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Article

# Curriculum Agility and the Integration of Climate-Smart Agriculture in Higher Education Institutions in Northern Ghana

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## Abstract

**Purpose:** Agriculture in Northern Ghana faces increasing vulnerability to climate change, requiring higher education institutions (HEIs) to equip graduates with climate-smart agriculture (CSA) competencies. This study examines the curricula of InstituteA and InstituteB to assess their capacity to integrate CSA principles and prepare students for climate-resilient agriculture. **Design/Methodology/Approach:** Guided by the Context–Input–Process–Product (CIPP) evaluation model and the FAO Climate-Smart Agriculture Sourcebook, data were collected through qualitative curriculum analysis and eight semi-structured interviews with curriculum developers. **Findings:** CSA integration is fragmented, inconsistently embedded, and largely peripheral in both institutions. While InstituteA’s BSc Agribusiness programme prioritises entrepreneurship and management with only two climate-related electives, InstituteB’s BTech Sustainable Agriculture programme includes indirect references to climate variability but lacks an explicit and coherent climate change framework. Cross-cutting themes such as gender, ICT, indigenous knowledge, and energy conservation are either absent or weakly integrated. **Practical Implications:** These gaps result in a mismatch between higher education outputs and the competencies required for climate adaptation, highlighting the need for systematic CSA mainstreaming, interdisciplinary curriculum reform, and improved institutional support. **Theoretical Implications:** The findings contribute to scholarship on curriculum agility by demonstrating how structural and policy constraints limit effective climate change integration in agricultural education within climate-vulnerable contexts. **Originality/Value:** This study provides empirical evidence from Northern Ghana, offering one of the first structured evaluations of CSA integration in higher agricultural education in the region.

**Keywords:** agricultural education; curriculum agility; climate-smart agriculture (CSA); higher education institutions (HEIs); Northern Ghana; climate change adaptation

## Introduction

### *Climate Vulnerability and Agricultural Education in Northern Ghana*

Particularly in sub-Saharan Africa, where rain-fed farming predominates, climate change is one of the biggest threats to global agriculture, food security, and rural livelihoods (Anderson et al., 2020; Antwi-Agyei and Nyantakyi-Frimpong, 2021). Northern Ghana is particularly susceptible to climate shocks such as unpredictable rainfall, droughts and floods, because of its delicate agro-ecological systems and significant reliance on smallholder farming (Atanga and Tankpa, 2021; Bawa, 2019). Adopting climate-smart techniques is only one aspect of enhancing resilience in the agriculture

sector; another is training graduates with the necessary skills to bridge the gap between research, innovation, and practice in ways that promote sustainable adaptation (FAO, 2019b; IPCC, 2018).

Institutions of higher learning (HEIs) are essential to this change. HEIs are responsible for training future professionals to create and execute sustainable agricultural systems that successfully address climate problems, since they are hubs for knowledge generation and skill development (National Research Council, 2012; Reimers, 2021). However, studies indicate that African agricultural curricula frequently lag behind in incorporating multidisciplinary methods, sustainability, and climate change, which causes a gap between academic outputs and industrial demands (Boateng, 2015; Davis et al., 2020). For higher education to be relevant in the face of uncertainty, scholars contend that curriculum agility, defined as the capacity of curricula to adjust quickly and effectively to changing environments, is a crucial requirement (Menon et al., 2022; Dooley and Roberts, 2020).

### *Curriculum Agility and Climate Responsiveness in Higher Education*

In developing economies, agricultural education has long been seen as essential to reducing poverty, ensuring food security, and promoting sustainable development (Brooks and Loevinsohn, 2011; Osabohien et al., 2019). However, because of the complex and ever-changing threats posed by climate change, curricula must go beyond standard technical training to equip graduates with interdisciplinary knowledge, climate-smart abilities, and adaptive capacities (Verchot et al., 2007; Partey et al., 2018). Integrating climate change into agricultural education is essential for resilience and long-term change in Ghana, where agriculture employs a sizable portion of the labor force and makes a substantial contribution to GDP (World Bank Group, 2022; Ministry of Environment, Science, Technology and Innovation, 2013).

A key lens for examining whether HEIs are adaptable to these issues is curriculum agility. According to Menon and Suresh (2021), external forces like industry demands, climatic realities, and governmental frameworks, as well as internal forces like institutional flexibility, leadership, and instructional strategies, influence agility in higher education. Agility in agricultural education refers to upgrading curriculum to meet international CSA requirements, mainstreaming cross-cutting issues like gender, ICT, and indigenous knowledge, and integrating climate change into core courses (FAO, 2013; Molthan-Hill et al., 2019). Graduates run the danger of receiving training for antiquated agricultural models rather than being prepared to handle future climatic risks in the absence of such responsiveness (Hess and Collins, 2018; Henderson et al., 2017).

According to recent research, HEIs in Africa have structural obstacles that impede flexible responses to climate change, such as a lack of teaching resources, pedagogy that is heavily reliant on theory, and laborious curriculum revision cycles (Ssekamatte, 2023; McGrath et al., 2020). For example, Lempert and Groves (2010) contend that flexible institutional planning and iterative evaluation are necessary for effective adaptation methods; yet, Ghanaian agricultural curriculum are frequently evaluated only every three to four years, which delays the country's ability to respond to new climatic issues. Furthermore, it has been determined that curricular gaps in gender, energy conservation, and ICT are significant flaws that restrict comprehensive climate-smart training (Boateng, 2015; Antwi-Agyei and Stringer, 2021).

