

Innovative Teaching of Cocoa for the Future: Using Indigenous Knowledge to Build Climate-Resilient Cocoa Education for Ghanaian Youth

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ABSTRACT

This short communication was developed from a presentation by the author at the 2026 Cocoa Leadership Bootcamp jointly organized by Earth Care Ghana in partnership with Real-Ento, Kasetsart University in Thailand, Rights of Nature Ghana Movement, and the Forestry Research Institute of Ghana (FORIG). It describes the current problems facing Ghana's cocoa sector, which comprises an aging workforce, youth reluctance to engage in the sector, and the use of Western models for teaching that ignore indigenous knowledge for cocoa production. It discusses the need to adopt a radical approach of using indigenous knowledge in promoting a climate-resilient cocoa education targeted at Ghanaian youth. It highlights the need to consciously teach Ghanaian youth about traditional cocoa production and its valid scientific procedures. It positions indigenous knowledge in cocoa production as a window in understanding the lived experiences of cocoa farmers and as a step in understanding the unique micro-climate conditions of cocoa communities. It refutes the thought that indigenous knowledge stands in a binary position to modern science and calls for a synergistic approach to Ghana's cocoa production by building on the strengths of traditional and modern cocoa production techniques. It contends that Ghanaian youth can be attracted to the cocoa sector if their education factors in indigenous cocoa production techniques, migrates from theoretical overload, and focuses on discovery learning that prioritizes hands-on activities which simulate the agrarian situation in the real world. It calls for the adoption of a teacher-as-farmer community-based model, field-based teaching, a tech-tradition hybrid innovations model, and a cross-sector framework as the surest path in building a climate-resilient cocoa education for Ghana's youth.

Keywords: Agribusiness; cocoa production; cocoa farmers; Ghanaian youth; indigenous knowledge; experiential teaching; school demonstration farms, student-Managed mini farms



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INTRODUCTION

Ghana is ranked the third largest producer and second exporter of cocoa, making it a big player in the global cocoa industry. The cocoa value chain is an economic titan as it contributes 8% GDP to Ghana's economy, offering revenue of over 2 billion US dollars annually. Cocoa is the commercial ingenuity and lifeblood of Ghana. The field offers employment avenues and livelihood support to over 6.3 million citizens of the country. While the industry looks very promising on the surface due to its position on the global map and significant contributions to Ghana's economy, the system that supports it suffers from very dire challenges, which, if not addressed urgently, could potentially lead to a collapse of this thriving industry.

The first foundational problem faced by Ghana's cocoa industry is the workforce, which is literally aging out. The average cocoa farmer is between 50 and 55 years (Löwe, 2017). The Oxford Institute of Population Ageing in their report titled 'Cocoa and Continuity: Ageing in the Ghanaian Cocoa Sector' published on June 5, 2024 hinted that the average age of cocoa farmers in Ghana is around 55 years while over a third of Ghanaians are youth aged between 15-35 and the average cocoa farmer is around 55 years old with a life expectancy between 55 and 60 years. Ordinarily, as it happens in other industries, it is expected that the younger generation would offer the lifeblood to the industry while the aging workforce exits. Yet, the haunting reality is that most of the Ghanaian youth are running away from the industry. This demographic time bomb threatens the sustainability of the industry. There is an inter-generational disconnect between the elderly class and the youth of today regarding the cocoa industry. The exodus of the youth from pursuing careers in the cocoa industry is driven by negative perceptions of the cocoa industry as strenuous, difficult, low-paid, and less prestigious. The notion held by the youth is that tech-driven jobs or careers are stress-free, prestigious, and well-paid. To get them to return to the cocoa industry, there is a need to reorient them on how technology could be leveraged to harness the potential in cocoa production.

