified after review of pilot

completion-time distributions and minimum item-reading requirements. Cases completed in fewer than six minutes at Wave 1 or fewer than five minutes at Wave 2 were classified as speeding. Straightlining was defined as a standard deviation below .15 across the substantive Wave 1 items. No retained measurement values were imputed. All cases in the analytical sample contained complete responses for the retained measurement items.

3.8 Measures and Composite Specification

Physical environmental management accounting was measured using six items that assessed recording or estimation of water use, energy or fuel use, major agricultural inputs, waste and unsuccessful production, climate-related physical losses, and relevant production-resource conditions. Monetary environmental management accounting was measured using seven items concerning input costs, waste and production-loss costs, climate-related financial losses, separately identifiable environmental and adaptation expenditures, budgeting, investment appraisal, and comparison of actual and planned environmental costs. Items used a five-point extent-of-practice scale ranging from ‘not used’ to ‘systematic use’.

The six physical items and seven monetary items were modeled as reflective first-order constructs. Each dimension score was calculated as the mean of its complete items. Environmental management accounting capability was specified before analysis as an equal-weight higher-order composite calculated from the physical and monetary dimension scores.

Environmental resource-cost visibility was measured with six reflective items. The construct assessed whether managers could identify avoidable costs created by inefficient resource use, estimate the financial consequences of waste and production loss, evaluate the financial consequences of climate disruption, identify costs not separately visible within general expenses, compare the expected costs of action and delay, and clarify organizational investment priorities. Responses used a five-point agreement scale.

Climate-smart agriculture investment readiness was measured relative to one focal investment and represented organizational preparation rather than completed adoption or implementation. The construct comprised four first-order dimensions covering strategic readiness, analytical readiness, financial readiness, and implementation readiness. Each dimension contained three items and used a five-point scale ranging from ‘not prepared’ to ‘fully prepared’. Dimension scores were calculated as item means, and the overall readiness composite was the equal-weight mean of the four-dimension scores. A higher readiness score therefore indicated more advanced preparation for the selected investment without implying that the organization had financed, adopted, or implemented it.

Institutional support accessibility contained seven components. These assessed usable access to climate and agricultural information, extension or technical advice, training and demonstration opportunities, feasibility or business-planning assistance, finance and incentives, insurance or risk-sharing mechanisms, and clear program procedures. Responses ranged from unavailable to readily accessible and usable. Institutional support accessibility was specified as an equal-weight formative composite. The higher-order environmental management accounting and investment-readiness constructs were treated as prespecified composites because their dimensions represented conceptually

distinct and jointly constitutive components of the broader constructs. Institutional support accessibility was specified formatively because access to one support domain did not imply access to the others, and the seven components were not assumed to be interchangeable or highly correlated [25]. Equal weights were fixed before analysis to preserve transparent construct composition and avoid sample-specific optimization [26].

Three global criterion items were included solely for redundancy assessment. They evaluated the organization's ability to use physical and financial environmental information, the accessibility and usability of external support for the selected investment, and the organization's overall readiness to advance that investment. These items were not included in the structural composites.

The structural models controlled for organization size, accounting arrangement, climate exposure, and previous investment experience. Organization size was coded from micro to medium. Accounting arrangement comprised informal or no dedicated accounting, external-accountant support, internal accounting capability, and combined internal and external support. Climate exposure ranged from limited to severe. Previous investment experience distinguished no previous investment, consideration without implementation, and completed implementation. The primary models used prespecified ordered codings, while the robustness models represented the categorical controls through dummy variables because equal intervals between categories could not be assumed.

3.9 Analytical Strategy

The analytical sample consisted of 360 cases. An a priori noncentral F calculation for the most complex primary structural equation, which contained seven predictors, indicated that 295 cases were required to detect Cohen's f^2 of .05 at an alpha level of .05 with .80 power [27]. The final analytical sample exceeded this requirement.

Composite scores were calculated according to the prespecified equal-weight rules. Variables included in the path models were standardized using sample means and population-standard-deviation scaling. The environmental resource-cost visibility equation regressed environmental resource-cost visibility on environmental management accounting capability and the four control variables. The climate-smart agriculture investment-readiness equation regressed climate-smart agriculture investment readiness on environmental resource-cost visibility, environmental management accounting capability, institutional support accessibility, and the same controls.

Reflective measurement quality was reassessed for each first-order construct using one-factor maximum-likelihood factor analysis. The assessment reported standardized loadings, Cronbach's alpha, composite reliability, and average variance extracted. Discriminant validity among the reflective first-order constructs was examined using heterotrait-monotrait ratios because HTMT is designed to identify insufficient empirical distinction among conceptually related constructs [28]. HTMT values below .85 were interpreted as supporting discriminant validity among the reflective first-order constructs. The higher-order unit-weighted composites and the formative institutional-support composite were not evaluated as reflective latent factors. The higher-order and formative composites were evaluated using their prespecified unit weights, variance inflation factors among their components, and redundancy correlations with global criterion items. Structural collinearity was

assessed before interpreting the path coefficients.

Direct and indirect associations were estimated using standardized ordinary least squares path models. The indirect association between environmental management accounting capability and investment readiness was calculated as the product of the environmental management accounting to resource-cost visibility coefficient and the resource-cost visibility to investment-readiness coefficient. Percentile confidence intervals were estimated from 10,000 bootstrap resamples using the fixed seed 20260802. The results are interpreted as statistical associations and indirect relationships rather than demonstrated causal effects.

The analysis reported explained variance and local effect sizes for the structural equations. Predictive performance was first examined using a fixed ten-fold partition and was then reassessed across ten repetitions of ten-fold out-of-sample cross-validation. The seed 20260802 was used for both procedures. Cross-validated Q^2 was calculated relative to a training-mean benchmark, and prediction error was evaluated using root mean square error. Predictive assessment was interpreted separately from explanatory fit [29].

Robustness checks included full and structural collinearity diagnostics, alternative control-variable coding, contextual sensitivity models, residual diagnostics, early–late response comparisons, and Wave 2 attrition comparisons. Supplementary OLS diagnostics included Breusch–Pagan tests of heteroscedasticity, Ramsey RESET tests of functional form, Cook’s distance for potentially influential observations, and externally studentized residuals for extreme case-level departures. Early and late respondents were compared using Welch independent-samples t-tests, with the first and final quartiles of response order defining the comparison groups. Retained cases and Wave 2 noncompleters were compared using Welch independent-samples t-tests of Wave 1 environmental management accounting capability and institutional support accessibility. Hedges’ g was calculated to assess the magnitude of group differences. Additional models used dummy-coded controls and examined sensitivity to investment category, preparation stage, geography, and agrifood activity.

