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Assessing Food and Livelihood Security in Sea Salt Community: A GIAHS Study in Ban Laem, Phetchaburi, Thailand

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Abstract: This study investigates food and livelihood security in Ban Laem District, Phetchaburi, a unique sea salt community recognized under the Globally Important Agricultural Heritage Systems (GIAHS). We assess the current status of food and livelihood security, utilizing the entropy weight method. Our findings reveal a composite evaluation score of 2.724, comprising an average food security rating of 1.476 and a livelihood security score of 1.248. Agricultural diversity emerges as pivotal for food security, while financial support, indigenous knowledge preservation, and climate adaptation strategies are crucial for livelihood security. Our recommendations include fostering awareness, collaboration, diversified farming, financial accessibility, and cultural conservation initiatives. This research provides valuable insights into coastal community security and informs transformative policies for sustainable development.

Keywords: food security; livelihood security; GIAHS; sea salt communities

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1. Introduction

The contemporary global emphasis on the intricate interconnections among sustainable agriculture, food security, and securing livelihoods underscores their interplay grounded in economic principles. Agriculture's role extends beyond sustenance, propelling employment, earnings, and community advancement. Scholars such as Phuripanyo [1], Mughal [2], Krishna Kumar et al. [3], and Alila and Atieno [4] have recognized this dynamism as a foundational factor in poverty alleviation. Yet, rural landscapes for the past few decades have grappled with challenges arising from climate fluctuations, evolving land use policies, and shifting demographics, as articulated by Lurie and Brekken [5]. Meanwhile, communities can navigate these complexities by leveraging their accumulated wisdom, ancestral heritage, and traditions, collectively referred to as agricultural cultural capital, to foster local stability, sustainability, and resilience, as seen through McCorckle [6].

Agricultural heritage and the intergenerational transmission of agricultural cultural capital emerge as pivotal catalysts for economic and societal advancement, seamlessly aligning with the core principles of the Globally Important Agricultural Heritage Systems (GIAHS), which underscore the role of traditional agricultural practices in propelling sustainable progress [7]. Initiated in 2002 by the Food and Agriculture Organization (FAO) of the United Nations, the GIAHS program aims to recognize and fortify traditional agricultural practices conducive to sustainable development, finding that the convergence of agricultural cultural capital and GIAHS principles—particularly in the sustainable utilization of agricultural biodiversity, traditional knowledge, and cultural heritage—contributes significantly to biodiversity and natural resource conservation [8]. Furthermore, through the GIAHS program, which is closely intertwined with agricultural cultural capital, valuable resources are channeled towards the tourism and cultural heritage sectors, thereby bolstering local identity and fostering community-based tourism initiatives, as evident in the work of Kajihara et al. [9].

Central to the Globally Important Agricultural Heritage Systems (GIAHS) is the acknowledgment and endorsement of traditional agricultural systems, which have historically underpinned local food production and livelihoods, serving as reservoirs of agricultural knowledge, practices, and genetic diversity intimately tailored to local contexts and, by preserving and advocating for these systems, directly reinforcing food security through ensuring a diverse and locally adapted food supply. Furthermore, GIAHS-designated sites not only exemplify sustainable agricultural practices, addressing climate-related risks and enhancing soil health, but also bolster resilience against environmental challenges and leverage tourism to enhance rural livelihoods, offering alternative income streams for farmers and exerting a positive impact on food production, local economies, incomes, and employment opportunities as validated by Lun et al. [10], Su et al. [11], and Wang et al. [12]. Currently, the Food and Agriculture Organization (FAO) recognizes a total of 73 GIAHS sites [13], strategically dispersed across varied regions (listed in Table 1) and each encapsulating a unique lifestyle, cultural heritage, and distinct landscapes teeming with biodiversity; though, achieving the designation of a GIAHS site entails a rigorous process that requires meticulous evaluation and certification by the FAO, covering pivotal aspects such as food and livelihood security, agrobiodiversity, and local knowledge systems, as delineated by Scheurer et al. [14].

Table 1. List of Globally Important Agricultural Heritage Systems (GIAHS).

Region	Country or Territory (Number of Sites)
Africa	Kenya (1), Tanzania (2)
Asia and Pacific	China (19), Japan (13), the Republic of Korea (5), Islamic Republic of Iran (3), India (2), the Philippines (1), Jammu and Kashmir (*) (1), Sri Lanka (1) Bangladesh (1), Thailand (1)
Europe and Central Asia	Italy (2), Portugal (1), Spain (5)
Latin America and the Caribbean	Ecuador (2), Mexico (2), Peru (1), Brazil (1), Chile (1),
Near East and North Africa	Morocco (3), Tunisia (3), Algeria (1), Egypt (1), the United Arab Emirates (1)

Note: Territory (*); Sources: FAO [13].

In the realm of countries boasting GIAHS-designated sites, Thailand distinctly shines, with its agricultural heritage deeply woven into its cultural and economic tapestry, persisting as a cornerstone of economic sustainability and cultural identity amidst modernization currents. Such heritage, amidst societal shifts documented by Gödecke and Waibel [15], has impelled the Ministry of Agriculture and Cooperatives in Thailand to advocate for the conservation of traditional practices and cultural identity through GIAHS site designations. Nonetheless, despite its abundant cultural and ecological heritage, Thailand's sea salt production, steeped in a 900-year-old tradition, especially in Ban Laem, Phetchaburi—a seminal hub for sea salt production—has yet to be recognized by GIAHS. Acknowledging its potential, the Thai Ministry of Agriculture and Cooperative, substantiated by MOAC [16] and Tansuchat [17], is actively facilitating its candidacy. Farmers in the Ban Laem district of Phetchaburi, celebrated as a historical sea salt hub, encounter issues related to debt, market volatility, and climate risks, as articulated by MOAC [18] and MOAC [16], and to navigate these challenges while elevating sea salt culture to a GIAHS-designated heritage site, the Thai Sea Salt Development Committee has instigated initiatives, as delineated in a 2022 report by MOAC [19].

Spanning a diverse spectrum, the advantages of GIAHS registration, which encompasses enhanced food security, policy alignment, and sustainable development as delineated by FAO in 2021 [20], are substantial. The GIAHS recognition selection process, governed with specific criteria detailed in FAO's 2017 guidelines, necessitates a comprehensive

governmental authorities' assessment, addressing vital aspects such as food and livelihood security, agrobiodiversity, and cultural components, with the cultural dimensions of sea salt farming being specifically explored by Plaiphum and Tansuchat [21]. Furthermore, ensuring food and livelihood security proves imperative for the long-term sustainability of agricultural systems, and through evaluating sustainable food and livelihood security, GIAHS can gauge the impact of agricultural practices on local communities, pinpointing specific community challenges and needs, thereby facilitating the development of targeted interventions to enhance security in these pivotal areas.

Emphasizing the paramountcy of "Food and Livelihood Security" and its critical role in societal welfare, this study elucidates the "food security" concept, which ensures access to nutritious food for all, according to the FAO [22], and aligns livelihood security with economic, social, and environmental facets, corroborated by Lun, Jianhui, et al. [23]. Despite its pivotal role, scant research has investigated food and livelihood security in Thailand's GIAHS-designated regions. Thus, this inquiry not only aims to demystify the current food and livelihood security status in Ban Laem, Phetchaburi, but also strives to identify, dissect, and explicate pivotal indicators and factors essential for appraising food security within the GIAHS parameters, ultimately formulating pragmatic policy recommendations, enriched with derived insights, to fortify local well-being and bolster sustainable development. Leveraging a nuanced quantitative analysis grounded in the entropy weight method (EWM), which calculates objective weights from diverse datasets and eschews the bias of subjective weight methods, this research provides a balanced, thorough foundation for weight determination by considering dispersion and differentiation degrees, as detailed by Zhu et al. [24], and innovatively introduces indicators, including climate change impact and youth participation in agriculture, to amplify comprehension of the area's potential.

In conclusion, this research makes several substantial contributions to the field. Firstly, it offers a comprehensive assessment of the present status of food and livelihood security within the specific research area of Ban Laem, Phetchaburi. Secondly, it identifies and scrutinizes the particular indicators and factors instrumental in evaluating food security within the GIAHS criteria framework in the context of Ban Laem, Phetchaburi. Lastly, it derives pragmatic policy recommendations from the insights gleaned through the evaluation process, with the overarching objective of elevating the well-being of the local community and advancing sustainable development. Altogether, this research provides valuable insights into the integration of GIAHS criteria in assessing food and livelihood security, offering vital guidance for policymaking and sustainable practices.

The paper is structured as follows: Section 2 covers literature on GIAHSs, food and livelihood security assessments, climate change in GIAHSs, and young labor in GIAHSs. Section 3 outlines materials and methods; Section 4 presents results and discussions; and Section 5 summarizes findings, offers policy recommendations, notes limitations, and suggests future research directions.

2. Literature Reviews

2.1. Globally Important Agricultural Heritage Systems (GIAHS)

In our quest to assess food and livelihood security in Ban Laem, Phetchaburi, Thailand, it is imperative to grasp the essence of the Globally Important Agricultural Heritage Systems (GIAHS). These systems encapsulate millennia of farming, herding, fishing, and forestry practices renowned for their profound influence on local knowledge accumulation, which has bolstered food security, preserved biodiversity, stimulated economic growth in communities, enriched cultures, and sculpted unique landscapes [25].

