

Banana Farmers' Lived Experiences and Adaptation Strategies Amid Increasing Heat: A Phenomenological Study in Barangay Balagunan, Sto. Tomas, Davao del Norte, Philippines

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Abstract

Introduction: Rising temperatures and increasing heat indices associated with climate change pose growing challenges to banana production in tropical, smallholder-dependent communities such as the Philippines. However, limited research captures how farmers experience and respond to increasing heat. This study addressed this gap in Barangay Balagunan, Sto. Tomas, Davao del Norte, where banana farming is a major livelihood.

Objective: The study explored the lived experiences, adaptation strategies, and realizations of banana farmers in response to perceived increasing heat.

Methods: A descriptive phenomenological design guided by Colaizzi's (1978) method was employed. Fourteen purposively selected banana farmers with at least 10 years of farming experience participated in individual in-depth interviews (n = 7) and a focus group discussion (n = 7). Data were collected through a validated semi-structured interview guide and analyzed using Colaizzi's seven-step procedure.

Results: Three major themes emerged: (1) experiences of increasing heat, characterized by heat stress and fatigue, reduced yield and crop quality, water scarcity, psychological strain, changing weather patterns, and increased farming uncertainty; (2) adaptation strategies, including water conservation, mulching and shading, shifts to heat-tolerant Cardava, simple irrigation, and peer knowledge sharing; and (3) realizations involving climate-change awareness, preparedness, cooperation, institutional support, livelihood reconsideration, and resource conservation.

Conclusions: Perceived increasing heat significantly challenges banana production, physical labor, and household livelihoods. Despite these challenges, farmers demonstrate locally grounded resilience through adaptive practices, consistent with the Sustainable Livelihoods Framework. However, limited financial resources, inadequate irrigation, and insufficient institutional support constrain their capacity to adapt. Coordinated support from government agencies, agricultural institutions, and community networks is needed to strengthen climate-resilient banana farming.

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1. Introduction

Banana production is among the tropical agricultural systems most exposed to rising heat. Escalating temperatures and an intensifying heat index — a combined measure of air temperature and relative humidity — pose a serious and escalating threat to yields and increase susceptibility to pests and disease in producing countries such as the Philippines (Gomez, 2015; Salvacion, 2019; International Tropical Fruits Network, 2015). Climate projections suggest that by 2080 up to 60% of current banana-growing regions may become unsuitable for cultivation, while heat-facilitated diseases such as Fusarium Wilt TR4 already threaten the dominant Cavendish variety in other producing regions (Carbon Brief, 2024; British Broadcasting Corporation, 2024). For the smallholder farmers who depend on banana cultivation as a primary livelihood, these pressures are not abstract projections but daily, embodied realities that shape occupational heat exposure, farm labor, and household income security.

In the Philippines, heat index levels have risen markedly over the past decade (2015–2025), regularly reaching danger and extreme-danger classifications (42–51°C) during the dry season and prompting health advisories and warnings for outdoor workers (Climate Change Commission, 2025; PAGASA, 2023). Climate attribution research further indicates that human-induced climate change has substantially increased the frequency and intensity of extreme heat events in the country, placing it among the most heat-affected nations in Asia (World Weather Attribution, 2024; Cariaso, 2025).

These national-level heat-index records, however, are conceptually distinct from the everyday climatic conditions farmers describe. Heat index specifically denotes the combined effect of air temperature and relative humidity on perceived heat; it is a measured meteorological construct and is not synonymous with drought, reduced rainfall, or climate change more broadly, even though these conditions often co-occur (PAGASA, 2023). Water scarcity and erratic rainfall may accompany periods of high heat, but they are not, by themselves, evidence of a rising heat index. Because this study did not collect independent meteorological data, it examines farmers' perceived increasing heat — the hotter, drier conditions they describe experiencing — situated within, but not equated with, the broader trend of intensifying heat index conditions documented for the region (Climate Change Commission, 2025; PAGASA, 2023). This distinction follows a conceptual sequence linking climate change to extreme and local heat exposure, to farmers' perceived agricultural and livelihood effects, to farmer adaptation, and finally to the livelihood assets and institutional constraints that shape those strategies.

Despite the promotion of climate-resilient strategies such as conservation agriculture and improved agronomic practices, a research gap remains: much of the existing evidence on climate impacts in banana-growing regions relies on quantitative data and generalized climate models that do not capture how individual farmers interpret, narrate, and respond to these changes in their own words (Boko et al., 2022). Locally grounded, farmer-perspective accounts — attentive to how adaptation strategies evolve over time and how local conditions shape vulnerability — remain comparatively scarce for Philippine and Southeast Asian smallholder banana farmers specifically. What has not yet been documented is how banana farmers in a specific Mindanao farming community, such as Barangay Balagunan, describe and make sense of increasing heat in their own daily work, and what locally developed strategies they use to cope with it — questions that broader quantitative or climate-model studies are not designed to answer.