The analysis was conducted in R version 4.5.1. The psych, car, boot, and rsample packages supported measurement diagnostics, collinearity analysis, bootstrap inference, and cross-validation. Base R and purpose-written functions estimated the standardized ordinary least squares models and calculated HTMT ratios, indirect associations, effect sizes, cross-validated Q^2 values, and benchmark root mean square errors. Bootstrap and cross-validation settings were fixed before the final results were generated.

3.10 Common-Source and Procedural Safeguards

Procedural safeguards were incorporated into instrument design and administration. Environmental management accounting capability and institutional support accessibility were measured during Wave 1, while environmental resource-cost visibility and investment readiness were measured during Wave 2. Construct-specific response formats were used, item wording was neutral, and respondents were informed that no answer was correct or preferred. Anonymized identifiers connected the two waves without placing direct identifiers in the analytical dataset.

Temporal separation reduced immediate consistency between the principal predictor and

outcome modules, but it did not separate environmental resource-cost visibility from investment readiness or eliminate common-source risk. Collinearity and discriminant validity diagnostics were therefore treated as supplementary checks rather than as proof that method bias was absent [30]. The findings are interpreted with recognition that the same informed respondent supplied the substantive organizational measures.

3.11 Ethical Considerations

Participants received information about the research purpose, participation requirements, the voluntary nature of their involvement, confidentiality procedures, and their right to withdraw. Survey participants provided digital informed consent by selecting the consent confirmation before accessing the questionnaire. Interview, expert review, and cognitive-testing participants completed electronic written consent forms before their respective sessions. At the beginning of each interview, the researcher verbally reconfirmed consent and obtained separate permission to record audio before recording commenced.

Personal and organizational identifiers were removed from the analytical records. Contact and organization information used for matching and duplicate detection was converted into anonymized hashes and stored separately from survey responses. Interview recordings, deidentified transcripts, consent records, survey exports, identifier keys, and analytical files were stored in separate encrypted folders within the institutionally managed Microsoft 365 SharePoint environment. Access to the recordings and identifier key was restricted to the lead researcher. Deidentified qualitative records were accessible to the lead researcher and the second qualitative reviewer. The clean survey dataset, statistical scripts, and analytical outputs were accessible to the lead researcher and the designated statistical analyst. Records will be retained for five years after publication or formal project closure, whichever occurs later, and will then be securely deleted in accordance with institutional data-retention procedures. Participants were not required to disclose exact commercially sensitive financial information and could omit any question or discontinue participation without penalty.

4. Results

4.1 Instrument-Development Findings

Table 1 integrates the principal construct development, content review, cognitive testing, and pilot findings. Across the four phases, the evidence supported distinctions between environmental information practices, decision-level resource-cost visibility, investment-specific readiness, and practically accessible institutional support.

Table 1. Integrated findings from the instrument-development phases

Phase and evidence base	Principal findings	Final instrument decision
Qualitative construct development	Participants distinguished resource-use measurement from environmental/climate-cost identification;	physical Retained physical and monetary EMA separate first-order dimensions. Specified environmental resource-cost

Phase and evidence base	Principal findings	Final instrument decision
	information possession from visibility of visibility as a distinct reflective avoidable, hidden, or dispersed costs; construct. Divided investment interest from strategic, readiness into four dimensions linked analytical, financial, and implementation to one focal investment. Defined readiness; and formal support availability institutional support by accessibility from practical accessibility and usability. and usability.	
Expert content review	S-CVI/Ave = .951. Thirty-eight substantive items met the criterion. Four were flagged items, leaving 38 substantive and 3 items for inadequate relevance, excessive global criterion items. Findings specialization, or construct contamination. supported content relevance and All three global criterion items were representativeness, not final retained for redundancy assessment. psychometric validity.	Provisionally removed 4 substantive items.
Cognitive testing	Participants distinguished systematic records from informed estimates. Adaptation expenditure, hidden-cost wording, focal-investment specification, and institutional-support accessibility/usability required clarification.	Revised instructions and wording, introduced a focal-investment prompt, and revised the institutional-support response scale. Confirmed the same four removals; no additional items were removed.
Developmental pilot	Median completion time was 25.0 minutes; item missingness was 0%. Preliminary α values for the retained item sets representing seven reflective constructs ranged from .830 to .920. Item standard deviations ranged from .99 to 1.42. Maximum floor and ceiling concentrations were 28.2 percent and 25.6 percent, with no problematic restriction or endpoint concentration.	Supported item domains, response scales, focal-investment anchoring, routing, feasibility, and response-quality rules. No further substantive items were removed. Results were treated as developmental, not final psychometric, evidence.
Final integrated instrument	Evidence supported distinct but related measures of EMA capability, environmental resource-cost visibility, institutional-support accessibility, and climate-smart agriculture investment readiness.	Final instrument: 38 substantive items—6 physical EMA, 7 monetary EMA, 6 resource-cost visibility, 7 institutional-support, and 12 investment-readiness items, with 3 items each for strategic, analytical, financial, and implementation

Phase and evidence base	Principal findings	Final instrument decision
		readiness. Three global criterion items were retained only for redundancy assessment and excluded from structural composites.

Note. Four substantive candidates were removed because they were overly specialized, insufficiently relevant, or contaminated adjacent constructs. The three global criterion items were retained only for redundancy assessment and were excluded from the structural composites. Source: By the author.

4.2 Participant Flow, Sample Profile, and Focal Investments

Table 2 presents participant flow in Panel A, and Panel B summarizes the organizational profile of the final analytical sample. The recruitment process generated 525 invitations and 420 survey starts. A total of 399 respondents submitted Wave 1, and 382 submitted Wave 2. After 22 complete Wave 2 records were excluded under the prespecified eligibility and response-quality rules, the analytical sample comprised 360 eligible organizations. This represented 68.6 percent of the invitations and 94.2 percent of the Wave 2 submissions.

The sample covered all reported operating regions and included micro, small, and medium organizations across crop production, livestock, agro-processing, storage and post-harvest operations, aquaculture and fisheries, cooperatives, mixed farming, and agricultural services. Small organizations accounted for the largest size category, while external and internal accounting capabilities were the most common accounting arrangements. The sample also contained substantial variation in climate exposure and previous environmental or climate-smart investment experience.

