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Developing Participatory Agro–Climate Services: A TVET Farming Curriculum proposal

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Abstract

Resilience to climate variability requires education and training for frontline workers such as farmers. Despite advances in weather prediction tools, farmers often lack awareness and skills to apply this information. Human resource constraints in agricultural extension and meteorological services highlight the potential of Technical and Vocational Education and Training (TVET) institutions as climate outreach hubs. This paper proposes the Jamaican Climate Information Service Training Vocational Education and Training (CISTVET) curriculum, developed with input from 493 stakeholders across five farming communities. It addresses farmers' needs for simpler communication, accessible media (TV/radio), and priority information (including rainfall, lunar cycles, and pest data). Synergies, such as community-based flood early warnings in Bog Walk, enhance adaptation. TVET institutions can act as Climate Information Service (CIS) access points for underserved farmers, fostering innovation and bridging gaps. This study integrates Jamaican and global insights to advance sustainable, climate-resilient agriculture locally and beyond.

Keywords: Climate Information Services, agriculture, sustainability, technology, TVET

Introduction

Small Island Developing States (SIDS) stand at the frontline of multiple exposure to extreme weather events due to increased climate variability and simultaneous socio–economic vulnerability (O'Brien & Leichenko, 2000; Thorpe & Figge, 2018). Climate projections for the Caribbean are of special concern, given their historical economic fragility, which renders the region more vulnerable to the projected magnitude of expected warming and drying of up to 15% from pre–industrial levels by the end of the 21st century (D. W. Gamble et al., 2017; Hoegh–Guldberg et al., 2019; Taylor et al., 2018). The resilience of Small Island Developing States to these projections requires adequate and effective education and training for the populace, especially climate frontline workers such as farmers, who face the brunt of these impacts (S. Buckland & D. Campbell, 2021; Buckland & Campbell, 2022).

While local climate scientists have made efforts to improve industry–relevant outreach through the launch of various CIS projects that make recommendations for farmer planning based on seasonal forecasts in Jamaica, previous studies have indicated that there remains a widespread lack of awareness, access, and know–how among farmers at the community level to effectively apply this information (Buckland, 2021; S. Buckland & D. Campbell, 2021; Buckland & Campbell, 2022; Buckland, 2015, 2020; Farrell & Trotman, 2013; Mahon et al., 2018; Vogel et

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al., 2017). With human resource constraints of agricultural extension agents and meteorological office staff, installing climate outreach and training hubs in Technical and Vocational Education and Training Institutions (TVET) holds great potential to revolutionize climate communication within farming communities, given the community trust that already exists within these institutions. Considering these gaps, this paper presents a preliminary proposal of curriculum topics for a Jamaican Climate Information Service Technical Vocational Education and Training (CISTVET) programme. This adds value to the existing discourse as it incorporates feedback from both the institutional level and farmers regarding barriers and opportunities affecting their awareness, access, and use of climate services, as well as aligning priority needs expressed at the community level. To this end, the specific objectives of this paper are three–fold:

1. To apply previous local research on Climate Information Service (CIS) uptake to guide priority targets for this type of curriculum training, by identifying the most vulnerable sub–populations based on previous piloted research in Jamaica.
2. To propose a working framework for core curriculum processes, structure, and content based on a synthesis of feedback and analysis from institutional and farmer stakeholders on key enablers, barriers, and priorities required for improving climate service uptake based on past case studies at the community level.
3. To reflect on a possible way forward for curriculum piloting based on other case studies globally.

State of the Jamaican Climate: Impacts and Information–Based Adaptation

Climate projections for Jamaica point to increases in warming and drying trends up to an average of 0.2°–1.0°C and 5%–15% less by end of the 21st century (D. Gamble et al., 2017; Hoegh–Guldberg et al., 2019). However, even more concerning than projections are reports of experiential impacts at the community level of changes in the frequency and magnitude of climatic events (Herrera & Ault, 2017; Moulton et al., 2015). Within the past decade, Jamaica has experienced debilitating extreme events that cost the island billions of dollars in Gross Domestic Product (GDP) earnings and threatened the livelihoods of over 200,000 registered farmers and their families (Agricultural Business Information System [ABIS], 2019; Brown, 2014). The impacts of these transcend ecology and have become not only an issue at the household level, but also for Jamaica's macro–economic stability. Climate–sensitive sectors such as tourism, fisheries, and agriculture form the mainstay of Jamaica's economy. Approximately 20% of the island's workforce is directly dependent on Jamaica's agricultural sector, with tourism and other sectors indirectly dependent on agriculture for food security (Farrell et al., 2010; WorldBank, 2016). On a macro–economic scale, the agriculture sector contributes to about 6.6% of Jamaica's Gross Domestic Product (GDP), with an increasing trend in recent years (PIOJ, 2019; O'Neill, 2025. Eighty percent of Jamaica's farming systems are also rainfed, further compounding exposure–sensitivity to climatic extremes (Farrell et al., 2010).

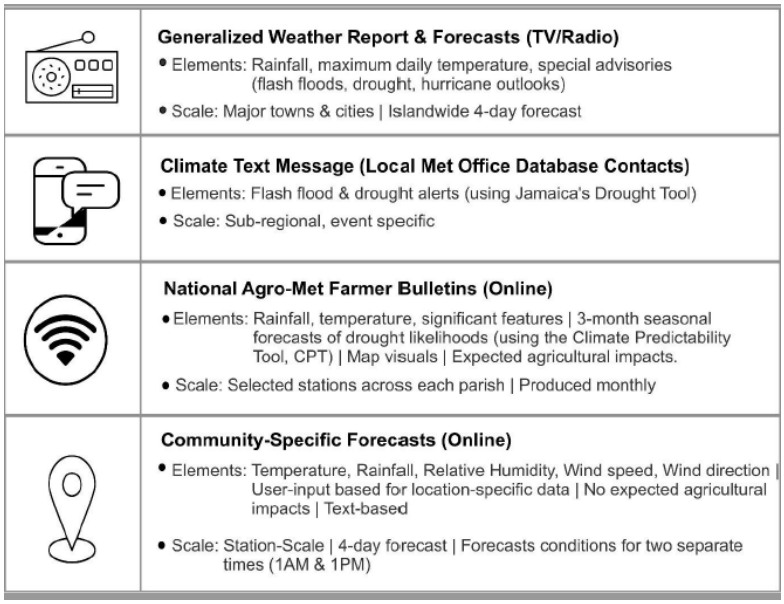
These changes and their linked macro–economic consequences have necessitated resilience programmes aimed at strengthening the capacity of farming communities to deal with climate uncertainty. Over the past 15 years, the Global Framework on Climate Services (GFCS) has facilitated the development of tailored Climate Information Services (CIS) internationally, with the distinct aims of improving climate risk management, increasing resilience, and enhancing developmental outcomes (World Meteorological Organization [WMO], 2011, 2012). The provision of these services is partly built on the assumption that improved awareness of, and access to climate services can strengthen farmers' response to climatic extremes. Consequently, tailored CIS has gained significant traction across the Caribbean, with emphasis on the agriculture sector as a

strategy to manage climate risks and associated societal impacts (Caribbean Institute for Meteorology and Hydrology [CIMH], 2010; Krupnik, 2019; WMO, 2025).

In the Caribbean, tailored CIS for the agriculture sector, have been actively integrated into local meteorological operations since the inception of the Caribbean Agro–Meteorological Initiative in 2010 (CIMH, 2010; Vogel et al., 2017). To date, a variety of additional climate products and services have been developed, with emphasis placed on seasonal outlooks of precipitation extremes, particularly through early warning systems for drought hazards that have ravaged the region with greater frequency in the recent past (see Figure 1). While successful forecasts of specific drought events have been reported locally (Chen et al., 2018; Fiondella, 2015), knowledge at the local level has remained very low (S. Buckland & D. Campbell, 2021).

Figure 1

Main Climate Service Products in Jamaica



Note: Adapted from Buckland and Campbell (2022).

Despite the low uptake, there is recent evidence that farmers who make use of this information during extreme events have been associated with fewer impacts (Buckland & Campbell, 2022; Fiondella, 2015). For example, previous research in Clarendon, Jamaica conducted following Jamaica's 2014/2015 "billion–dollar drought" event, revealed that farmers who did not use CIS had to expend more money more following drought events in the drought recovery process. These farmers were also more likely to be unable to reinvest in their farms, and were more likely to completely deplete their savings than their counterparts who had greater use of CIS in their on–farm decision–making (Buckland & Campbell, 2022). Of particular significance, farmers who did not use CIS in their farm decision–making during the 2014/2015 drought event, were associated with greater likelihood of losing more than 50% of their crops compared to those who used this information in decision–making (Buckland & Campbell, 2022).

In addition to highlighting the disproportionate impacts that are experienced by those who do not use CIS, research in some farming communities in Jamaica suggests that the digital divide may have further compounded vulnerability levels by hindering farmers without internet access from benefiting from access to this new guiding information (Buckland & Campbell, 2022). A contrasting scenario also emerged as farmers with relatively lower antecedent vulnerability levels had higher access to CIS and gained access to its benefits (Buckland & Campbell, 2022). This may pose a risk of broadening socioeconomic disparities due to inequalities in CIS access due to historical processes and structural factors impacting accessibility (Barker, 1993; Beckford & Campbell, 2013; Buckland & Campbell, 2022). Interventions that directly tackle existing barriers at the local level are therefore imperative to the building of resilience.