This study addresses that gap by documenting, through a qualitative phenomenological lens, the local climate observations, perceived impacts, and adaptation strategies of banana farmers in Barangay Balagunan (Landaverde et al., 2022; Andrista et al., 2025). By grounding climate-adaptation research in farmers' real-world experiences — including how strategies evolve over time and how local factors shape vulnerability — the study contributes toward more inclusive, practical, and context-relevant approaches

to strengthening climate resilience in banana-farming communities (Lemos et al., 2022; Creswell, 2021; Adger et al., 2005). The findings are intended to inform agricultural policy and local government responses, highlight gaps in institutional support, and offer a reference point for other Philippine and Southeast Asian farming communities confronting similar climatic pressures (Pelling & Manuel-Navarrete, 2019; Fankhauser & Burton, 2021; Boko et al., 2022).

Theoretical Lens

This study is anchored on the Sustainable Livelihoods Framework (SLF), which offers a holistic lens for understanding how individuals and communities mobilize human, social, natural, physical, and financial capital to sustain their livelihoods within a given vulnerability context (Scoones, 2015). In Barangay Balagunan, farmers' perceived increasing heat constitutes a significant climatic stressor within this vulnerability context, shaping how farmers draw on their available assets to adapt to heat stress and safeguard income and food security. The SLF further highlights the role of transforming structures and processes — institutions, policies, and social relations — in either enabling or constraining farmers' access to assets such as extension services, climate-resilient technologies, and financial support (Scoones, 2015). It also foregrounds livelihood diversification, such as integrating other crops or off-farm income, as a strategy for managing risk and building resilience.

Research Questions

This study sought to answer the following research questions:

1. What are the lived experiences of banana farmers regarding perceived increasing heat in Barangay Balagunan, Sto. Tomas, Davao del Norte?
2. What adaptation strategies do the banana farmers employ to respond to perceived increasing heat?
3. What realizations have the banana farmers drawn from experiencing perceived increasing heat?

2. Materials and Methods

2.1. Research Design

This study employed a descriptive phenomenological research design, following Colaizzi's (1978) method, to gain an in-depth understanding of the lived experiences and adaptation strategies of banana farmers responding to perceived increasing heat in Barangay Balagunan, Sto. Tomas, Davao del Norte. Descriptive phenomenology was selected, rather than an interpretive tradition such as hermeneutic phenomenology, because the study's primary aim was to describe farmers' experiences as they lived and narrated them, bracketing, to the extent possible, the researchers' own assumptions about climate change and heat exposure, rather than to produce a researcher-driven interpretive account (Neubauer et al., 2019; Sundler et al., 2019). Colaizzi's method was selected for its structured, transparent, and widely used procedure for moving from raw transcripts to a final description of the essence of a phenomenon, which supported the transparency this study aimed to provide (Sundler et al., 2019).

2.2. Research Locale

The study was conducted in Barangay Balagunan, one of nineteen barangays in the Municipality of Santo Tomas, Davao del Norte, within the Davao Region (Region XI) on the island of Mindanao. The barangay had a population of 6,230 as of the 2020 Census and spans approximately 1,839.90 hectares of predominantly agricultural land (PhilAtlas, 2020; Municipality of Santo Tomas, 2023). Situated at approximately 7°29'N, 125°36'E with an elevation of about 38.6 meters above sea level, Santo Tomas experiences relatively stable temperatures (mean daily maximum of 28–31°C), conditions conducive to banana cultivation but also increasingly susceptible to the effects of a rising heat index (Municipality of Santo Tomas, 2023; PhilAtlas, 2020).

2.3. Respondents and Sampling Procedure

Participants were banana farmers residing in Barangay Balagunan, selected through purposive sampling. Fourteen participants were recruited based on their direct experience with perceived increasing heat — a sample size appropriate for phenomenological research, which prioritizes in-depth exploration and typically involves 6 to 15 information-rich participants to achieve data saturation (Alase,

2017). Inclusion criteria required participants to have been active banana farmers for at least ten consecutive years, to have resided in the barangay for 10–30 years, and to be between 35 and 50 years of age. This age range was set to capture farmers who were both established enough to compare current conditions with at least a decade of prior farming seasons and still directly, physically engaged in day-to-day farm labor and decision-making, so that accounts of heat-related physical exertion would reflect current, ongoing experience rather than retrospective recall of work no longer performed. The residency range was set for a comparable reason: to ensure sufficient tenure in the barangay to notice localized climatic change while limiting reliance on recall spanning several decades. The authors acknowledge that these boundaries necessarily excluded farmers outside this age and residency range — including older, longer-tenured farmers who may hold particularly valuable longitudinal knowledge of climatic change — and this trade-off is revisited as a limitation in Section 6.