To encourage the youth to pursue careers in the field of agriculture, where the cocoa industry exists, educational institutions in Ghana have adopted the easy entry approach. They have lowered the entry requirements, such as the aggregate for admission in any agriculture-related program. For instance, the Kwame Nkrumah University of Science and Technology has been in existence for more than two decades, setting an aggregate of 20 as the limit for admission into a program in Agriculture, while the other Science-related programs are often in single aggregate grades. That notwithstanding, there is a high attrition rate of 50% of the students leaving the industry after their graduate studies. The agriculture program only becomes an alternative route to pursue other careers or programs in other fields.

The root cause of this problem has to do with the inability of the education system to foster the interests of the students for careers in agriculture, including cocoa production. The curriculum for teaching students in the field of agriculture is not able to develop the interests of the students to remain in the field. The curriculum is Western-dominated, built on Western pedagogical models that do not reflect the local contexts in Ghana. There is a disconnect between theory and practice in cocoa education (Yiridomoh, Bonye, & Derbile, 2022). More so, the curriculum and teaching pedagogies ignore indigenous knowledge and traditional cocoa practices in general. This is due to the long-standing ideology that indigenous knowledge rests in the past and stands in binary opposition to modern scientific knowledge. A classic example is evident in most extension programs run for cocoa farmers and other forms of training schools and academies set up to train the youth in cocoa production in Ghana. Attipoe et al. (2021) noted in their study that the main reason behind the reluctance of older farmers to participate in some extension programs is that. They noted that some extension officers fail to incorporate traditional cocoa production processes in their training programs. They accused the extension officers of failing to familiarize themselves with their unique farming environments. More so, these extension officers teach modern ways of cocoa production that do not align with local realities in cocoa production in their communities and microclimates. This study aims to examine how repositioning cocoa education in Ghana through a pedagogy of practice can address the disconnect between theory and practice, enhance youth engagement, and improve the sustainability of the cocoa sector.

LITERATURE REVIEW

Validation and utilization of Indigenous knowledge in cocoa education in Ghana

Indigenous knowledge is a validated empirical science (Berkes, 2012; Adom, 2021). Understandably, most of the indigenous knowledge and practices have not been subjected to scientific validation. Yet, they hold promising insights that are science-driven when thoroughly studied. Indigenous knowledge is a valid form of knowledge that is alive and very effective in its application today (Asante et al., 2025). It is culturally grounded and offers place-based experiential understandings that have evolved through long-term engagements with the environment and validated by generations of cocoa farmers (Demssie et al., 2020). Indigenous knowledge is erroneously viewed as standing in a binary position with modern science. However, it is evident today that whenever indigenous knowledge is actively synergized with scientific knowledge, it results in even richer and more sustainable

solutions (Adom, 2018; Nigussie et al., 2020). I want to illustrate why indigenous knowledge cannot be left out in any youth-driven education on cocoa production. A key example I want to highlight is how indigenous knowledge is, at times, more beneficial than modern science, and then set the tone for an integration of both streams of knowledge. A classic example is when the full sun system is compared to the traditional shade system in cocoa production. While the full sun system, which is promoted by modern science, increases the yield of cocoa in the short term, it is wrought with many detrimental effects. First, because the cocoa trees are exposed to full sun radiation, they are vulnerable to heat stress. As a result, there is a high loss of moisture. The only source of moisture intake is from the soil, which is not able to sustain the cocoa trees, leaving the soil in cracks. To replenish the moisture lost, there is a need to invest heavily in the provision of an irrigation system to constantly support the cocoa trees with water. Also, the full sun system exposes the cocoa trees to insect infestation, and there is a high potential of insect infestation, which results in several black pods (Wanger et al., 2014).