### *Study Aim and Research Questions*

In light of this, this study evaluates the curriculum of InstituteB and the InstituteA, two of Northern Ghana's top HEIs, to determine how adaptable they are to climate change. Through the use of the CIPP assessment technique (Stufflebeam and Zhang, 2017) and comparison with the FAO's CSA Sourcebook, the study examines how curricula either prioritize or ignore climate issues and what institutional, pedagogical, and policy aspects influence its results. Comprehending these processes is essential to coordinating higher education with Ghana's objectives for sustainable agricultural transformation and climate adaption.

## Literature Review

### *Climate Change Education in Ghanaian Agricultural Higher Education*

Ghana's economy depends heavily on agricultural education, yet the country's curriculum are frequently out of date, underfunded, and not well adapted to the reality of climate change (Boateng, 2015; UNDP and UNEP, 2018). A mismatch between graduates' skills and industry demands results from many programs that prioritize technical training while ignoring women, ICT, climate-smart agriculture (CSA), and sustainability (ILO, 2019; Antwi-Agyei and Stringer, 2021). This disparity is especially troubling in Northern Ghana, where livelihoods and food security are at danger due to climatic hazards including floods and droughts (Atanga and Tankpa, 2021; Anang et al., 2020).

The need of increasing postsecondary institution capability is emphasized by national policy frameworks as the Climate-Smart Agriculture Investment Plan (UNDP and UNEP, 2016) and Ghana's National Climate Change Policy (MESTI, 2013). However, due to the autonomy of Ghanaian technical and university institutions, curriculum design frequently falls behind national objectives and incorporates CCE to a limited extent (Zakaria et al., 2020). Research indicates that poor enrollment, a shortage of trained teachers, out-of-date curriculum, and cultural attitudes that devalue agricultural careers are some of the structural obstacles that Ghanaian agricultural education still faces (Bawa, 2019; Twumasi et al., 2019). Without reform, agricultural graduates run the danger of not having the skills necessary to help farmers mitigate the effects of climate change and adapt to them (Mensah et al., 2021).

### *Climate Change Education and Education for Sustainable Development (ESD)*

Because it gives students the values, information, and abilities needed to address the causes and effects of climate change, climate change education (CCE) is acknowledged as a crucial component of education for sustainable development (ESD) (UNESCO, 2015; Anderson, 2012). By promoting behavioral change, lowering ecological footprints, and bolstering climate-resilient communities, CCE develops capacities for mitigation and adaptation through both formal and informal education (Anderson, 2012; Dooley and Roberts, 2020). In order to represent the intricate and systemic character of climate change, it places a strong focus on multi-, inter-, and trans-disciplinary methods that combine the scientific sciences, social sciences, and humanities (Leal Filho and Hemstock, 2019; Ali, 2018).

At the global policy level, the Paris Agreement (United Nations, 2015) and the Lima Ministerial Declaration (UNFCCC, 2014) both reaffirmed the importance of education, awareness, and training for climate action, which was first highlighted in the United Nations Framework Convention on Climate Change (UNFCCC, 1992). These accords are in line with SDGs 4 (quality education) and 13 (climate action), which specifically demand that curriculum incorporate sustainable development and climate change (UN, 2020). Since then, UNESCO has helped nations integrate climate action into their educational systems by advancing the "Climate Change Education for Sustainable Development" (CCESD) initiative (UNESCO, 2018). Despite advancements, institutional impediments, insufficient teacher preparation, and a lack of finance cause CCE implementation to differ around the globe (Leal Filho and Hemstock, 2019; Hess and Collins, 2018).

### *Trends in Climate Change Education*

Global trends show that CCE is being mainstreamed gradually yet unevenly. Instead, then limiting climate information to specialized courses, international assessments emphasize the necessity of integrating it into all topics (UNESCO, 2022). Since information is passed down through the generations and used in community-level adaptation, mainstreaming is regarded as sustainable and cost-effective (Reid, 2019; Monroe et al., 2019). Higher education institutions frequently neglect to update their antiquated curriculum, which leaves graduates ill-prepared for the difficulties posed by climate change (Hess and Collins, 2018; Henderson et al., 2017).



Successful integration is demonstrated by several models. Multidisciplinary, research-based programs on climate change have been introduced by European institutions such as Copenhagen and Hamburg (Molthan-Hill et al., 2019). In order to improve resilience through skills-based training, the EU PacTVET program implemented vocational credentials in CCE across the Pacific (Havea et al., 2019). National-level attempts to integrate CCE into research and training are demonstrated in Africa by programs like South Africa's Global Change Grand Challenge (Bernstein et al., 2022). However, academics warn that in order for African curriculum to be relevant, they need to integrate indigenous knowledge and make a stronger connection to local reality (Shava and Nkopodi, 2020). Overall, research highlights that in order to effectively increase adaptive capacity, CCE has to be competency-based, transdisciplinary, and context-specific (Menon et al., 2022; Partey et al., 2018).

#### *Effective Strategies for Pedagogical Integration into the CCE Curricula*

While agricultural education, sometimes referred to as "agriscience" or "vocational agriculture," has sought to provide students with practical skills for the industry, agricultural sciences have historically sought to improve food and fiber production through advancements in agronomy, animal science, and related fields (Hanadayani, 2021; Şahin, Kumar and Altun, 2016). However, a move from merely technical training to sustainability-oriented pedagogies that develop adaptive capabilities is necessary due to the rising problem of climate change (Dooley and Roberts, 2020; Anderson, 2012).