Farmers with fewer than ten years of farming experience, non-residents of the barangay, or those unwilling to participate were excluded. Prior to data collection, informed consent was obtained and participants were briefed on the study's objectives and procedures. Seven participants took part in individual in-depth interviews (IDIs) to explore personal lived experience in depth, while a separate seven participated in one focus group discussion (FGD) to capture shared, socially negotiated accounts of farming under perceived increasing heat, consistent with recommended sample sizes for each method (Creswell & Poth, 2018; Krueger & Casey, 2015). Assignment to IDI or FGD was based primarily on participants' scheduling availability given the demands of farm labor, rather than on a substantive distinction between participant groups; both subsamples met the same inclusion criteria. The two datasets were transcribed and analyzed separately using the same descriptive phenomenological procedure described in Section 2.5, and their resulting themes were then compared. Where IDI and FGD accounts converged, this was treated as evidence of a shared, socially recognized experience; the FGD data were also examined for group-specific dynamics, such as points where participants built on, qualified, or diverged from one another's statements in ways an individual interview could not reveal. The FGD was thus used to corroborate and contextualize, rather than to simply pool with, the individually elicited IDI accounts — a distinction the authors judged compatible with a descriptive phenomenological aim of remaining close to participants' own articulation of their experience.

2.4. Research Instruments

The primary instrument was a semi-structured interview guide composed of open-ended questions designed to elicit detailed narratives regarding farmers' experiences with perceived increasing heat and their adaptation strategies (Adams, 2015; DeJonckheere & Vaughn, 2019). The guide was developed from a review of related literature and validated through expert consultation to ensure content relevance and clarity (Castillo-Montoya, 2016). A pilot interview with a non-participant was conducted prior to formal data collection to test question flow and comprehension, allowing for necessary refinements (Kallio et al., 2016).

2.5. Data Collection and Analysis

Interviews and the focus group discussion were conducted face-to-face at locations comfortable for participants, such as their homes or farms, and were audio-recorded with participants' consent and supplemented with field notes capturing contextual details and nonverbal cues. Recordings were transcribed verbatim in Cebuano, the language in which all interviews and the discussion were conducted. Data collection continued until the research team judged that informational sufficiency had been reached: recruitment and interviewing concluded when the final two interviews yielded no substantively new codes relative to the preceding transcripts, a judgment made jointly by the lead researcher and the data analyst during ongoing analysis rather than inferred solely from having reached a recommended sample-size range (Alase, 2017). Data were analyzed following Colaizzi's (1978) seven-step descriptive phenomenological procedure: (1) each transcript was read and reread in its original Cebuano to acquire a feeling for the whole; (2) significant statements directly pertaining to farmers' experiences of perceived increasing heat and their adaptation strategies were extracted; (3) meanings were formulated from each significant statement; (4) formulated meanings were organized into clusters of themes; (5) findings were integrated into an exhaustive description of the phenomenon;

(6) the exhaustive description was condensed into a statement of the fundamental structure of the phenomenon; and (7) findings were returned to a subset of participants for member checking, to confirm that the described structure resonated with their own experience. Coding was conducted manually in Cebuano to preserve linguistic nuance; no qualitative analysis software was used. The lead researcher and a data analyst — selected for prior qualitative research experience and familiarity with phenomenological and thematic analysis — coded the transcripts independently and then met to compare codes, discuss discrepancies, and reach consensus on the final coding scheme and theme clusters; disagreements were resolved through discussion and, where the two coders could not agree, by returning to the original transcript excerpt. Coding proceeded inductively from the data rather than from a predetermined framework; the Sustainable Livelihoods Framework was applied afterward, during the discussion phase, to interpret how the inductively derived themes related to farmers' livelihood assets and the structures and processes that shape access to them, rather than to shape the coding itself.

The data analyst's independent coding was not treated as rendering the analysis objective in an absolute sense. Rather, it functioned as a reflexive check that required the lead researcher to justify coding decisions to another reader, surface alternative interpretations, and document the reasoning behind the final themes, consistent with contemporary guidance on rigor in reflexive thematic and phenomenological analysis (Braun & Clarke, 2021; Nowell et al., 2017). The research team — undergraduate researchers in disaster resiliency and management who were not themselves banana farmers and did not depend on banana farming for their livelihood — kept reflective memos throughout data collection and analysis to document initial assumptions about climate change and heat exposure and to examine how these assumptions might shape questioning and interpretation; these memos were discussed during coding meetings as part of the reflexive check described above.