Initiated by the Food and Agriculture Organization (FAO) of the United Nations in 2002, the GIAHS program stands as a stronghold for safeguarding traditional agricultural practices and systems that hold immense social, cultural, and environmental values. The GIAHS program seeks to shine a spotlight on systems that achieve a delicate harmony between human activities and the natural environment, exemplifying resilience and adaptability while effectively addressing challenges tied to food security, poverty alleviation, and

biodiversity conservation [26]. It operates in conjunction with local communities, governments, and various stakeholders to foster sustainable management and conservation plans for these agricultural cultural systems. Additionally, it promotes socio-economic development, tourism, and the preservation of cultural heritage [27]. GIAHS employs a rigorous set of criteria to pinpoint and promote agricultural systems of remarkable social, cultural, and environmental significance. These criteria, outlined by L'Erario, A. [28], Yotsumoto and Vafadari [29], and Jeong et al. [30], encompass: Food and livelihood security; Agrobiodiversity, genetic preservation, and local knowledge; Local and traditional knowledge systems; Cultural and social integration; and Unique landscapes and seascapes features.

The FAO, as the governing body responsible for designating and certifying GIAHS sites, follows a meticulous process. Sites seeking GIAHS designation must submit a proposal to the GIAHS Secretariat at the FAO, subject to a comprehensive review. The Scientific Advisory Group (SAG), comprise specialists in the field, rigorously assesses the proposal to determine its alignment with the established criteria. Subsequently, upon acceptance of the proposal, an expert or a team of experts selected by the SAG embarks on a visit to the proposed site, culminating in the creation of an evaluation report based on their findings (as discussed in FAO [31]).

Since the inception of the GIAHS program, the FAO has acknowledged 72 agricultural heritage sites across 23 countries, each celebrated for its substantial social, cultural, and environmental values. These sites are actively promoted as models for sustainable development, underscoring the program's unwavering commitment to preserving the rich tapestry of agricultural heritage across the globe (as reported by FAO [31]).

2.2. Food and Livelihood Security Assessments and GIAHS

The assessment of food and livelihood security holds paramount importance within the context of the Globally Important Agricultural Heritage Systems (GIAHS) program. GIAHS places specific emphasis on identifying agricultural systems that play a pivotal role in ensuring food security and sustainable livelihoods, particularly for small-scale farmers and local communities, as covered in Fernandez et al. (2020) [32].

Food security is defined as the accessibility of an adequate quantity and quality of food that is physically, socially, and economically within reach, meeting the dietary needs and preferences of all individuals for a healthy and active life. This comprehensive definition extends beyond mere food access and encompasses factors such as a healthy environment, adequate healthcare services, stability, education, and care, as provided by the FAO [33], Lun et al. [34], and Lun et al. [23].

Conversely, livelihood security is defined by a household or community's capacity to sustain and enhance its income, assets, and social welfare while safeguarding against long-term developmental threats. For agricultural and fishing communities, this security encompasses capability assurance, asset stability, and social welfare. The overarching goal is to foster sustainable growth while ensuring a balance and cooperation between the economy, society, and the environment. This in-depth perspective is encapsulated by Lun et al. [23,34] and Ahmed et al. [35]. Furthermore, for local communities to achieve sustainable livelihoods, there must be efficient allocation and development of natural resources, including water sources, land use, and community forest areas, as highlighted by Jin et al. (2019) [36] and Wolde [37].

Within the framework of GIAHS, the preservation and promotion of traditional agricultural practices and systems play a pivotal role in ensuring food and livelihood security by providing sustainable and dependable sources of food and income for communities [38]. However, the limited research and discourse on food and livelihood security assessments have necessitated the development of a framework to assess these crucial aspects. This framework comprises two primary components: food security and livelihood security at the household level [34]. A previous study summarized, extracted, and constructed a framework for food security and livelihood security assessments, employing the max–min

normalization method with subjective weights to gauge the food and livelihood security levels of different types of farmers [23].

Prior research underscores the limited exploration of food security and livelihoods within the context of the GIAHS framework. A notable study by Yang et al. [39] employed subjective weights to assess these aspects in Diebu, Zhagana's Agriculture–Forestry–Animal-Husbandry system, a GIAHS site in China. Yet, such subjective weighting poses risks of bias and interpretation challenges [40,41]. To mitigate these concerns, we suggest adopting the weighted entropy method. Furthermore, climate change and the declining involvement of the youth in agriculture are significant factors influencing food security and livelihoods.

The GIAHS program recognizes the significant impact of climate change on various agricultural facets, including crop yield, plant and animal health, soil and water quality, and extreme weather occurrences. This phenomenon poses a considerable threat to global and local food security and the livelihoods of those reliant on agriculture. The IPCC links global warming to human actions, emphasizing its widespread effects on ecosystems, societies, and economies [42]. Climate change affects multiple aspects of food security, from accessibility and availability to utilization, influencing agricultural productivity, work conditions, property rights, and dietary nutrition [43–45]. Thus, GIAHS emphasizes resilient agricultural systems that integrate traditional practices, agro-biodiversity, and sustainable techniques. Studies have revealed farmers' perceptions of agriculture's vulnerability to climate change [46], with specific issues like varying rainfall patterns causing crop failures in Kenya and negatively impacting livestock in Nigeria [47,48]. Furthermore, shifts in climate patterns can alter salt production [49,50]. Therefore, understanding climate change's effects on food security is vital, necessitating active stakeholder involvement in both documentation and mitigation efforts.

The GIAHS program acknowledges the profound influence of climate change on agriculture, encompassing aspects such as crop yields, the health of plants and animals, soil quality, water resources, and the frequency and severity of extreme weather events. These changes pose substantial risks to both local and global food security, as well as the livelihoods of those who depend on agriculture. The Intergovernmental Panel on Climate Change (IPCC) has unequivocally attributed global warming to human activity, highlighting its far-reaching consequences for ecosystems, societies, cultures, and economies on a global scale [42].

Climate change has exerted multifaceted effects on various dimensions of food security, influencing such factors as accessibility, availability, and utilization. These changes have implications for agricultural productivity, working conditions, property rights, and the nutritional quality of diets [43–45]. Consequently, the GIAHS program is committed to promoting agricultural systems that demonstrate resilience and adaptability in the face of climate change. This includes traditional practices that incorporate agro-biodiversity and the adoption of sustainable agricultural techniques.

Empirical studies employing Likert scales have shed light on the perception of farmers regarding the vulnerability of the agricultural sector to climate change, which directly threatens food security [46]. Reports from women's groups in Kenya have highlighted fluctuations in rainfall and temperature leading to crop failures, while farmers in Nigeria have reported adverse impacts on livestock and agricultural production [47,48]. In addition, the change in temperature and rainfall patterns due to climatic shifts may affect salt production [49,50]. Thus, assessing climate change's repercussions on food security is imperative, and various stakeholders play a pivotal role in recognizing and tackling these issues.

Additionally, a major challenge facing the agricultural sector is the waning interest of the youth in farming careers. This decline is evident in emerging Asian economies like Indonesia, China, and the Philippines, as cited in multiple studies [51–54]. Such a trend threatens the future of agriculture, risking labor shortages and diminished productivity.

Thailand, which defines young farmers as those between 18 and 45 years old [55], also witnesses this dwindling youth participation, attributed to its aging populace [56,57].

Several reasons deter the youth from farming in Thailand. Common perceptions include farming as a low-income, unattractive profession, hurdles in obtaining agricultural finance, and restricted access to resources. This mindset has led to suboptimal farming practices and increased food insecurity [58]. Literature highlights deterrents like small farm sizes, limited earnings, and scant profits [59,60], with the youth seeking more lucrative opportunities [61,62]. Another factor is the parental push towards non-agricultural professions [63], risking a successor crisis in farming [64]. For the GIAHS program, drawing youth to farming is pivotal. Yet, there is a noticeable research gap in this area, especially within the GIAHS framework. Some researchers [65,66] argue for the inclusion of youth-centric indicators in the GIAHS criteria, emphasizing the repercussions of the reduced number of young farmers. This underscores the need for extensive research to address this issue.

3. Materials and Methods

3.1. Study Area

This research took place in the Ban Laem District, Phetchaburi Province, Thailand. This site was chosen by the Thai government as part of the Action Plan for the Development of Thai Sea Salt in Fiscal Year 2023 [67]. Additionally, Phetchaburi Province gained UNESCO recognition as a member of the Creative City Network in 2021 due to its diverse natural resources, rich cultural heritage, and innovative cultural initiatives promoting sustainable development and cultural diversity, as well as its remarkable contributions to the cultural and creative industries [68–70].

The Ban Laem District of Phetchaburi Province is situated on Thailand's east coast at coordinates 13°12′2″ N, 99°58′49″ E, in Figure 1. It experiences two distinct seasons: a dry period from December to April and a wet period from May to November. The annual average rainfall is 1042.4 mm, with temperatures ranging from 15.0 to 37.9 °C throughout the year. The district features flat terrain intersected by freshwater, brackish water, and saltwater canals, making it ideal for sea salt farming from December to May.

In 2019, the Ban Laem District had 3122 agricultural households, accounting for approximately 21.77 percent of all households in the district. The farming area in the district covered 16,625 rai, primarily dedicated to rice fields which represents about 23.53 percent of the total agricultural land. Furthermore, the majority of the remaining agricultural land was used for salt farming, encompassing 44,797 rai, equivalent to approximately 63.40 percent of the overall agricultural land area [71].

The fishery is another significant occupation in the area due to its coastal location, abundant natural resources, and extensive mangrove forests, which provide a habitat for various aquatic life. Therefore, in addition to sea salt production, the community is engaged in other coastal activities such as coastal fishery, shellfish culture, and shellfish collection, all of which are traditional skills passed down through generations.