Project-based learning (PjBL) and problem-based learning (PBL) are becoming more and more acknowledged as successful methods for teaching sustainability. These models foster critical thinking, multidisciplinary cooperation, and innovation by exposing students to real-world agricultural issues (Pavlova et al., 2019; Brennan and Widdop Quinton, 2020). For example, since 2007, the School of Sustainability at Arizona State University has employed a combined problem-and project-based learning (PPBL) paradigm, resulting in graduates who are adept at co-creating solutions to sustainability and climate concerns (Massitah and Ahmed, 2020). Similar to this, the problem-oriented and project-based learning (POPBL) framework, which has been tested in Malaysia, improves communication and cooperation abilities by connecting ethical decision-making with reflective problem formulation (Pavlova and Chen, 2019).

In line with demands for higher education to support climate-smart agricultural and resilient food systems, these integrative methods place a strong focus on interdisciplinarity, experiential learning, and stakeholder involvement (Partey et al., 2018; Menon, Suresh and Raman, 2022). POPBL emphasizes ethical reasoning and reflective practice, whereas PPBL emphasizes cross-disciplinary cooperation and real-world application. Both models are suitable for Ghanaian agricultural education. Curricula run the danger of being out of date and disengaged from the skills needed to address sustainability and climate change in the absence of such innovations (Boateng, 2015; Hess and Collins, 2018).

## **Methods**

For this study, qualitative research was employed. As Creswell (2007) defined, a case study is an inquiry that focuses intently on a subject significant to the researcher, such as a syllabus or curriculum. To understand the degree to which climate change is covered in the curriculum, the research was divided into two parts: a content analysis of official curriculum documents and interviews with curriculum developers' analysis was used as the research design (Bowen, 2009).

#### *Data collection method*

##### **Sampling Method**

Purposeful sampling was employed to select the two institutions and participants, as it allows the identification of information-rich cases (Creswell, 2018). Curriculum developers were specifically chosen for their involvement in programme design and expertise in agricultural education.

### Primary Data: Curriculum Documents

Curriculum materials were gathered from two Northern Ghanaian agriculture schools. Course descriptions and the BTech Sustainable Agriculture curriculum (64 courses spread over 8 semesters) were supplied by the Head of Sustainable Agriculture at InstituteB. Similar paperwork was supplied by the Department of Food Security and Climate Change at the InstituteA for the BSc Agribusiness program, which consists of 53 courses spread over 10 trimesters. Following COVID-19 interruptions, both programs began in-person instruction in 2022, mixing theory with differing levels of hands-on experience. Extension agents, farm managers, economists, entrepreneurs, and agronomists were among the career pathways that were found.

### Curriculum Analysis

The CIPP evaluation framework guided analysis of context (objectives and scope) and input (relevance of content and resources). The process and product dimensions were explored through curriculum review and interviews, focusing on how pedagogies and resources prepare students for climate change resilience.

### Interviews

Eight semi-structured interviews were conducted (four per institution) with curriculum developers in February 2023. Initial contact was made via departmental heads, and participants gave written consent. Although 15 were recommended, only eight volunteered; three female developers declined due to scheduling conflicts. Interviewees held MPhil or PhD qualifications, averaging five years' service, with expertise in agricultural economics, agribusiness, agricultural technology, and endogenous development. Notably, none specialised in climate change.

Interviews explored curriculum design, teaching methods, evaluation processes, and challenges, with emphasis on energy, climate change, and gender. Themes addressed included programme content, resources, evaluation, pedagogy, employment opportunities, and partnerships. Sessions averaged 40 minutes, were conducted in offices/classrooms, and were audio-recorded for transcription. A research assistant a junior lecturer at InstituteB supported data collection after training to ensure procedural consistency.

### *Data Management and Analysis*

Examining how well two agricultural education curriculum prepared students to adapt to climate change was the goal of the investigation. The FAO Climate-Smart Agriculture Sourcebook (FAO, 2017), a widely accepted manual for creating agricultural curricula and training manuals, was used to identify climate-related content for Research Question 1 ("What is the current content of the Agricultural Education curriculum on climate change?"). To address soil and crop production, animal and fish production, entrepreneurship, pest control, sustainable agriculture and food security, water management, ICT, gender, energy conservation, and indigenous knowledge, eleven pertinent modules were chosen for this research.

### Curriculum Analysis

To find climate-related information in course outlines, a thematic content analysis (Braun and Clarke, 2006) was carried out. Codes (such as climate change, CSA, water management, energy, gender, and indigenous knowledge) were taken from the FAO handbook and categorized into themes. These were then evaluated for conformity with CSA principles by comparing them with curricular goals and objectives. Analysis was further directed by the CIPP assessment approach, which evaluated the process (pedagogies) and product (student results) through interviews while examining curricular materials for context (objectives and outcomes) and input (resources and theory/practice balance).

**Table 1.** Themes from the FAO Sourcebook against which the two curricula were analysed.

|    | Themes                                           |
|----|--------------------------------------------------|
| 1  | Soil production and conservation                 |
| 2  | Crop production                                  |
| 3  | Animal and fish production                       |
| 4  | Entrepreneurship                                 |
| 5  | Pest management                                  |
| 6  | Sustainable agriculture and food security        |
| 7  | Water conservation and irrigation                |
| 8  | Information, Communication and<br><br>Technology |
| 9  | Gender studies.                                  |
| 10 | Energy                                           |
| 11 | Indigenous agriculture                           |

Interviews

Curriculum creators' interview material was transcribed and subjected to theme analysis (Creswell, 2018). Using categories including teaching and learning strategies, assessment procedures, gender, ICT, resources, and collaborations, transcripts were manually tagged in Microsoft Word. In keeping with the goal of the study, codes were combined into more general topics. While the product part of the CIPP model looked at perceived student abilities in solving agricultural and climatic concerns, the process dimension recorded instructional methods.