Adult Education for Low Literacy Learners: Frameworks, Challenges, and Opportunities

While climate impacts do not discriminate based on status or educational level, individuals with low educational levels or limited "know–how" are disproportionately impacted due to limited knowledge capital, which often hampers effective response strategies (Muttarak & Lutz, 2014; Wamsler et al., 2012). Addressing this gap in intervention initiatives is therefore relevant, given the high proportion of the rural farming population attaining educational levels past the primary level (Buckland, 2021). However, while this population may be the focus of targeted initiatives, the challenge emerges to enable knowledge-sharing effectively in a low literacy context and requires a review of key strategies for adult education to achieve optimal outcomes and ensure widespread engagement. The role of TVET in this context is critical, as the hands–on approach is ideal and accessible for individuals who may not have benefited from formal education by focusing on skill acquisition rather than theoretical knowledge.

Andragogy

Andragogy, or adult learning is an educational theory that emphasizes the value of self–directed learning and its relevance to lived experiences in adult education (Knowles et al., 2020; Loeng, 2018). In this approach, five key attributes common to adult learners that differentiate them from children are capitalized on to maximize the effectiveness of teaching approaches. These include: an individual's self–concept, experience, disposition/orientation, motivation, and readiness (Knowles et al., 2020; Loeng, 2018).

Regarding the first principle, the existence of a mature self–concept in adults enables them to be more self–aware to direct their learning processes. This concept posits that learners should therefore be co-creators in shaping the curriculum content and approach, rather than be passive recipients (Blondy, 2007; Merriam, 2001). The first principle in this approach is similar in approach used in participatory learning theories as applied to all age groups (Adu-Gyamfi, Ampiah & Agyei, 2020; Hedges & Cullen, 2011). One such participatory framework is the Participatory Action Learning and Action Research (PALAR) methodology, which take a hands-on approach at integrating learners' own funds of knowledge (culturally accumulated insights), with external research (Wood, 2019). The attributes of this approach, as applied in Andragogy would enable the integration of the adult learners' own experiences aim to nurture positive dispositions among them, including their curiosity and empathy, to foster motivation to learn. This individual self-concept principle of Andragogy also emphasizes the existence of past learning experiences that can be built upon during learning engagement. It also emphasizes the existence of past learning experiences that can be built upon during learning engagement. Adding to this tenet, adult learners' exposure to practical problems may fuel their readiness and practical reasons to learn. According to this theory, curriculum content for adults should be tailored to solve existing problems that the learners face, as this would appeal to their internal motivators (Blondy, 2007; Palis & Quiros, 2014). Consistent with these principles, this approach therefore includes a focus on project–based activities that mimic real–world tasks, rather than a memorization of content. In the farm context, this may include activities on water management in field demo plots; Socratic dialogue (open discussions on present practices led by questions); and hands–on use of weather instruments to understand weather data (Luu et al., 2024). Research has shown that by focusing on immediate applicability, andragogy's practical principle makes its uptake by participants more likely, when compared with traditional theoretically-focused approaches used in traditional pedagogy, as it appeals to the internal motivations of the learners (Knowles et al., 2020).

Experiential Learning Theory

Another relevant framework for consideration in a low literacy context is experiential learning theory (Kolb, 1984). In this framework "learning through experience" is the main thrust. In the context of community climate engagement,

this would include an emphasis on practical applications of the use of technologies for familiar tasks to directly observe the processes; for instance, direct training in the use of rain gauges, interpreting climate forecasts, and adjusting planting schedules based on expected weather patterns. It may also include experience–sharing sessions where farmers recount of their success stories using the methods and technologies being introduced in the course. This is particularly important for low–literacy learners, who benefit from practical learning activities, in contrast to text–heavy instructional methods. Experiential Learning (experience-centred) designs follow a humanistic framework, in which the chief objective is to ensure each learner's perspective is included in class engagement, where human context and sentiments are central to the interactions (Kolb, 1984).

Despite limited rollout, there have been some successful implementations of adult learning theories in farmer outreach in Latin America and the Caribbean. However, these have often been project–specific and not mainstreamed into educational curricula. One such example is the Regional Climate Science Initiative, which includes experiential learning curricula for farmers (Ferguson, 2020). The Climate Services for Resilient Development initiative by the United States Agency for International Development (USAID, 2017) is another international public–private partnership that includes training funding and implementation for community–based Climate Smart Agriculture (CSA) projects which emphasize the use of hands–on demonstrations, workshops, and other forms of peer learning.

In the context of low literacy, the application of these theoretical approaches may take multiple forms; including, but not limited to, a heavy emphasis on visual aids such as infographics, pictograms, and video tutorials, group concept mapping (e.g., to show the expected climate impacts on different crops) or group brainstorming about ideal cropping calendars. This multimodal approach to education ensures that content absorption is high, regardless of the literacy levels of participants.

In the rollout of these concepts for iterative adult learning, the curriculum development process of Analysis, Design, Development, Implementation, and Evaluation (ADDIE) has been widely adopted as an effective framework, including in TVET contexts (Allen, 2006; Rauner, 2009; Shakeel et al., 2023) (see Table A1).

TVET and Farming Community Synergies: The Need, Challenges and Opportunities for Climate Resilience

With an ever–increasing pool of climate mitigation and adaptation projects in response to challenges, the emerging dilemma has shifted from predominantly being insufficient adaptation, to the challenge of fostering effective communication for practical uptake at the local level (S. Buckland & D. Campbell, 2021). Despite Jamaica being a leader in the region in climate adaptation (Dawkins, 2020; Linton, 2016), awareness of existing climate information services at the community level remains as low as 4% in some random samples (Buckland & Campbell, 2022). The challenges of establishing effective communication with farmers is not unique to Jamaica, but has been highlighted as a common problem in less economically developed countries (Clarkson et al., 2022). Economic constraints often present a barrier for staff adequacy in National Meteorological and Extension Services, resulting in lack of direct synergies between farmers and forecasters (Buckland, 2015). Due to limited interaction with the realities of the field, this sometimes results in unmatched priorities, which compound difficulties for CIS to establish its desired outcomes of farmer use in decision–making to build resilience and reduce losses in extreme events. This disconnect is usually worsened, as top–down approaches tend to dominate in the development of CIS, which may result in the apathy or irrelevant focuses of farmer bulletins (Buckland, 2015; Clarkson et al., 2022).

In the Jamaican context, the Meteorological Service of Jamaica (MSJ) and the Rural Agricultural Development Authority (RADA) are

the main institutions pioneering local climate services in production and communication. However, previous institutional evaluation during the 2014 drought event identified several issues, including slow official mainstreaming of tasks, multi–expansion of roles, and inadequate staffing to train farmers as barriers to effective implementation of climate communication on the ground (Buckland, 2015). In terms of staffing adequacy, during the 2014 drought, data from RADA personnel revealed that the average ratio of agricultural extension officers to farmers is 1:2041, with 98 extension officers to around 200,000 registered farmers islandwide at the time of that event (Buckland, 2015).

Since the disconnect is at the level of the field or community (the scale at which climate impacts are most directly felt), it may be useful for future phases of adaptation to consider strengthening the communication link in both co–educational and co–developmental initiatives for climate services using a more permanent and direct approach than occasional farmer fora (ACDI/VOCA, 2013). TVET institutions hold a unique position as community–based institutions already equipped for hands–on training, while having established community trust. Existing infrastructure, human capital capacity and community training initiatives that exist through TVET institutions in rural and urban Jamaica provide a prime enabling environment for them to be key intermediaries in the local climate service network. This role of TVET as part of the equation for a greener society has been recently acknowledged by various international agencies, given its track record in fostering technical skills for individuals and groups who have been excluded from other formal channels of training (Taylor–Stone, 2008; UNESCO–UNEVOC, 2012, 2023).