Table 2, Panel C, shows that the focal investments covered multiple climate-adaptation and resource-management categories and all prespecified preparation stages. This variation supports the interpretation of readiness across heterogeneous investment contexts rather than one technology or stage.

Table 2. Participant flow, sample profile, and focal-investment characteristics

Panel A. Participant flow

Recruitment or screening stage	n	Percentage	Reference population or disposition
Invitations issued	525	100.0	All invitations
Survey starts	420	80.0	Percentage of invitations
Wave 1 submissions	399	76.0	Percentage of invitations
Wave 1 noncompleters	21	5.0	Percentage of survey starts
Wave 2 submissions	382	72.8	Percentage of invitations
Wave 2 noncompleters	17	4.3	Percentage of Wave 1 submissions
Complete Wave 2 records excluded	22	5.8	Percentage of Wave 2 submissions

Recruitment or screening stage	n	Percentage	Reference population or disposition
Ineligible respondent role or insufficient decision authority	6	1.6	Percentage of Wave 2 submissions
Duplicate record	4	1.0	Percentage of Wave 2 submissions
Attention-check failure	4	1.0	Percentage of Wave 2 submissions
Speeding case	4	1.0	Percentage of Wave 2 submissions
Straightlining case	4	1.0	Percentage of Wave 2 submissions
Final analytical sample	360	68.6	68.6 percent of invitations and 94.2 percent of Wave 2 submissions

Panel B. Sample characteristics

Characteristic and category	n	Percentage	Reference population
Geography			Final analytical sample (N=360)
Trinidad Central	92	25.6	Final analytical sample
Trinidad South	77	21.4	Final analytical sample
Trinidad North	71	19.7	Final analytical sample
Tobago	46	12.8	Final analytical sample
National or multi-location	43	11.9	Final analytical sample
Trinidad East	31	8.6	Final analytical sample
Primary agrifood activity			Final analytical sample (N=360)
Crop production	103	28.6	Final analytical sample
Agro-processing	57	15.8	Final analytical sample
Livestock	53	14.7	Final analytical sample
Storage and post-harvest operations	46	12.8	Final analytical sample
Aquaculture and fisheries	34	9.4	Final analytical sample
Cooperative production or marketing	33	9.2	Final analytical sample
Mixed farming	25	6.9	Final analytical sample
Agricultural services or input supply	9	2.5	Final analytical sample
Organization size			Final analytical sample (N=360)
Micro	146	40.6	Final analytical sample

Characteristic and category	n	Percentage	Reference population
Small	158	43.9	Final analytical sample
Medium	56	15.6	Final analytical sample
Accounting arrangement			Final analytical sample (N=360)
External accountant	115	31.9	Final analytical sample
Internal accounting capability	112	31.1	Final analytical sample
Informal or no dedicated accounting	84	23.3	Final analytical sample
Combined internal and external support	49	13.6	Final analytical sample
Climate exposure			Final analytical sample (N=360)
Limited	83	23.1	Final analytical sample
Moderate	163	45.3	Final analytical sample
Severe	114	31.7	Final analytical sample
Previous environmental or climate-smart investment experience			Final analytical sample (N=360)
No previous investment	96	26.7	Final analytical sample
Considered but not implemented	117	32.5	Final analytical sample
Implemented	147	40.8	Final analytical sample
Panel C. Focal climate-smart investment characteristics			
Characteristic and category	n	Percentage	
Selected focal investment			
Protected agriculture	54	15.0	
Efficient irrigation	51	14.2	
Rainwater harvesting	47	13.1	
Climate-controlled storage	38	10.6	
Drainage or flood protection	37	10.3	
Solar or renewable energy	33	9.2	
Soil-management system	33	9.2	
Resilient planting material	24	6.7	
Integrated pest management	19	5.3	
Other context-specific investment	14	3.9	
Livestock cooling or water system	10	2.8	

Characteristic and category	n	Percentage
Investment preparation stage		
Under appraisal	105	29.2
Identified	72	20.0
Budget prepared	70	19.4
Financing sought	62	17.2
Implementation planned	51	14.2

Note. Percentages in Panels B and C were calculated using the final analytical sample of 360 organizations and may not total exactly 100.0 because of rounding. Panel A percentages use the reference populations stated in the final column. The 22 complete Wave 2 records excluded during final screening were mutually exclusive. Source: By the author.

4.3 Descriptive Statistics and Measurement Quality

Table 3 presents the descriptive statistics and construct correlations. Environmental management accounting capability had a mean of 3.04 and a standard deviation of .88. The corresponding values were 2.81 and .90 for institutional support accessibility, 3.00 and .98 for environmental resource-cost visibility, and 3.02 and .88 for climate-smart agriculture investment readiness. Because the constructs used different response anchors, these means were interpreted as within-scale summaries rather than as directly comparable levels of organizational capability, accessibility, visibility, and readiness.

Environmental management accounting capability correlated positively with environmental resource-cost visibility (.536) and with investment readiness (.493). Resource-cost visibility had the strongest bivariate association with investment readiness (.624). Institutional support accessibility correlated with investment readiness at .352, while its correlations with environmental management accounting capability and resource-cost visibility were smaller at .173 and .125. These bivariate patterns were consistent with the proposed model, but hypothesis decisions were based on the multivariable structural equations.

Table 3. Descriptive statistics and construct correlations

No.	Construct	Mean	SD	1	2	3	4
1	Environmental management accounting capability	3.039	.875	—			
2	Institutional support accessibility	2.814	.897	.173***	—		
3	Environmental resource-cost visibility	3.002	.984	.536***	.125*	—	
4	Climate-smart agriculture investment readiness	3.016	.879	.493***	.352***	.624***	—

*Note. N = 360. Values below the diagonal are zero-order Pearson correlations. Because the constructs used different five-point response anchors, their means should be interpreted within each scale rather than compared as equivalent levels. No retained measurement values were missing. * $p < .05$. ** $p < .01$. *** $p < .001$. Source: By the author.*

Table 4, Panel A, reports the reflective measurement results. The construct-specific one-factor maximum-likelihood analyses produced standardized loadings from .738 to .852. Cronbach's alpha ranged from .806 to .922, composite reliability ranged from .806 to .922, and average variance extracted ranged from .580 to .641. These results supported the internal consistency and convergent validity of the seven reflective first-order constructs. The construct-specific analyses assessed the intended unidimensional structure of each item set but did not constitute a simultaneous confirmatory factor analysis of the complete measurement system.