Findings are presented using direct verbatim quotations to preserve the authenticity of participants' voices; the translation procedure used to render these quotations in English is described in Section 2.6 below. All interviews and the focus group discussion were conducted in Cebuano, and coding was carried out on the Cebuano-language transcripts rather than on translated text, to minimize the loss of meaning that can occur in translation. Quotations selected for presentation in this report were translated into English by the lead researcher, a native Cebuano speaker, and independently reviewed by a second bilingual member of the research team for equivalence of meaning; differences in phrasing were resolved by discussion, with priority given to preserving the sense and emphasis of the original statement over literal, word-for-word rendering.

2.5 Ethical Considerations

The research instrument was validated prior to data collection through expert review and pilot testing. Informed consent was obtained from all participants after they were briefed on the study's purpose, procedures, and their right to withdraw at any time without penalty; participation was entirely voluntary. Confidentiality was maintained through the use of pseudonyms, and all personal identifiers were removed from transcripts and the final report. Audio recordings and field notes were stored securely, accessible only to the researchers, and disposed of upon completion of the study. Trustworthiness was supported through member checking, peer review, an audit trail, and researcher reflexivity to minimize bias and enhance credibility, dependability, and confirmability. The principle of beneficence guided the research process throughout. The study underwent ethical review and clearance through the research protocols of the Institute of Leadership, Entrepreneurship, and Good Governance, Davao del Norte State College.

3. Results and Discussion

3.1. Lived Experiences of Banana Farmers Amid Perceived Increasing Heat

This section presents and discusses the study's findings, organized according to the three research questions: farmers' lived experiences of perceived increasing heat, their adaptation strategies, and the realizations they have drawn from these experiences. All fourteen participants were male banana farmers with 10 to 30 years of farming experience and educational attainment ranging from elementary level to

college graduate; the exclusively male composition of the sample is addressed as a limitation in Section 6. Themes below are described first as they were reported by participants; where the discussion draws on climatic, agronomic, or physiological literature to interpret these reports, this is indicated explicitly, since the study did not independently measure heat index, yield, or health outcomes.

3.1.1 Intensified Heat Stress and Work Fatigue

Participants described perceived increasing heat as a direct, embodied strain that reshapes daily farming life. Many reported starting work earlier and stopping by mid-morning because their bodies could no longer endure prolonged heat exposure, while others described recurring dizziness, weakness, and exhaustion while working under hot conditions.

"Sayo na kayko ko magsugod ug trabaho kay sayo nasad ko mopahunway kay alas dyes init naman kaayo ug mas nigamay ang harvest karon kumpara sauna."

"I start working early because I also rest early since by ten o'clock it is already very hot, and the harvest now is lesser compared to before. (Luigi)"

This pattern is consistent with the physiological literature on occupational heat stress: as ambient temperature rises, the body works harder to maintain a stable internal temperature, elevating heart rate, accelerating dehydration, and inducing fatigue more quickly than under normal conditions (Flouris et al., 2018). Outdoor workers, including farmers, experience pronounced productivity losses, slower reaction times, and heightened risk of heat-related illness as heat exposure increases, often requiring more frequent rest breaks and shortened working hours (De Sario et al., 2023; Han et al., 2024; Nelson et al., 2024). Beyond the physical toll, the inability to sustain long working hours disrupts routines that once structured farming life and that farmers link to their own sense of capability, generating frustration and anxiety as physical endurance visibly declines (Mora et al., 2024).

3.1.2 Decreased Yield and Crop Quality

Farmers reported experiencing heat first at the plant level, describing banana plants that grew more slowly, leaves that wilted more easily, and fruit that developed abnormally during hotter periods — changes they associated with smaller, cracked, or sunburned bananas and reduced market value.

"Ang pagsaka sa kainit nakapalisod sa pag-uma, nakapaminos sa harvest ug nakapastress sa tanom ug sa akong helper."

"The rising heat made farming more difficult, reducing banana yield and stressing both plants and my helper. (Luigi)"

According to agronomic literature, excessive heat accelerates moisture loss and intensifies plant stress, making bananas more susceptible to sunburn, cracking, and deformities that lower market value, consistent with broader findings that banana production in tropical regions is highly sensitive to sustained heat exposure (Chaiwong et al., 2021; Fischer et al., 2021; Abdoussalami et al., 2023). Within the Sustainable Livelihoods Framework, farmers' accounts illustrate how perceived increasing heat may undermine multiple livelihood assets simultaneously: natural capital through the reduced crop quality and yield farmers described, human capital through declining physical work capacity, and financial capital through the household income reductions participants reported (El Khayat et al., 2022).