Hence, there is a need to constantly spray the cocoa trees with chemicals, which in the long term is detrimental to the loss of other ecological beings in the broader ecosystem. It is estimated that cocoa trees raised using the full sun system have a life expectancy rate of not more than 15 years when managed well using the cost-intensive measures previously discussed. On the other hand, the traditional shade system is meritoriously beneficial to the cocoa trees and biodiversity in general. Cocoa grows well as an undercover tree. Hence, traditionally in Ghana, cocoa is grown alongside native trees that act as a canopy to provide shade, regulating the right measure of humidity and sunlight the tree needs (Wanger et al., 2014). This agroforestry strategy helps in the buffering of moisture, which stabilizes cocoa yields while enhancing the soil structure to promote water retention. Aside from this, the cocoa trees are naturally adaptive to climate change, with a life expectancy pegged between 35 years and more than 50 years, with a sustainable yield. Moreover, the traditional shade system enhances pollination while protecting the lives of other ecological beings in the ecosystem (Wanger et al., 2014). While modern cocoa production depends on monoculture, traditional cocoa production promotes mixed cropping (Clough et al., 2011). Staple crops such as cassava, plantain, and cocoyam have traditionally been planted alongside cocoa. This benefits the cocoa farmer in that s/he would have a means of sustenance or food security as s/he waits for the cocoa to mature. The mixed cropping farming technique enriches the soil (Lithourgidis et al., 2011). In terms of pest control management, cocoa farmers have traditionally used cues from wind patterns, flowering cues, insect behaviour, and crop conditions in managing pests. This approach is less costly and beneficial to soil and biodiversity.

Indigenous methods mitigate risk through biological monitoring rather than calendar-based chemical spraying (Pretty & Bharucha, 2015). The above examples highlight the importance of traditional cocoa production and validate the deep scientific mechanisms behind indigenous knowledge. Hence, teaching and learning in cocoa production should incorporate these traditional cocoa production techniques.

From lecture theatre to the field: Ghana's cocoa education as a pedagogy of practice

The World Bank (2022), in its report *Strengthening Higher Agricultural Education in Africa*, identifies a persistent structural weakness in agricultural education systems across the continent: the continued reliance on externally derived and theoretically oriented curricula. These models often privilege classroom-based instruction over experiential, field-based learning, thereby limiting graduates' ability to engage effectively with local agricultural systems. This misalignment is particularly pronounced in smallholder-dominated sectors such as cocoa production in Ghana, where farming practices are deeply embedded in socio-cultural contexts and experiential knowledge systems. As noted by Yiridomoh, Bonye, and Derbile (2022), formal agricultural education frequently overlooks farmers' lived realities, resulting in a disconnect between institutional knowledge and on-the-ground practice.

To address this gap, there is a need to conceptualize cocoa education as pedagogy of practice an approach that prioritizes experiential, participatory, and context-specific learning. Grounded in experiential learning theory (Kolb, 1984), this paradigm emphasizes learning through concrete experience, reflective observation, active experimentation, and iterative knowledge construction. Within this framework, the farm becomes a primary site of learning, transforming agricultural education from abstract instruction into a process of situated practice.

The integration of structured experiential learning platforms such as school demonstration plots, student-managed mini-farms, and farmer field schools has been widely recognized as critical for enhancing practical competencies in agriculture (Davis et al., 2012). These platforms simulate real-world farming conditions and enable students to engage in trial-and-error learning, decision-making under uncertainty, and the management of agricultural risks. By participating in the full cycle of production activities, students develop not only technical skills but also entrepreneurial capacities, including cost management, productivity optimization, and market-oriented thinking. Such competencies are essential for sustainable agribusiness engagement and rural livelihood improvement (Maziku & Mwambes, 2026). Furthermore, cocoa education must adopt a holistic value chain perspective. Rather than focusing narrowly on primary production, training programmes should encompass the entire cocoa value chain from land preparation,