Table 4, Panel B, presents the heterotrait-monotrait ratios. The maximum heterotrait-monotrait ratio was .812 and occurred between two conceptually related readiness dimensions. All ratios remained below the .85 criterion, supporting adequate empirical distinction among the reflective first-order constructs.

Table 4. Reflective measurement quality and discriminant validity

Panel A. Reflective measurement quality

Construct	Items	Standardized loading range	Cronbach's alpha	Composite reliability	Average variance extracted
Physical environmental management accounting	6	.745–.797	.898	.899	.596
Monetary environmental management accounting	7	.760–.824	.922	.922	.629
Environmental resource-cost visibility	6	.746–.836	.903	.903	.609
Strategic readiness	3	.770–.852	.841	.842	.641
Analytical readiness	3	.778–.812	.838	.838	.633
Financial readiness	3	.738–.784	.806	.807	.582
Implementation readiness	3	.754–.768	.806	.806	.580

Panel B. Heterotrait-monotrait discriminant validity matrix

Construct	PEMA	MEMA	ERCV	SR	AR	FR	IR
PEMA	—						
MEMA	.557	—					
ERCV	.533	.493	—				
SR	.461	.398	.624	—			
AR	.466	.339	.630	.812	—		
FR	.500	.379	.575	.735	.759	—	

Construct	PEMA	MEMA	ERCV	SR	AR	FR	IR
IR	.428	.400	.633	.798	.811	.675	—

Note. $N = 360$. PEMA denotes physical environmental management accounting. MEMA denotes monetary environmental management accounting. ERCV denotes environmental resource-cost visibility. SR denotes strategic readiness. AR denotes analytical readiness. FR denotes financial readiness. IR denotes implementation readiness. Standardized loadings were obtained from separate one-factor maximum-likelihood analyses of each reflective first-order construct. These construct-specific analyses did not constitute a simultaneous confirmatory factor analysis of the complete measurement system. Composite reliability and average variance extracted were calculated from the maximum-likelihood standardized loadings. Values below the diagonal in Panel B are heterotrait-monotrait ratios. All ratios remained below .85. Source: By the author.

4.4 Composite Diagnostics

Table 5 presents the prespecified composite diagnostics. Environmental management accounting capability had component variance inflation factors of 1.346 and a redundancy correlation of .765. Climate-smart agriculture investment readiness had component variance inflation factors from 1.843 to 2.433 and a redundancy correlation of .766. These results supported the intended use of the two higher-order composites.

Institutional support accessibility had component variance inflation factors from 1.514 to 1.958, indicating that component collinearity was not problematic. Its redundancy correlation was .685, providing moderate and comparatively weaker convergent evidence than the corresponding results for environmental management accounting capability and investment readiness. Because institutional support accessibility was specified as a formative composite, with its seven components representing noninterchangeable support domains and collinearity diagnostics acceptable, the composite was retained in the structural analysis. The comparatively weaker redundancy result was retained as a qualification when interpreting the institutional-support findings.

Table 5. Prespecified composite diagnostics

Composite	Composition and prespecified weighting	Component VIF	Redundancy correlation
Environmental management accounting capability	Equal-weight higher-order composite comprising physical environmental management accounting and monetary environmental management accounting. Each dimension received a weight of .50.	1.346	.765
Institutional support accessibility	Equal-weight formative composite comprising seven support domains. Each component received a weight of (1/7).	1.514–1.958	.685
Climate-smart	Equal-weight higher-order composite comprising	1.843–2.433	.766

Composite	Composition and prespecified weighting	Component VIF	Redundancy correlation
agriculture investment readiness	strategic, analytical, financial, and implementation readiness. Each dimension received a weight of .25.		

Note. VIF denotes variance inflation factor. Composite structures and unit weights were specified before the main structural analysis. Global criterion items were used only for redundancy assessment and were excluded from the structural composites. Source: By the author.

4.5 Structural Model Results

Table 6, Panel A, presents the environmental resource-cost visibility equation. Environmental management accounting capability was positively associated with environmental resource-cost visibility ($\beta = .498$, bootstrap SE = .042, $p < .001$), with a 95 percent confidence interval from .411 to .577. The local effect size was .354. The model explained 32.9 percent of the variance in resource-cost visibility, with an adjusted R^2 of .319. H1 was supported.

Under the prespecified ordered coding, accounting arrangement was positively associated with resource-cost visibility ($\beta = .176$, $p < .001$). Because the accounting categories do not constitute an unambiguous continuous scale, this coefficient should be interpreted as coding-dependent rather than as evidence of a monotonic increase in visibility. Previous investment experience showed a smaller positive association ($\beta = .123$, $p = .006$). Organization size and climate exposure were not statistically distinguishable from zero.

Table 6, Panel B, presents the climate-smart agriculture investment-readiness equation. Environmental resource-cost visibility had the largest direct association with climate-smart agriculture investment readiness, with $\beta = .475$, bootstrap SE = .043, $p < .001$, and a 95 percent confidence interval from .387 to .556. Its local effect size was .302. Environmental management accounting capability retained a smaller direct association with readiness after resource-cost visibility was included, with $\beta = .182$, bootstrap SE = .044, $p < .001$, and a 95 percent confidence interval from .094 to .266. Its local effect size was .046.

Institutional support accessibility was independently associated with investment readiness, with $\beta = .248$, bootstrap SE = .039, $p < .001$, and a 95 percent confidence interval from .172 to .324. Its local effect size was .115. Consequently, the standardized coefficients and local effect sizes indicated that resource-cost visibility had the strongest direct association with investment readiness, followed by institutional support accessibility and the remaining direct association of environmental management accounting capability.

Organization size, accounting arrangement, climate exposure, and previous investment experience were not statistically distinguishable from zero in the readiness equation. Their p -values ranged from .136 to .308. The model explained 49.9 percent of the variance in investment readiness, with an adjusted R^2 of .489. H2, H3, and H5 were supported.