3.1.3 Water Scarcity and Drought-like Conditions

Participants consistently reported that soil dries faster during periods of perceived increasing heat, requiring more frequent watering to prevent wilting. Luigi noted faster soil drying and identified water shortage as a key concern, while Recmar, Klipord, Kardo, and Rigor similarly described rapidly drying soil and fast-wilting leaves that demanded constant attention to irrigation. These observations are consistent with the physiological stress banana plants undergo as high temperatures accelerate soil-moisture evaporation and increase crop water demand, as documented in research on drought stress in banana cultivation (Nansamba et al., 2020; Santos et al., 2018; Uwimana et al., 2021). Within the

vulnerability context of the SLF, dwindling water availability constrains natural capital directly while increasing the labor and financial burden required to compensate through more frequent irrigation.

3.1.4 Emotional and Psychological Strain

Alongside physical exhaustion, farmers described persistent worry and anxiety tied to their crops' vulnerability to heat. Kardo, for example, described feeling persistently tired and worried about his crops during periods of extreme heat, while Recmar described feeling weak and anxious about his crop during hot spells. This intertwining of physical depletion and worry about crop outcomes reflects documented links between heat exposure and psychological strain, particularly among outdoor workers whose livelihoods depend directly on weather-sensitive labor (American Psychological Association, 2024; World Health Organization, 2024; De Sario et al., 2023). Within the SLF, this emotional strain represents an erosion of human capital that compounds the physical and economic pressures already reshaping farmers' daily lives (El Khayat et al., 2022).

3.1.5 Observed Climate Changes and Weather Shifts

Participants reported perceiving noticeably hotter and longer summers with rarer, less predictable rainfall compared to previous years, a pattern echoed across the group of farmers interviewed. This lived perception of a warming climate is consistent with regional and global assessments documenting rising heat index levels and increasingly erratic rainfall across tropical agricultural zones (IPCC, 2022; Chaiwong et al., 2021; Santos et al., 2018; Nansamba et al., 2020; Uwimana et al., 2021). Farmers' firsthand recognition of these shifts, independent of formal climate data, underscores the value of experiential knowledge in documenting localized climate change impacts (Uwimana et al., 2021).

3.1.6 Increased Farming Risks and Uncertainty

Farmers increasingly perceive banana production as a riskier undertaking under current climatic conditions, emphasizing the need for preparation, planning, and mutual support among growers to manage this uncertainty. This heightened perception of risk mirrors findings that climate variability increases uncertainty in smallholder agricultural systems, compelling farmers toward more deliberate planning and collective coping strategies (Mitter et al., 2019; Purwanti, 2023; Campbell, 2022; IPCC, 2022).

3.1.7 Essence of the Experience

Taken together, these six themes point toward a deeper experiential pattern beyond their individual descriptive content. Shortened working hours, physical exhaustion, crop uncertainty, water scarcity, and persistent worry collectively suggest that perceived increasing heat is lived by Balagunan's banana farmers primarily as a loss of control over the timing and pace of their own labor, an embodied vulnerability that links physical endurance directly to household income, and a pervasive livelihood uncertainty about the future viability of banana farming. This essence — heat as an encroachment on farmers' control over their own working lives — recurs across the adaptation strategies and realizations discussed in the following sections, which can be read as farmers' active attempts to reclaim a measure of that control.

Table 1. Major Themes and Core Ideas on the Lived Experiences of Banana Farmers Amid Perceived Increasing Heat

Theme	Core Ideas (Representative Participant)
Intensified Heat Stress and Work Fatigue	• Starts work much earlier and stops by mid-morning because of the heat (Luigi) • Cannot sustain long working hours under heat (Recmar) • Frequently experiences dizziness and heavy tiredness on hot days (Larpe) • Often feels weak and easily exhausted when it is hot (Charlie)

Decreased Yield and Crop Quality	• Reports reduced harvest linked to rising heat (Luigi) • Notes heat-related strain that lowers family income (Recmar) • Observes fruit cracking and plant wilting under heat (Larpe) • Records sunburned fruit and decreased income (Klipord)
Water Scarcity and Drought-like Conditions	• Sees faster soil drying and cites water shortage as a key concern (Luigi) • Notes that soil dries quickly, requiring more frequent watering (Recmar) • Finds that soil dries easily and plants wilt quickly (Klipord) • Describes rapid soil drying and fast-wilting leaves (Rigor)
Emotional and Psychological Strain	• Feels exhausted and stressed under extreme heat (Luigi) • Feels weak and anxious about the crop during hot spells (Recmar) • Is persistently worried about the bananas; work in the heat is exhausting (Dexter) • Feels very tired and worried about the crop during heat (Kardo)
Observed Climate Changes and Weather Shifts	• Notes hotter summers and rarer rainfall now compared to before (Luigi) • Perceives longer, hotter summers than in past years (Recmar) • Reports longer summers and unpredictable rain patterns (Kardo)
Increased Farming Risks and Uncertainty	• Realizes farming is getting harder and needs better preparation (Luigi) • Judges banana farming as riskier, requiring quick adaptation (Recmar) • Emphasizes preparation and unity among farmers amid the heat (Larpe)

3.2.

