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# Insights into food security and safety issues in a Myanmar refugee camp

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**Abstract**

This study examines food security within a Myanmar refugee camp near Mae Sot District, Tak Province, Thailand. Employing qualitative observations from residents and medical staff, alongside photographic documentation, we assessed the accessibility and sufficiency of dietary resources and food safety. Our findings highlight significant limitations in food diversity, particularly regarding staple crops and culturally important vegetables like those from the *Solanum* spp. and legumes. These limitations were notably exacerbated by restricted seed availability. The absence of elders capable of transmitting food knowledge, combined with limited resource availability within the camp, directly impacted the preservation and practice of traditional plant food utilisation knowledge. Furthermore, animal farming, while serving as a primary protein source, raised concerns about sufficiency. Food handling practices were also a concern, as improper handling may lead to cross-contamination and possibly induce gastrointestinal diseases. This research underscores the urgent need for enhanced humanitarian supports, including diversifying food sources, improving supply chain management, and providing training on safe animal husbandry practices. The study highlighted the critical role of accessible and culturally appropriate food resources in maintaining the well-being and stability of refugee communities in challenging border regions.

**Keywords** Food insecurity, Foodscape, Food safety, Staple food, Military coup

## 1 Introduction

Food security, defined as the consistent access to sufficient, safe, and nutritious food, is fundamentally underpinned by the pillars of availability, access, utilisation, and stability [1]. The escalating conflict in Myanmar directly undermines each of these critical components, leading to widespread food insecurity. Myanmar's current turmoil represents the culmination of decades-long tensions between the military and ethnic minorities, a struggle for autonomy and territorial control that has persisted since the country's independence in 1948 [2]. This historical foundation of conflict set the stage for the dramatic escalation that would follow the military coup of February 2021. The military coup in February 2021 marked a critical turning point, transforming existing tensions into a

multifaceted national crisis [3]. The takeover immediately triggered widespread protests and civil unrest, as citizens rejected the military's seizure of power. However, the military's violent response to these demonstrations has intensified the conflict exponentially, resulting in severe human rights violations, mass displacement, and widespread economic hardship. This political upheaval has simultaneously emboldened ethnic minority rebel groups, who have exploited the military's weakened position and divided attention to strengthen their resistance against the regime. Consequently, conflicts in minority-dominated areas have escalated dramatically, creating multiple fronts of warfare across the country despite continued international peace efforts [2].

The coup's impact extended far beyond the political sphere, triggering a cascade of economic disruptions that have proven catastrophic for Myanmar's development trajectory. Just as the country was beginning to recover from COVID-19-related economic shocks, the military takeover derailed any potential recovery and plunged the nation into far more severe and prolonged economic disturbance [4, 5]. The widespread protests and strikes that followed the coup systematically disrupted the country's economy and financial system, contributing to a devastating 18% GDP contraction in 2021. This economic collapse has transformed Myanmar from a recovering economy into one experiencing deep recession, with implications that extend far beyond financial metrics.

The convergence of political violence and economic collapse has generated a massive humanitarian crisis. The number of refugees has surged to over 200,000 following the coup, adding to an estimated 700,000 internally displaced persons (IDPs) and creating increasingly dense populations in camps along the Thai-Myanmar border [6, 7]. These displacement figures represent more than statistics—they reflect a deepening humanitarian emergency exacerbated by chronic underfunding and diminishing international attention. The resulting conditions in refugee camps have become increasingly dire, manifesting in a distressing surge in suicides and domestic violence among Burmese refugees [8]. Food insecurity has reached critical levels, with insufficient supplies leading to widespread hunger and malnutrition among displaced populations. Simultaneously, severely limited access to education and medical care compounds the hardships faced by those who have already lost their homes and livelihoods, creating a cycle of vulnerability that threatens an entire generation's future prospects. To address these challenges, it is crucial to implement a comprehensive and adequately funded humanitarian response, coupled with initiatives targeting the underlying causes of conflict and instability [9, 10].

Armed conflicts are not merely destructive to physical infrastructure; they are equally devastating to the intangible infrastructure of cultural knowledge, particularly ethnobotanical wisdom. The transmission of traditional ecological knowledge (TEK), which encompasses plant identification, usage, and management, relies heavily on oral traditions and intergenerational transfer. Wars disrupt these processes in profound ways. The wars could also have a devastating impact on ethnobotanical knowledge, as they often disrupt traditional systems of knowledge transfer and hurdle the social supports that fabric the preservation. The displacement of populations can result in the loss of traditional knowledge and skills, as older generations may be unable to pass on their knowledge to younger generations [11]. For example, the Bosnian War saw the loss of many elderly individuals who held essential knowledge of traditional medicine and food practices [12]. Furthermore, conflict and instability can also lead to the destruction of local ecosystems and the loss of plant species, reducing the overall diversity of

plant knowledge and the ability to utilise it for food and medicine [13]. Sudan provides a striking example, suffering from 60 years of chronic civil wars and instability. These conditions have severely affected the country's biological diversity, pushing many species to critical thresholds of extinction, which further diminishes indigenous knowledge of local flora and fauna [14]. The consequences of losing the traditional knowledge along with the management of its ecosystems include a reduction in the potential of available resources for food [15], medicine [16, 17] and cultural practices, leading also to the loss of biodiversity, cultural heritage and the identity [18, 19].