Table 6. Standardized structural-model results

Panel A. Environmental resource-cost visibility equation

Model $R^2 = .329$, adjusted $R^2 = .319$

Hypothesis	Predictor path	β	Bootstrap SE	p	95% bootstrap CI	(f^2)	VIF	Decision
H1	EMA capability → ERCV	.498	.042	<.001	[.411, .577]	.354	1.046	Supported
—	Organization size → ERCV	-.005	.043	.907	[-.090, .081]	<.001	1.011	—
—	Accounting arrangement → ERCV	.176	.043	<.001	[.089, .259]	.044	1.049	—
—	Climate exposure → ERCV	-.017	.044	.704	[-.104, .070]	<.001	1.005	—
—	Previous investment experience → ERCV	.123	.045	.006	[.035, .211]	.022	1.010	—

Panel B. Climate-smart agriculture investment-readiness equation

Model $R^2 = .499$, adjusted $R^2 = .489$

Hypothesis	Predictor path	β	Bootstrap SE	p	95% bootstrap CI	(f^2)	VIF	Decision
H2	ERCV → CSAIR	.475	.043	<.001	[.387, .556]	.302	1.491	Supported
H3	EMA capability → CSAIR	.182	.044	<.001	[.094, .266]	.046	1.440	Supported
H5	ISA → CSAIR	.248	.039	<.001	[.172, .324]	.115	1.067	Supported
—	Organization size → CSAIR	.043	.038	.253	[-.030, .118]	.004	1.022	—
—	Accounting arrangement → CSAIR	.041	.041	.308	[-.037, .122]	.003	1.096	—
—	Climate exposure → CSAIR	-.052	.035	.136	[-.121, .016]	.005	1.006	—
—	Previous investment experience → CSAIR	.055	.038	.153	[-.020, .128]	.006	1.052	—

Note. $N = 360$. EMA denotes environmental management accounting capability. ERCV denotes environmental resource-cost visibility. ISA denotes institutional support accessibility. CSAIR denotes climate-smart agriculture investment readiness. β denotes the standardized ordinary least squares coefficient. SE denotes standard error. CI denotes confidence interval. f^2 denotes the local effect size.

VIF denotes variance inflation factor. Bootstrap standard errors and percentile confidence intervals were estimated using 10,000 resamples with seed 20260802. Variables were standardized using sample means and population-standard-deviation scaling before model estimation. Organization size, accounting arrangement, climate exposure, and previous investment experience were entered using the primary coding described in the Method. Dashes identify control paths for which no hypothesis decision was specified. Hypothesis decisions indicate statistical support for the stated associations and do not establish causal effects. H4 concerns the indirect association through environmental resource-cost visibility and is reported in Table 7. Source: By the author.

4.6 Indirect Association Through Environmental Resource-Cost Visibility

Table 7 summarizes the direct and indirect environmental management accounting associations with investment readiness and the descriptive share represented by the indirect association. The bootstrapped indirect association between environmental management accounting capability and climate-smart agriculture investment readiness through resource-cost visibility was .237 (SE = .030, $p < .001$), with a 95 percent confidence interval from .178 to .297. The confidence interval did not include zero.

In the model excluding environmental resource-cost visibility, the total association between environmental management accounting capability and climate-smart agriculture investment readiness was .417. In the readiness equation that included environmental resource-cost visibility, the direct association was .182 and remained statistically supported. The indirect association represented 56.7 percent of the total association based on the unrounded model estimates. These results supported H4 and indicated a partial indirect association pattern, with a statistically supported indirect association and a remaining positive direct association. Because environmental resource-cost visibility and investment readiness were measured during the same wave, the result does not establish temporal or causal mediation.

Table 7. Direct and indirect environmental management accounting associations with investment readiness

Metric	Estimate	Bootstrap inference	Interpretation
Direct EMA association with CSAIR	.182	SE = .044, $p < .001$, 95% CI [.094, .266]	Direct association retained
Indirect EMA association through ERCV	.237	SE = .030, $p < .001$, 95% CI [.178, .297]	H4 supported
Indirect share of total EMA association	56.7%	Descriptive ratio	Partial indirect association pattern

Note. N = 360. EMA denotes environmental management accounting capability. ERCV denotes environmental resource-cost visibility. CSAIR denotes climate-smart agriculture investment readiness. The total EMA association before resource-cost visibility was introduced was .417. The indirect association equals the product of the EMA capability-to-ERCV coefficient and the ERCV-to-CSAIR

coefficient. Percentile confidence intervals were calculated from 10,000 bootstrap resamples using seed 20260802. The 56.7 percent share was calculated from the unrounded indirect and total association estimates. Source: By the author.

4.7 Predictive Performance and Robustness

Table 8, Panel A, shows positive out-of-sample performance for both endogenous constructs. Fixed and repeated cross-validation produced positive values, model root mean square errors below the training-mean benchmarks, and minimal variation across repeated fold assignments.

Panel B evaluates the stability of the investment-readiness equation under alternative control coding and progressively broader contextual adjustment. The focal coefficients remained within narrow ranges across all specifications. Although the fully adjusted contextual model increased R^2 to .550, its adjusted R^2 was .497 and therefore did not exceed the adjusted explanatory performance of the more parsimonious geography specification. Panel C did not identify material collinearity, heteroscedasticity, functional-form, influence, extreme-residual, response-timing, or attrition concerns. The nonsignificant early-late and attrition comparisons should not be interpreted as formal evidence of equivalence.

Table 8. Predictive and robustness assessments

Panel A. Out-of-sample predictive assessment

Endogenous construct	Cross-validation design	Q ²	Q ² SD	Model RMSE	Benchmark RMSE
Environmental resource-cost visibility	Fixed ten-fold cross-validation	.303	—	.822	.984
Climate-smart agriculture investment readiness	Fixed ten-fold cross-validation	.474	—	.639	.881
Environmental resource-cost visibility	Ten repetitions of ten-fold cross-validation	.310	.003	.819	.986
Climate-smart agriculture investment readiness	Ten repetitions of ten-fold cross-validation	.481	.004	.634	.880

Panel B. Structural sensitivity specifications

Model specification	ERCV CSAIR β	→ EMA CSAIR β	→ ISA CSAIR β	→ R ²	Adjusted R ²	k
Primary model with prespecified ordered controls	.475	.182	.248	.499	.489	8
Dummy-coded categorical controls	.474	.180	.249	.515	.498	13
Dummy-coded controls plus focal-investment type	.477	.173	.257	.526	.495	23
Dummy-coded controls plus the investment-preparation stage	.471	.181	.250	.521	.499	17

Model specification	ERCV CSAIR β	→ EMA CSAIR β	→ ISA CSAIR β	→ R^2	Adjusted R^2	k
Dummy-coded controls plus geography	.467	.189	.251	.525	.501	18
Dummy-coded controls plus agrifood activity	.468	.181	.247	.520	.493	20
Fully adjusted contextual model	.456	.186	.255	.550	.497	39