Adaptation Strategies Employed by the Banana Farmers to Respond to Perceived Increasing Heat

Consistent with the Sustainable Livelihoods Framework, farmers actively mobilize their available assets — human, natural, physical, social, and financial capital — to adapt to heat stress and sustain their livelihoods (Scoones, 2015).

Table 2. Major Themes and Core Ideas on the Adaptation Strategies Employed by Banana Farmers to Respond to Perceived Increasing Heat

Theme	Core Ideas (Representative Participant)
Water-saving Routines	• Waters early morning and late afternoon to avoid heat stress (Larpe) • Waters in the morning and applies compost to retain soil moisture (Charlie) • Stores rainwater and pairs it with mulching for efficiency (Dextoyjan) • Uses stored water (drums, river source) and manages watering schedules (Rigor)
Mulching, Soil Care, and Shade Creation (Agroforestry)	• Uses mulching and shade trees as part of soil-moisture management (Larpe) • Combines compost application with morning and late-afternoon watering (Charlie) • Plants large trees and coconuts around the farm to create shade buffers (Dexter)
Varietal Shifts and Scheduling	• Chooses Cardava over Cavendish for its greater heat tolerance (Klipord) • Continues planting Cardava because it withstands heat better (Charlie) • Shifts planting to cooler months to avoid peak heat (Rigor)
Use of Simple Irrigation Technologies	• Uses pumps, hoses, and sprinklers to save time and effort (Recmar) • Relies on hoses, drums, and a small water pump for irrigation (Dexter, Joaquin)

Knowledge Sharing and Cooperative Support

- Learns from older farmers and personal experience (Recmar)
- Notes that Department of Agriculture trainings occur but without financial assistance (Dexter)
- Draws on knowledge from elders and government trainings (Kardo)

3.2.1 Water-saving Routines

Farmers reported adjusting their watering schedules to early morning and late afternoon to minimize evaporation and heat stress on crops, with some storing rainwater and pairing it with mulching for greater efficiency (Larpe, Charlie, Dextoyjan, Rigor).

3.2.2 Mulching, Soil Care, and Shade Creation (Agroforestry)

"I put mulch and plant big trees for shade. (Dexter)"

Mulching helps retain soil moisture, regulate soil temperature, and enhance nutrient availability, while shade trees stabilize farm microclimates by lowering evapotranspiration and heat load, findings consistent with agroforestry and soil-conservation research (Aitkenhead-Peacock et al., 2021; Chalise et al., 2024; Santosh et al., 2022; Singh et al., 2022).

3.2.3 Varietal Shifts and Scheduling

Several farmers, including Klipord and Charlie, shifted toward the heat-tolerant Cardava variety over Cavendish, while Rigor adjusted planting schedules to cooler months to minimize heat-related losses — practices aligned with recommendations for climate-resilient banana cultivation (DA-HVCDP, 2022; Van Noordwijk et al., 2020; Van den Houwe et al., 2020; Muthusamy et al., 2016; FAO, 2023).

3.2.4 Use of Simple Irrigation Technologies

"I use hoses and sprinklers to save time. (Rigor)"

The adoption of accessible, low-cost irrigation tools such as hoses, drums, and small water pumps reflects farmers' practical mobilization of physical capital to manage water demand more efficiently under heat stress (FAO, 2023).

3.2.5 Knowledge Sharing and Cooperative Support

Farmers draw substantially on knowledge from older farmers and personal experience, supplemented by occasional government-led training. However, Dexter noted that while such trainings

occur, they are often unaccompanied by financial assistance, limiting farmers' capacity to implement recommended practices — a gap consistent with literature on the uneven translation of agricultural training into adaptive capacity (Cishahayo et al., 2024; Harvey et al., 2018; Lei et al., 2021; Mutuku et al., 2024).