The urgency of research in this context cannot be overstated. Such investigation contributes not only to immediate regional development and humanitarian response but also holds the key to long-term sustainability of communities and ecosystems. The intricate connections between food security, economic stability, cultural preservation, and biodiversity highlight the necessity for a holistic approach in regional development, where interventions in one domain can have profound effects across others. The objective of this study is to comprehensively understand the food security challenges faced by affected populations in Myanmar by assessing the situation across the key pillars of food security, including availability, accessibility, utilisation, and stability. The assessment aims to identify the root causes of food insecurity within these fundamental pillars, with the overarching goal of developing effective interventions to improve the well-being and stability of refugee and displaced communities.

This study addresses three primary research questions:

1) What is the current state of food security among affected populations in Myanmar across the four key pillars of availability, accessibility, utilisation, and stability?
2) How has the erosion of ethnobotanical knowledge and traditional food systems affected food security and nutritional outcomes among ethnic minority communities?
3) What formal and informal coping strategies do affected communities employ to address food insecurity, and how effective are these mechanisms in different contexts?

Beyond addressing immediate humanitarian needs, this research seeks to highlight critical areas for further investigation and coordinated humanitarian response that tackles both urgent requirements and underlying structural causes of food insecurity. The study recognises that sustainable solutions must address the interconnected nature of food security challenges within Myanmar's broader crisis context.

## 2 Methodology

### 2.1 Site description

The Burmese refugee camp, located along the Moei River shoreline near Tak province in Northern Thailand (Fig. 1) [16° 32′ 42.0″ N 98° 35′ 37.4″ E] was accessed by medical staff from the Mae Tao Clinic (Tha Sai Luat, Mae Sot District, Tak, Thailand). This camp is situated within a region characterised by mountainous terrain and a tropical deciduous forest ecosystem. The area experiences inclimate weather patterns, including a pronounced monsoon season with heavy rainfall from May to October, leading to potential flooding and logistical challenges [20]. The soil type is predominantly lateritic, known for its poor water retention and nutrient content, which can limit agricultural productivity. The vegetation is typical of tropical deciduous forests, featuring a mix of

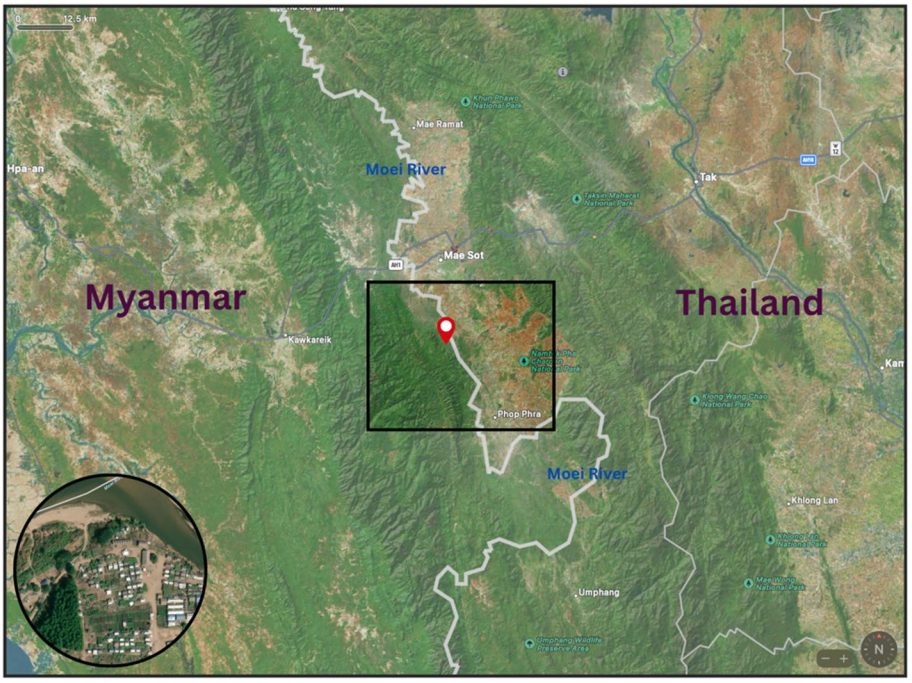


**Fig. 1** A Burmese refugee camp on the Myanmar side

teak (*Tectona grandis*), various Dipterocarpus species, and bamboo [21], which are utilised by the refugees for shelter construction and other purposes.