Software and Tools

DELVE software was employed to assist in organising and coding curriculum data. Codes were cross-referenced to ensure reliability, and themes were used to compare the extent to which climate change content was systematically integrated into each programme.

*Conceptual framework*

**Results**

*Curriculum Integration of Climate Change*

Institute A's BSc Agribusiness programme, launched in 2022, was designed to strengthen Ghana's agribusiness sector by equipping students with managerial, extension, and entrepreneurial skills. The curriculum, comprising 53 courses, emphasises marketing, farm economics, and business

planning, but climate change integration is minimal. Only two elective courses Climate Change Economics and Environmental and Sustainable Natural Resource Management explicitly address the issue, and none of the lecturers specialise in climate change. Compared with the FAO Sourcebook on Climate-Smart Agriculture (2013), key areas such as soil and crop productivity, pest management, food security, ICT, energy, gender, and indigenous knowledge are largely absent. While entrepreneurship is strongly represented, it omits sustainability dimensions like eco-labelling, carbon footprinting, and certification systems. As a result, students graduate with financial and managerial skills but lack CSA competencies to address hazards such as droughts, floods, and pest outbreaks. This creates a skills mismatch, threatening the long-term sustainability of Ghana's agricultural transformation if profitability is prioritised over climate resilience.

Similar to this, InstituteB's BTech Sustainable Agriculture program promotes problem-solving techniques and encompasses agricultural, livestock, aquaculture, and agribusiness production. Climate change, however, is not a recognized program goal nor a stand-alone course. Although there is some indirect reference to climate variability in courses like agroecology, animal health, and soil and water management, the material is disjointed and superficial. Only seven of the eleven CSA topics listed in the FAO Sourcebook (2013) are covered in the program; energy conservation, gender, ICT, and indigenous knowledge are left out. Rather of being a top concern, climate change is still viewed as an entrenched or secondary problem. As a result, InstituteB graduates are equipped for traditional farming but lack the adaptability needed to deal with climate change, perpetuating the same disconnect between the demands of a climate-vulnerable agricultural industry and the outputs of higher education.

#### Interview Insights: Developer Perspectives

Meeting with the Head of the Department (HoD) of Bachelor of Technology in Sustainable Agriculture. After several attempts to get a copy of the curriculum, the HoD finally said the curriculum was not ready for public review. However, he explained that the programme was created mainly to highlight climate change. He said agroecology was a course that discussed the 10 elements of agroecology: co-creation and sharing, diversity, synergies, efficiency, recycling, resilience, human and social values, culture and food traditions, responsible governance, and a circular economy. He also stressed the fact that climate change was included in the curriculum. *"It is impossible in today's 21<sup>st</sup> century to design an agricultural programme at this university without including climate change especially in courses that are related to water, soil crop and plants, and animals, which form the basis for agriculture"*.

By word of mouth, the Head of Department emphasised that climate change was integrated into the course outline. He said it included climate change adaptation and mitigation approaches in agriculture and the environment.

The confirmations on climate change integration are further stated in the interview session. On indigenous knowledge, energy conservation, and gender studies, he said no courses treat these topics; however, during lectures, these topics are discussed as they arise. These results from the Head of the Department go against the results found in the curriculum; the emphasises that climate change is integrated into the curriculum. however, the results from the curriculum analysis do not reflect his answers. Gender studies, ICT, energy conservation and indigenous knowledge attested

that it is not given attention in the curriculum as it is not a priority for the program. This affirms that the curriculum is not interdisciplinary and does not offer students with climate change competencies to solve challenges the agricultural sector is facing.

#### Climate Change Integration by CIPP

The CIPP model is employed here to assess the curriculum's context, input, process, and product. Contextually, both curricula are rooted in agriculture and aim to produce skilled labour for industry needs. Developers confirmed that while some challenges are addressed, major deficiencies remain in areas such as climate change, gender, energy conservation, and indigenous knowledge.



Although certain courses touch on the causes and effects of climate change, neither curriculum adequately incorporates adaptation and mitigation strategies. When asked about the relevance of climate content, all eight developers agreed it was essential but insufficiently embedded. As one InstituteB developer explained: *"I will say yes to the integration of climate change. It is important for agriculture, but climate change content has not been incorporated enough. It is key to training students for the current industry and trends."*

This consensus reflects the content analysis: climate change integration is not robust enough to build competencies. Moreover, the FAO Sourcebook (2013) stresses that cross-cutting areas such as gender, indigenous knowledge, and energy conservation are integral to CSA, yet these themes were largely excluded. The developers' perspectives highlight a pressing gap between curriculum design and CSA requirements.