Panel C. Regression diagnostics, response-timing, and attrition checks

Diagnostic area	Test or statistic	Observed result	Benchmark or comparison
Full collinearity	Maximum construct-level VIF	1.961	Below 3.3
Structural collinearity	Maximum predictor VIF	1.491	Below 3.0
Early–late response comparison	Welch independent-samples tests across EMA, ISA, ERCV, and CSAIR	Minimum (p=.511). First response-order quartile Maximum absolute Hedges' compared with final response-order quartile (g=.098).	
Wave 2 attrition comparison	Welch independent-samples tests of Wave 1 EMA and ISA	Minimum (p=.771). Retained cases, (n=360), Maximum absolute Hedges' compared with Wave 2 noncompleters, (n=17) (g=.067).	
Heteroscedasticity	Breusch–Pagan test	ERCV equation, (p=.376). CSAIR equation, (p=.687).	(p>.05)
Functional form	Ramsey RESET test	ERCV equation, (p=.336). CSAIR equation, (p=.670).	(p>.05)
Influential observations	Maximum Cook's distance	ERCV equation, .031. CSAIR equation, .029.	Both substantially below 1.00
Extreme residuals	Maximum absolute externally studentized residual	ERCV equation, 2.70. CSAIR equation, 2.91.	Both below 3.00

Note. $N = 360$. EMA denotes environmental management accounting capability. ERCV denotes environmental resource-cost visibility. ISA denotes institutional support accessibility. CSAIR denotes climate-smart agriculture investment readiness. β denotes a standardized ordinary least squares coefficient. VIF denotes variance inflation factor. RMSE denotes root mean square error. Q^2 denotes cross-validated predictive relevance relative to a training-mean benchmark. Positive Q^2 values and model RMSEs below the corresponding benchmark indicate positive out-of-sample performance. Repeated results report the mean and standard deviation across ten repetitions of ten-fold cross-validation. k denotes the number of estimated parameters including the intercept. Nonsignificant early–late and attrition comparisons should not be interpreted as evidence of equivalence. Source: By the author.

5. Discussion

The findings indicate that climate-smart agriculture investment readiness among agrifood SMEs was associated with informational and institutional conditions beyond climate exposure alone. Readiness was most strongly associated with environmental resource-cost visibility, which captures whether resource inefficiency, production losses, and climate-related consequences become sufficiently identifiable and comparable to inform a focal investment. Environmental management accounting capability was strongly associated with this visibility, while institutional support accessibility retained an additional independent association with readiness. The indirect component represented more than half of the total association between environmental management accounting capability and readiness, although the same-wave measurement of visibility and readiness precludes a temporal or causal mediation claim. Consequently, the findings support a model in which internal information-processing capability, decision-relevant cost visibility, and usable external support make distinct but complementary contributions to investment preparation.

The qualitative and quantitative phases converged on the distinction between possessing environmental information and achieving decision-level visibility. Qualitative participants distinguished between physical and monetary information practices and the ability to identify and compare resource- and climate-related consequences. Quantitatively, the reflective constructs remained empirically distinct, and environmental resource-cost visibility showed the strongest direct association with readiness. This convergence supports the interpretation of visibility as a distinct informational condition rather than as an alternative label for environmental management accounting capability or investment readiness.

5.1 Environmental Management Accounting as An Information-Processing Capability

The strong positive association between environmental management accounting capability and environmental resource-cost visibility is consistent with the central premise of organizational information-processing theory. Galbraith argued that organizational uncertainty increases the need for mechanisms to acquire, process, and distribute information to support coordinated decision-making [9]. The findings extend this reasoning to environmental and climate-related investment decisions. In the study context, relevant evidence was distributed across physical resource use, production losses, environmental conditions, operating expenses, and climate-related disruption. Environmental management accounting capability was associated with greater visibility of these organizational consequences.

This interpretation is also consistent with the established distinction between physical and monetary environmental management accounting. Burritt, Hahn, and Schaltegger conceptualized environmental management accounting as a framework that connects physical environmental information with monetary information to support different managerial decisions [4]. The findings add empirical specificity to that framework by identifying environmental resource-cost visibility as a proximal managerial condition associated with environmental management accounting capability. Accordingly, the contribution lies not in restating the general usefulness of environmental information,

but in identifying decision-level resource-cost visibility as a condition associated with the integration of physical and monetary evidence. This condition concerns managers' ability to identify avoidable costs, attribute losses, estimate the consequences of disruption, and compare the financial implications of intervention and delay.

This result aligns with Swalih, Ram, and Tew's systematic review, which shows that environmental management accounting has expanded from short-term cost control toward strategic planning, investment analysis, and sustainable decision-making [5]. Whereas much of that literature evaluates broad outcomes such as organizational efficiency, legitimacy, or strategic sustainability, the study examines a more proximal decision condition. Resource-cost visibility captures what environmental accounting enables managers to identify and compare before a focal investment is approved or implemented.

The result also complements material flow cost accounting research. Chetanraj and Senthil Kumar showed that material flow cost accounting could visualize negative product costs and identify specific locations for operational improvement in an Indian manufacturing SME [13]. The findings support the value of making losses financially visible, but they extend the argument beyond a single production process and accounting technique. The participating agrifood organizations considered water, energy, agricultural inputs, unsuccessful production, spoilage, environmental expenditure, and climate disruption across multiple activities and investment types. Environmental resource-cost visibility, therefore, represents a broader decision-level condition than the process-specific cost visibility generated through material flow cost accounting.

The qualitative evidence also cautions against equating visibility with objectively complete environmental costing. Some participating organizations relied on structured estimates alongside formal records rather than sophisticated environmental accounting systems. The relevant condition is therefore whether managers can produce credible, comparable estimates of resource- and climate-related consequences to support a focal decision. This interpretation preserves the decision-support function of environmental management accounting without imposing large-firm accounting expectations on micro and small enterprises.

5.2 Environmental Resource-Cost Visibility and Investment Readiness

Environmental resource-cost visibility had the strongest direct association with climate-smart agriculture investment readiness. This pattern indicates that readiness was more closely associated with whether the organizational consequences of environmental problems had become identifiable and comparable than with climate exposure alone. Where resource inefficiency, production loss, climate disruption, and delayed adaptation remain dispersed across general expenses or informal observations, an investment may be viewed as desirable without becoming analytically or financially actionable. The observed association is consistent with a role for resource-cost visibility in problem definition, alternative comparison, cost-of-inaction estimation, and justification of organizational priorities.