As indicated by several authors, for the goals of climate science to yield its intended outcome of reducing impacts, increased uptake requires an emphasis on "work on the ground" and not only increased production of information (Clarkson et al., 2022). For implementation of resilience goals to be sustainable for scaling up, there needs to be a sense of ownership by intermediaries from the private and public sectors as part of a generalized national strategy for adaptation. This participatory approach has been taken in other countries, such as Malawi, and even closer in the Caribbean in countries such as Haiti (Clarkson et al., 2022). Several case studies globally have indicated that these community–based approaches proved to be an effective means to improve adaptive action (Cvitanovic et al., 2019; Dayamba et al., 2018; Gwenzi et al., 2020). Imparting content using an interactive approach by entering the farmers' world rather than only summoning farmers to attend formal events outside of their workspace, enables farmers to more likely see distinct relevance to their livelihood. This experiential perception has been documented to play a very important role in farmers deciding to adapt (Banerjee, 2015; Elum et al., 2017; Maddison, 2007). Utilizing TVET as partner and conduit for Participatory Integrated Climate Services (PICS) in the Jamaican context may therefore enable that missing synergy in facilitating both the training of farmers and their involvement in the process of prioritizing factors that are most relevant to their own local contexts and needs. This may result in higher buy-in to these services at the community level (S. Buckland & D. Campbell, 2021; Buckland & Campbell, 2022). The proximity of many TVET institutions to rural farming communities (with at least 2–3 existing National Service Training Agency's (NSTA) in each parish) (NTA, 2023), may enable them to be a hub for climate information dissemination and training for understandability as new climate services are developed, particularly for rural farmers who may otherwise lack the know–how and access to such information (Jones et al., 2016). The existing internet and learning infrastructure in these facilities also present a cost–effective solution, both on the supply and demand side, reducing setup costs and with all programmes being at no cost to participants (NSTA, 2023). Given the emphasis on greening TVET in the global and national community, the proposed curriculum aligns well with existing policy priorities for mainstreaming (Langus, 2016). Using TVET as a conduit for Participatory Integrated Climate

Services for Agriculture (PISCA) also addresses a gap found in a previous evaluation of climate service efficiency, by strengthening inter–institutional linkages that tend to be weak in the Jamaican context (Buckland, 2015).

The following sections of this paper provide an overview of curriculum approaches and consultation methodologies that shaped the content of this curriculum. The priority content areas were based on five local case study communities, drawing on research conducted over the past decade (2014–2022).

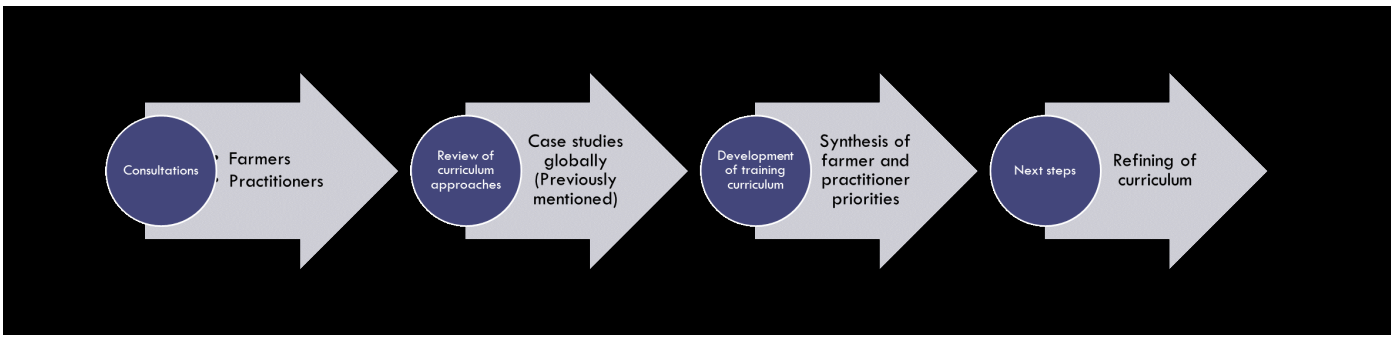
Methodology

Theoretical and Methodological Approach

The theoretical approach to curriculum delivery and structure was selected following a review of farmer training curricula within the last decade, and comparing historical paradigms used in andragogy—predominantly following Taba's Model of Curriculum Development which emphasizes a grassroots approach in identifying students' needs as the basis for curriculum content. To achieve this, farmer consultations form the foundation of the proposed Jamaican CISTVET pilot curriculum (see Figure 2). Despite using a predominantly inductive approach (as advocated by Taba's Model) for the content, the development of this curriculum also applied an eclectic approach (including the review of international case studies of farmer curricula structure and activities) to deductively inform the structure and some suggested activities of the curriculum proposal. This complemented feedback from industry practitioners involved in the Jamaican climate service network (primarily the MSJ and RADA). Consistent with the aim of maintaining a grassroots connection to enhance farmer uptake, pedagogical approaches allow some latitude to customize aspects of the curriculum based on the dominant needs of the community of context (Bhuttah et al., 2019; Taba, 1962). As Figure 2 outlines sequentially, primary feedback was prioritized, followed by the review of selected curricula. Feedback from the climate services consultations (many of which have now been published in peer–reviewed journals) was then synthesized to identify the most important enablers and barriers to climate services. An iterative process of refinement was also included. The following sections detail the methods involved in each step of the process.

Figure 2

Overview of the CISTVET Curriculum Development Process



Consultation

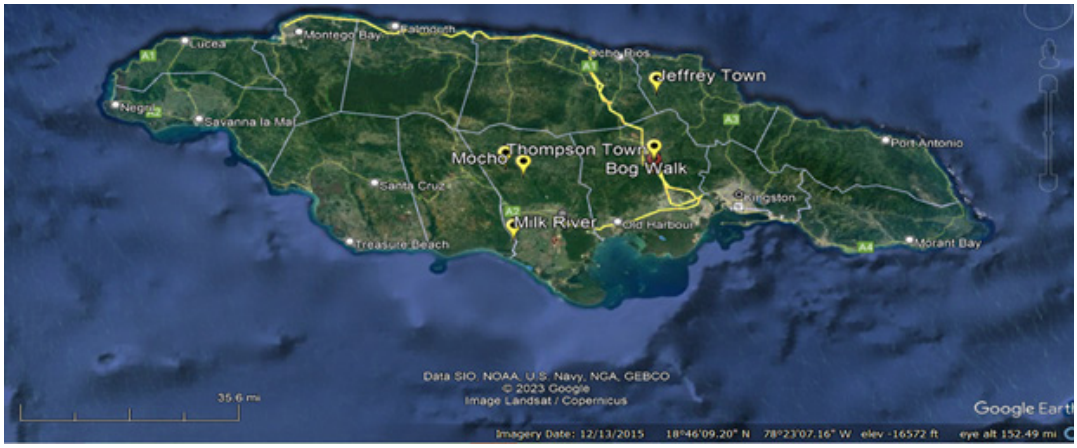
Feedback used to inform the content of this curriculum proposal was gathered using an indirect participatory approach, where the outputs of the consultations were repurposed and applied to this compilation (Nabatchi & Leighninger, 2015). The primary aim of the consultations was to perform direct assessments of the state of Jamaican climate services, particularly gauging levels of awareness, access, and use of specific climate products and the factors that enabled or presented a barrier (Buckland, 2021; S. Buckland & D. Campbell, 2021; Buckland & Campbell, 2022; Buckland, 2015, 2020). However, given

the practicality of the results, this information has been applied to inform a potential intervention to address some of the gaps arising from previous research.

This curriculum draws from an information pool including a total of 487 stakeholders from 5 main study regions: Thompson Town, Mocho, and Milk River (Clarendon), Jeffrey Town (St. Mary) and Bog Walk (St. Catherine) (Figure 3). There were also an additional 74 consultations performed with Climate Service Providers (MSJ, Water Resources Authority (WRA), and RADA) and industry end–users (Climate Studies Group (Mona), community group leaders, agropark operators and academia). Consultations were held intermittently between June 2014 to October 2022, with emphasis on post–drought evaluations following the 2014/15 drought event (Brown, 2014). The locations were selected based on the importance of agriculture, and the presence of past climate interventions. As an added benefit, there was a focus on emerging regions that are relatively less studied for agricultural outreach, rather than the traditional breadbasket parish of St. Elizabeth (Buckland, 2021; S. Buckland & D. Campbell, 2021; Buckland, 2015; Jamaica Information Service [JIS], 2010).

Figure 3

Farming Regions Forming Community Consultations Informing this Curriculum



Adapted from: Google Earth Inc. (2023).

To enable summative applications in this curriculum, feedback from consultations was analysed using descriptive and inferential statistics, and inductive content analysis. The special focus of the content was to glean socio–demographic tendencies to provide context for consideration of the priorities presented, and to inform data–driven targets for farmers who appear to be most vulnerable (Buckland, 2021; S. Buckland & D. Campbell, 2021; Buckland, 2015).

Curriculum Theoretical Approaches and Designs

Following the consultations that informed the content of the curriculum, various farmer field training protocols were reviewed to inform the potential structure of the proposed Jamaican CISTVET curriculum (Bangladesh Centre for Advanced Studies [BCAS], n.d.; Food and Agricultural Organization [FAO], 2019; Florian & Mercado, n.d.; World Bank, 2019). Four main types of curriculum designs were identified during the review: 1) subject–centred, 2) problem–centred, 3) learner–centred, and 4) system–oriented.

The proposed curriculum applies an eclectic approach, merging the strengths of the learner-centred, problem–centred, and subject–centred designs. Given the core objective to focus on overcoming barriers of climate service uptake among farmers, the learner–centred approach will be dominant, to ensure that their priorities are met in an iterative process of customizing aspects of the curriculum. The core content of imparting knowledge on how to access and use CIS will remain.