#### Findings from Interview Coded by FAO Sourcebook Themes

Interviews with curriculum developers confirmed that gender studies are not integrated into the curricula, which they described as a shortfall. While they acknowledged its importance, gender was only discussed informally during class sessions rather than as structured content. As one InstituteB developer noted: *"Courses that dwell on gender could be integrated into the curriculum, which is unfortunately not included now. However, it is important. Apart from that, any course that teaches climate change and has something to do with gender, we can integrate as well. Lecturers teach about gender issues when they come up in classes."*

Similarly, indigenous knowledge was not intentionally embedded, though lecturers occasionally touched on it in class discussions. Developers admitted its growing relevance but expressed uncertainty about how it fits within agribusiness curricula. As a InstituteA developer explained: *"Well, in agribusiness, integrating this is a bit difficult because we are not looking at agricultural science that looks at rural farm practices and systems. I am unsure if this can be included as a course, but it can probably be a topic in one of the courses."*

The developers' perspectives on energy conservation were divided. InstituteB recognized its importance and had partially integrated it, while InstituteA did not see a strong link with agribusiness. Five developers agreed it should be included, while three disagreed. One InstituteA's developer stated: *"I am not a specialist in this field. We also cannot include every course in the curriculum. we only included what was directly linked to agribusiness. We deliberated and consulted with regulators such as Environmental Protection Agency and key industry players to draft the curriculum. If it were important to the program, we would have added."* In contrast, InstituteB's developer reflected: *"I am sure we added one or two courses on energy efficiency. We know that the northern women travel miles to cut down trees to get firewood. This is happening before us. How could we forget about it? However, we can do more to address the issue."*

Overall, the interviews reveal that gender, indigenous knowledge, and energy conservation are treated as peripheral rather than integral, despite their centrality to CSA as emphasised by FAO (2013). This reflects a gap between curriculum content and the multidimensional realities of climate change in Ghana.

#### Teaching and Learning Resources

The CIPP model is also applied here to assess inputs and processes, focusing on resource availability and pedagogical approaches. All curriculum developers agreed that teaching and learning resources were inadequate. As one InstituteB developer noted: *"Looking at the numbers currently, we don't have enough resources. We sometimes improvise to meet their needs. Especially internet connectivity."* An InstituteA developer added: *"I find it difficult to teach my three credit hours; the classrooms are not enough. Also, I try to project videos and other materials, but sometimes the projector will malfunction."*

These shortages were seen as a major barrier to effective teaching and learning. Consequently, pedagogy relies heavily on lectures and theory-based instruction, with limited opportunities for

hands-on learning. InstituteA developers highlighted the third-trimester field practicum, which allows students to engage in community-based projects, while InstituteB developers noted industry attachments during the programme. However, both institutions admitted these opportunities were limited and insufficient to provide students with practical CSA competencies.

### Partnerships and Collaboration

The curriculum developers confirmed collaborating with organisations and governments to develop the curriculum. This answers the process aspect of CIPP; the industry players are asked to review the curriculum draft, and their inputs are considered when drafting the curriculum. The curriculum developers were asked to elaborate on other partners' and government organisations' roles. The curriculum developers mentioned Ghana Tertiary Education Council, Centre for Scientific and Industrial Research as the main collaborators and partners. All eight curriculum developers agree that partners play a key role in the teaching and learning process. They also rely on their partners and other industry players to make inputs in their curriculum.

### Curriculum Evaluation

This section addresses the product dimension of the CIPP model, focusing on curriculum evaluation. Developers explained that reviews occur every three to four years, a period they felt was too long given the fast-changing needs of the agricultural sector. As one InstituteB developer stated: *"We apply for curriculum review every three to four years. In my opinion, that is too long. However, GTEC is always available to review the curriculum."* Similarly, a InstituteA developer noted: *"GTEC reviews and approves the curriculum, but the process is difficult. I think the four-year period is too long. Because within these four years trends change and the curriculum might be missing some important issues."*

They added that the strenuous process involved in seeking GTEC approval discourages frequent updates. This delay means curricula may fail to incorporate emerging issues such as climate change, leaving graduates underprepared for current industry challenges.

### Policy Gaps

Interviews revealed recognition of the importance of climate change integration but also identified three major policy gaps. First, there is no standardised guideline for institutions, leaving each to decide what climate change content to include, creating inconsistency. Second, without such guidelines, climate change is often treated as a standalone course rather than a cross-cutting theme, undermining interdisciplinarity. Third, the long review cycle (every 3–4 years) and the strenuous approval process make it difficult to keep curricula updated with emerging issues such as climate change.

Developers acknowledged these gaps, noting that gender, energy conservation, and indigenous knowledge were excluded, and that inadequate resources further constrained delivery. While support from partners and regulators exists, it has not been sufficient to close the gaps. As one curriculum developer put it: *"The curriculum evaluation is done every four years that is the standard. However, an institution can decide to evaluate it on a yearly basis but the curriculum developers opt for the four years only as the processes involved in the evaluation process is cumbersome."*

Overall, the absence of national CSA guidelines, limited interdisciplinarity, and infrequent reviews prevent effective integration of climate change into agricultural curricula.

## Discussions

### Discussion of Findings Using the CIPP Evaluation Framework

With particular goals centered on curriculum content, delivery methods, resource availability, and graduate readiness, this study set out to investigate the degree to which climate change and Climate-Smart Agriculture (CSA) principles are incorporated into agricultural curricula at InstituteB) and the InstituteA. The Context–Input–Process–Product (CIPP) assessment paradigm, which offers a

thorough lens for connecting curriculum design and implementation to expected educational outcomes, is used to organize the findings discussion (Stufflebeam and Zhang, 2017). While preserving consistency across curricular aims, implementation realities, and results, the application of CIPP enables the findings to be methodically analyzed in connection to the study questions and objectives.

### *Context*

Examining whether the curriculum is in line with current agricultural issues, especially climate change, was the initial study goal. The results show that although agriculture and national development aims are contextually entrenched in both InstituteA and InstituteB, climate change is not positioned as a key or cross-cutting concern within their curriculum goals. In line with Ghana's larger vision for economic development, InstituteA's BSc Agribusiness program places a high priority on entrepreneurship, job generation, and company management. However, two elective courses Climate Change Economics and Environmental and Sustainable Natural Resource Management that are not required only partially cover climate change. Similar to this, the focus of InstituteB's BTech Sustainable Agriculture program is on traditional agricultural output; course outlines do not specifically highlight climate change as a program aim.