This finding extends the climate-smart agriculture literature, which has largely examined adoption decisions and realized outcomes. Ma and Rahut's synthesis of 19 studies found that

extension, training, access to information, institutional capital, credit, production conditions, and farmer characteristics influence the adoption of climate-smart practices [6]. It also showed that several demographic and structural determinants have mixed effects across settings. These studies clarify why farmers and agricultural organizations adopt or reject technologies, but they provide less detail on the organizational preparation that occurs before adoption. The study addresses that earlier stage by examining whether a focal investment has been strategically defined, analytically appraised, financially prepared, and operationally planned.

This distinction between readiness and adoption is theoretically and empirically consequential. Adoption is a realized behavior, while readiness is an organizational state that may precede approval, financing, or implementation. An enterprise may recognize the value of efficient irrigation or protected agriculture but remain unprepared because it lacks reliable cost estimates, technical comparisons, a budget, a financing plan, or assigned implementation responsibilities. By anchoring readiness to one focal investment, the study avoids treating favorable attitudes toward climate-smart agriculture as equivalent to practical preparedness.

The findings can also be compared with recent research on green investment readiness among Ghanaian SMEs. Padi and colleagues found that green investment readiness mediated the relationships of environmental awareness and financial literacy with renewable-energy adoption [8]. Their results support the broader proposition that readiness is an important bridge between organizational resources and environmental investment behavior. However, this study differs in three respects. It examines agrifood investments rather than renewable-energy adoption alone. It conceptualizes readiness through strategic, analytical, financial, and implementation preparation. It also identifies resource-cost visibility as an antecedent that helps explain why environmental accounting capability is associated with readiness. The two studies are therefore complementary. The Ghanaian evidence positions readiness as a pathway toward adoption, whereas the study identifies resource-cost visibility as a conceptually prior condition associated with readiness.

The conceptualization also differs from investment-readiness research in corporate finance. Alexakis and colleagues examined European SMEs and defined investment readiness largely in terms of the willingness to use equity capital. They found that entrepreneurial ecosystems, regulatory conditions, skilled labor, and market outlook were important predictors [7]. That perspective is appropriate for equity financing, but it does not capture the operational preparation required for a specific climate-smart investment. The current study, therefore, extends investment-readiness research by shifting attention from investor orientation and financing willingness to the organizational capacity to define, appraise, budget, finance, and initiate a specific environmental investment.

5.3 Indirect Association Through Environmental Resource-Cost Visibility

Environmental resource-cost visibility represented 56.7 percent of the total standardized association between environmental management accounting capability and investment readiness, while the direct association remained positive. This pattern indicates a statistically supported indirect association alongside a remaining direct association. Substantively, it supports the proposition that environmental management accounting capability is linked to readiness, in part through its

association with greater clarity about resource inefficiency, production losses, and climate-related costs. It does not establish that visibility temporally or causally transmits the relationship.

The result is consistent with recent evidence suggesting that environmental management accounting may be linked to distal organizational outcomes through more proximal processes. Huy and Phuc found positive associations among environmental management accounting, green innovation complexity management, and strategic resilience in SMEs, with green innovation management serving as an intermediary mechanism [15]. Although their dependent variable and proposed intermediary differ from those examined in this study, their findings challenge a simple direct-effect interpretation of environmental management accounting. These studies are consistent with the view that environmental accounting information is more consequential when it is associated with a proximal organizational condition that makes dispersed evidence more actionable. In the model, resource-cost visibility occupies that proximal position. The finding, therefore, identifies a statistically supported intermediary condition rather than a demonstrated conversion mechanism. The remaining direct association suggests that additional decision-support processes may also connect environmental management accounting capability with readiness. Identifying those processes requires direct measurement in future research.

5.4 Institutional Support Accessibility as A Complementary External Antecedent

Institutional support accessibility was positively associated with investment readiness, although its contribution was smaller than that of resource-cost visibility. This result is consistent with climate-smart agriculture research linking extension, technical advice, training, finance, organizational membership, and access to information with agricultural adaptation and technology adoption [6]. It is also consistent with the meta-analysis by Jiang and colleagues, which synthesized 1,541 estimates from 145 studies and found a positive overall association between social support and climate-smart agriculture adoption [11]. Their findings further indicated that informational support was more consistently beneficial than instrumental support, whose effects varied more substantially across institutional contexts.

The current study advances this evidence by defining support in terms of practical accessibility and usability rather than formal program availability. A loan, advisory service, training program, or insurance mechanism may exist without being sufficiently clear, timely, affordable, or relevant to support an SME's investment. The positive association is therefore consistent with the importance of support perceived as sufficiently clear, timely, attainable, and relevant to the focal investment.

The relative coefficient pattern is consistent with complementary roles for external support and internal organizational capability. Institutional programs can provide expertise, finance, information, and risk-sharing mechanisms, but these resources may be difficult to use when an enterprise cannot define its resource problem, estimate the associated costs, or prepare a credible investment proposal. Conversely, internal cost visibility may identify a strong investment case that cannot advance without technical validation or financing. The study did not estimate interaction or substitution effects. Complementarity should therefore be interpreted as a conceptual, additive pattern rather than a statistically tested interaction.

In Trinidad and Tobago, the distinction provides an organizational-level interpretation of policy barriers concerning finance, coordination, technical knowledge, and feasibility evidence [2]. These barriers concern the external enabling environment, whereas resource-cost visibility concerns the internal evidence needed to use that environment effectively.

Regional evidence reinforces this interpretation. Research on Green Climate Fund readiness grants in Caribbean Small Island Developing States indicates that climate-finance support can strengthen institutional adaptive capacity, although its contribution depends on the institutional arrangements through which support is delivered [31]. Regional climate-finance analysis also identifies substantial gaps between the financing needs stated by Caribbean Small Island Developing States and the international resources received [32]. These findings strengthen the case for distinguishing nominal support availability from support that organizations can access and use in preparing specific investments.

5.5 Organizational Characteristics and Resource-Cost Visibility

Previous environmental or climate-smart investment experience was positively associated with environmental resource-cost visibility in the primary equation. The ordered accounting arrangement code was also positive, but its categories do not form an unambiguous, continuous scale. That coefficient should therefore be interpreted as coding-dependent rather than as evidence of a monotonic increase in visibility. The focal associations remained stable when the categorical controls were represented through dummy variables.

Organization size and climate exposure were not statistically distinguishable from zero in either structural equation. These results do not establish that size or exposure is unimportant. They indicate only that neither variable retained an independent association within this sample and specification after the other predictors were included. This differs from conventional investment-readiness and climate-smart agriculture studies, although those studies examine different outcomes and units of analysis [6], [7].