The learner–centred approach is a curriculum design that has been utilized for several decades through experiential activities centred on the realities, needs, and priorities of prospective students (Cleveland–Innes & Emes, 1969). The learner–centred approach continues to be used in modern practice as a dominant approach in various farmer curriculums in other regions globally, such as Africa, Latin America, the Caribbean (such as Belize), and South Asia (Clarkson et al., 2022; Florian & Mercado, n.d.). Given the importance of experiential learning to improve farmers' decision–making (Buckland & Campbell, 2022), the learner–centred approach may produce higher rates of uptake. The proposed sequence of instruction would also integrate the Experience–Centred and Humanistic Designs, which emphasize the importance of the context and experience of the learners.

The third proposed module which would provide farmers with the opportunity to give further feedback on their emerging needs for iterative improvement of the relevance of the curriculum and climate services, will use a problem–centred approach. The problem–centred design also enables farmers to be active in also solving their problems in their immediate, transient life situations (Ali, 2019). This will be particularly important in addressing the nuanced differences in farmer priorities such as variations in specialized crop types.

The Curriculum

The Data–Informed Curriculum Development Process

The overarching aim for the proposed Jamaican CISTVET Curriculum is to improve local uptake of Climate Information Services (CIS) among farmers. This aim is operationalized using previous local research as a framework, with the core of maximizing factors empirically found to improve farmer uptake of CIS locally (enablers) and to reduce factors that hinder CIS uptake (barriers). The curriculum is framed loosely following the logic sequence of thinking (cognitive), feeling (affective), and doing (psychomotor) advocated by Maslow (1962), and fits well with addressing the gaps identified in previous studies in awareness, access, and use of climate services in decision–making (Buckland & Campbell, 2021). This logic pattern has been followed in other recent curricula; for example, the Climate Smart Agriculture Trainer of Trainers Curriculum by the Food and Agricultural Organization (FAO, 2019).

Following the aforementioned andragogy principles, the themes for units were designed to target any observed gaps in farmer perception and experience and overcome the barriers. Table A2 outlines the guiding research questions and source studies that informed the content development of each Unit. The contributory research predominantly includes published research from academic journals, conference proceedings, and technical papers.

Researcher's Work

Proposed Modalities and Learning Outcomes

The proposed modality of imparting this curriculum instruction is utilizing a collaborative approach, headed by TVET institutions which are a part of the HEART NSTA Trust through Community Training Intervention (CTI) programs; working closely with community stakeholders, as well as the public and private sectors (UNESCO–UNEVOC, 2012). Following a piloting phase to inform the content (which was initiated in proximity to the study regions) and iterative developments, there is the potential to scale up the programme for mainstreaming within Agriculture and Fisheries, as has been done in other contexts (Taylor–Stone, 2008). The proposed duration of the programme may be 6 months–1 year, with contact hours for 2 days per week. Each proposed module builds on the findings of what enables and what hinders climate service uptake in the Jamaican case

studies that are available and attempts to impart key leverage points among learners in a bid for farmers to incorporate climate information more actively in their decision–making, with emphasis on their priority needs.

Proposed Recruitment Approach, Target Population, and Delivery

All proposed aspects of implementation will be guided by previous research done locally. Pilot community training will prioritize farmer cohorts who have been found to have the highest need in terms of climate risk, in addition to lowest awareness, access and use of climate services. Box 1 summarizes six key variables which were found to be significant differentiators of vulnerability levels based on the previous studies in the pilot areas (Buckland, 2021; Buckland & Campbell, 2022; Buckland, 2015, 2020).

Box 1: Suggested Socio–Demographic Targeting Priorities for CISTVET and Justifications

Educational level: Farmers with lower levels of education have low accessibility and understanding of modern CIS (Buckland & Campbell, 2021).

Small farmers: Farmers with larger land sizes had a greater likelihood of being aware and having access to climate text information forecasts than farmers with smaller land sizes. (Buckland, 2021; Buckland & Campbell, 2021; Buckland & Campbell, 2022).

Non-diversified farmers: Farmers who have non-farm sources of income were two times more likely to be aware and have access to climate text messages than those who only relied on farming means for their livelihood (Buckland & Campbell, 2021).

Age: Farmers over 50 years old do not integrate traditional knowledge and modern CIS well (higher losses). All online CIS users were under 40 years old. Proposal: Mix age groups for knowledge transfer (S. Buckland & D. Campbell, 2021).

Gender: Women farmers have lower levels of awareness than men, but those who are aware use multiple sources (S. F. Buckland & D. Campbell, 2021).

Registration status: Unregistered farmers have up to 15 times lower access/use of certain CIS (especially online bulletins) (S. F. Buckland & D. Campbell, 2021).

Note: Compiled from: (Buckland, 2021; Buckland & Campbell, 2022; S. F. Buckland & D. Campbell, 2021).

The proposed delivery model of the Jamaican CISTVET is face–to–face, with integration of field components. Based on ethnographic analysis of farming community culture in the proposed pilot regions (and based on community observations), tactile and psychomotor activities will be used as the primary activity approach. Guided by other previous local research, instructors may be mindful to favour empowerment language over "stress" language, as the latter has been linked to farmer perceptions of powerlessness (Buckland, 2021). For context, "stress" language involves the emphasis of words conveying intense urgency referring to climate extremes (Buckland, 2021; Buckland, 2024). These terms have been statistically linked in some Jamaican case studies as having higher usage among local farmers who either give up farming during extreme events such as droughts, or display an attitude of powerlessness in not attempting to implement adaptation measures (Buckland, 2024).

This observation has been seen in various case studies globally, identifying psychological factors as a significant driver of farmers' decisions to implement adaptive action, and call for a need to balance public discourse of climate impacts to avoid confusion among farmers or reduce sentiments of powerlessness (Gil-Clavel, Wagenblast, Filatova, 2025; Sorvali, Kaseva, & Peltonen-Sainio, 2021;

'Transformational' adaptation (i.e., long-term actions implemented to adjust to climate variability) is often linked to farmers' economic capacity to cope with the extremes of climate stresses. In a resource-constrained context, high exposure to references or experiences of climate stress has been linked to resource-constrained farmers giving up their livelihood, at least temporarily.

The following sections detail the proposed content units and justifications for the Jamaican CISTVET programme.

Proposed Curriculum Structure and Content Units

As informed by previous local research (Banerjee, 2015; Becker, 2020; Boon et al., 2012; Buckland, 2015, 2020; Buckland & Campbell,

2021, 2022; Campbell et al., 2011; Deressa et al., 2009; Deressa et al., 2011; Dharmendra Agashe et al., n.d.; DoGG, 2022; Elum et al., 2017; Fiondella, 2015; Giraldo et al., 2023; Gumucio et al., 2020; Knowles et al., 2020; Kuika Watat & Jonathan, 2020; Tiitmamer & AMayai, 2018) within the past decade (2014–2022), the proposed Jamaican CISTVET programme will consist of two units and one essential segment of course evaluation (see Table A3). Embedded within one of these Units is an optional module which contains its own evaluation. Table A3 includes specific references to the findings and implications informing each emerging unit, topic, and content outline.

The following sections contain the summative tables of the content outline, proposed activities, and justifications for each unit and module of the proposed CISTVET curriculum.

Unit 1: Foundations – Building Awareness and Relevance

This Unit focuses on assessing the perceptions, attitudes, and knowledge of the participants. Table A4 details the topics, content, proposed activities, and justifications for Unit 1.

Unit 2: Maximizing Enablers and Reducing Barriers

Table A5 details the topics, content, proposed activities, and justifications for Unit 2.

Final Evaluation Component: Aligning Priorities for Future Refining of Climate Services

The final evaluation component tackles an important component, to ensure future CIS remains relevant for farmer end–users. For climate services to be effective, the information supplied by climate service providers must directly address farm–level vulnerabilities, taking into account farmers' decision–making processes on varying temporal and spatial scales and specific agro–meteorological hazards faced (Tall & Njinga, 2013). Table A6 details the topics, content, proposed activities, and justifications for the final course evaluation.

Discussion and Conclusions

While Jamaica has made significant headway as a regional leader in climate adaptation, the link between innovation and community uptake remains weak. This paper proposed one way forward as a step toward bridging the gap by integrating climate services training into existing TVET curriculum infrastructure.

The curriculum and TVET integration approach presented in this paper is a step towards mainstreaming and institutionalizing participatory climate services at a scale that could reap several benefits. The proposed curriculum approach taps into already digitally connected institutions, thus overcoming several systemic barriers of literacy and digital information access, while tailoring content to the needs of specific farmer demographics and agronomic systems. Mainstreaming CIS in TVET has the potential to significantly expand CIS uptake among the most vulnerable farmers, providing them with information that has been shown to improve preparation and reduce losses in extreme climate events (Buckland, 2021; Buckland & Campbell, 2022; Fiondella, 2015). This TVET partnership approach is unique, as it makes use of existing structure and institutions for its execution, which will likely lead to significant implementation cost savings. This paper also presents a significant contribution to both the climate education literature and practice, as it integrates culturally–relevant content and activities informed by Jamaican and international studies. The focus on addressing key shared barriers and opportunities that are documented for farmers both locally and internationally presents a further opportunity for similar approaches proposed in this curriculum to be scaled up and piloted in other regions to address shared challenges.