The first study question on contextual relevance is immediately addressed by these results. Curriculum materials show a discrepancy between institutional aims and formal curriculum design, notwithstanding creators' vocal acknowledgement of the significance of climate change. This discrepancy implies that climate change is viewed as an add-on rather than a fundamental issue. Such a strategy runs counter to regional and international policy frameworks that highlight climate change as a key issue facing agricultural systems, especially in Sub-Saharan Africa (FAO, 2013; IPCC, 2022). Climate adaptation, mitigation, and resilience are identified as fundamental pillars of agricultural education in the FAO Sourcebook on Climate-Smart Agriculture, highlighting the necessity of purposefully designing curriculum around climate realities rather than merely including them.

According to CIPP, the curricula's capacity to adequately address Ghana's climate-vulnerable agriculture sector is compromised by this poor contextual alignment. According to Stufflebeam (2003), future inputs, procedures, and results are likely to be unproductive when educational programs fail to identify and prioritize the most important social issues at the context stage. The findings thus suggest that both institutions lack the contextual basis required for strong CSA integration.

### *Input*

The degree to which CSA-related materials and content are integrated into the curriculum was the subject of the second study goal. When compared to the FAO CSA framework, curriculum analysis showed that both programs' coverage of CSA topics is fragmented and insufficient. Gender, indigenous knowledge, ICT, renewable energy, water management, and food security are some of the major themes that are either completely absent or only partially represented. At InstituteA, entrepreneurship is deeply ingrained, yet sustainability-focused elements like carbon accounting, eco-labeling, and climate certification systems are absent. Resilience components are introduced via agroecology at InstituteB, however they are not consistently connected to measures for climate adaptation or mitigation.

These findings respond directly to the research question on curriculum content adequacy. The absence of interdisciplinary CSA themes suggests that the curricula do not provide students with a holistic understanding of climate-smart agriculture. This is particularly problematic given evidence that effective CSA education requires integration of social, technological, ecological, and economic dimensions (Lipper et al., 2014; UNESCO, 2017). Gender and indigenous knowledge, for example, are recognised as critical to climate adaptation in African agriculture, yet they remain peripheral in both curricula (Jost et al., 2016; Nyantakyi-Frimpong and Bezner Kerr, 2015).

In addition to content gaps, findings from interviews revealed significant deficiencies in teaching and learning resources. Developers from both institutions reported inadequate classroom infrastructure, limited access to functional ICT tools, unreliable internet connectivity, and insufficient instructional materials. These constraints limit the effective delivery of climate-related content and restrict opportunities for experiential learning. From a CIPP input perspective, the inadequacy of both curriculum content and material resources constrains the potential for achieving CSA-related learning objectives. As UNESCO (2015) emphasises, climate change education requires not only relevant content but also supportive learning environments that enable inquiry-based and problem-oriented learning.

### *Process*

The delivery and practical use of climate change material was the third research goal. Results show that both InstituteA and InstituteB's teaching and learning procedures are mostly lecture-based and theory-driven. Opportunities like InstituteB's industrial attachments and InstituteA's third-trimester field practicum are available, but they are narrowly focused and not specifically designed around CSA competences. Students' exposure to climate-smart behaviors is therefore irregular and frequently coincidental.

Disparities between the claims made by developers and the curriculum documentation were also discovered using interview data. Although several developers claimed that topics like gender, energy conservation, indigenous knowledge, and climate change are included in lectures, these topics are not explicitly included in course outlines or learning objectives. Coherence and accountability are weakened by this dependence on casual conversation, which is indicative of a disciplinary rather than interdisciplinary approach to curriculum delivery. Constructive alignment, according to Biggs and Tang (2011), necessitates the explicit linking of instructional activities, assessment techniques, and intended learning outcomes an alignment that is mainly lacking in the curricula under observation.

The efficiency of these relationships is limited by the absence of national CSA curriculum requirements, despite signs of cooperation with research organizations like CSIR and regulatory agencies like the Ghana Tertiary Education Council. This result answers the study question on curriculum development procedures and draws attention to a structural flaw: climate change integration is still uneven and reliant on the initiative of individual lecturers rather than institutional commitment in the absence of a clear policy direction. This compromises the accuracy of curriculum implementation and lowers the possibility of attaining desired CSA outcomes from the perspective of the CIPP process (Stufflebeam and Zhang, 2017).

### *Product*

The last goal of the study evaluated how well the courses prepared graduates to deal with agricultural issues connected to climate change. The results show that although InstituteA and InstituteB graduates may be skilled in traditional agricultural production or agribusiness management, they lack critical CSA abilities like sustainability-oriented innovation, adaptive decision-making, and climate risk assessment.

The cumulative consequences of flaws found at the context, input, and process phases are reflected in this result. Graduates are ill-prepared to deal with climatic shocks including droughts, floods, and pest outbreaks due to a lack of curriculum emphasis on climate change, insufficient transdisciplinary material, theory-heavy teaching, and irregular curriculum review cycles. This directly answers the research question on curriculum effectiveness and confirms a mismatch between higher education outputs and labour market needs in a climate-stressed agricultural sector.

Additionally, creators generally felt that curriculum assessment procedures, which are carried out every three to four years, were too frequently. Such lengthy review cycles impede the integration of new CSA information since climate change and agricultural innovation are continually changing. The literature on higher education has expressed similar worries, highlighting the necessity of

responsive and adaptable curriculum review procedures in sustainability education (Tilbury, 2011; Leal Filho et al., 2018).