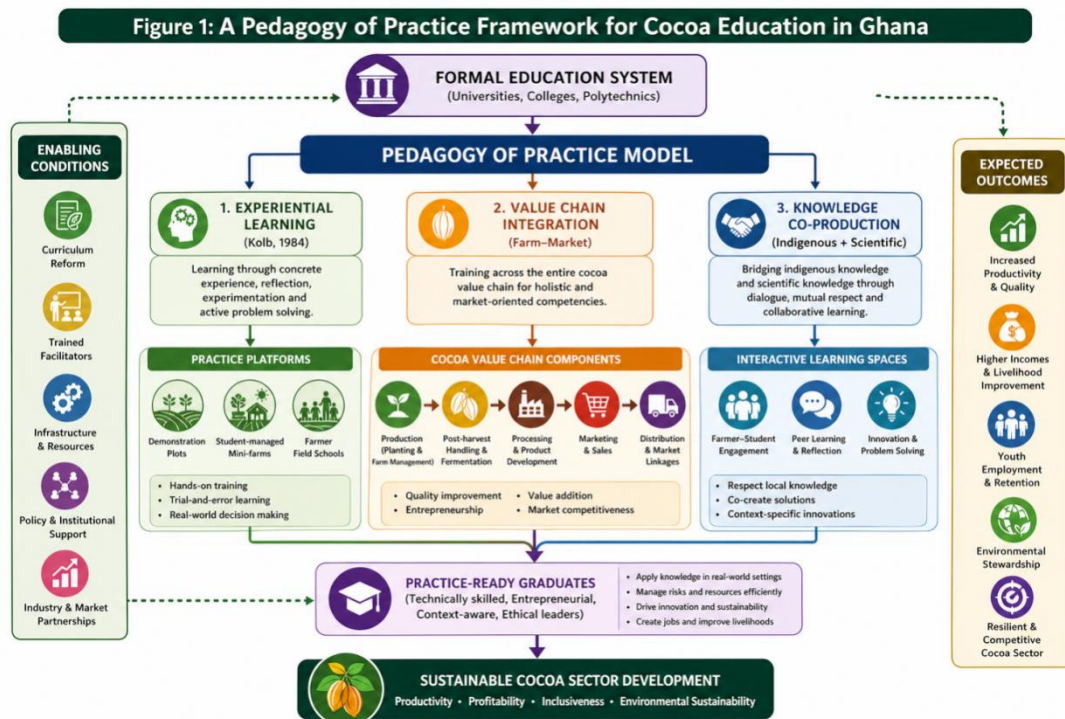


Figure 1: Pedagogy of Practice Framework for Cocoa Education in Ghana.

planting, and crop management to post-harvest handling, processing, marketing, and distribution. This integrated approach reflects contemporary understandings of agricultural commercialization and value addition (López et al., 2024; Lescuyer, 2026), while also aligning with broader sustainable development frameworks that emphasize economic diversification and resilience in rural economies (Maniatis & Jeffery, 2026).

Equally important is the integration of indigenous knowledge systems with scientific agricultural knowledge. In many West African contexts, local farming practices are informed by generations of accumulated experiential knowledge, which often complements formal scientific approaches. However, tensions between these knowledge systems can hinder effective knowledge transfer and adoption (Ayeni, Aborisade, & Soneye, 2026). Pedagogy of practice provides a pathway for bridging this divide by creating interactive learning environments where students, farmers, and extension agents co-produce knowledge. Such hybridized learning models enhance contextual relevance, promote innovation, and support culturally grounded agricultural practices (Figure 1).

Ultimately, repositioning cocoa education in Ghana as a pedagogy of practice represents a transformative shift toward more responsive and impactful agricultural training systems. By embedding experiential learning, value chain integration, and knowledge pluralism into curricula, agricultural institutions can produce graduates

who are technically proficient, socially attuned, and economically adaptive. This transformation is essential for strengthening the resilience and sustainability of Ghana's cocoa sector within an evolving global agricultural landscape (Lomotey, 2026).