By applying iterative data–driven methods with continuous feedback, Jamaica is presented with an opportunity to move from theory to action, not only in scientific circles, but at the community level, to target communities that need interventions the most. This paper is a first step toward collating a proposed application of previous theoretical research. As internationally sanctioned, "Green TVET" presents an open door to strengthen present efforts toward sustainable agriculture in the face of change.

As evident in the mixed modalities of instructional approaches, success requires continuous iterations and collaborations with practitioners already involved in CIS (MSJ, RADA). Collaboration with funders is also key as a starting mechanism. As this proposal aligns with national, regional, and international development goals, there is scope for project financing. However, for local buy–in, it remains critical that the integrity of the instructional content be maintained as grassroots-led.

It is suggested that this proposal be piloted in various phases, with intermittent evaluations from practitioners combined with a heavy component of community awareness in the proposed pilot areas. Practitioners should remain aware of potential limitations such as distrust in institutions and lack of interest in external interventions, including attitudinal barriers that continue to characterize many rural farming regions. However, considering new policies featuring free programmes, CISTVET stands as a golden opportunity to strengthen community–based resilience.

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Appendix

Table 1

The ADDIE Framework in the context of Adult Learning

	Purposes of Process	
Analysis	Needs and goal analysis for adult learners: Identifying problems and objectives, resources needed. Task analysis: Selection of type of instruction required based on prospective learner characteristics (adult age group, former expertise to build on and make connections).	Muruganantham (2015)
Design	Conceptualizing how learning objectives will be achieved and in what timeframe for the adult learners. This often bears in mind the work obligations of adult learners. This also includes a review of existing instructional materials.	(Arkun & Akkoyunlu, 2008)
Development	Creation of content for materials based on the conceptualization in the design phase. This phase includes error identification during pilot tests on groups with similar sociodemographic characteristics as the target adult learners.	(Mayfield, 2011)
Implementation	This includes the delivery of the curriculum to the adult learners	(Morrison et al., 2006; Yeh & Tseng, 2019)
Evaluation	Assessments of the effectiveness and efficiency of the curriculum design and implementation. This may be ongoing and iterative	(Allen, 2006)

Note: Adapted from: Allen (2006), Morrison et al., (2006), Arkun & Akkoyunlu, (2008), Mayfield (2011), Muruganantham (2015), Yeh & Tseng, (2019).

Table 2
The Data-Curriculum Connection for Each Unit of the Proposed Curriculum

Key questions from previous research	Source Publication(s)	Rationale and Connection	Emerging Units
Question Group A: Knowledge, Awareness, and Perception of Climate: 1. To what extent do farmers perceive climate considerations as important in their livelihood? 2. Do farmers perceive the information on climate change as personally relevant to them now? 3. Does farmer perception of climate impact their decisions to prepare? (Are personal perceptions enablers of adaptive action?) 4. Do farmers tend to perceive themselves as "powerless" to climate extremes?	(Buckland, 2015, 2020) (Buckland, 2021; Buckland & Campbell, 2022) (Buckland, 2021; Buckland & Campbell, 2022; Buckland, 2022)	The focus of Question Group A connects with a core principle of andragogy—self-awareness and personal motivation for adult learners. Depending on the responses, farmers can share knowledge and experiences to co-create the slant of the course.	Unit 1: Foundations—Building Awareness and Relevance
Question Group B: Barriers and Enablers 1. To rank the parameters that are most important to farmers in case study regions (rainfall, temperature, wind direction, wind speed, hours of sunshine, pest forecasting, other (please state). 2. To rank the problems that affect case study farmers and selected agriculturally-relevant organizations most in their operations (drought, floods, hurricanes, praedial larceny, high costs of inputs, lack of markets, other (please state). 3. To evaluate the factors influencing farmer adaptation or non-adaptation using a multinomial regression model. 4. To explore the socioecological barriers and enablers of awareness, access, and use of CIS. 5. To evaluate what needs to be in place for effective communication of climate information for a subset of Jamaican farmers.	(Buckland, 2015, 2020) (Buckland, 2021) (Buckland, 2021; Buckland & Campbell, 2022) (S. F. Buckland & D. Campbell, 2021) (Buckland, 2015, 2020)	This set of questions shapes the direction of the course deepening. This is designed to capture the experiences of barriers and evaluate the factors that lead to higher adaptation levels, for focus in the course content. The questions also probe farmers' own priorities to ensure relevant content for the unique problems that they face. This guides the instructor to focus on priority areas that matter to farmers. Having an evidence basis to inform this section of the curriculum increases the likelihood of uptake.	Unit 2: Maximizing Enablers and Reducing Barriers
Not applicable: Farmers give feedback about their opinions from the course content about the extent to which the content aligns with their priorities.	This will be an ongoing collection of farmer perspectives during the course.	Iterative co-creation connecting once again to the first principle of andragogy.	Unit 3: Aligning Priorities for Future Refining of Climate Services

Table 3

Proposed Units, Learning Outcomes and Assessments for the Jamaican CISTVET Programme

Units	Objectives/Learning Outcomes
Unit 1: Foundations	At the end of this Unit, farmers should be able to: 1. identify key climate impacts as well as coping and adaptive mechanisms for their farm. 2. share success stories of good practices in different types of weather for specific crops. 3. explain the cultural relevance and religious/biblical compatibility of science with the Bible to dispel myths and community scepticism around using scientific materials on their farms. 4. demonstrate the relevance of climate information services, including identifying two specific tasks on their farm where climate information would be useful. 5. define key weather, climate, and farm adaptation concepts in simple language, using mixed modes (practical demonstrations, drawing, or oral explanation).
Unit 1 Assessments	**Oral presentation (20%):** Farmers will present any two specific types of climate information presented in class that they find useful on their farm. **Oral examination (20%):** Testing farmers' recollection of definitions taught in the Unit.
Unit 2: Module A: Maximizing Enablers	At the end of this Module, farmers should be able to: 1. identify and recommend priority climate needs in a group setting as it relates to their farm operations. 2. develop and demonstrate basic digital skills by following practical steps on how to access text messages on their phone, or farmer bulletins on the internet. 3. orally memorize and practically demonstrate the steps to operate digital assistance tools such as text to speech, which may help farmers with low literacy to access climate services. 4. interpret and share relevant weather and climate information in an understandable way with their peers
Unit 2A Assessments	**Practical lab (10%):** Farmers will complete a live demo of downloading a specific climate app not yet downloaded in class. **Graded Class Activity (10%):** Farmers will be randomly assigned a section of an audio farmer bulletin and explain in up to 5 minutes what the section means.
Unit 2, Module B: Reducing Barriers	At the end of this module, farmers should be able to: 1. share two benefits of enrolling in a farmer group or enrolling in the Rural Agricultural Development Authority, with the aim of reducing collective trust barriers by reconstructing perceptions of farmer groups. 2. demonstrate on their farm how one concept in a sample farmer bulletin can be applied practically to their field. 3. reflect within a group setting how specific crops may benefit from specific climate information.
Module B Assessment	**Capstone project (30%):** Present an oral (e.g., through recorded voice notes), or written diary of farmer experience in using information from a climate app to grow a specific crop and document the experience (including challenges and opportunities):
Optional Module: Become a Champion Farmer!	At the end of this optional module, farmers should be able to: 1. demonstrate how to read basic weather instruments and interpret what they mean for farmers in their area. 2. identify methods of how to protect farm and weather instruments from vandalism. 3. provide peer on-the-ground support for climate information community updates.
Assessment for Optional Module (with separate certification)	A 3-month practicum period shadowing an extension officer, culminating in an assessment based on the extension officer's report and a practical demonstration of the concepts taught in the module).
Final Course Evaluation: Aligning Priorities to Refine Future CIS	At the end of the course, farmers should be able to: 1. share feedback about the extent to which the present curriculum meets their needs and priorities.