From a CIPP product viewpoint, the results imply that the curricula do not completely accomplish their targeted aims of generating climate-responsive agricultural experts. Instead, graduates risk advocating methods that prioritize short-term production or profitability at the price of long-term sustainability, so perpetuating vulnerability within Ghana's agricultural sector.

### *Integrative Interpretation*

When considered collectively, the CIPP study shows that weak contextual prioritization, inadequate CSA inputs, restricted and dispersed delivery procedures, and subpar graduation results impede the integration of climate change into the curriculum at InstituteA and InstituteB. The findings demonstrate that present curricula fall short of the stated study objectives connected to climate-smart agricultural education, despite the fact that both institutions provide significant contributions to the development of agricultural capability.

The results confirm that CSA has to be systematically mainstreamed across curriculum objectives, content, pedagogy, and assessment frameworks. Ghanaian agricultural education runs the risk of falling behind the climate realities it is supposed to address in the absence of national guidelines, improved resources, multidisciplinary integration, and shorter review cycles. According to FAO (2013) and UNESCO (2017), improving CSA integration is necessary to guarantee that graduates are prepared to make meaningful contributions to climate-resilient and sustainable agricultural growth.

## **Conclusions**

This study evaluated the adaptability of the agricultural education programs at Northern Ghana's InstituteA and InstituteB in response to climate change. The study, which was conducted using the CIPP model and the FAO Climate-Smart Agriculture (CSA) Sourcebook (FAO, 2013), found that both organizations' programs do not sufficiently address climate change. Only two elective courses specifically address climate change in InstituteA's BSc Agribusiness program, which is primarily focused on management skills and entrepreneurship. Although InstituteB's BTEch Sustainable Agriculture program offers broad agriculture instruction and some agroecological covering, it lacks clear goals and cross-cutting CSA integration.

Important CSA topics including soil conservation, pest control, food security, ICT, gender, energy conservation, and indigenous knowledge are either completely missing or very briefly included in both curriculum. In contrast to CSA principles, which advocate for integration throughout the agricultural value chain, this shows a disciplinary rather than an interdisciplinary attitude (FAO, 2013; Lipper et al., 2014). Since Ghana's agricultural output is already under danger due to climate shocks including unpredictable rainfall, droughts, floods, and insect outbreaks, graduates gain technical or business skills but lack the adaptability necessary to handle these events (IPCC, 2022; Antwi-Agyei et al., 2017).

The survey also discovered that both schools, which are hampered by a lack of classroom space, internet access, and field equipment, mostly rely on lecture-based instruction. Although InstituteB offers industry attachments and InstituteA offers a trimester field practicum, both programs are insufficient to provide the hands-on, problem-solving learning that CSA demands (Pretty et al., 2018). Inconsistencies between declared aims and curriculum content were also discovered during interviews with curriculum developers; for example, whereas climate change is frequently claimed to be included into course outlines, this is rarely evident. This disparity highlights how rigidly curricula are designed and delivered.

Institutional and policy constraints exacerbate these deficiencies. Different institutions have taken different methods to CSA integration as a result of the lack of national rules. Interdisciplinarity and comprehensive training are undermined by the common treatment of climate change as a stand-alone subject rather than a cross-cutting issue (UNESCO, 2021). The inability of institutions to swiftly



adjust to changing climate realities is further hampered by the infrequent curriculum reviews, which are carried out every three to four years and leave programs out of date and out of step with industry and community demands (World Bank, 2020).

The study concludes by showing that Northern Ghana's agricultural education is not adaptable enough to the changing environment. The InstituteA and InstituteB's curricula are still disjointed, too theoretical, and unrelated to the complex problems that climate variability presents. Cross-cutting issues including gender, ICT, indigenous knowledge, and energy conservation must be methodically included into basic courses in order to mainstream CSA and increase resilience. Higher education institutions must be equipped to create graduates who can lead sustainable agricultural transformation, which requires national rules, more funding, and shorter review cycles. Agriculture education in Northern Ghana runs the danger of training graduates for the past rather than preparing them to address the urgent climatic concerns of the future in the absence of these reforms (FAO, 2013; IPCC, 2022; UNESCO, 2021).

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## References

- Agovino, M., Casaccia, M., Ciommi, M., Ferrara, M., and Marchesano, K. 2019. Agriculture, climate change and sustainability: The case of EU-28. *Ecological Indicators*, 105, 525–543. <https://doi.org/10.1016/j.ecolind.2018.03.050>
- Ali, G. 2018. Climate change and associated spatial heterogeneity of Pakistan: Empirical evidence using multidisciplinary approach. *Science of the Total Environment*, 634, 95–108. <https://doi.org/10.1016/j.scitotenv.2018.03.297>
- Anderson, A. 2012. Climate change education for mitigation and adaptation. *Journal of Education for Sustainable Development*, 6(2), 191–206. <https://doi.org/10.1177/0973408212475199>
- Anderson, R., Bayer, P. E., and Edwards, D. 2020. Climate change and the need for agricultural adaptation. *Current Opinion in Plant Biology*, 56, 197–202. <https://doi.org/10.1016/j.pbi.2019.12.006>
- Anang, B. T., Bäckman, S., and Sipiläinen, T. 2020. Adoption and income effects of agricultural extension in northern Ghana. *Scientific African*, 7, e00219. <https://doi.org/10.1016/j.sciaf.2019.e00219>
- Antwi-Agyei, P., and Nyantakyi-Frimpong, H. 2021. Evidence of climate change coping and adaptation practices by smallholder farmers in northern Ghana. *Sustainability*, 13(3), 1308. <https://doi.org/10.3390/su13031308>