### 2.2 Study design and approach

This study employed a qualitative research design to comprehensively assess food security challenges across the four key pillars (availability, accessibility, utilisation, and stability) among affected populations in this Myanmar's border region [1, 10, 22]. The methodology was specifically designed to identify root causes of food insecurity while ensuring participant safety and data integrity in a conflict-affected environment.

#### *2.2.1 Participant recruitment and selection*

Interviews were conducted with informed and consenting clinic-attending camp residents and village leadership, ensuring strict adherence to voluntary participation principles. Participants were selected to represent diverse household compositions, economic activities, and food access experiences to capture the full spectrum of food security challenges. All participants provided informed consent, with particular attention to explaining data use, confidentiality measures, and participants' right to withdraw at any stage.

#### *2.2.2 Data collection methods*

**2.2.2.1** Primary data collection Due to security concerns that limited direct camp access, we adapted our data collection approach by conducting interviews outside the camp premises while maintaining comprehensive data gathering. Through structured open-ended questions [22], we collected detailed information on:

1) Food security pillars assessment: Current availability, accessibility, utilisation, and stability of food resources

2) Household food strategies: Daily food procurement, preparation, and allocation practices
3) Economic activities: Livelihood strategies and their relationship to food access
4) Traditional knowledge systems: Use of ethnobotanical knowledge and traditional food sources
5) Coping mechanisms: Formal and informal strategies employed during food scarcity
6) Living conditions: Housing, sanitation, and environmental factors affecting food security

**2.2.2.2** Ethnobotanical documentation Participants provided comprehensive lists and photographic documentation of available food resources, including detailed information on plant species availability, traditional utilization methods, and perceived nutritional quality. Our taxonomist, Prateep Panyadee, conducted scientific classification of plant species from photographic evidence to ensure accurate identification and documentation of traditional food systems [23].

**2.2.2.3** Complementary data sources Medical staff with authorised border-crossing access contributed additional photographic documentation of the food landscape, camp facilities, and hygiene conditions. These healthcare professionals also provided observational insights on nutritional status and health outcomes related to food security challenges.

Knowledge systems in current coping strategies and long-term sustainability.

#### *2.2.3 Data management and ethics*

Local interpreters received thorough briefing on maintaining confidentiality, neutrality, and research ethics standards. All data handling procedures were designed to protect participant privacy through secure storage and anonymisation protocols. Interview transcripts, handwritten notes, and photographic materials were systematically de-identified to remove all personal identifying information.

#### *2.2.4 Data analysis*

All relevant qualitative data, including transcribed interview quotations, field notes, and observational insights from the medical team, were compiled and subjected to a rigorous analysis. Our approach employed a hybrid coding method, deductively structured around the five pillars of food security while remaining open to new codes and themes emerging inductively from the data [24, 25]. Despite researchers specializing in different pillar scopes, the underlying coding scheme was applied consistently across all data. This consistency was ensured through a collaborative process of shared codebook development, regular team discussions, and consensus-building on code definitions and application. This collaborative analytical process ensured consistency and trustworthiness across the dataset. Our iterative approach, where all researchers contributed to understanding how specific codes applied across various contexts, enhanced the credibility of our findings and allowed for a shared interpretation of the data. Ethnobotanical documentation was integrated to understand the role of traditional knowledge systems in current coping strategies and long-term sustainability.

## 3 Results

### 3.1 Location and accessibility

The camp located near the borders between Thailand and Myanmar, houses approximately 500–1,000 refugees with about 30,000 square meters of space, the majority of whom are Karen people, the majority ethnic community in Myanmar (Fig. 2). From the interview with the village head, the camp located proximity to major transportation routes and infrastructure not only improved accessibility for humanitarian organisations but also, due to the area's relative stability, lessened the threat of military action, thus providing a dual benefit of aid access and security for the refugees.

"This location, situated near major transportation routes and infrastructure, not only enhances accessibility for humanitarian organisations but also, due to the area's relative stability, reduces the threat of military operations. This provides a dual benefit: access to aid and security for the refugees." [Refugee camp head].

However, the refugees may remain vulnerable to border conflicts, cross-border violence, and movement restrictions, which can limit their access to essential services such as healthcare and education.