3.2. Population and Samples

3.2.1. Population and Samples

In this study, we employed Krejcie and Morgan's formula put forward in 1970 to determine the appropriate sample size [73]. Following the criteria outlined in their work, we selected a total of 409 households to participate in our research for the assessment of food and livelihood scores. The sample size (s) was calculated using the formula below:

$$s = \frac{\chi^2 N p(1-p)}{d^2(N-1) + \chi^2 p(1-p)} \quad (1)$$

where s is the sample size; χ^2 is the Chi-square value for 1 degree of freedom at the desired confidence level, (3.841); N is the population size, encompassing 8936 households from five subdistricts; p is a population proportion (assumed to be 0.50, as it provides the maximum

sample size); and d is a degree of accuracy expressed as a proportion (0.05). According to this formula, the calculated sample size should have been 369. However, we collected data from 409 samples in our study.

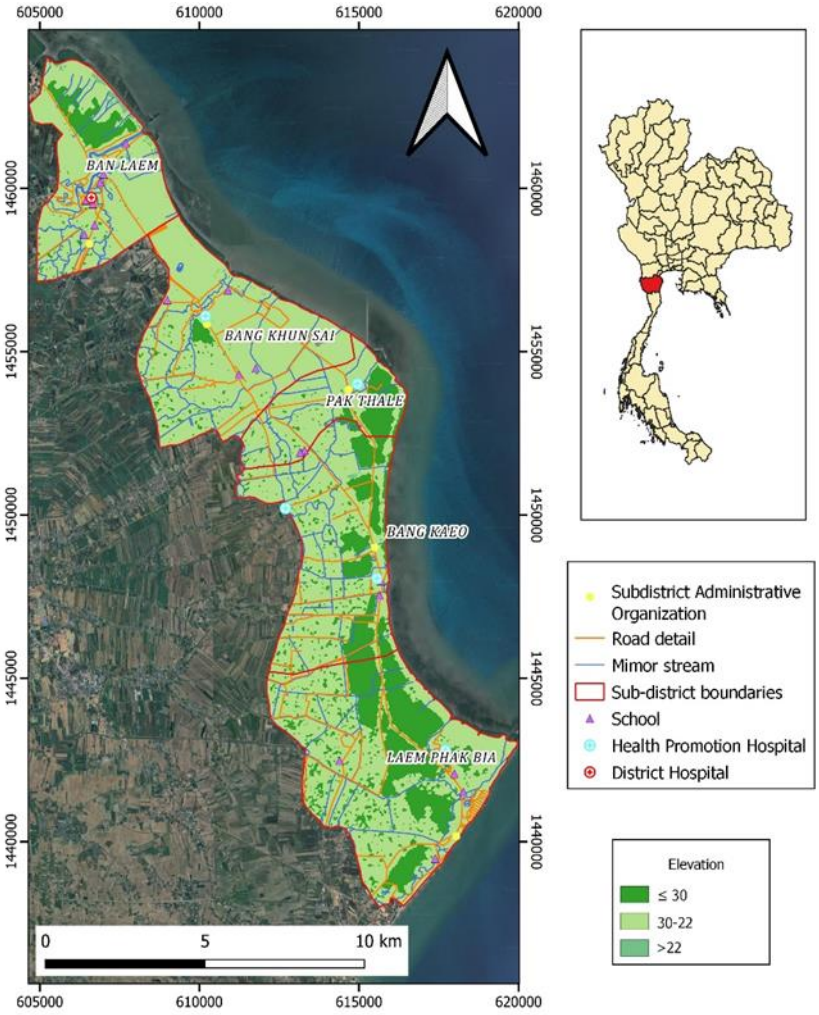


Figure 1. The Ban Laem District of Phetchaburi Province, Thailand. Source: The author designed the figure in a QGIS 3.32 program [72].

3.2.2. Data Collection

Our research adopted a comprehensive data collection approach, utilizing a range of methods to ensure a holistic understanding of the subject. These methods included non-participatory observation, key informant interviews, focus group discussions, and questionnaire surveys.

Non-participatory observation provided valuable visual insights into the daily lives and livelihoods of rural individuals engaged in agriculture and coastal occupations. Key informant interviews and focus group discussions were instrumental in gathering qualitative data, shedding light on local customs, culture, and traditional knowledge. Key informant interviews particularly helped explore socio-cultural aspects, rural livelihoods, and stakeholder food production.

In addition, we conducted extensive questionnaire surveys between April and October 2022, involving 409 households across the five subdistricts. These surveys were thoughtfully designed to collect quantitative data spanning various dimensions, including community assets, economic activities, and cultural practices.

Furthermore, we implemented the snowball sampling technique to access data from sea salt stakeholder groups and evaluate their capital ratio status in each subdistrict, using

a modified sustainable livelihood framework. We successfully reached our target of 100 sea salt stakeholder respondents by collecting data from 20 respondents in each subdistrict. The choice of the snowball sampling technique was driven by the necessity to address challenges associated with sampling salt stakeholder populations that might be otherwise difficult to reach through conventional methods [74].

3.3. Assessment Criteria Development and Methods

3.3.1. Food Security Assessment

Within our research context, we adopted Lun et al.'s [34] food and livelihood security evaluation framework, subsequently refined in their 2021 work [23]. This framework effectively categorizes indicators into six distinct groups, as detailed in Table 2. Our focus in food security assessment centered on three primary indicators: essential food supply product security (*EFS*), related essential food supply product security (*RFS*), and related non-food supply product security (*NFS*). In parallel, our evaluation of livelihood security concentrated on the following primary indicators: livelihood background security (*LBS*), livelihood assets security (*LAS*), and livelihood outcomes security (*LOS*).

Table 2. Primary and secondary indicators with definitions, weights, and references.

Primary-Indicator	Secondary-Indicator	Indicator Definition	Weight	Reference
Essential food supply products security (*EFS*)	The quantity of essential food supply products	EF1: The annual output of essential food supply products per household (kg)	0.2487	[23,34]
	The quality of essential food supply products	EF2: Farmers' and fishermen's evaluation on the quality of essential food supply products (Likert scale (1–5))	0.1423	[23,34]
	The environmental quality of essential food supply products	EF3: Farmers' and fishermen's evaluation on the environmental quality of essential food supply products (Likert scale (1–5))	0.1415	[23,34]
	The diversity of essential food supply products	EF4: The extent of diversity in essential food supply products (Simson Index value (0–1))	0.3495	[23,34,75]
	Young labor engagement in essential food supply products	EF5: The level of engagement of the younger generation in the production of essential food supply products (Likert scale (1–5))	0.0712	[46,76]
	Climate change impact on essential food supply products	EF6: The level of climate change as a threat to essential food supply products (Likert scale (1–5))	0.0469	[46,77]
Related essential food supply products security (*RFS*)	The quantity of related essential food supply products	RF1: The annual output of related essential food supply products per household (kg)	0.4309	[23,34]
	The quality of related essential food supply products	RF2: Farmers' and fishermen's evaluation on the quality of related essential food supply products (Likert scale (1–5))	0.0975	[23,34]
	The environmental quality of related essential food supply products	RF3: Farmers' and fishermen's evaluation on the environmental quality of related essential food supply products (Likert scale (1–5))	0.0903	[23,34]
	The diversity of related essential food supply products	RF4: The extent of diversity in related essential food supply products (Simson Index value (0–1))	0.2259	[23,34,75]
	Young farmer engagement in related essential food supply products	RF5: The level of engagement of the younger generation in the production of related essential food supply products (Likert scale (1–5))	0.1029	[76,78]
	Climate change impact on related essential food supply products	RF6: The level of the climate change as a threat to related essential food supply products (Likert scale (1–5))	0.0525	[46,77]

Table 2. *Cont.*

Primary-Indicator	Secondary-Indicator	Indicator Definition	Weight	Reference
Related non-food supply products security (*NFS*)	The quantity of related non-food supply products	NF1: The annual output of related non-food supply products per household (kg)	0.2040	[23,34]
	The quality of related non-food supply products	NF2: Farmers' and fishermen's evaluation on the quality of related non-food supply products (Likert scale (1–5))	0.0898	[23,34]
	The environmental quality of related non-food supply products	NF3: Farmers' and fishermen's evaluation on the environmental quality of related non-food supply products (Likert scale (1–5))	0.0943	[23,34]
	The diversity of related non-food supply products	NF4: The extent of diversity in related non-food supply products (Simson Index value (0–1))	0.4407	[23,34,75]
	Young farmer engagement in related non-food supply products	NF5: The level of engagement of the younger generation in the production of related non-food supply products. (Likert scale (1–5))	0.0794	[76,78]
	Climate change impact on related non-food supply products	NF6: The level of the climate change as a threat to related non-food supply products (Likert scale (1–5))	0.0918	[46,77]
Livelihood background security (*LBS*)	External natural background	LB1: The perspective of local farmers and fishermen on the natural environment of the area (Likert scale (1–5))	0.3596	[23,34]
	External economic background	LB2: The perspective of local farmers and fishermen on the economic environment of the area (Likert scale (1–5))	0.2212	[23,34]
	External social background	LB3: The perspective of local farmers and fishermen on the social environment of the area (Likert scale (1–5))	0.3077	[23,34]
	Family geographical characteristics	LB4: The distance between residence and the downtown area (km)	0.1115	[23,34]
Livelihood assets security (*LAS*)	Natural asset	LS1: The amount of agricultural land, grassland, and pond space available to each household (ha)	0.6443	[79,80]
	Physical asset	LS2: Access to infrastructure and equipment in communities (Likert scale (1–5))	0.0149	[81,82]
	Human asset	LS3: The total number of people who work in agriculture and fishery for each household (person)	0.0712	[81,83–85]
	Social asset	LS4: The number of people who share a common relative with another resident in the sea salt communities area (person)	0.0581	[81,83,86]
	Financial asset	LS5: Households' saving and debt status and loan access (Likert scale (1–5))	0.0552	[87–90]
	Cultural asset	LS6: The degree of indigenous knowledge and willingness to retain traditional manual skills for the next generation (Likert scale (1–5))	0.0760	[83,84,91–93]
	Informational asset	LS7: The number of various types of access-to-information equipment (items)	0.0802	[94]
Livelihood outcomes security (*LOS*)	Total income level	LO1: The annual aggregate amount of money received by each household (baht)	0.2448	[23]
	Per capita income level	LO2: The annual total income per household member (baht)	0.3658	[23]
	Agricultural/Fisheries income level	LO3: The aggregate annual income earned by a household via agricultural and fishing activities (baht)	0.3893	[23]

Source: Compiled from various sources; references provided in the last column. The weights are calculated from Entropy. Note: Likert scale (1–5) means (1 = Very poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Excellent).