- Antwi-Agyei, P., and Stringer, L. C. 2021. Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. *Climate Risk Management*, 32, 100304. <https://doi.org/10.1016/j.crm.2021.100304>
- Boateng, C. A. 2015. Tertiary institutions in Ghana curriculum coverage on climate change: Implications for climate change awareness. *Journal of Education and Practice*, 6(12), 99–106.
- Braun, V., and Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Brooks, S., and Loevinsohn, M. 2011. Shaping agricultural innovation systems responsive to food insecurity and climate change. *Natural Resources Forum*, 35(3), 185–200. <https://doi.org/10.1111/j.1477-8947.2011.01396.x>
- Creswell, J. W. 2018. *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- Dooley, K. E., and Roberts, T. G. 2020. Agricultural education and extension curriculum innovation: The nexus of climate change, food security, and community resilience. *The Journal of Agricultural Education and Extension*, 26(1), 1–3. <https://doi.org/10.1080/1389224X.2019.1703507>
- Food and Agriculture Organization. 2017. *Climate-smart agriculture sourcebook*. FAO.
- Food and Agriculture Organization. 2019. *Agricultural extension manual for extension workers*. FAO.
- Goni, F. A., Chofreh, A. G., Mukhtar, M., Sahran, S., Shukor, S. A., and Klemeš, J. J. 2017. Strategic alignment between sustainability and information systems: A case analysis in Malaysian public higher education institutions. *Journal of Cleaner Production*, 168, 263–270. <https://doi.org/10.1016/j.jclepro.2017.08.208>
- Hanadayani, I. P. 2021. Science of climate change in agricultural courses. *IOP Conference Series: Earth and Environmental Science*, 810(1), 012029. <https://doi.org/10.1088/1755-1315/810/1/012029>
- Leal Filho, W., and Hemstock, S. L. 2019. Climate change education: An overview of international trends and the need for action. In *Climate change and the role of education* (pp. 1–17). Springer.
- Lempert, R. J., and Groves, D. G. 2010. Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American west. *Technological Forecasting and Social Change*, 77(6), 960–974. <https://doi.org/10.1016/j.techfore.2010.04.007>
- Menon, S., and Suresh, M. 2021. Factors influencing organizational agility in higher education. *Benchmarking: An International Journal*, 28(1), 307–332. <https://doi.org/10.1108/BIJ-04-2020-0184>
- Menon, S., Suresh, M., and Raman, R. R. 2022. Curriculum agility in higher education. *Journal of Further and Higher Education*, 46(9), 1175–1194. <https://doi.org/10.1080/0309877X.2022.2041598>
- Pavlova, M., and Chen, C. S. 2019. Facilitating the development of students' generic green skills in TVET: An ESD pedagogical model. *TVET@Asia*, 12, 1–21.
- Partey, S. T., Zougmore, R. B., Ouédraogo, M., and Campbell, B. M. 2018. Developing climate-smart agriculture to face climate variability in West Africa: Challenges and lessons learned. *Journal of Cleaner Production*, 187, 285–295. <https://doi.org/10.1016/j.jclepro.2018.03.199>
- Reimers, F. M. 2021. *Education and climate change: The role of universities*. Springer.
- Reid, A. 2019. Climate change education and research: Possibilities and potentials versus problems and perils? *Environmental Education Research*, 25(6), 767–790. <https://doi.org/10.1080/13504622.2019.1664075>
- Saeed, I., Khan, J., Zada, M., Ullah, R., Vega-Muñoz, A., and Contreras-Barraza, N. 2022. Towards examining the link between workplace spirituality and workforce agility: Exploring higher educational institutions. *Psychology Research and Behavior Management*, 15, 31–49. <https://doi.org/10.2147/PRBM.S343653>
- Şahin, A., Kumar, A., and Altun, B. 2016. The need for a pedagogical approach to agricultural education. *Journal of Agricultural Faculty of Uludag University*, 30, 17–23.
- Stufflebeam, D. L., and Zhang, G. 2017. *The CIPP evaluation model: How to evaluate for improvement and accountability*. Guilford Publications.
- UNESCO. 2013. *Education sector technical notes on climate change education*. <https://unesdoc.unesco.org/ark:/48223/pf0000222117>
- UNESCO. 2015. *Shaping the future we want: Education for sustainable development*. UNESCO.
- UNESCO. 2018. *Global action programme on education for sustainable development*. <https://en.unesco.org/gap>
- UNESCO. 2020. *Education for sustainable development: A roadmap*. <https://unesdoc.unesco.org/ark:/48223/pf0000374802>

- UNESCO. 2022. *Youth demand for quality climate change education*. <https://unesdoc.unesco.org/ark:/48223/pf0000383615>
- UNFCCC. 1992. *United Nations Framework Convention on Climate Change*. <https://unfccc.int/resource/docs/convkp/conveng.pdf>
- UNFCCC. 2014. *Education day at COP20: Lima ministerial declaration*. <https://unfccc.int>
- UNFCCC. 2021. *Education day at COP26: Stepping up climate education*. <https://unfccc.int>
- United Nations. 2015. *Paris agreement*. <https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>
- Verchot, L. V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., ... and Palm, C. 2007. Climate change: Linking adaptation and mitigation through agroforestry. *Mitigation and Adaptation Strategies for Global Change*, 12(5), 901–918. <https://doi.org/10.1007/s11027-007-9105-6>

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