The farmer-as-teacher community-based model

Master farmers possess extensive experiential knowledge in cocoa production, accumulated through decades of continuous farm management, adaptive learning, and iterative experimentation (David et al., 2006; David & Asamoah, 2011). Through this long-term engagement, they have refined context-specific production techniques, particularly within traditional cocoa farming systems, while also developing the capacity to integrate indigenous practices with modern agronomic approaches to create hybrid systems that are both locally relevant and technically efficient (Baah, 2007; Fred et al., 2022; Rayuddin et al., 2021; Acheampong et al., 2023). These farmers have not only mastered traditional methods such as shade management, pest control, and mixed cropping, but have also learned how to synergise these practices with contemporary production processes through years of practical observation and experimentation. Within this context, the farmer-as-teacher community-based model represents a pedagogically innovative and transformative approach that advocates for the systematic inclusion of

experienced farmers as co-educators in formal academic institutions. By inviting master farmers as guest lecturers, educational systems can facilitate the transfer of practical, experiential knowledge to students, thereby addressing critical gaps in existing cocoa curricula that often marginalise or exclude indigenous knowledge systems (Pamphilon et al., 2022; Anlimachie et al., 2025; Baah, 2007; David et al., 2006). This integration ensures that students are exposed not only to theoretical frameworks but also to real-world production insights that reflect the complexities of cocoa farming. Importantly, the implementation of this model must be guided by principles of inclusivity and equity. Participation should not be limited to older male farmers but must intentionally include older female farmers, whose contributions to cocoa production particularly in Ghana have historically been significant yet under-recognised due to entrenched cultural norms that marginalise women in public and professional discourse (Anlimachie et al., 2025; Anyidoho et al., 2012; Fred et al., 2022). Recognising and incorporating the knowledge of these women is both a matter of social justice and a strategic necessity for building comprehensive and representative agricultural knowledge systems.

Furthermore, the model reinforces culturally grounded notions of intergenerational knowledge transfer and stewardship. Elderly farmers often perceive the sharing of knowledge as an ancestral duty, rooted in the responsibility to prepare younger generations to sustainably manage land and agricultural resources (Pamphilon et al., 2022). Formalising this process within educational structures strengthens cultural continuity while enhancing agricultural resilience and sustainability (Rayuddin et al., 2021; Pamphilon et al., 2022).

The integration of farmer-led experiential knowledge with formal academic instruction ultimately creates a holistic learning framework. While lecturers provide theoretical foundations such as the chemistry of soil nutrients experienced farmers contribute practical diagnostic skills, including the identification of nutrient deficiencies through observable plant characteristics such as leaf coloration, flowering patterns, and root development (David et al., 2006; Acheampong et al., 2023). This complementary approach bridges the persistent gap between theory and practice, equipping students with both conceptual understanding and applied competencies.

Overall, the farmer-as-teacher community-based model offers a robust pathway for advancing cocoa education by embedding experiential, indigenous, and context-responsive knowledge within formal learning systems. Such integration not only enhances educational outcomes but also contributes to broader objectives of sustainability, inclusivity, competitiveness, and long-term resilience within cocoa production systems (Rayuddin et al., 2021; Pamphilon et al., 2022; Executive Committee, 2025; Verona, 2025; Rivera-López et al., 2024).

Hybrid innovation model for Ghana's cocoa production: Traditional meets technology

The growing digital orientation of Ghanaian youth presents a strategic opportunity to transform cocoa production education through a hybrid innovation model that integrates indigenous knowledge systems with advanced technological tools. Cocoa remains central to Ghana's socio-economic development, yet its future is shaped by intersecting challenges related to climate change, sustainability pressures, global pricing systems, and value chain restructuring (Akyeampong et al., 2025; Lezziero, 2023; Musselli et al., 2025; Konar et al., 2026). Addressing these complexities requires a new generation of technologically skilled and climate-aware farmers equipped through innovative educational frameworks.