As per the GIAHS food security evaluation criteria, various factors are considered, encompassing the quantity, quality, and diversity of essential food supply products, related essential food supply products, and related non-food supply products. Additionally, the assessment considers the environmental quality of the food production process. Essential food supply products, designated as "flagship" and "landmark" within the GIAHS framework, hold particular importance due to their central role as the primary food source for local communities. Related essential food supply products complement essential items, offering additional dietary support to farmers. Moreover, the evaluation encompasses related non-food supply products, such as energy and fertilizer, acknowledging their pivotal role in food production, including their use in fodder processing. These insights align with the research of Ahmed et al. [95], Lun et al. [23], and Lun et al. [34].

Furthermore, we propose incorporating the assessment of young farmers' involvement in agricultural activities as a key indicator for evaluating food security. This assessment is based on the perspectives of each household's farmers regarding the participation of younger generations in agricultural tasks. The declining engagement of youth in the agricultural sector, coupled with rural youth out-migration, an aging farming demographic, and the absence of successors within farming families, poses a potential threat to sustainable agriculture and heightens food insecurity [58,64,96]. Therefore, evaluating the role of young farmers in household agricultural activities is paramount for assessing the food security indicator. Additionally, it is crucial to assess the potential impact of climate change on agricultural production, ensuring that sudden shocks or cyclical events do not jeopardize farmers' access to food [97].

3.3.2. Livelihood Security Assessment

In the evaluation of livelihood security within the GIAHS framework, indicators are categorized into three distinct domains: LBS, LAS, and LOS. LBS encompasses external environmental factors, family characteristics, and geographical considerations. On the other hand, LAS encompasses a range of assets, including natural, physical, human, social, financial, cultural, and informational aspects. LOS is centered around income levels. The livelihoods of local communities in regions with GIAHS sites are intricately linked with external natural, economic, and social factors, as well as their family's geographical context, often resulting in complex interactions between population, economy, and the environment [23,34,98]. In evaluating the livelihood security of these local populations, it is imperative to comprehensively consider their background, practices, and the context of preservation.

Among the various livelihood evaluation frameworks available [99], the most crucial variables for assessing the livelihood status of local communities revolve around assets and outcomes. Livelihoods are constructed upon a foundation of diverse assets, including natural, physical, human, social, financial, and other resources collectively known as "livelihood assets". We have identified specific sub-indicators related to physical, financial, and cultural assets through our prior studies [85,86,89,91,98–103]. Inhabitants of GIAHS regions have accumulated profound traditional knowledge in agricultural production throughout their lives, underscoring the significance of rural culture for attracting tourism.

With the rapid proliferation of mobile internet technology, farmers now have increased access to advanced agricultural practices [39,104]. Therefore, when assessing the livelihood assets of local populations in GIAHS regions, it becomes essential to consider cultural and informational assets. Enhanced income and improved well-being stemming from the engagement of residents in livelihood activities are collectively recognized as "livelihood outcomes". While agriculture remains the primary income source for local communities in most GIAHS sites situated in economically disadvantaged areas, these regions possess distinctive agricultural environments that open opportunities for agricultural landscape-based tourism development.

In addition to the evaluation framework by Lun et al. [23], our study incorporates the Modified Sustainable Livelihood Framework (MSLF) analysis, as proposed by Hutton et al.

in 2015 [105]. This strategy emphasizes the utilization of various forms of capital, including natural, physical, human, social, and financial, to sustain livelihoods within GIAHS communities. The list of indicators in each MSLF capital is presented in Table 3. Notably, it recognizes the significance of indigenous knowledge capital, encompassing the rich traditional knowledge base, skill sets, and community transfer mechanisms that support the operation and maintenance of GIAHSs. By adopting this approach, we can make meaningful comparisons of livelihood impacts across different community systems.

Table 3. Indicators for assessment by the Modified Sustainable Livelihood Framework (MSLF) following Hutton et al., 2015 [105].

MSLF Capitals	Indicators	Indicator Detail
Natural capital	Natural resource diversity (N1)	Rural areas have a wider variety of natural resources
	Socio-ecological adaptation (N2)	The communities have been planning for the perennial and diverse utilization of natural resources and ecosystem services for promoting sustainable development and achieving high resilience to environmental shocks.
Physical capital	Local Infrastructure (P1)	Availability of accessible roads, electricity, and modern infrastructure
	Agriculture Technology (P2)	A high level of technology is used in the agricultural production process
	Health support (P3)	Communities have access to basic health support
Financial capital	Household asset (F1)	Most households in the region have a wide living-condition gap
	Income diversity (F2)	Farm income and tourism income
	Employment support (F3)	Development, promotion of agrotourism resources/activities, and rural employment
Human capital	Knowledge (H1)	The ability to adapt to a changing environment, including agricultural innovation and the use of conservation practices
	Education (H2)	Communities have access to basic education institutions in sufficient numbers for the younger generations
Social capital	Social cooperation (S1)	Intercommunity network existence
	Social opportunity (S2)	Communities have access to agricultural training
	Social support (S3)	The existence of public organizations operating to support rural livelihoods
	Social equity (S4)	Communities' rights to access land and other natural resources in regions
Indigenous knowledge capital	Agriculture practice (I1)	Use of the traditional seasonal farming calendar and rural synchronization of agricultural activities employment
	Transferring knowledge (I2)	Indigenous knowledge transfer to the young generation
	Rural indigenous knowledge diversity (I3)	Several forms of indigenous knowledge are prevailing in rural areas

Source: Hutton et al., 2015 [105].

The concept of the 'capital ratio' serves as the foundation for evaluating the potential of the sea salt farming communities in the Ban Laem District. In the context of GIAHS, our survey seeks to gather information from stakeholders concerning sea salt. It is important to note that we will be using snowball sampling for our data collection. Upon reaching 100 respondents, the collection will be considered complete, as this number is deemed sufficient to fulfill the objectives of our investigation [106].

3.3.3. Data Processing

1. Data processing for evaluating food and livelihood security.

To effectively evaluate food and livelihood security, especially given the diverse dimensions and scales of the selected indicators, we employed the maximum difference

normalization method (Equation (2)). This approach allows standardization of the original data, placing them on a common scale ranging from 0 to 1.

$$x'_{ij} = \frac{(x_{ij} - x_{\min})}{(x_{\max} - x_{\min})}. \quad (2)$$

Here, x'_{ij} represents the standardized value of the jth evaluation indicator for the ith sample, x_{ij} is the actual value of the jth evaluation indicator of the ith sample, and $x_{\max}$ and $x_{\min}$ denotes the maximum and minimum values of the evaluation indicator, respectively.

We then employed the entropy weight method to calculate indicator weights, chosen for its ability to minimize human biases and yield more objective–comprehensive evaluation results (Zhu et al., 2020 [24]). The entropy weight method involves several steps as shown below.

We computed the proportion (p_{it}) of the i-th farmer household's values for the j-th indicators with

$$p_{ij} = x'_{ij} / \sum_{i=1}^{m} x'_{ij}. \quad (3)$$

Next, we calculated the entropy value (e_j) for the j-th food and livelihood indicator by using

$$e_j = -1/\ln m \sum_{i=1}^{m} p_{ij} \ln p_{ij}. \quad (4)$$

Then, we determined the weight (w_j) for each food and livelihood indicator based on

$$w_j = (1 - e_j)/\ln m \sum_{j=1}^{n} (1 - e_j). \quad (5)$$

Finally, we assessed the food and livelihood security (LA_i) for individual farming households, and provided a combined index of the interviewed individuals, as outlined in

$$LA = \sum_{j=1}^{n} w_j x'_{ij}. \quad (6)$$

The overall food and livelihood security values (LA) for six types of farming households were derived by averaging the values obtained for *EFS*, *RFS*, *NFS*, *LBS*, *LAS*, and *LOS* from the sampled households in the area in this research, following the methodology described by Yang et al. in 2018 [83]. Lower entropy values signify greater indicator dispersion, indicating that the indicator's relevance to the comprehensive evaluation objective is directly proportional to the information's usefulness [107].

2. Data processing for an assessment using the Modified Sustainable Livelihood Framework (MSLF)

The status of sea salt communities can be determined by calculating the mean Likert value of the capital ratio, as described in Equation (6). Communities are categorized as GIAHSs when the capital ratio surpasses 1.5, they are classified as weak GIAHSs/GIAHSs under threat if the ratio falls within the range of 1.0 to 1.4 and are labeled as non-GIAHSs when the ratio is less than 1.0 [34].

The MSLF is defined as the sum of natural capital and indigenous capital divided by the sum of financial capital and physical capital:

$$MSLF = \frac{Natural\ capital + Indigenous\ capital}{Financial\ capital + Physical\ capital} \quad (7)$$

4. Results

4.1. Food and Livelihood Security Descriptive Statistics of the Respondents' Characteristics

Table 4 provides a comprehensive overview of the demographic characteristics of the farmers who participated in this study. It highlights key details related to gender, age, education level, land size, land ownership, and annual total household income. These demographic insights shed light on the profile of the respondents and offer valuable context for understanding this study's participants.