### 3.2 Infrastructure development and organisation

Within this refugee camp, a meticulous organisation is evident, complete with well-equipped shelters, water tanks, agricultural zones, a clinic, a training center, a designated meeting area, and small shops—conforming to the guidelines set forth by the United Nations High Commissioner for Refugees (UNHCR) [26]. The accessibility to the major cities and towns however is difficult due to its temporary nature. The shelters are made from some construction materials cooperated with locally available materials, such as Bamboo wood, Tueng leaves (*Dipterocarpus tuberculatus*) and Fan Palm (*Corypha lecomtei*). The shelters are relatively close to the next, and typically houses three-four individuals who may be either family members or strangers. In addition, this camp is located next to the Moei River, where the refugees can bathe and swim. Clean water was facilitated by the installation of water filters and tanks for harvesting rainwater. Additionally, due to its proximity to the official boarder checkpoint in Mae Sot, the camp has

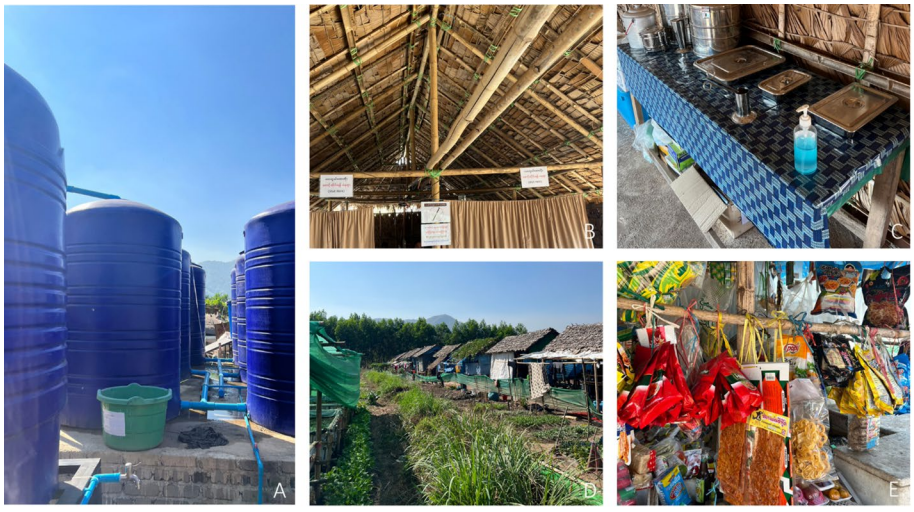


**Fig. 2** Some utilities in Myanmar refugee camp **A** water tanks **B** a clinic **C** medical equipment **D** accommodations and farming area **E** commercial processed products in the store

access to basic utilities, food and goods available in Thailand. Even though the refugee camp was designed to provide temporary housing for refugees, it has all the basic amenities required for people to live. The fact that the situation in the area is uncertain and fragile, which means that access to utilities like water, electricity, and gas may be disrupted at any time. Consequently, a contingency plan is necessary to ensure that people in the refugee camp have access to these utilities even if the normal supply is disrupted.

### 3.3 Foodscape in the refugee camp

The continuing conflict in Myanmar has deeply affected the lives of refugees residing in the camp. Land for cultivation was allocated to refugee residents, with plot size determined in proportion to household demographic composition. They were equipped with necessary cultivation tools and had access to fertilisers and irrigation systems. From the interview, we identified that several small home gardens where common crops, such as water spinach, pumpkin, and gourd, were cultivated to meet the primary food needs of the residents. The availability, cultivation schedule, and utilisation of food crops in this refugee camp are presented in Table 1. The crops cultivated mainly consisted of vegetables, including wax gourd and eggplant, both of which are nutrient-rich. While rice is considered the major staple food in Myanmar, maize, groundnut, and potato are

**Table 1** Qualitative availability of food crops as assessed by the village head and medical staff, using a scale from minimal (+) to extensive (++++)

| Food crops | Method of consumption | Cultivation (month–month) | Quantity | Demand |
|---|---|---|---|---|
| Maize *(Zea mays)* | Staple | September–October | + | +++ |
| Ground nut *(Arachis hypogaea)* | Staple | All year | ++ | ++ |
| Potato *(Solanum tuberosum)* | Staple | All year | ++ | +++ |
| Water spinach *(Ipomoea aquatic)* | Vegetable | All year | +++ | ++ |
| Pumpkins *(Cucurbita moschata)* | Vegetable | June–October | ++ | ++ |
| Tomato (*Solanum lycopersicum*) | Vegetable | November–February | + | +++ |
| Yardlong bean (*Vigna unguiculata* ssp. Sesquipedalis) | Vegetable | November–February | ++ | +++ |
| Asian eggplant (*Solanum melongena*) | Vegetable | March–May | +++ | +++ |
| Wax Gourd, winter melon (*Benincasa hispida*) | Vegetable | All year | +++++ | +++ |
| Long eggplant, eggplant (*Solanum melongena*) | Vegetable | All year | ++++ | +++ |
| Chinese okra (*Luffa acutangular*) | Vegetable | March–May | +++ | +++ |
| Cabbage (*Brassica oleracea* var. capitata) | Vegetable | June–October | +++ | +++ |
| Coriander (*Coriandrum sativum*) | Vegetable spice (fruit) | January–February | +++ | +++ |
| Chinese flowering cabbage (*Brassica Chinensis* Linn.) | Vegetable | June–October | ++ | ++ |
| Beetroot (*Beta vulgaris*) | Vegetable | March–May | ++ | + |
| Okra (*Abelmoschus esculentus*) | Vegetable | November–May | + | + |
| Lettuce (*Lactuca sativa*) | Vegetable | June–October | ++ | + |
| Broccoli (*Brassica oleracea* var. italica) | Vegetable | November–February | ++ | + |
| White Mugwort (*Artemisia lactiflora*) | Vegetable | May–October | ++ | + |
| Lemon grass (*Cymbopogon citratus*) | Spice | All year | +++ | +++ |
| Galangal (*Alpinia galanga*) | Spice | All year | ++ | ++ |
| Ginger (*Zingiber officinale*) | Spice | November–December | +++ | ++ |
| Bird's eye chili, chili (*Capsicum frutescens*) | Spice | All year | ++++ | +++ |
| Roselle (*Hibiscus sabdariffa* L) | Spice colorant | March–May | + | + |
| Papaya (*Carica papaya*) | Fruit | June–October | + | +++ |