Table 4 continued

Table 4

Unit 1 Outline

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATIONS
Module 1: Why is climate important to me? (Relevance)	This topic covers the objective: *To identify key climate impacts and coping and adaptive mechanisms for their farm*. This topic will include the sub-topic: *Climate change is now, not just the future*. This will include: Definitions and types of climate and climate-related hazards (e.g., droughts [agricultural, meteorological, hydrological and socioeconomic], floods; saline intrusion, wildfire, hurricanes/storm surge, wind damage) Examples (numbers and videos) of recent disasters experienced, videos of farmers expressing changes in fruit seasons, sharing updates. Recommended reference materials for this subtopic may include**:** • **Agricultural sector and Climate change (youtube.com) (JIS, 2016)** • Climate Change Impacts in Jamaica (Ja REEACH) Climate Change Video Part 2 (youtube.com) The second sub-topic for this topic includes the provision of examples of the climate differences in the community, including any changes in expected rainfall in the microclimate zones. The recommended content reference materials include a discussion about a video of Jamaican farmers detailing their own experiences with climate impacts, such as is available in the following resource: Climate Change & Its Impact on Jamaican Farmers (youtube.com)	Group reflection exercise: This will be guided by the following question: *Are there any differences from when you started farming?* Potential for a guest lecture by an agricultural extension officer or a representative from the Meteorological Service of Jamaica on the basics of community climate variability observed. Games resources may include: • Oregon Climate Education • Climate Centre • Climate Interactive	Personal perceptions of climate change were found to be an enabler of adaptive action in the Jamaican context (Buckland & Campbell, 2021). This is also consistent with other case studies internationally (Alam et al., 2017; Betzold, 2015; Boon et al., 2012; Campbell et al., 2011; Gandure et al., 2013; Hou et al., 2018; Linden, 2014; Munyuli et al., 2017). Farmers who indicated that the climate in the area in which they farm had changed since they started farming were more likely to use more "modern" climate information services in their on-farm decision-making than their counterparts (Buckland & Campbell, 2021). This topic enables farmers to share their own personal perceptions of climate variability to both act as a baseline inventory of perceptions and as a conduit of peer influence to impact farmer thought processes for awareness.
	This section of the curriculum responds to the following objective: *To share success stories of good practices in different types of weather for specific crops.* The third sub-topic under the main topic of "Climate Matters to Me" is: *Securing generations: Adapting to Economic, Social Impacts*. This discussion is to be linked with the concepts of food security for households (and by extent, Jamaica as a nation), and factors that influence poverty due to disasters. Impacts and definitions to be explored include, but are not limited to (1) food insecurity, (2) sanitation,(3) schooling disruption, (4) crop losses (quantity and quality), (5) lack of seeds to replant, (6) complete exhaustion of savings, (7) "throwing up" the farm, (8) root rot. "Throwing up" the farm is a common colloquial expression locally, meaning giving up/abandoning farming temporarily. This subtopic also includes a discussion on coping and adaptation mechanisms. Farmers will learn technical concepts in a simple form, including income and consumption smoothing, and an introduction to Climate Smart Agriculture (soil and water management, crop management, and integrated pest management). Some key resources for the above concepts and terms include: • Income Smoothing and Consumption Smoothing • What are climate services for farmers? • Farmers and Climate Services	Hands-on brainstorm sessions: The brainstorm session may be guided by the following question: *If trends continue, what will happen to my family?* It may include the use of a central whiteboard documenting key themes from the free flow conversation moderated by the instructor. Key terms (see content column) are taught visually. Farmers share openly in a group setting any success stories of good practices that maximize yield in different types of weather for specific crops.	Previous local studies showed that farmers "throw up" their farms including complete abandonment of the profession after certain climate extremes such as drought (Buckland, 2022; S. F. Buckland & D. Campbell, 2021). In a 2016 study following Jamaica's 2014/15 drought, farmers were asked what they did (if anything) to attempt to reduce the impacts of disasters such as droughts. Some communities (such as Thompson Town) recorded nearly one-fifth of respondents who did not do anything to attempt to reduce drought impacts (Buckland & Campbell, 2021). Inaction as a coping strategy has been found internationally to be a high-risk factor for farmers (Adger et al., 2005; Alam et al., 2017; Anderson, 2011; Birkmann et al., 2013; Blennow & Persson, 2009). This session aims to reduce nonchalance among farmers, enabling them to share experiences and become more convinced of the urgency of new action. This aligns with other farmer curriculum approaches internationally (Bangladesh Centre for Advanced Studies [BCAS], n.d.; Food and Agricultural Organization [FAO], 2019).

Table 4 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATIONS
Module 2: Why is it not business as usual?	This topic will explore the reflective question: "*Are you coping well with climate?*" The resource content reference for this section will be generated by open class discussion). Following this discussion, farmers will learn the basics of weather and climate, including how meteorologists can make intelligent guesses about the future. Recommended resources for this topic include: • Weather forecasts made simple • Forecasting for agriculture	Case studies of impacts will be shared by open discussion among participants in their own community. A hands-on/visual documentary will be created about basic improvements in understanding climate. • Forecasting for agriculture	This lesson is founded upon previous research findings that farmer resistance to change is a barrier to climate service uptake in sections of Jamaica (Buckland, 2021). This was also found to be a common barrier in studies internationally (Schewe & Stuart, 2017; Whitton & Carmichael, 2024). This session aims to reduce this barrier by enabling introspection or self-awareness, to realize that change and new information is important in dealing with the emerging impacts more adequately. This reflective approach is consistent with the andragogy framework; emphasizing farmer self-awareness and motivation for learning are usually centred around their desire to problem-solve from past experience.
Module 3: What science has to offer to help me	This module covers the following objective: *To explain the cultural relevance and religious/biblical compatibility of science with the Bible in an effort to dispel myths and community skepticism of using scientific materials on their farms.* This subtopic will cover content that bridges their predominantly religious (Christian) worldview, with the aim of reducing perceptions of powerlessness and skepticism of science. The content will briefly focus on the compatibility between science and the Bible (used by both Christians and Rastafarians). Concepts to be covered include: Stewardship and Dominion; Reference to Meteorology in the Bible; and how the Bible has historically been used as a basis for scientific discovery in nature. Recommended materials for this subtopic include: • Definitions of Stewardship and Dominion • Examples and application of Stewardship and Dominion • The Bible and Science: Integrating Scriptural view of innovations, including Psalms (e.g., Psalm 111:2—"*The works of the Lord are great, STUDIED by those who have pleasure in them"*); weather observation (Luke 12:54); and Science insights in the Bible (Psalm 8:8 – Matthew Fontaine Maury: Discoverer of wind and ocean currents through using Psalm 8 as a basis for scientific hypothesis)	Suggested activities include: Open discussions— for and against this view of science and the Bible/religion. Farmers freely share viewpoints. Other activities include: farmers reading scriptures suggested in the curriculum content (or playing them from an audio Bible app), followed by viewing and discussion of a video documentary on the life of Christian scientist and father of modern oceanography, Matthew Fontaine Maury.	Previous research found that farmers tended to feel they could not control the weather and that everything was up to God (Buckland, 2015; S. F. Buckland & D. Campbell, 2021). This caused some to shy away from innovations (Buckland, 2021; Buckland & Campbell, 2022). The importance of acknowledging citizens' values as a means of both scientific development and increased trust has been acknowledged by various authors internationally (Douglas, 2017; Paterson, 1998; Spaling & Vander Kooy, 2019; Stephen Uwumbordo Nachibi et al., 2023). This lesson deals with these prevailing assumptions directly. In an earlier study among farmers in Jeffrey Town, St. Mary, over 50% of respondents believed there was little to nothing that could be done by anyone to minimize agro-meteorological hazard risk (Buckland, 2015). This topic is one way of addressing this attitude found from previous research, and it aligns with the prevailing religious thinking in farmer conceptualizations of science and their livelihoods. The use of these culturally relevant approaches aligns with the andragogy approach and may enable the reduction of suspicion for community-level interventions.

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATIONS
Module 3: What science has to offer to help me **(Continued)**	This section responds to the following objectives: • *To demonstrate the relevance of climate information services, including identifying two specific tasks on their farm where climate information may be useful,* and • *To define key weather, climate and farm adaptation concepts in simple language, using mixed modes (practical demonstrations, drawing, or oral explanation).* The second subtopic for this section is entitled "*Demystifying science - Introduction to CIS"*. This section of the content focuses on explaining the purpose and types of Climate Information Services (agroclimatic services, tourism climate services, health climate services, fisher warnings). Farmers will then learn of the various interfaces used to communicate climate information to farmers (generalized and tailored climate services for agriculture; climate text messages; farmer bulletins online). **Recommended resources include**: • (S. Buckland & D. Campbell, 2021) • Climate Services for Farmers • CIS in Action: Example of Rwanda **End of Unit Assessments: Total 40% (Table 3)**	Activities include the use of graphics (see Figure 1) that summarize the main types of CIS available locally. Other activities include practical labs with hands-on activities to access the portals and apps with the CIS.	Previous research found that over 90% of farmers in various study communities were unaware of online climate services (Buckland and Campbell, 2021; Campbell, 2022).This topic tackles lack of awareness of CIS among farmers. This is especially important, as farmers who access and use CIS have been empirically found in Jamaica to have fewer estimated losses in specific past drought events (Buckland & Campbell, 2022). It is hoped that this module will foster greater trust and awareness of CIS among farmer participants.

Unit 2: Maximizing Enablers and Reducing Barriers.
Table 5 details the topics, content, proposed activities and justifications for Unit 2.