3.3. Realizations of the Banana Farmers Who Experienced Perceived Increasing Heat

Table 3. Differences in the Dimensions of Culturally Responsive Pedagogy Between Private and Public School Teachers

Theme	Core Ideas (Representative Participant)
Recognition of Climate Change	• Acknowledges climate change impacts and hotter, drier patterns (Luigi) • Recognizes direct and serious effects of climate change on farming (Recmar) • Affirms that climate change is real and strongly affecting farmers (Kardo)
Need for Adaptation and Preparedness	• Emphasizes better preparation in response to increasing difficulty (Luigi) • Stresses changing farming methods and conserving water (Larpe) • Highlights resource-saving and quick adaptation to current climate (Klipord)
Cooperation and Collective Action	• Encourages working together and conserving water among peers (Recmar) • Advocates farmer unity and shared water systems (Larpe) • Calls for helping each other and sharing know-how to adapt (Klipord)
Desire for Government and Institutional Support	• Requests stronger irrigation support for farmers (Klipord) • Notes the lack of support and calls for aid amid extreme heat impacts (Dextoyjan) • Hopes for irrigation projects targeted at small farmers (Kardo)
Shift in Livelihood Perspective	• Considers a small store and animal raising to diversify income (Luigi) • Invests in livestock raising alongside farming to spread risk (Larpe) • Recognizes that farming alone is insufficient and seeks another income source (Charlie)
Resource Stewardship and Conservation Mindset	• Has become more serious about saving water in daily practice (Larpe) • Prioritizes water conservation and soil care under heat stress (Charlie) • Values water more now than before because of lived experience (Kardo)

3.3.1 Recognition of Climate Change

Farmers overwhelmingly acknowledged climate change as a real and directly felt force reshaping their farming conditions, consistent with global evidence that smallholder farmers often perceive climate shifts accurately through lived, seasonal observation even without access to formal climate data (Ghosh & Kirsten, 2019; IPCC, 2021).

3.3.2 Need for Adaptation and Preparedness

Participants emphasized that farming conditions now demand deliberate planning, resource conservation, and a willingness to adjust established practices — a realization aligned with adaptive-capacity literature emphasizing anticipatory planning as central to climate resilience (Talukder, 2021).

3.3.3 Cooperation and Collective Action

Farmers recognized that unity, shared water systems, and mutual assistance strengthen their collective capacity to cope with heat stress, echoing research on the role of cooperative structures in smallholder drought and climate risk management (Chhinh et al., 2023; Chang et al., 2022; Lamichhane et al., 2022; Makate et al., 2018).

3.3.4 Desire for Government and Institutional Support

Several participants explicitly called for stronger irrigation infrastructure and institutional assistance, expressing concern about the current lack of support amid intensifying heat impacts — a gap consistent with broader assessments of institutional support deficits in smallholder climate adaptation (FAO, 2019; World Bank, 2019).

3.3.5 Shift in Livelihood Perspective

Recognizing that banana farming alone may no longer provide sufficient or stable income, several farmers began considering or pursuing livelihood diversification, such as small retail or livestock raising, consistent with diversification as a livelihood-resilience strategy under climatic stress (Asante et al., 2018).

3.3.6 Resource Stewardship and Conservation Mindset

"Mas gibatagan nako ug bili ang tubig karon kumpara sauna." "I value water more than before. (Kardo)"

This growing appreciation for water reflects an emerging conservation mindset shaped directly by lived scarcity: as climate change brings more droughts and unpredictable rainfall, farmers who depend on consistent irrigation increasingly recognize water as a resource requiring deliberate stewardship, consistent with sustainable resource-management literature linking personal awareness of scarcity to conservation behavior (Velasco-Muñoz et al., 2018; Smith, 2023; Soujanya & Gurjar, 2024; Arslan & Kartal, 2023).

4. Conclusion

This study concludes that perceived increasing heat has become a defining challenge for banana farmers in Barangay Balagunan, as described in their own accounts, significantly altering both their day-to-day work and the overall stability of their livelihoods. Farmers' lived experiences reveal that hotter conditions are, in their accounts, now a constant and largely unavoidable part of farm life, bringing dizziness, weakness, and fatigue that shorten working hours and, in farmers' own reports, coincide with diminished banana yield and quality. Farmers' accounts also point to drying soil and less predictable rainfall, which they associate with the intensifying heat they describe; this study cannot independently confirm a causal relationship between these observations and measured heat-index trends, since no meteorological data were collected. Despite these hardships, farmers demonstrate considerable resilience through a range of self-driven adaptation strategies — mulching, early-morning watering, shade-tree planting, and more efficient water use — alongside adjusted work routines and knowledge-sharing with fellow farmers. These practices suggest that farmers are active agents drawing on experience, resourcefulness, and community relationships to cope with the conditions they describe, even as participants reported that such self-driven strategies remain limited by scarce financial resources, insufficient irrigation systems, and restricted access to climate-resilient inputs. Framed within the Sustainable Livelihoods Framework, the findings show that farmers actively mobilize human, natural, physical, social, and financial capital to sustain their livelihoods amid the conditions they describe, yet participants reported persistent gaps in institutional and government support that continue to constrain the effectiveness of these efforts. Section 5 outlines recommendations, organized by level of responsibility, that follow directly from these findings.