The climate-exposure result is consistent with the possibility that exposure creates an information requirement without providing the organizational capacity needed to meet it [9]. Stronger conclusions concerning exposure require longitudinal, objective, and independently validated evidence.

5.6 Predictive Relevance and Robustness

Beyond the explanatory associations, the predictive analysis provided additional evidence that the model retained out-of-sample relevance. Positive cross-validated Q^2 values and root mean square error values below the corresponding training-mean benchmarks were observed for both environmental resource-cost visibility and investment readiness. The consistency of these results across repeated fold allocations reduces concern that the predictive pattern depended on a single favorable partition of the sample. These findings do not establish deployment-level forecasting accuracy because the analysis predicted composite visibility and readiness scores rather than subsequent financing, implementation, or organizational performance.

5.7 Theoretical Contributions

The study's central contribution is the conceptualization and initial operationalization of environmental resource-cost visibility as a distinct decision-level informational outcome of environmental management accounting capability and, simultaneously, as a proximal informational condition associated with investment-specific readiness. This distinction extends organizational information-processing theory from the organizational capacity to process information to the decision-level state that exists when dispersed physical and monetary evidence becomes sufficiently interpretable for a focal investment decision [4], [9]. It also sharpens environmental management accounting theory by identifying what becomes actionable before investment approval or implementation rather than treating environmental information capability as directly equivalent to broad performance or adoption outcomes [4], [5].

The framework further separates investment preparation from adoption and separates external support accessibility from internal information processing. Climate-smart agriculture investment readiness is modeled as strategic, analytical, financial, and implementation preparation for one focal investment, while institutional support accessibility remains a distinct external antecedent [6], [7], [8], [11]. This architecture connects previously fragmented research streams without collapsing their constructs and provides a testable account of the organizational stage between environmental information, accessible support, and realized investment behavior. The contribution is therefore an empirically supported organizational framework that identifies a previously underexamined decision-level condition and provides a basis for longitudinal tests of whether visibility precedes readiness and whether readiness predicts financing and implementation.

5.8 Practical Implications

For agrifood SME managers, the findings imply that climate-smart agriculture investment preparation should begin with disciplined visibility of resource use and environmental costs. This does not require every micro or small enterprise to install a sophisticated accounting system. A proportionate approach may begin with structured records of water, energy, inputs, waste, failed production, emergency expenditure, and disruption-related losses. These records should then be connected with budgets and comparisons of investment alternatives.

Accountants and business advisers should extend their contribution beyond statutory reporting. They can help SMEs identify costs dispersed across general accounts, estimate the financial implications of resource inefficiency, and prepare documentation that is credible to lenders and support agencies. Extension providers should similarly integrate technical recommendations with costing, feasibility assessment, avoided-loss estimation, and implementation planning.

Financial institutions and public programs should avoid treating access to finance as the only readiness constraint. Effective support should combine financing with technical appraisal, simplified procedures, standardized costing templates, and staged preparation assistance. Program performance should be assessed not only by funds announced, applications received, and training delivered, but also by whether participating enterprises are able to define, evaluate, finance, and initiate appropriate investments. The focal associations remained stable after adjustment for investment type, preparation

stage, location, and agrifood activity, suggesting that the implications are not confined to one investment category. This robustness should not be interpreted as evidence that the associations are identical across all organizational or technological subgroups.

5.9 Limitations and Future Research

Several limitations qualify the interpretation of the findings. First, the observational design does not permit causal inference and cannot rule out reverse causation or omitted-variable bias. Although environmental management accounting capability and institutional support accessibility were measured before environmental resource-cost visibility and investment readiness, visibility and readiness were measured during the same wave. The indirect association, therefore, does not establish temporal or causal mediation. Future research should use three-wave longitudinal designs, field interventions, or repeated organizational assessments to determine whether changes in environmental management accounting capability precede changes in resource-cost visibility and subsequent investment preparation.

Second, one informed respondent supplied the substantive organizational measures. Temporal separation, construct-specific response formats, and the diagnostic checks reduced some common-source concerns but could not eliminate them. Future studies should combine responses from operational and financial decision-makers with accounting records, technical assessments, lender evaluations, or other independent organizational evidence.

Third, recruitment through agrifood associations, professional networks, extension contacts, and limited participant referral supported coverage across activities and locations, but the resulting sample does not permit statistical generalization to the wider national SME population. Replication is needed in other Small Island Developing States, developing economies, and agrifood value-chain settings.

Fourth, the measurement framework remains preliminary. The locked Version 3.0 instrument was not administered as a complete independent pilot form, and the reflective constructs were assessed using separate one-factor models rather than a single simultaneous measurement model. The higher-order constructs also used prespecified equal weights, while institutional support accessibility produced comparatively weaker redundancy evidence than the environmental management accounting and readiness composites. Independent samples should evaluate the complete measurement structure, compare theoretically justified composite specifications, and assess measurement invariance across relevant organizational and contextual groups.

Finally, the study examined investment readiness rather than subsequent financing, implementation, adoption, or organizational performance. Longitudinal research should test whether the four readiness dimensions predict investment approval, access to finance, implementation quality, and environmental or economic outcomes.

6. Conclusion

This study used a multiphase mixed-methods design and two-wave data from 360 agrifood organizations in Trinidad and Tobago to examine how environmental management accounting capability, environmental resource-cost visibility, and institutional support accessibility relate to

climate-smart agriculture investment readiness.

Environmental resource-cost visibility emerged as the model's central decision-level informational condition, strongly associated with environmental management accounting capability and showing the largest direct association with investment readiness. Environmental management accounting capability also retained a smaller direct association, while institutional support accessibility retained a separate positive association. The indirect component represented 56.7 percent of the total environmental management accounting association with readiness, although the same-wave measurement of visibility and readiness precludes temporal or causal mediation claims. These findings support an integrated organizational account in which environmental information becomes useful for investment preparation when resource and climate-related consequences can be identified and compared, while usable external support remains independently relevant.

Practically, the findings support proportionate tools that connect environmental records with cost attribution, feasibility assessment, budgeting, financing preparation, and implementation planning. The evidence remains bounded by the observational, single-country, and single-respondent design and does not establish downstream financing, implementation, or performance outcomes. Longitudinal, multisource, and cross-context research should validate the measurement framework and test whether readiness predicts realized investment. Subject to these qualifications, the study positions environmental management accounting as an organizational information-processing capability whose strategic relevance is reflected in greater decision-level resource-cost visibility.

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Conflicts of Interest

The author confirms that there are no conflicts of interest.

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