Table 5
Unit 2 Outline

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 1: Climate matters to me!	This section responds to the following objective: *To identify and recommend priority climate needs in a group setting as it relates to their farm operations*. The first subtopic under Module 1 of Unit 2 is entitled: *My own priority parameters: What matters most to me when I farm?* Consistent with the andragogy approach, this portion of the curriculum will enable farmers to co-create the content of focus for their own iteration of the course from group brainstorming sessions. Brainstorm prompts to be used include: What are your needs as a farmer, based on the following: *Crop type vs. soil type?* The next section of the content is geared towards sensitizing the farmers that CIS contains the information that they themselves prioritize. As CIS locally includes a broad range of parameters, instructors may highlight the alerts that target the most frequently occurring priority needs expressed in class. Depending on the farmers' priorities in the class, the first focus would be on explaining how these parameters are already displayed in farmer online bulletins and accessible at the community level to help them with their needs. (Recommended resources to match the parameters that exist in farmer bulletins may be found in some of the following examples and publications: • Jamaica Farmer Bulletin Example • Buckland, 2021 • Buckland, 2015, 2020)	Group brainstorm focus group and mind-mapping session: The group brainstorm session may have the following guiding question: "What matters most to me when I farm?" The facilitator could bring pictorial cards with an adhesive representing different symbols of parameters (e.g., pictures of rain, wind impacts, sunshine, soil) and farmers could place these pictorial cards in order based on their perceived importance. This exercise can be conducted with different homogenous groups, e.g., women farmers brainstorming their own priorities, as distinct from men; as well as farmers under 50 years old, brainstorming separately from farmers over 50 years, for a richer discussion and comparison. Farmers could also be grouped based on similar crop type.	In previous studies, farmers had distinct priorities and knew the parameters that mattered most to them, although preference for rainfall forecasts appeared to be most common (Buckland, 2015, 2020). Climate perception and crop type appeared most critical in determining farmers' use of CIS in their on-farm decision-making (Buckland and Campbell, 2021). International studies corroborate with the importance of personal perceptions being an important step towards adaptive action (Banerjee, 2015; Boon et al., 2012; Campbell et al., 2011; Deressa et al., 2011; Deressa et al., 2009; Elum et al., 2017). From this finding, this module connects farmers' perceived climate needs based on factors such as crop type, since it was found to be an important factor statistically affecting farmers' use of climate services.

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 2: Accessing useful climate information: Overcoming cognitive barriers	This subsection responds to the following objectives: • *To develop and demonstrate basic digital skills by following practical steps on how to access text messages or farmer bulletins on the internet*, and • *To orally memorize and practically demonstrate the steps to operate digital assistance tools such as text to speech, which may help farmers with low literacy to access climate services.* The primary focus for the first topic of Module two is: *Digital Literacy for Climate 101*. The focus of this content is enabling farmers to access the internet: (i.e. community-specific forecasts & farmer bulletins online). The content includes assisting farmers through the steps involved in turning on and operating a mobile phone and computer device; how to download weather and agriculture apps (e.g., the Jamaica Weather App, and the RADA app); navigating digital climate services information (virtual tour of the sections of each app, showing text to voice for farmer bulletins and pdf files for narration options). The recommended resources for this content include: Examples of climate bulletins to show the various types of information: • Jamaica Farmer Bulletin Example • Video resource on read aloud feature for pdfs **UNIT 2 ASSESSMENTS PART A (PRACTICAL LAB (10%):** Live demo of accessing climate app.	Digital literacy exercises may be done in a group setting. This may involve the formation of heterogenous groups that may use the mobile phone or computer in the same space in the session (whether sharing or using devices provided in class in close proximity), with a mixture of farmer ages and sexes. This activity was informed by previous research which revealed that understandability is heavily influenced by socio-demographics (e.g. farmer age and gender) (Buckland, 2021; S. F. Buckland & D. Campbell, 2021)	The focus of this module is informed by the results from the study on *Effective Communication for Climate services* in which it was found that the understandability and accessibility of media to farmers was of "poor quality, a direct obstacle to efficiency" (Buckland, 2015). Based on this finding, building digital literacy is an intervention that can reduce the barrier of understandability and accessibility to media. Other studies internationally show that the digital divide among rural farmers is a common barrier to resource accessibility for adaptation, including CIS uptake (Becker, 2020; Gumucio et al., 2020; Kuika Watat & Jonathan, 2020). The focus on the formation of heterogenous groups for the digital literacy section of the program was informed by the finding that farmer age and sex characteristics greatly determined the likelihood of access and understandability of CIS (Buckland, 2021; S. F. Buckland & D. Campbell, 2021). The lack of awareness of early warning systems for floods, and timeliness were also issues in previous research conducted in Bog Walk (DoGG, 2022).

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 2: Accessing useful climate information: Overcoming cognitive barriers (Continued)	The following subsections provide an introductory coverage of content aligning with the following objective: *To interpret and share relevant weather and climate information in an understandable way to their peers.* The next session's content under Module 2 is entitled: "*Decoding key terms in farmer bulletins and community forecasts, 3-month seasonal precipitation index outlooks*". This content covers key terms (and definitions in the parentheses) including but not limited to: (1) Outlook (same as forecast); (2) Secondary rainfall season (September, October, and November); (3) Troughs (a weather system that brings rainfall); (4) Mean rainfall (average amount of rain that falls for a particular season, month, or year); (5) Interpreting percentages (e.g., 100% increase meaning double); (6) Standardized Precipitation Index (SPI), (A numbering system used to describe whether the rainfall for a specific month or season is above or below the "normal" or average that is usually experienced for that month or season).	Use of pictorial explanations: Each term in the content may be explained using either a chart or digital image explaining the term. Farmers could alternatively be given an ungraded assignment to present an oral explanation to the class of one of the terms.	This portion of the curriculum was based on institutional feedback from the Meteorological Service of Jamaica that most of the "modern" locally available forms of agroclimatic services involve primarily text-based formats, with no comprehensive pictorial alternative (Buckland, 2015, Buckland & Campbell, 2021). Textual analysis of samples of these documents revealed the prevalence of technical key terms used in drought forecasting, pest forecasts, and temperature outlooks in the farmer bulletins (Buckland, 2015, 2020). This portion of the content attempts to address this barrier by explaining recurring terms in these forecasts using audiovisual aids.
	The second subtopic linked with this topic is: *Interpreting visuals: Maps & graphs.* Among the guiding questions include the central question: What does each scenario of the SPI mean for my farm in planning? Specific focus will be placed on interpreting the Standardized Precipitation Index numbers and maps that are published in Jamaica's farmer bulletins. Farmers will learn that positive numbers (those above 0) mean that that location is receiving more rainfall than usual; while negative numbers (those below 0) mean less rainfall than usual. When the number is higher than -1 or +1, we enter a drought (-1) or are likely to get a flood (+1) (Svoboda, 2012). Farmers will learn standard colour codes to interpret map forecasts. Specifically, red, orange, or yellow means abnormally dry. Blue or purple means abnormally wet. The key recommended resource is showing examples of climate bulletins to show the parts of the information: Jamaica Farmer Bulletin Example (Sections: Drought monitoring and forecasts, pest forecasting, seasonal temperature outlooks). **UNIT 2 GROUP CLASS ACTIVITY (10%) (Refer to Table 3)**	The activity for this content may include the use of visual aids showing the coloured SPI maps in Jamaica's farmer bulletins • Jamaica Farmer Bulletin Example To further reinforce farmer learning of the meaning of the colours in the maps, the instructor can assign roleplays for groups; with one farmer pretending to be a meteorologist showing the map and one farmer representing a separate parish. Each farmer may explain what conditions the parish they were assigned are experiencing according to the map, and make suggestions for a planting plan for this condition. Farmers may take turns to allow the "meteorologist" to also perform scenario planning.	The inclusion of this content was based on previous assessments which highlighted that the language and even some of the visuals were unclear to farmers. In some farming communities, a third or more of farmers only have primary level education (Buckland, 2015; Buckland & Campbell, 2021). The importance of using simplified language for increased climate service uptake has been documented in other countries (e.g., Sudan and India as well as regionally within Central America (Dharmendra Agashe et al., n.d.; Giraldo et al., 2023; Tiitmamer & AMayai, 2018).

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 3: Social & Environmental Support Systems: Keys For Improved Productivity (Stakeholder guest partners: MSJ and RADA)	This section responds to the following objective: *To share two benefits of enrolling in a farmer group or enrolling in the Rural Agricultural Development Authority, with the aim to reduce collective trust barriers by reconstructing perceptions of farmer groups.* The first subtopic for Module 3 is entitled: *Overcoming trust issues re institutions: Dispelling myths and uncovering benefits.* Content for this subtopic includes: Examining the benefits of farmer registration and joining community groups, including but not limited to: (1) Connection opportunities to markets through RADA, e.g., the Agri-Links Exchange Programme (ALEX) and Agro-Tourism Farmers Market; (2) Free training programmes for farmers; (3) Resource distribution and technical advice; (4) Access to community grants through institutions. This example can be studied by examining specific case studies, for example, the Case study of the Dawkins Community Farmers Group Mocho and their funding of a community greenhouse.	To enable exposure to success stories of CIS (Fiondella, 2015), the main activity would be a focus group discussion or guest speaker (e.g., a RADA farmer giving testimonials of their experience with extension services, or a community group leader (virtually or in-person, but preferably in-person). A second activity could include brainstorming among farmers regarding present adaptation methods used. The instructor may use at least one session to plan field day interactions with extension officers, including the process of registration. This activity is hoped to improve communication between RADA and both registered and unregistered farmers. Another session in the series could include a guest speaking or a case community group leader who received grants for community improvement.	From the multinomial analysis of socioecological barriers and enablers of awareness, access, and use of CIS (Research Question Group B4, Table 2), it was found that access to extension support and formal institutional membership exerted the strongest positive influence on respondent farmers' likelihood of accessing climate information services, up to 15 times more than those without this social interaction (Buckland and Campbell, 2021). Other studies internationally confirm the importance of social capital in farmer adaptation practices (Abdul-Razak & Kruse, 2017; Adger, 2001; Adger, 2003; Hagedoorn et al., 2019; Inkpen, 2005; Pelling, 2019; Rubin & Rossing, 2012). The inclusion of content geared towards overcoming trust barriers was informed from interviews with farmers that revealed a common sentiment of distrust of government-run institutions due to fear of high taxation and perceived unfairness in benefit distribution—hence a hesitancy to formally register, despite the potential benefits available (Buckland & Campbell, 2022; S. F. Buckland & D. Campbell, 2021).