**Fig. 3** Overall foodscape of the Myanmar refugee camp


**Fig. 4** Grocery store **A** and fresh food storage issue **B**

alternative crops found in this refugee camp. Our survey also found that the camp had limited supplies of fruit, with papaya being the only short-lived perennial type available (Fig. 3). Based on the assessment, the refugee camp faced a shortage of staple food crops, particularly maize, peanuts, and potatoes, which were in high demand. Certain vegetables, crucial for the ethnic group from Myanmar, were notably scarce. These included Asian vegetables like those from the *Solanum* spp. and various legumes. Additionally, the camp exhibited a lack of fruit crops, with papaya being the sole fruit option available.

### 3.4 Food hygiene

In this camp, there was a grocery store where food supplies, snacks, and beverages, and a shaved ice were sold (Fig. 4A). It was depicted from the survey that fresh food was

**Fig. 5** Raising catfish in Myanmar refugee camps as protein source

improperly stored usually due to the absent of refrigerator or cold storage in the camp. The common practice involved submerging fresh food, such as blood curd and soybean tofu, in water, which likely led to cross-contamination and posed a significant risk of illness (Fig. 4B). Also, we also found that packed ice was stored in white sacks and placed on the ground, with the direct contact with physical and microbial contaminants. In addition, access to clean water for cooking, cleaning food and personal uses is essential for food safety. As mentioned in the issue of food hygiene in the refugee camps, we are concerned that food-related diseases and illnesses among the migrants could become more serious in the future, therefore, the refugees should effectively disseminate knowledge of food hygiene.

### 3.5 Animal farming as source of protein

In the refugee camps, instead of relying solely on humanitarian programs, animal husbandry is regarded as the sustainable and reliable food production. In general, the animal farming in the refugee camps is often small-scale and limited by space and resources. Small animals such as fish, chickens, and ducks can be raised by the refugees, as they require less space and resources than livestock. Due to the condensed living conditions, animal farming is often limited by space and the resources to feed the animals. What we have found in the camp was that freshwater fish farming was the primary sources of protein (Fig. 5). The residents purchased meats and eggs from distant cities, which

required approximately two to three hours of arduous and dangerous travel during the civil war. Through interviews with the residents in the camp, it was determined that the majority of the individuals had some background in growing animals such as beef cattle and native chickens as food prior to immigration. It is essential that aid organisations and governments provide the civilian populations with safe and dependable feed access along with the necessary training of animal farming. More importantly, animal breed and alternative protein options such as milk and legume should also be considered.

### 3.6 Diminishing of traditional knowledge and local plant biodiversity

Despite the high population density in the camp, most of the land had been cleared out for habitation and agriculture, leading to the loss of local food system such as wild vegetables and native plants and the cultivation practices. This is very common in the refugee camp where its residents are unable to grow and harvest food in the same way they did in their home communities. Although the younger correspondents were knowledgeable about the crops being cultivated, they had limited knowledge of the traditional plants found within the camp.

"The number of elderly residents in the camp is not very large, and due to space limitations, most food crops come from seeds that can be found." [Refugee resident, age 28].

"We never go out to search for food in the forest. We only bring food in or cross over to buy from markets on the Thai side." [Refugee resident, age 32].

These traditional plants, such as *Acmella uliginosa*, *Phyllanthus amarus*, and *Scoparia dulcis*, were often overlooked and considered as mere weeds. Upon speaking with the elders in the camp, we learned that these plants were once commonly used for food and medicine, but the restrictions imposed by the civil war and the resulting constraints of life in the camp had prevented them from collecting these plants and passing down their traditional knowledge to the younger generation. This loss of ethnobotanical knowledge has left the refugees in the camp with limited resources and options for food and medicine. They are now dependent on exotic crops that acquired external supports, as they cannot collect the seeds themselves. This loss of traditional knowledge has not only resulted in a significant cultural loss, but also has practical consequences for the refugees' overall well-being, food security, and healthcare. The impact of the civil war is therefore compounded by the loss of this valuable knowledge, which could have provided much-needed support to the residents of the camp.