Table 4. Demographic characteristics of surveyed participants.

	Number (Persons)	Percentage
Gender		
male	272	66.50
female	137	33.49
Age range		
less than 31 years old	1	0.26
31–45 years old	74	18.09
46–60 years old	203	49.63
over 61 years old	131	32.02
Education level		
primary school	55	13.45
secondary school	238	58.20
high school	64	15.65
Bachelor's degree	39	9.53
postgraduate	13	3.17
Land size Less than 5 hectares	199	48.66
5–10 hectares	139	33.99
11–15 hectares	42	10.27
16–20 hectares	19	4.65
Over 21 hectare	10	2.44
Landownership		
Owner	214	52.32
Rent	195	47.68
Annual total household income		
less than THB 2,500,000	24	5.87
THB 2,500,000–4,500,000	286	69.93
over THB 4,500,000	99	24.21

Source: Author's calculation.

The data reveal that the majority of the respondents who completed the questionnaire are male, making up approximately 66.50% of the respondents, while the remaining 33.49% are female. In terms of age, the average age of the participating farmers is approximately 57.85 years old. Further analysis of age groups indicates that a significant portion of farmers falls within the 46–60-year-old age bracket, suggesting that a substantial proportion of farmers in Phetchaburi Province are of advanced age. Conversely, the number of farmers below the age of 31 is relatively low. This demographic trend of an aging farmer population

raises considerations about the sustainability and continuity of agricultural undertakings in the region as farmers continue to age.

Regarding education levels, the majority of farmers have completed secondary school, followed by high school and primary education. Only a small percentage, approximately 12.7%, have attained a bachelor's degree or higher educational qualification. The data also highlight variations in land sizes owned by farmers. Notably, around 17.36% of farmers possess land sizes exceeding 11 hectares, while most farmers own land ranging from 5 to 10 hectares. Ownership of land is another significant factor, with over half of the respondents, approximately 52.32%, reporting that they own the land they cultivate. In contrast, 47.68% of farmers mentioned that they rent the land they work on.

When examining annual total income per household, the majority of farmers tend to earn incomes falling within the range of THB 2,500,000 to 4,500,000 and over THB 4,500,000, respectively. A comparative analysis reveals variations based on the type of agricultural activities. Sea salt farming, fishery, and rice farming households typically report higher annual incomes, while households engaged in officialdom, employment, and running grocery stores tend to have relatively lower annual incomes.

4.2. Food and Livelihood Security in Sea Salt Communities

This section delves into the food and livelihood security assessment within sea salt communities. To gain an insight into the essential food supply products, focus group sessions were conducted, revealing a range of items critical to these communities. These included shrimp, green mussels, sea salt, rice, octopus, blue swimming crab, mackerel, blood cockle, hard clam, razor clam, squid, and lingula anatina. Additionally, other related products supporting food security were identified, such as sugar palm, coconut, ray, seabite, cattle, fleur de sel, green caviar, seabass, mullet, barracuda, Nile tilapia, acetes, clupeiformes, mud crab, mantis shrimp, horseshoe crab, jellyfish, flatfish, and croaker. Furthermore, essential non-food supply products, including rice straw, cattle manure, salt pan sediments, crab shells, shrimp shells, shells, and scrap mangrove wood, were recognized.

This study employed 32 secondary indicators categorized into six groups to assess food and livelihood security among the farmers. The results revealed that sea salt communities achieved an average score of 2.724 for food and livelihood security. This total comprises a food security score of 1.476 and a livelihood security score of 1.248. Of the six primary indicator categories in Figure 2, "livelihood background security" received the highest score (0.558), followed by "essential food supply products security" (0.504), "related non-food supply products security" (0.488), "related essential food supply products security" (0.485), "livelihood outcomes security" (0.384), and "livelihood assets security" (0.306).

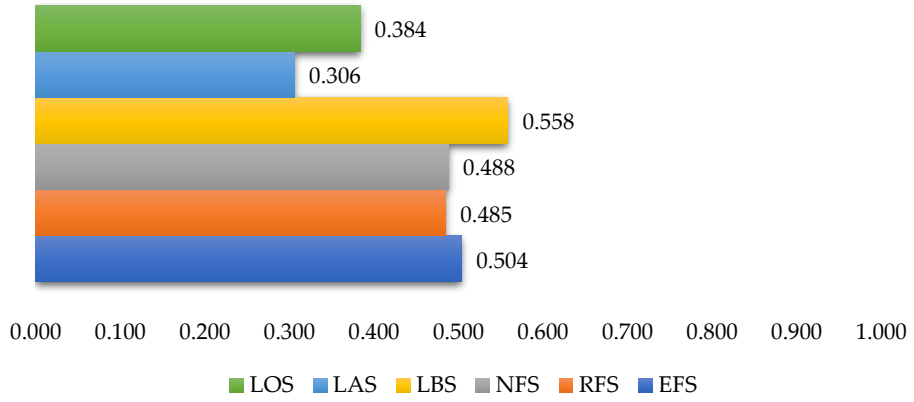
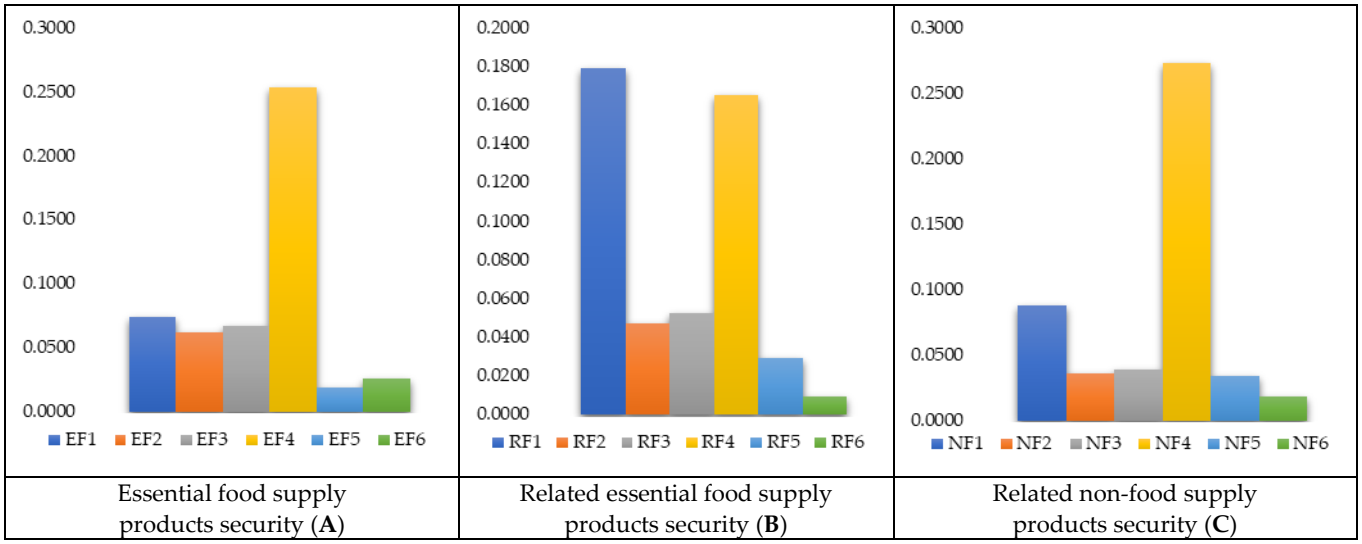


Figure 2. The overall score of food and livelihood security in Sea Salt Communities. Food security in sea salt communities: essential food supply product security (EFS), related essential food supply product security (RFS), related non-food supply product security (NFS), livelihood background security (LBS), livelihood assets security (LAS), and livelihood outcomes security (LOS). Source: Author's calculation.

In summary, the food and livelihood security situation in these sea salt communities was generally lacking, with specific deficiencies in related essential food supply products, livelihood asset security, related non-food supply products, and livelihood outcomes security. However, relatively better scores were observed in livelihood background security and the security of essential food supply products among the farmers.

Figure 3 displays the overall scores of food security in the sea salt communities.



Essential food supply products security (**A**)	Related essential food supply products security (**B**)	Related non-food supply products security (**C**)

Figure 3. The overall scores of food security in the sea salt communities.

(i) Essential food supply products security (*EFS*): Figure 3A shows that most farmers in the area primarily focus on producing essential food supply products, either for household use or sale. Abundant natural resources, including freshwater, brackish water, and saltwater areas, support a diverse range of product cultivation. The evaluation results emphasize the importance of product diversity, with the highest score (0.2540) among the six specific evaluation indicators, highlighting the significance of promoting various food products for enhanced food security.

The region's resources enable year-round production, ensuring a consistent supply for consumption and commercial purposes. Quantity is also important, with a notable score (0.0741). The quality of these products, attributable to the region's rich natural environment, contributes moderately to food security, as seen in the scores for the environmental quality of essential food supply products (0.0673) and product quality (0.0624).

However, challenges remain, including the impact of climate change (0.0269) and limited engagement of young labor (0.0190) in food production. Climate fluctuations pose risks to staple food production, affecting overall food security. The limited involvement of young individuals in farming threatens the long-term sustainability of agriculture, leading to relatively lower food security levels in the region.

(ii) Related essential food supply products security (*RFS*): Figure 3B emphasizes that farmers in this study area commonly produce related essential food supply products alongside essential food supply products primarily for household consumption rather than commercial purposes. The evaluation results indicate that the quantity of essential food supply products receives the highest average score among the six specific evaluation indicators (0.1795). Furthermore, the diversity of food supply products plays a crucial role in maintaining food security, as reflected by the second-highest score for the diversity of the related essential food supply products (0.1654). The environmental quality and product quality also contribute to food security, albeit at a moderate level, as indicated by the scores for the environmental quality of related

essential food supply products (0.0529) and the quality of related essential food supply products (0.0477).