Educational technologies including mobile applications, online learning platforms, simulation tools, and gamified systems offer significant potential to enhance agricultural training beyond traditional classrooms. These tools enable experiential learning where students can simulate real-life cocoa farming scenarios such as pest outbreaks, soil nutrient deficiencies, yield variability, and climate shocks. Such approaches complement field-based and discovery learning methods, ensuring a holistic understanding of cocoa production systems while strengthening adaptive capacity under changing climatic conditions (Kolapo et al., 2025; Tahiru et al., 2026). A core pillar of this hybrid model is the systematic documentation and digitization of indigenous cocoa farming knowledge. Traditional practices such as shade management, agroforestry systems, and mixed cropping have long supported ecological balance, yield stability, and resilience in cocoa landscapes (Mensah et al., 2024; Gockowski & Sonwa, 2011; Kroeger et al., 2017). Digitizing these practices into accessible formats including local-language audio archives, image repositories, and interactive knowledge platforms ensures their preservation and integration into modern learning systems (Akyeampong et al., 2025; Lezziero, 2023). This aligns with broader sustainability transitions and knowledge co-production frameworks identified in Ghana's environmental research landscape (Der Tambile et al., 2026). Student-centered, project-based learning is essential to operationalizing this hybrid framework. Ghanaian youth can be engaged in developing innovative solutions such as decision-support mobile applications, participatory Geographic Information Systems (GIS), and digital farm management tools. Additionally, forecasting models developed by students can combine indigenous ecological indicators such as plant phenology, insect behavior, and soil conditions with statistical and predictive models for cocoa production forecasting (Quartey-Papafio et al., 2021; Tahiru et al., 2026). These innovations strengthen localized climate intelligence and improve farm-level decision-making. Artificial intelligence (AI) is a transformative component of this model.

AI-driven systems enable predictive analytics, disease detection, yield forecasting, and real-time farm monitoring, thereby enhancing efficiency across the cocoa value chain (Senthil & Janve, 2025). Integrating AI into cocoa education fosters innovation ecosystems where students can develop smart agricultural solutions. This is particularly relevant for technologies such as artificial hand pollination, where productivity gains are strongly influenced by access to credit, training, and institutional support (Adams et al., 2025; Boansi et al., 2024). Moreover, socio-economic factors shaping technology adoption such as farmer behavior, incentives, and institutional frameworks must be incorporated into training programs (Folmer, 2025).

The hybrid innovation model is further strengthened by enabling economic and institutional mechanisms. Access to finance, contract farming arrangements, and inclusive agribusiness models play a critical role in scaling innovations and supporting youth participation in cocoa production (Wongnaa et al., 2026; Musselli et al., 2025). Circular economy approaches including cocoa waste valorization and resource efficiency also offer pathways for sustainability and income diversification (Afedzi et al., 2026; Agbefu et al., 2025). In addition, digital innovations such as traceability systems and digital product passports enhance transparency, regulatory compliance, and market access within global cocoa supply chains (Fernando et al., 2026).

At the systems level, this model aligns with broader strategies for sustainable intensification, climate-smart agriculture, and resilient supply chains. It supports the development of cocoa systems capable of withstanding environmental shocks while maintaining productivity and livelihoods (Kolapo et al., 2025; Merino-Gaibor et al., 2026). Furthermore, strengthening agricultural transformation pathways in Africa requires integrating innovation, policy support, and capacity building, as highlighted in broader continental development frameworks (Oduola, 2021). Importantly, future-oriented cocoa education must also incorporate crop improvement and resilience-focused breeding strategies to address extreme climate conditions. Developing and deploying climate-resilient cocoa varieties will be essential for sustaining production under increasing environmental stress, making crop science and biotechnology critical components of youth training programs (Albertsen et al., 2026).

The convergence of indigenous knowledge and modern technology provides a powerful pathway for transforming Ghana's cocoa sector. This hybrid innovation model enhances climate resilience, promotes sustainability, and equips youth with the technical, digital, and entrepreneurial skills required to thrive in a rapidly evolving agricultural landscape. By embedding innovation within education and aligning it with socio-economic and environmental realities, Ghana can secure the long-term viability and global competitiveness of its cocoa industry

(Akyeampong et al., 2025; Folmer, 2025; Lezziero, 2023).