## 4 Discussion

Civil wars can have a significant impact on food security, leading to an increase in hunger and malnutrition and a deterioration of economic conditions [27]. In one instant, the wars can displace many people, frequently to refugee camps or other regions where food and other resources are scarce. They also often involve the destruction of public infrastructure such as roads, bridges, and ports, making it harder to convey food and other necessities. Refugee camps are defined as temporary shelters for people fleeing wars or conflicts in their home countries (refugees), with the safety and availability of basic facilities being important and necessary for refugee camps [28]. The observation that this refugee camp, despite its temporary design, provides basic amenities is a positive finding. This suggests a level of organisation and resource allocation that supports the residents' fundamental needs. Location, space, water and sanitation, health care, security,

community spaces, infrastructure, and accessibility should be taken into account when designing the layout of a refugee camp to ensure the safety and well-being of the refugees [29, 30]. Regarding this, the research on South Sudanese refugee camps highlights how increasing refugee populations have led to reduced land sizes. This directly compromises the feasibility and scale of food production for self-consumption. Furthermore, the distance to market centers and geographical characteristics like rain shadow areas are crucial spatial factors profoundly affecting agricultural output and food security [31].

From our observation, the critical issue lies in the severe limitations in food security, particularly concerning the availability of staple foods, culturally significant vegetables, and fruits. Local food systems are widely considered a sustainable solution to the environmental and socioeconomic issues caused by industrialised and specialised agriculture, such as loss of biodiversity, environmental pollution, rural depopulation, and marginalisation of small farmers [32, 33]. However, conflict often disrupts this system due to the destruction of farmland, storage facilities, and displacement of people, leading to food insecurity and malnutrition, especially among women and children. In refugee camps, food supply organizations are often complex, but growing food for self-consumption through home gardening or community farming initiatives is a sustainable approach [34–36]. For Syrian refugees resettled in Denmark, a community garden project demonstrated significant social, health, and integration benefits. Specifically, it promoted learning and language skills, fostered community and a sense of belonging, increased empowerment, and alleviated stress while improving overall well-being. A key aspect of this initiative was its ability to encourage collaboration between refugee families and their Danish neighboring garden tenants, proving highly beneficial for both the integration program and the refugees [37].

The shortage of staple crops (maize, peanuts and potatoes) has far-reaching implications. These crops are often primary sources of calories and nutrients, and their absence could lead to malnutrition and related health problems. The scarcity of specific vegetables (*Solanum* spp. and legumes) is particularly concerning as these are not just sources of vitamins and minerals, but also hold cultural and economic significances for Asian cultures along with the Myanmar refugees [38]. Their absence could lead to dietary deficiencies and a sense of cultural loss. The extreme lack of fruit diversity, with only papaya available, further compounds the nutritional deficiencies. A balanced diet requires a variety of fruits and vegetables to ensure adequate intake of essential vitamins and minerals [39]. This limited availability suggests a severe restriction in dietary options, potentially impacting the health and well-being of the camp's residents. Seasonal availability and seed availability are the factors that determine the common garden vegetables cultivated in the camp. Winter melon is a good source of vitamins C and B1, while eggplant is a good source of dietary fiber, vitamins, and minerals [40, 41]. Bird's eye chili, a common spice in many Southeast Asian food recipes, including Thai and Burmese, was also abundant in the camp [42]. It is an important crop for smallholder farmers, especially in rural areas, as it is relatively easy to grow and has a high yield, making it a valuable source of income. The cultivation of these crops provides refugees with an opportunity to generate income within the camp. They can sell surplus produce in local markets, thereby contributing to economic growth and promoting decent work opportunities for themselves and other camp residents. It could also stimulate the development of local markets and

trade within the community [43]. These practices align well with the UN sustainable Development Goal (SDG 8)—Decent Work and Economic Growth.

The persistent emergency status in refugee camps is represented in a food basket based primarily on the overall calorie intake rather than the variable of food choices. It is worth highlighting that in the conflict-affected regions, preserving and revitalising local food systems is critical not only for food security but also for broader sustainable development goals (SDGs) set out by the United Nations (UN) [44]. The local food systems contribute to achieving zero hunger (SDG2) by enhancing food security and reducing dependence on external food aid [45]. They provide a sustainable source of nutrition, particularly crucial for vulnerable groups like women and children. The prevalence of anemia and acute malnutrition, notably among these vulnerable groups, emerges as a severe and pressing concern [46, 47]. In this context, protein assumes a pivotal role in sustaining the well-being of the camp residents. Primary sources of protein, encompassing meat, fish, and eggs, stand as indispensable staples of daily sustenance [48, 49]. A study of 182 households in Thailand's Mae La Refugee Camp revealed that rice was the primary source of protein among ration foods, contributing 71.5% of the total. In contrast, only 12% of the average household's total protein intake came from animal sources [50].