However, food security faces challenges, particularly that of climate change. The ongoing concerns regarding the impact of climate change pose significant risks to food security. Additionally, the low participation of young workers in food production negatively impacts the related essential food supply product's security scores, keeping them at a lower level. The engagement of young farmers with related essential food supply products (0.0297) and the impact of climate change on food supply products (0.0095) are indicators that highlight these challenges.

(iii) Related non-food supply products security (*NFS*): Figure 3C shows that non-food products in the area are mainly produced for fuel, fertilizer, or animal feed purposes. The highest-scored indicator, with a score of 0.2737, is the diversity of related non-food supply products, highlighting its crucial role in promoting food security. Quantity also matters, as seen in the second-highest score for the quantity of related non-food supply products (0.0881). Environmental and product quality moderately contribute to food security, with scores of 0.0386 and 0.0359, respectively.

However, challenges persist, particularly the limited engagement of young farmers and the impact of climate change. The minimal involvement of young labor in non-food supply product production threatens agricultural sustainability. Additionally, climate sensitivity adds complexity to ensuring food security, with indicators for the engagement of young labor in related non-food supply products (0.0339) and the impact of climate change on these products (0.0180) requiring focused attention to enhance overall food security.

Figure 4 displays the overall scores of livelihood security in the sea salt communities.

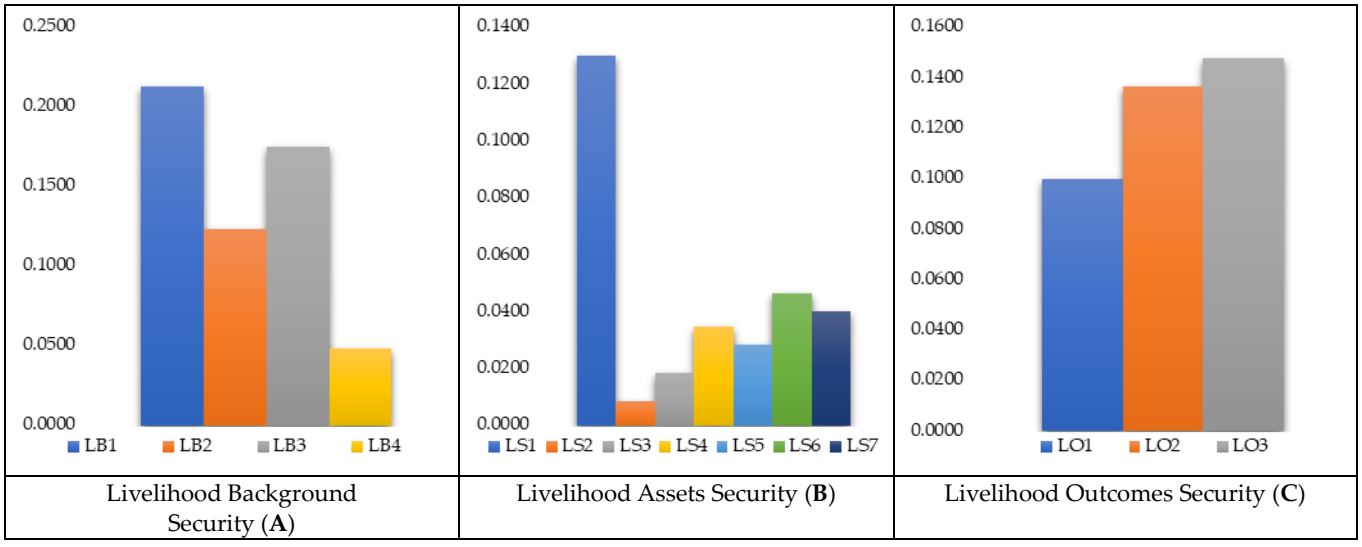


Figure 4. The overall scores of livelihood security in the sea salt communities.

(i) Livelihood background security (*LBS*): In Figure 4A, the evaluation results show that the external natural background receives the highest average score among the four specific evaluation indicators, with a score of 0.2127. This high score reflects the significance of farm areas, cultivated land, and mangrove forests in shaping the external natural background. These natural resources serve as essential raw materials for farmers, enabling them to pursue sustainable livelihoods.

On the social front, government agencies like Subdistrict Joint Administrative Organizations, the District Agricultural Office, and the District Fisheries Office provide substantial support and assistance to the community, resulting in an average score of 0.1748 for the external social background. However, the economic background within the area offers

relatively lower support for livelihoods. Despite agriculture and fishing being the primary occupations employing many locals, limited integration with the external economy results in a lower contribution to the subsistence background, as reflected in the external economic background score (0.1228). Family geographical characteristics, particularly the distance between residences and the downtown area, also significantly influence farmers' livelihood activities. Since most individuals are concentrated within the same area, there are no distinct advantages or disadvantages in terms of supporting subsistence backgrounds, resulting in a geographical characteristics score of 0.0480.

(ii) Livelihood assets security (*LAS*): In Figure 4B, the evaluation centers on livelihood assets security, with land emerging as the most critical natural asset for sustaining livelihoods, especially in agriculture and fisheries. It serves as a fundamental means of production, earning it the highest average score among the seven specific evaluation indicators at 0.1299. Cultural assets, representing valuable heritage that enriches individuals and communities, closely follow with a score of 0.0462. These cultural assets play a pivotal role in shaping livelihoods, as farmers continue to rely on traditional knowledge, actively passing it down to future generations.

Information assets also hold significance, with widespread access to information through mobile phones and the internet contributing to an average score of 0.0401. This access enables farmers to stay informed and secure their information assets effectively, ranking it third. Social assets, cultivated through close-knit community ties, especially among relatives, positively impact livelihoods and earn a score of 0.0345, placing them fourth. However, financial assets face challenges due to economic downturns, resulting in a relatively lower score of 0.0284, while human capital, reflected in a relatively high labor force index, suggests the need for additional labor to achieve truly sustainable livelihoods. Finally, physical assets, crucial for livelihoods and production, reveal the need for improvements in irrigation systems and road networks, garnering the lowest score among the indicators at 0.0086.

(iii) Livelihood outcomes security (*LOS*): In Figure 4C, the focus shifts to livelihood outcomes security. Interviews with farmers revealed that their income sources were relatively limited, predominantly stemming from farming and fishery activities. Among the three specific evaluation indicators, agricultural income received the highest average score at 0.1475, closely followed by per capita income with a score of 0.1365 and total income with a score of 0.0996. These scores underline the pivotal role of income generated from agriculture and fisheries in stabilizing the livelihoods of farming households.

These findings underscore the significant contribution of farming and fishery activities to the overall income and economic well-being of farmers. They serve as primary income sources that not only support their livelihoods but also sustain their households. The evaluation results emphasize the critical nature of agricultural income as a major component in securing livelihood outcomes, highlighting the importance of promoting and fortifying agricultural and fishery practices to enhance the economic stability and overall well-being of farmers in the area of this study.

4.3. Descriptive Statistics of Sea Salt Farmers' Demographic Characteristics

Table 5 provides a comprehensive overview of sea salt stakeholders' demographic and experiential characteristics. Among the respondents, the majority are male (69%), while females constitute 31% of the sample. The age distribution of salt farmers who participated in the survey has an average age of 50.9 years, with the eldest respondent being 74 years old and the youngest 32 years old. Notably, 48% of the respondents fall within the 46–60-years-old age group, highlighting the significant presence of elderly individuals in the sea salt farming community. Regarding education levels, most respondents have completed secondary schooling (53%), with 41% having completed primary education. Higher levels of education, such as high school (2%), bachelor's degree (1%), and post-

graduate qualifications (3%), are less common among sea salt farmers. Experience in salt farming varies, with 35% of respondents having 21–30 years of experience, and 34% having 11–20 years. This distribution aligns with the relatively high average age of the farmers, indicating a correlation between years of experience and age. Furthermore, when it comes to annual income, 38% of sea salt farmers earn less than THB 100,000, 32% fall within the THB 100,000-to-200,000 range, 17% earn between THB 200,000 and 300,000, and 13% report annual incomes exceeding THB 300,000.

Table 5. Sea salt farmers' demographic characteristics.

	Number (Persons)	Percentage
Sex		
male	69	69.0
female	31	31.0
Age range		
31–45 years old	31	31.0
46–60 years old	48	48.0
over 61 years old	21	21.0
Education level		
primary school	41	41.0
secondary school	53	53.0
high school	2	2.0
Bachelor's degree	1	1.0
postgraduate	3	3.0
Salt farming experience		
less than 11 years	15	15.0
11–20 years	34	34.0
21–30 years	35	35.0
More than 30 years	16	16.0
Annual Income		
Less than THB 100,000	38	38.0
THB 100,000–200,000	32	32.0
THB 200,000–300,000	17	17.0
More than THB 300,000	13	13.0

Source: Author's calculation.

4.4. The Assessment and Monitoring Results on GIAHS Status under the Modified Sustainable Livelihoods Framework (MSLF)

The evaluation results, depicted in Figure 5, shed light on the mean scores of the MSLF capital, as perceived by the sea salt interviewees. Additionally, the evaluation employed the capital ratio formula (Equation (7)) to gauge the overall status of the area in this study. These findings indicate that the area in this study currently falls under the category of a weak GIAHS or a GIAHS under threat, with a score of 1.17. This score signals the presence of challenges and vulnerabilities that require attention to enhance the sustainability and resilience of the agricultural systems in the region.