5. Recommendations

The following recommendations are based on the study's findings and are directed toward strengthening farmers' capacity to adapt to increasing heat. At the farmer and household level, continued peer-to-peer sharing of low-cost practices such as water conservation, mulching, and shading is encouraged to expand their adoption. At the barangay and local government level, the feasibility of community-based water-storage and shared-irrigation systems should be assessed in consultation with farmer groups, given reported constraints in irrigation access. The Department of Agriculture and

agricultural extension services should complement climate-resilient farming training with accessible financing and material or input support for practices such as varietal diversification and irrigation technologies. For future research, qualitative accounts should be integrated with meteorological, yield, and economic data to compare farmers' perceptions with measured climate and production trends, while also including women involved in banana farming and households with more diverse ages and farming tenures to provide a broader understanding of climate adaptation.

6. Limitations of the Study

This study is limited by its reliance on self-reported narratives, which may be influenced by personal interpretation and recall bias — a recognized characteristic of phenomenological research (Alase, 2017). Findings are not intended to be statistically generalizable; rather, as is appropriate for qualitative research, readers are invited to judge the transferability of these findings to other, contextually similar smallholder banana-farming communities (Lincoln & Guba, 1985). The study involved a small, purposively selected group of fourteen participants from a single barangay. Two further limitations concern the study's central construct and sample composition. First, although the study is framed around perceived increasing heat and the broader construct of heat index, no independent meteorological data on temperature, humidity, or heat-index trends were collected or triangulated against participants' accounts; the study therefore documents farmers' perceived increasing heat rather than an objectively measured increase in heat index, and this distinction should be kept in mind when interpreting the findings. Second, all fourteen participants were male, which substantially limits insight into gendered farming experiences and household-level adaptation decisions; women's roles in banana-farming households in Barangay Balagunan were not captured by this study. The research did not include quantitative measurements of crop yield or economic losses, nor did it examine other climate-related stressors such as typhoons, flooding, or pest outbreaks, despite their relevance to agricultural vulnerability (FAO & WMO, 2023). These limitations reflect the study's deliberate focus on the depth of lived experience rather than breadth or quantitative assessment; future research incorporating mixed methods, larger and more gender-diverse samples, and quantitative climate and yield data would help triangulate and extend these findings.

Supplementary Details

Supplementary Materials & Data availability statement (If Applicable):

The semi-structured interview guide, validation questionnaire, participant informed-consent form, and institutional ethics-clearance documentation (RES-Form 3, RES-Form 5, RES-Form 8, RES-Form 10) are available from the corresponding author upon reasonable request.

Author Contributions:

All authors jointly conceptualized the study and contributed to its methodology, data collection, formal analysis, and writing of the original draft; all authors reviewed and approved the final manuscript.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Arcenio	✓	✓				✓		✓	✓	✓				
Vallecera	✓	✓				✓		✓	✓	✓				
Asotigue	✓	✓				✓		✓	✓	✓				
Manginsay	✓	✓				✓		✓	✓	✓				
Apa	✓	✓				✓		✓	✓	✓				
Palabras	✓	✓				✓		✓	✓	✓				

C: Conceptualization · M: Methodology · So: Software · Va: Validation · Fo: Formal analysis · I: Investigation · R: Resources · D: Data Curation · O: Writing – Original Draft · E: Writing – Review & Editing · Vi: Visualization · Su: Supervision · P: Project administration · Fu: Funding acquisition

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Institutional Review Board Statement

This study was reviewed and cleared through the research ethics protocols of the Institute of Leadership, Entrepreneurship, and Good Governance, Davao del Norte State College (RES-Form 3, RES-Form 5, RES-Form 8, and RES-Form 10)

Informed Consent Statement:

The study adhered to ethical standards in research involving human participants. Prior to data collection, participants were provided with a comprehensive informed consent form detailing the purpose of the study, procedures, potential risks and benefits, confidentiality measures, and their rights, including voluntary participation and the option to withdraw at any time without

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Conflicts of Interest:

The authors declare no conflict of interest.

Disclosure Statement:

The authors used ChatGPT to assist with reformatting the manuscript into the journal's required structure and condensing the results section for length. The AI tool was not used for data collection, data analysis, or interpretation of findings. All AI-generated or AI-assisted content was reviewed, verified, and edited by the authors, who take full responsibility for the accuracy, originality, and integrity of the manuscript.

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