The significance of protein in mitigating malnutrition and anemia cannot be overstated, as these conditions bear far-reaching health implications. As such, there is an essential need for comprehensive strategies that not only ensure the availability of protein-rich foods but also address underlying factors contributing to nutritional deficiencies. Access to adequate and nutritious animal feed is often limited. Refugees may rely on locally available vegetation, which may lack essential nutrients, impacting animal health and productivity. The quality of feed may be inconsistent, leading to malnutrition and disease in livestock. Seasonal fluctuations in vegetation availability exacerbate feed scarcity, particularly during the dry season. This increases the risk of disease outbreaks among livestock, leading to animal losses and impacting protein availability. Animal disease outbreaks, particularly among small ruminants in Algeria, pose a severe threat to food security by drastically reducing the availability of animal protein due to livestock losses and decreased productivity. These outbreaks also inflict substantial economic burdens on farmers and the national economy through direct mortality, increased import costs, and hindered livelihoods, while also raising public health concerns due to zoonotic transmission and complicating transboundary disease control [51].

The lack of preventative care (vaccinations, parasite control) further compromises animal health [52]. In relevant with partnership for the goals (SDG17), humanitarian organisations and agencies are actively involved in addressing nutritional challenges within refugee camps. There is a pressing need for coordinated, integrated, and collaborative responses at all levels—international, national, and subnational. These responses should involve various stakeholders, including humanitarian agencies, governments, and civil society. It is essential to tailor these efforts to the specific needs of both displaced and host populations, considering their socio-cultural contexts and realities [53, 54]. During the military takeover, the pandemic caused significant shocks to the staple food supply. To address potential social protection issues, the country's interventions included in-kind transfers of rice and food vouchers for a diversified basket of rice and non-staple foods [55]. The nutritional challenges identified in refugee diets, particularly regarding

protein adequacy, are further compounded by concerns about food safety and hygiene practices.

Food hygiene, otherwise known as food safety, are generally a concern in the refugee camp, particularly after the overpopulation, unsanitary conditions and limited access to clean water and proper facility. In this trip, we were able to classify the two possible food safety issues in the refugee camp. Firstly, food contaminations of both physical and biological types. Improper handling of raw materials prior to consumption might result in dangers due to soil, rock, or dirt especially when food is stored in the open area or containers. Perishable food items including meat, dairy products, fish, and prepared meals undergo accelerated deterioration when stored at ambient temperatures, with this process significantly intensified in tropical climatic conditions in this camp. The consumption of inadequately refrigerated foodstuffs substantially elevates the probability of foodborne illness, potentially manifesting as gastrointestinal distress including diarrhea and emesis, pyrexia, and various additional adverse health outcomes [56]. More importantly, inadequate sanitation among the migrants and foodborne contamination are also regarded as important [57]. If personal hygiene care has not been given enough attention, an outbreak could develop and spread across the camp [58]. From our studies, the refugee camp experiences a tropical monsoon climate with distinct wet and dry seasons. Water sources in the refugee camp are likely to include rainwater harvesting and from Moei River. The availability of these sources may fluctuate significantly depending on the season. During the dry season, reliance on limited groundwater or river sources may increase. Regular monitoring for microbial contaminants (e.g., *Escherichia coli* and coliform bacteria) is essential to prevent waterborne diseases like diarrhea, cholera, and typhoid. This is especially crucial in refugee camps, where overcrowding and poor sanitation increase the risk of disease outbreaks [58]. The other studies in this context of other refugee camps such as the Rohinga suggest that inadequate sanitation, improper waste management, and insufficient personal hygiene practices within the refugee camps create a pervasive environment for disease outbreaks, including waterborne and fecal–oral diseases that strongly imply a significant risk of foodborne contamination. These conditions, exacerbated by high population density and infrastructure challenges, lead to widespread health issues like diarrheal diseases, skin infections, and the proliferation of disease vectors, profoundly impacting the well-being of camp residents [59, 60].

As to comply with SDG 6—Clean Water and Sanitation, the following interventions could be addressed. Implementing comprehensive hygiene education programs within the camp involves training camp residents, particularly community leaders and caregivers, on the significance of personal hygiene, safe food handling practices, and preventing foodborne illnesses. Camp residents should be encouraged and empowered to assume a leading role in upholding sanitation within the camp. This entails establishing community committees tasked with overseeing waste management, the construction and maintenance of sanitary facilities, and conducting regular cleaning campaigns. Finally, the refugee camp leader should collaborate with humanitarian organisations and local authorities to enhance the camp's sanitation infrastructures.