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 4: What does this mean for my farm?	This subsection responds to the following objectives: *To demonstrate on their farm how one concept in a sample farmer bulletin can be applied practically to their field,* and *To reflect within a group setting how specific crops may benefit from specific climate information.* The first sub-topic for Module 4 is entitled: *"Converting meteorological information to agro-advisory".* Within this topic, farmers will be exposed to the various practical ways to apply climate information to help their farm decision-making. Farm applications include guidance as to when is best to apply irrigation, and what crops to plant for specific seasons based on present weather and seasonal trends). Among the resources for the content include: Introduction to Farmer Decision Support Tools around the World (including: Apps to tell how much water a specific crop type needs at each stage of growth and when and what crop is best to plant based on rainfall forecasts). Another subsection of this content will focus on areas of comparison with local/traditional methods. The content for this subsection will be co-created by farmers from group discussions during class. An introductory video on commonly used traditional resources such as the McDonald Almanac may precede the discussion: A look at the McDonald almanac (Moon phases and crop harvesting and planting). Another subsection of this module may examine the benefits of an Integrated Pest Management System. Content for this section may be shared by an extension officer as a guest speaker. The key questions to be covered are: (1) What combinations of crops work best together to ward off climate-related pests?	Activity: Participants will share what they customarily do in response to various hazard scenarios. The instructor may show what was broadcast in the bulletin and how activities (e.g., irrigation timing and seed selection) may enhance productivity. A guest presenter from the MSJ may also be brought in to interact with the farmers and clarify other ways in which climate information can be applied. A field day of interactions with extension officers showing how climate information can be applied in their farming.	This connects with the experience portion of the andragogy framework (Knowles et al., 2020). The need to incorporate practical farmer experience emerged from qualitative discussions on what information farmers find relevant being predominantly based on daily major tasks, including cropping cycles (Buckland, 2021; Buckland & Campbell, 2022). The sharing of CIS success stories was informed by the finding that less than 10% of farmers in random Jamaican samples use CIS for decision-making (S. F. Buckland & D. Campbell, 2021). The inclusion of this content is expected to reduce these barriers. The use of simplified, practical strategies to sensitize farmers is a practice used to increase climate service uptake in several case studies (Dharmendra Agashe et al., n.d.; Fiondella, 2015; Giraldo et al., 2023; Tiitmamer & AMayai, 2018).

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 4: What does this mean for my farm? (Continued)	The final subtopic for this module includes a farmer-led reflection entitled: *How can I apply this information to my own conditions?* This includes a consideration of crop types and soil types, with content co-created by farmers from discussions. **FINAL ASSESSMENT: CAPSTONE PROJECT (30%) (Refer to Table 3)**	• Group activity: Farmers will be grouped based on crop types and soil types to discuss how to apply the information to their situational context. • Invitation for a guest agronomist for a field day/ talk.	The inclusion of this focus on local conditions was informed by previous findings where local factors (crop and soil types) were found to have a significant bearing on productivity output, even with the use of CIS (Buckland, 2021), Jamaica, root crop farmers had disproportionately higher losses than vegetable farmers, even when both used the same information (Buckland, 2021). Without assuming the types of impact, enabling experiential sharing among farmers with similar crop types is one step towards addressing common challenges based on crop type. Farmer sharing of experiences is a common practice in many case study climate service interventions globally (ACDI/VOCA, 2013; FAO, 2019; Florian & Mercado, n.d.).

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 5 (Optional): Be a Champion Farmer!	This section's content responds in greater depth to the following objectives: (1) To demonstrate how to read basic weather instruments and interpret what they mean for farmers in their area; (2) To identify methods of how to protect farm and weather instruments from vandalism; and (3) To provide peer on-the-ground support for climate information updates for their community. The first subtopic is entitled: *Be a Citizen Scientist!: How to provide peer on-the-ground support for your community.* This session may be preceded by a video introduction such as: What is citizen science?, or a guest speaker. This topic's content will cover the basics of equipment types (manual and automatic weather stations, including soil moisture equipment); and parameters—how they are observed, and how to read weather instruments & upload data. Detailed specialized but simplified content for this section may be generated through practical exercise by a guest speaker from the Meteorological Service of Jamaica, teaching farmers how to read the numbers on important instruments such as rain gauges; how to interpret the numbers; and simplifying some content from the World Meteorological Organization's guide to instrumentation.	Farmers enrolled in this module may make a sample agro-advisory in whatever format (pictorial or audio, for example), shared with the community (whether on the community's bulletin board or an announcement in a community WhatsApp group). Farmers enrolled may even be challenged to form a community group if one does not presently exist in the community. An incentivized activity during the proposed practicum assessment may be the monthly champion farmer as a competitive game.	The inclusion of this content was informed by institutional feedback from the Rural Agricultural Development Authority, which divulged the human capacity constraints. At the time of the initial study (2014/2015), the average ratio of agricultural extension officers to farmers in Jamaica was 1:2041, with 98 extension officers to around 200,000 registered farmers islandwide (Buckland, 2015, 2020). The baseline training and recruitment of farmers to offer peer advice in their communities is expected to be a first step in offsetting this barrier. This approach of "citizen science" is a trend used in various contexts to offset limitations in the formal sector, including situations where human resources are inadequate (Douglas, 2017; Poortinga, 2012).

Table 5 continued

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Module 5 (Optional): Be a Champion Farmer! (Continued)	The follow-up session in this module may be entitled: "How I can protect equipment from vandalism?" Content includes digital solutions (e.g., camera installations, sensors and alarms); structural solutions (e.g., adequate fencing or coverings); and personal and group patrol vigilance methods. Other content could be supplied by a community police officer or guest speaker to train farmers on the reporting lines and protocols). **SUGGESTED ASSESSMENT FOR OPTIONAL MODULE** (with separate certification): 3-month practicum period shadowing an agricultural extension officer and assessment based on extension officer's report as well as a practical demonstration of the concepts taught in the module).	Challenge the participants to find 4 friends to start a patrol team if their community has any equipment.	This section of the content was informed by one of the emerging barriers found from RQ Group B2 (Table 2). Vandalism/theft from scrap metal trading emerged from both institutional and farmer feedback as a major problem facing Jamaica's agricultural system (Buckland, 2015, 2020). This constrains the accuracy of climate services (ranked as the 6th most frequently cited challenge for MSJ and RADA) (Buckland, 2015). The MSJ network at the time of the 2014 drought consisted of around 154 manual rain gauges, as opposed to approximately 300 in years past, and approximately 6 climatological stations as opposed to about 23 in the past (Chin, personal communication, 2014; Buckland, 2015). The content and activities included in this section attempt to address this barrier.

Final Evaluation Component: Aligning Priorities for Future Refining of Climate Services

The final evaluation component tackles an important imperative, to ensure that future CIS remains relevant for farmer end-users. For climate services to be effective, the information supplied by climate service providers must directly address farm-level vulnerabilities, taking into account farmers' decision-making processes on varying temporal and spatial scales, and specific agro-meteorological hazards faced (Tall & Njinga, 2013). Table 6 details the topics, content, proposed activities, and justifications for the final course evaluation.

Table 6

Final Course Evaluation Outline

TOPICS	CONTENT OUTLINE	PROPOSED ACTIVITIES	JUSTIFICATION
Final Course Evaluation: What works? What does not work?	This section of the curriculum responds to the objective: *To share feedback about the extent to which the present curriculum meets their needs and priorities.* For this section of the curriculum, farmers will give feedback about their opinions from the course content about the extent to which the content aligns with their priorities.	Group brainstorm mind-mapping. The instructor may use a predefined list with the flexibility of adding issues, and also use farmer rankings to provide feedback on perceptions about how climate services can be improved. Reference may be made to a listing from a previous local study (Buckland, 2015) performed among MSJ staff. Allow farmers to freely brainstorm (including their own imagination) what kind of information product may be useful for them in the future. They can be as specific or general as they wish. Feedback will be delivered to the Climate Service Providers after each course's iteration.	This future ongoing feedback is a critical part of the iterative process of not only course engagement, but facilitation of communication with climate service providers to ensure that the future development of climate services incorporates new trends of farmer needs. This is founded on the principles of self-awareness of adult learners as agents for content co-creation in curriculum development (Knowles et al., 2020).