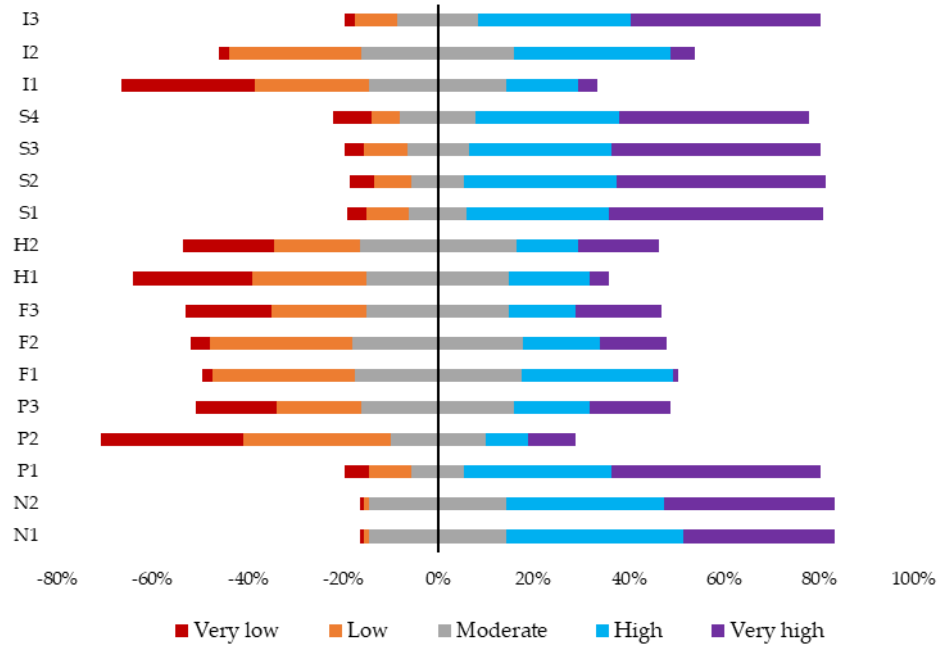


Figure 5. Attitudes of sea salt farmers in interviews under the Modified Sustainable Livelihoods Framework (MSLF). Source: Author's calculations.

1. **Natural capital** encompasses the valuable and beneficial natural resources that salt farmers and the community rely upon. The assessment of natural capital includes gauging natural resource diversity and socio-ecological adaptation. The results of this research assign a value of 4.00 to natural assets, signifying a high level of natural capital. The survey findings indicate that natural capital plays an indispensable role in the livelihoods of people in each area. Respondents attest that the natural resources in the region are in good condition. Local resources such as freshwater, brackish water, and saltwater areas serve as essential raw materials for subsistence activities and provide habitats for aquatic animals and food sources for shorebirds. The abundance of these resources in the Ban Laem District contributes to the diversification of agricultural products.

To preserve and sustain these vital natural resources, the community has developed conservation plans encompassing sustainable fishing, aquaculture, and mangrove planting activities. These initiatives receive support from enterprise groups and local governments. Nevertheless, challenges persist in managing agricultural chemicals, marine debris, and oil spills, which have adverse effects on natural resources. Addressing these obstacles is imperative to ensure the long-term health and conservation of natural capital. Effective management strategies must be implemented to allow the community to continue benefiting from these invaluable resources while safeguarding them for future generations.

2. **Physical capital** encompasses the facilities and amenities owned by respondents, crucial for supporting their livelihoods and overall well-being. It reflects the ease of access to essential services and infrastructure. As per the findings of this research, the value assigned to physical capital is 3.12, indicating a moderate level of access to physical capital. The evaluation of physical capital encompasses local infrastructure, agricultural technology, and health support.

Salt farmers in the area of this study assign a high rating for infrastructure, signifying their access to amenities like electricity, water supply, and well-maintained roads. However, some agricultural areas in the Pak Talay and Bang Kaeo sub-districts encounter challenges related to concrete roads and irrigation, which adversely affect agricultural activities. The baseline value for infrastructure was at a lower level. While technology is playing an increasingly crucial role in the production process, especially in salt transportation,

the adoption of advanced agricultural technology remains limited. This underscores the necessity to develop and implement advanced manufacturing technologies to enhance productivity and efficiency. Overall, health support in the community is at a medium level. Although each area has a sub-district health center and there is the Ban Laem District Hospital, some respondents expressed concerns regarding the adequacy of health services. In conclusion, the sea salt community exhibits favorable physical capital, with access to essential services such as healthcare and infrastructure. However, specific issues require attention, including improving agricultural infrastructure, adopting advanced technology for increased production efficiency, and addressing healthcare service concerns. Raising awareness about healthcare can contribute to the overall well-being of the community.

3. **Financial capital** represents the financial resources available to the sea salt farming community to achieve their livelihood goals. As per the results of this research, the assigned value for financial capital is 3.01, indicating a moderate level of support from financial capital. The assessment of financial capital assets encompasses household assets, income diversity, and employment support within the area in this study.

Households in the region generally have moderate living conditions, primarily because salt farmers possess household assets like housing, cars, televisions, and other essential amenities. Furthermore, concerning income diversity, it was assessed as moderate, with 36% of salt farmers considering it moderate, 32% rating it high, and 1% regarding it as very high. Salt farmers typically enjoy good household wealth due to various income sources such as rice farming, salt farming, coastal fishing, and livestock raising, which contribute to income-source diversity. However, 30% of respondents perceived their income diversity as low, and 4% as very low, primarily among salt farmer workers with limited household wealth and income streams. In addition, due to insufficient promotion of the region's tourism potential and limited integration with the external economy, employment support in the tourism sector remains somewhat limited. However, salt farmers in the area believe that the tourism sector moderately contributes to local employment.

4. **Human capital** encompasses an individual's capacity to access improved living conditions. The evaluation of human capital involves assessing skills, knowledge in agriculture, and youth receiving education locally. As per the results of this research, the assigned value for human capital is 2.17, indicating a moderate level of human capital. It was observed that human capital is a relatively weak aspect of the community.

The community's ability to adapt to a changing environment, including agricultural innovation and the adoption of conservation practices, was assessed as being at a low level. This is primarily because most sea salt farmers rely on traditional farming knowledge passed down through generations. While this inherited knowledge holds value, it limits agricultural innovation and the community's capacity to adapt to sudden environmental changes. Integrating and implementing new agricultural practices from external sources becomes challenging within the community. Concerning access to education, it was determined to be at a moderate level. Presently, the youth in the area have access to education from elementary to high school. However, there has been a decline in school enrollments in the area. Parents often opt to send their children to schools in urban areas in search of better quality and modern education. Consequently, the number of students attending local schools has decreased.

5. **Social capital** encompasses the social relationships and patterns of social interaction between respondents and others in the community and can also be observed within specific situations or organizations. The assessment of social capital includes factors such as social cooperation, social opportunity, social support, and social equity. According to the results of this research, the value assigned to social capital is 3.99, indicating a high level of social capital.

Through interviews, it became evident that farmers in the community receive substantial support and cooperation from various local agencies, including those related to

agriculture, fisheries, and local government entities. These agencies collaborate effectively as a network to promote the holistic development of local communities. Their efforts encompass various aspects, such as providing livelihood assistance, facilitating infrastructure development, and offering agricultural and fisheries education. Furthermore, the community places strong emphasis on ensuring equal rights for all residents to express themselves and actively participate in the development and conservation of natural resources. This collective endeavor is directed towards enhancing the overall well-being of the entire community and promoting sustainable practices.

6. **Indigenous knowledge capital** encompasses the wealth of knowledge, skills, and traditions that have been developed and passed down through generations within communities in the local area. This assessment encompasses various aspects, including agricultural practices, knowledge transfer, and the diversity of indigenous knowledge in rural areas. Based on the results of this research, the assigned value for indigenous knowledge capital is 3.18, indicating a moderate level of indigenous knowledge capital.

Salt farmers in the community strongly believe that the local population possesses a wide-ranging knowledge base related to their profession. This knowledge spans various domains, including farming, salt production, fisheries, animal husbandry, and even toolmaking, all of which are essential for their livelihoods. Consequently, the diversity of agricultural knowledge received a high rating. However, the assessment for knowledge transfer was found to be moderate, suggesting room for improvement in sharing this valuable knowledge through experiential learning. It is worth noting that farming, while rich in tradition and knowledge, is perceived as a challenging occupation with unstable incomes, which has led many young individuals to abandon these traditional practices passed down by their families. Additionally, it was observed that this knowledge has not been adequately documented in written form, posing challenges to its preservation and protection as part of indigenous knowledge capital. Furthermore, the assessment value for seasonal farming practices was relatively low, indicating that the traditional occupational calendar has undergone only minor adjustments in response to changing climatic conditions. This underscores the challenges faced by farmers in adapting their agricultural practices to the prevailing climate patterns.

4.5. Discussion

In the Ban Laem District of Phetchaburi Province, our research sought a comprehensive evaluation of food security and livelihoods within the Globally Important Agricultural Heritage Systems (GIAHS) criteria framework, following the models of Lun et al. (2020) [34] and Lun et al. (2021) [23]. We adopted objective data weighting through entropy to ensure methodological robustness and precision. While our results might slightly deviate from other researchers due to differing locations and methodologies, this technique facilitated a nuanced and precise assessment of indicators. Prior studies, particularly Lun et al. (2021) [23], accentuated yield as the primary determinant for enhancing food security. In contrast, our study underscores the combined importance of both product diversity and quantity in agriculture, asserting that they play a vital role in bolstering food security.

A resilient agricultural system is foundational to food security. Crop diversity is crucial in buffering against risks like adverse climate conditions, pests, and diseases. Such diversification not only mitigates the risk of crop failures but also ensures consistent food availability. Furthermore, diverse agriculture offers a variety of essential nutrients, enhancing nutrition. This perspective finds support in the work of Waha et al. [108], who highlighted the positive role diversified agriculture plays in the food security and nutrition of low and middle-income nations. Product quality and environmental sustainability also moderately influence food security, emphasizing the need for sustainable farming—a sentiment echoed by Capone et al. [109]. Our study found that consistent access to ample food supplies and associated products, both food and non-food, is crucial for food security

in sea salt communities, resonating with Smith and Haddad's (2015) [110] stance on the significance of natural resource access.