## 5 Recommendations

Based on our observations, we strongly recommend implementing comprehensive training and education programs within the refugee camps. These initiatives can be transformative, equipping displaced individuals with skills for survival and self-sufficiency.

Firstly, educational programs focused on local plant food conservation and utilisation should be implemented. These programs should provide instruction on cultivating, collecting germplasm, and conserving indigenous plant resources, thereby ensuring sustainable food availability. Introducing diverse food crop varieties will further promote self-sufficiency and nutritional balance within the community. Crucially, facilitating knowledge transfer from older generations will preserve traditional plant food utilisation practices, safeguarding cultural heritage and valuable ecological wisdom. Secondly, infrastructure development is paramount. Installing adequate utilities, including clean water supply, electricity, and refrigerated appliances, will significantly improve living conditions and food hygiene. Collaboration with humanitarian aid organisations is vital to support these infrastructural upgrades. Thirdly, hygiene and food safety education must be prioritised. Training on personal hygiene and safe food preparation practices will minimise the risk of food contamination and disease outbreaks. Finally, establishing sustainable animal farming initiatives, such as egg-laying hens, cows, and fish farms, will provide reliable and nutritious protein sources, reducing dependence on potentially dangerous external procurement.

These programs not only secure the camp's food supply and act as income generators but also promote sustainable resource management and environmental conservation. They build resilience against climate fluctuations, market changes, and other challenges, strengthening the camp community's ability to withstand crises. Beyond tangible benefits, these initiatives foster food safety knowledge, improve health, empower refugees, strengthen social bonds, preserve cultural heritage, and enable long-term planning. Ultimately, these programs offer a pathway to a brighter future within the camp, contributing to peaceful coexistence and reducing the likelihood of conflict. Critically, agricultural programs within refugee camps have the potential to significantly contribute to a more peaceful environment. By directly increasing food availability, these initiatives mitigate competition and conflict over scarce resources. Empowering refugees to cultivate their own food fosters a sense of ownership and control, shifting the dynamic from competition to cooperation. Furthermore, the shared labor and communal benefits inherent in agricultural projects cultivate a collective identity and purpose, effectively reducing social fragmentation. This empowerment extends to economic spheres, as self-sufficiency diminishes dependence on aid, thereby lessening frustration and resentment. Finally, education on sustainable agricultural practices promotes responsible resource management, minimising environmental degradation and the potential for disputes over land and water. This holistic approach, integrating food security, economic empowerment, and environmental stewardship, directly addresses key drivers of conflict, fostering a more harmonious and stable camp environment.

## 6 Conclusion

In summary, the precarious situation in Myanmar, characterised by persistent violence and political instability, has precipitated a severe humanitarian crisis. This crisis manifests as acute limitations in access to food, clean water, and healthcare, with far-reaching

consequences for the regional economy and agricultural systems, leading to the erosion of biodiversity and traditional knowledge. Our findings underscore the critical role of integrating local food systems, hygiene, and educational initiatives within refugee camps to mitigate these challenges. Specifically, securing livelihoods through sustainable practices like animal farming and crop cultivation, coupled with comprehensive nutrition support and educational programs, is paramount. These initiatives not only enhance food security but also foster resilience and self-sufficiency. Furthermore, the provision of adequate utilities, such as clean water and refrigerated appliances, alongside education on personal hygiene and safe food preparation, is essential for preventing disease outbreaks and maintaining public health. The importance of preserving and transmitting traditional knowledge of plant food utilisation, particularly through intergenerational engagement, cannot be overstated, as it ensures the continuity of valuable cultural and ecological practices. Ultimately, this article serves as a call to action for collaborative partnerships between humanitarian organisations and governments to implement holistic interventions that address the interconnected needs of refugees in Myanmar. By prioritising integrated approaches that combine food security, hygiene, and education, we can contribute to a more sustainable and peaceful future for these vulnerable populations.

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**Author contributions**
Sarana Rose Sommano: conceptualization, methodology, writing—reviewing and editing. Patipon Teerakitchotikan: investigation, visualization. Tibet Tangpao, Malaiporn Wongkeaw, Chompunut Lumsangkul and Prateep Panyadee: investigation writing—reviewing and editing. Soo Hee Lee: supervision.

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**Data availability**
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
The protocol was approved by Chiang Mai University Research Ethics Committee (Certificate of Exemption: COE No. 031/67) in accordance with the Declaration of Helsinki, International Conference on Harmonization in Good Clinical Practice (ICH- GCP) and The Belmont Report. Informed consents were obtained from all individual participants included in the study. For participants under the age of 18, informed consents ware obtained from a parent and/or legal guardian.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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## Publisher's Note