Cross-sector framework: An enabler for climate-resilient cocoa education for Ghanaian youth

Institutional support and structural collaboration across multiple sectors are essential for advancing an indigenous knowledge-driven, climate-resilient cocoa education system for Ghanaian youth. Cocoa production remains central to Ghana's rural economy and livelihoods, yet it is increasingly threatened by climate variability, deforestation pressures, and evolving global sustainability requirements (Maziku & Mwambes, 2026; Martey et al., 2025; Verona, 2025). Addressing these challenges requires a coordinated, cross-sector framework that integrates education, policy, technology, and local knowledge systems.

The collaboration between the Ministry of Education and COCOBOD is particularly critical in driving curriculum reforms that embed indigenous knowledge alongside modern scientific cocoa production techniques. Integrating such knowledge into Senior High Schools (SHS), Technical and Vocational Education and Training (TVET) institutions, and tertiary agricultural programs can enhance youth capacity to adopt climate-smart and sustainable farming practices (Lindblad, 2018; Aneani et al., 2012). These reforms should align with broader national development strategies aimed at transforming Ghana's agricultural sector and strengthening resilience. Extension services play a pivotal role in bridging knowledge systems. Extension officers must be equipped with both scientific expertise and a deep understanding of local microclimates and traditional farming practices. Evidence suggests that the adoption of sustainable cocoa practices such as agroforestry, integrated pest management, and soil conservation is significantly influenced by access to extension services and localized knowledge dissemination (Martey et al., 2025; Attipoe et al., 2021). Furthermore, climate adaptation strategies, including income diversification, crop insurance uptake, and improved farm management practices, depend heavily on effective extension support (Amfo & Ali, 2020; Agbenyo et al., 2022; Danso-Abbeam et al., 2014).

Non-governmental organizations (NGOs) and the private sector are equally important actors within this framework. They can support educational institutions and government agencies by providing digital tools, capacity-building programs, mentorship, and internship opportunities. The integration of digital agriculture and precision farming technologies, including climate-smart innovations and circular economy approaches, has been shown to improve productivity and resilience in Ghana's agricultural systems (Agbefu et al., 2025; Frimpong et al., 2026; Baffour-Ata et al., 2026). Additionally, emerging adaptation strategies such as solar-powered irrigation services highlight the importance of technological

innovation in enhancing climate resilience among cocoa farmers (Agyemang et al., 2026). A well-coordinated cross-sector approach also addresses structural barriers that hinder sustainable cocoa production, including limited access to finance, insecure land tenure, and weak institutional coordination (Martey et al., 2025). Strengthening collaboration among stakeholders government agencies, research institutions, private sector actors, and farmer organizations can facilitate the scaling of bundled innovations and promote inclusive participation, particularly among youth and women. Moreover, improving cocoa education through such a framework contributes to broader socio-economic outcomes, including increased household income, improved standards of living, and enhanced livelihood security among cocoa farmers (Schmid et al., n.d.; Owusu & Frimpong, 2014; Asamoah et al., 2013; Ingham, 1973). By embedding indigenous knowledge within formal education systems and aligning it with contemporary sustainability practices, Ghana can foster a new generation of skilled, climate-aware cocoa farmers.

Conclusion

This short communication has underscored the relevance of tactfully using innovative teaching approaches in ensuring climate-resilient cocoa production among Ghanaian youth. This innovative teaching approach synergises indigenous knowledge in cocoa production with modern scientific cocoa production, leveraging on educational technologies. During teaching and learning sessions on cocoa production, educators must explain the science behind traditional cocoa production and management techniques to validate indigenous knowledge. To assist in this, the farmer-as-teacher community-based model should be deployed to allow experienced farmers to practically apply the theoretical concepts taught students while exposing them to the contextual issues in the agrarian reality of cocoa production. Gaming and simulation tools should be heavily utilized, aside from the field approaches such as school demonstration plots, student-managed mini farms, and farmer field schools. These digital tools must provide immersive experiences for students to develop emotional connections to cocoa production as a career path. Projects for students could explore how technology could be leveraged in developing helpful digital apps that combine scientific data with indigenous knowledge. When these innovative teaching approaches are implemented, Ghana could have its younger generation return to the cocoa production sector.

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