Additionally, our emphasis on product diversity mirrors Pingali's (2015) [111] views on agricultural diversification's role in food security. Furthermore, the challenges of climate change and dwindling young workforce numbers pose threats to food security. We align with Godfray et al. (2010) [112] in this aspect, noting the necessity for a balance between staple foods and other products, especially in climatically vulnerable regions. A decline in youth involvement in agriculture, coupled with an aging demographic, casts shadows over future food security, in line with Poungchompu et al. 2012 [58]. The lack of successors in family farms and land repurposing are significant contributors to this trend, as covered in Duesberg et al. 2017 [64]. Climate change further complicates matters, with potentially detrimental effects on agricultural output and heightened vulnerabilities—concerns emphasized by Thompson et al. (2010) [113].

Furthermore, our analysis of livelihood stability, encompassing life assets and outcomes, indicates that natural assets and agricultural earnings play a pivotal role in ensuring local farmers' livelihood security. Regarding livelihood background security (LBS), natural resources, especially farmlands and mangrove forests, are fundamental. This observation is consistent with Scoones (1998) [114] and Ellis (2000) [115], who stressed these resources' role in sustaining livelihoods. Factors like governmental support and the interplay between policies and local economics are instrumental for community development, a viewpoint mirrored in Chambers and Conway's (1992) [116] framework. In our exploration of livelihood asset security (LAS), we discerned that agricultural and fishing land assets are pivotal for households to maintain sufficient livelihoods. This insight aligns with de Haan and Zoomers (2005) [117], who contended that land accessibility and control often shape rural livelihood outcomes. We also observed that cultural assets in agriculture and fishing, such as traditional practices and tools, can amplify community value, attracting tourism, as discussed in Yang [83] and Li [84]. Access to pertinent information is equally essential for sustainable rural livelihoods, as noted by Yang et al. (2019) [39] and Yang et al. (2018) [94]. For livelihood outcome security (LOS), agricultural earnings remain central to outcomes, a sentiment shared by Dorward et al. (2009) [118], who asserted that agriculture frequently determines a community's socioeconomic health. Interestingly, our insights diverge from Lun et al.'s [23] findings in the GIAHS-recognized Zhagana village. While they identified economic background and household income as key life security determinants, our study notes the increasing influence of industrial development, escalating local commerce, and augmented non-agricultural earnings. Thus, it is crucial to acknowledge that factors like community contexts, lifestyles, and economic shifts can generate diverse outcomes [23,39,83,91].

The analysis of the sea salt community's potential to attain GIAHS status through the MSLF framework indicates a pressing need to enhance both natural and indigenous knowledge capital, especially with their current categorization as a weak GIAHS. This observation concurs with insights from Hutton et al. [105], who posit that augmented natural and indigenous knowledge capitals can significantly bolster prospects for GIAHS recognition. Yet, to fortify these assets, multiple challenges must be surmounted. The pivotal role of natural capital in sustainability, particularly the prudent use and governance of natural resources, is well-established. Significant obstacles arise from waste management issues, encompassing the mitigation of fishery spills, curbing chemical water contamination, and addressing industrial waste. Such predicaments can instigate environmental deterioration and impede sustainable agricultural methodologies, a sentiment echoed in research by Kwanon et al. [119]. As for indigenous knowledge capital: Indigenous knowledge remains instrumental in fortifying the durability and sustainability of agricultural systems (Berkes et al., 2000) [120]. The Ban Laem District, as our results reveal, is a treasure trove of ancestral wisdom. Nevertheless, the observed disconnect in knowledge dissemination and the waning enthusiasm of younger generations mirror the apprehensions articulated by Agrawal (1995) [121]. He spotlighted the precarious nature of indigenous knowledge when

confronted with modernization—a sentiment that aligns with Damrongsiri et al. [122]. The diminishing number of successors and the inadequate emphasis on youth immersion in farming further erode the indigenous knowledge capital. Such impediments can potentially hinder the sea salt community's aspiration for GIAHS acknowledgment. To navigate these barriers and actualize the community's latent potential, synergies between farmers, governmental bodies, and relevant organizations are paramount. Practical strategies need formulation to mitigate waste management concerns, ensuring meticulous and efficient disposal methods. Concurrently, initiatives should be launched to invigorate the transmission of indigenous knowledge to budding generations, galvanizing their fervor for agriculture. By proactively addressing these concerns and bolstering both natural and indigenous knowledge capital, the sea salt community stands poised to optimize its chances for GIAHS recognition.

5. Conclusions and Policy Recommendations

5.1. Conclusions

This research aimed to systematically analyze food and livelihood security within the Ban Laem District's distinct "sea salt communities" in Phetchaburi. Utilizing an advanced evaluation technique enhanced with the entropy weight method, we conducted a field survey, framing our analysis within the Globally Important Agricultural Heritage Systems (GIAHS) paradigm. Our exploration spanned three primary food security segments: essential food supply (EFS), related essential food supply (RFS), and related non-food supply (NFS). We also probed into livelihood security, examining livelihood background (LBS), assets (LAS), and outcomes (LOS). Our findings painted a concerning picture: the sea salt communities exhibit subpar food and livelihood security, reflected in a composite score of 2.724. Specifically, the food security evaluation averaged 1.476, indicating the critical roles of agricultural product diversity and production quantity. These are, however, challenged with climatic effects and dwindling youth involvement. Livelihood security averaged at a score of 1.248, revealing that while natural resources, especially farmlands and mangroves, enhance the livelihood background, and while governmental support bolsters the social dimension, economic challenges persist. Livelihood assets security underscores the land's value, cultural heritage, and information access, but faces infrastructural and human capital. Livelihood outcomes security, informed by farmer interactions, points to the dominant role of agricultural income, necessitating enhanced backing for agriculture and fisheries. Additionally, our detailed sub-district evaluation within the GIAHS criteria revealed a troubling scenario of either fragile GIAHS statuses or communities at risk. While the Ban Laem District is endowed with plentiful natural resources, robust infrastructure, and cohesive communities, it confronts challenges in agricultural technology, tourism assimilation, contemporary farming practices, and education. The transmission and documentation of indigenous knowledge also grapple with modern environmental shifts.

5.2. Policy Recommendations

Building upon the insights gained from this study, the following recommendations are put forth to bolster responses to climate change, fortify practical adaptation strategies, and advance rural food and livelihood security:

(i) Climate Change Awareness and Agricultural Extension Services: Prioritizing climate change awareness campaigns, particularly among older generations, is crucial. Government agencies and rural organizations should spearhead information dissemination efforts, emphasizing the importance of climate change and its implications for agricultural practices. Enhancing agricultural extension services can play a pivotal role in motivating farmers to take proactive measures in response to climate change;

(ii) Collaborative Knowledge Sharing: Collaboration among academia, local government/organizations, fishermen, and farmers is paramount. A culture of shared knowledge, climate adaptation strategies, and best practices should be fostered. This collaboration should extend across research and educational institutions, businesses,

and rural government entities. Emphasizing community and national-level climate change responses is essential. Researchers should prioritize action research that actively involves participants and co-management processes to empower farmers and fishermen with effective adaptation capabilities;

(iii) Diversified Farming Strategies: Promoting farming strategies that encompass a diverse range of products and product processing can significantly enhance rural food security. Farmers should be encouraged to broaden their expertise in multicropping and advanced management techniques to keep pace with evolving agricultural technology. Local governments and organizations should conduct research and offer comprehensive training programs to enable farmers and fishermen to produce high-value goods and services;

(iv) Financial Support Mechanisms: Providing financial support to farmers and fishermen is instrumental in elevating livelihood security. Facilitating access to affordable loans and offering financial counseling services can substantially impact the livelihoods of farmers and fishermen. Collaboration among local government/organizations, farmers, and fishermen is pivotal in establishing sustainable market development plans through cooperative systems, thus increasing their bargaining power;

(v) Cultural Conservation Initiatives: Cultural conservation should be promoted as an integral component of rural development and food security. Government bodies, academic institutions, and the corporate sector should establish conservation funds and advocate sustainable tourism activities. Implementing positive marketing communication strategies can encourage local community engagement in preserving traditional cultural assets.

5.3. Limitations and Suggestions for Further Research

While this study extensively explored the dynamics of food and livelihood security within the Ban Laem District's sea salt communities in Phetchaburi, several limitations merit acknowledgment, subsequently paving the way for potential future research directions. Firstly, it is important to recognize that the findings are primarily contextual and confined to the unique circumstances of sea salt communities in this specific region. Generalizing these results to other agricultural or coastal communities should be undertaken with caution. Expanding the scope of research to encompass diverse geographical and cultural settings could provide a broader perspective. Secondly, this study heavily relied on data collected through surveys and evaluations, which, while valuable, may not fully encapsulate the multifaceted experiences and perceptions of community members. Integrating qualitative research methods such as interviews and focus groups with quantitative analyses could offer a more holistic understanding. Thirdly, this study's findings are contingent upon a dynamic external environment shaped by factors like policy changes, economic fluctuations, and climate events. These factors are subject to evolution and may impact food and livelihood security differently over time. Therefore, conducting longitudinal studies to track changes in security levels could yield richer insights. Lastly, given the vital role of indigenous knowledge and cultural practices in the sustainability of sea salt communities, future research endeavors could delve deeper into examining how indigenous knowledge influences food and livelihood security and explore strategies to ensure its transmission to succeeding generations.

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