Research Paper

The Potential of Local Food Diversification in Supporting Sustainable Food Security in Maluku Islands

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Abstract

Every region in Indonesia has food potential according to the region's characteristics, as is the case with Maluku, an archipelago province with a diverse group of small islands. Due to the distinctive characteristics of each island, sufficient knowledge regarding the condition of potential food and its constraints is needed to avoid food shortages. The study aimed to analyze the constraints and potential of local food diversification on each island situated in the XII Island Clusters of Maluku to achieve the fulfillment of sustainable food and food security for each of these islands. The data used was descriptive data collected from a significant number of previous research journals, documents, and field notes. Data analysis was conducted using a qualitative descriptive method that attempts to describe and interpret food diversification potentials and constraints in XII GP in Maluku based on the reality through a thorough literature study. The analysis results showed that in most of the small islands in Maluku, the land was dry and hilly, the rainfall was low, the tilling layer was thin, the soil fertility was low, and it was easily degraded. The resources of farmers with qualified agricultural knowledge were still very limited. However, the potential gained was that there were six main types of food spread across XII GP, namely sago, corn, barley (hotong), upland rice, sweet potatoes, and bananas, which can be obtained and processed to fulfill the food needs of the community and ultimately achieve sustainable food security for everyone in the islands.

Keywords: *Food Potential; Local Food Diversification; Food Security; Food Constraints*

INTRODUCTION

Food security is a global issue, especially in developing countries, including Indonesia. Food security, according to the Law of the Republic of Indonesia Number 18 of 2012, is "a condition of food fulfillment in the state down to individuals, which is reflected in the availability of sufficient food both in quantity and quality, safe, diverse, nutritious, equitable and affordable food which does not conflict with religion, belief, and culture of the community, in order to be able to live a healthy, active and productive life in a sustainable manner."

Since its establishment, FAO (Food and Agriculture Organization) has been leading international efforts to end hunger and achieve food security in the world (FAO, 2021). Ensuring that people have sufficient food requires aligning short-term assistance with a long-term development strategy that will help countries feed their own people. Data released by the National Food Agency of Indonesia placed Maluku Province as one of the provinces with the lowest Food Security Index; it ranked 31st out of 34 provinces in Indonesia (National Food Agency, 2022). However, according to the Food Security Service of Maluku Province, Maluku actually does not lack food, but recognition of local Maluku food has not yet been recognized nor accommodated by the National Food Agency (RakyatMaluku, 2023).

According to Maluku Province Statistics, in 2020, the Maluku population was 1,831,880, or approximately 0.68% of the total Indonesian population (269,603,400 people) (Central Bureau of Statistics, 2020). Becoming a province consisting of a great number of small and medium-sized islands which are characterized by mountainous and hilly topography and low agricultural land availability, Maluku is very vulnerable to global climate change, and it faces many complex development changes, especially with regard to food security (Far-Far & Ivakdalam, 2022). The

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boundary of small islands tends to have potential threats internally and externally. This is because many small islands in Maluku are located next to the country border, which isolates those small islands with limited transportation access. The majority of the areas close to the country border are considered less developed due to limited access to social and economic infrastructures (Pattinama & Nanere, 2021). Food security among people in the small islands of Maluku has been worsened due to their dependency on rice as their staple food (Adam, 2011). The late distribution of rice by the government could easily cause a hunger disaster.

In fact, the richness of plants (cultivated crops and wild relatives) in Maluku has been well-known for centuries; many of these components of biodiversity are unique and can only be found in this region. This biodiversity has been exploited for the economic improvement of the community in this island province (Leunufna & Evans, 2014). However, the dependency on rice supplied by the government made local people stop planting their traditional plants, including yam, corn, sago, and other tuber crops (Pattinama & Nanere, 2021).

With regard to the aforementioned complexity, sufficient knowledge regarding the condition of the potential food in Maluku and the existing constraints is needed in order to support sustainable food security in Maluku. Reflecting on this, the purpose of the study was to analyze the constraints and potential of food diversification on each island situated in XII Island Clusters of Maluku to achieve the fulfillment of sustainable food and food security for each of these islands.

LITERATURE REVIEW

Food Security

The Committee on World Food Security (CFS) mentioned that one of the most popular definitions of food security emphasizes its multidimensionality, describing food security as the condition that exists when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2021). Social capital and the synergy from interactions with community members enhance food security status—both directly and indirectly (Nosratabadi et al., 2020). Thus, food security gradually and consistently expanded to involve not only food availability and food production but also its expansion to ensure the explicit simultaneous accessibility of food (Al Jaafreh & Nagy, 2020). The food security approach "prioritizes trade-oriented goods, imports, and intensive agriculture while promoting poverty-alleviation policies" (Merino, 2022). Food security consists of four dimensions, namely food availability, food stability, food utilization, and access to food (Ashby et al., 2016). In developing countries, food security is a major concern because most of the population suffers from malnutrition. Policies to grow staple grain crops have been recognized, but diet diversity has received little attention.

Local Food Diversification and Food Security

According to Jalal et al. (2022), the food diversification program that the government has implemented in the developing agriculture sector is directed at the procurement of various local food commodities. The development of local food is an effort to strengthen food variety with many alternative foods.

Local food is the food that is consumed by the local society and is suitable with potential and local wisdom that is coming within (Government of Indonesia, Law Number 18 of 2012 regarding Food). Sections 41 and 42 stated that The Nation confesses the food diversity and the role of local food. Section 41 states that food diversity is an effort to increase food availability that has a wide variety and is based on the potential of local food resources. Furthermore, Section 42 states that food diversity: a. determines the food diversity principle; b. optimizes the local food.

According to Purwantini et al. (2016), the Indonesian population consumes more rice than

the required intake. In an effort to lessen rice dependency, Suyastiri (2008) conducted research on the diversification of food in rural households in Semin, Gunung Kidul, exploring the non-rice local potency. Staple's food diversification pattern includes rice, and its substitution is rice-corn, rice-tapioca, and corn-tapioca. In practice, the consumption pattern is able to lessen the dependency on rice. Likewise, Yuniarti et al. (2020), in their research in Kulon Progo and Gunung Kidul, Yogyakarta, indicated that poor households in both sub-districts have diversified food. Impoverished households substitute rice by most respondents in both sub-districts, especially in the Saptosari District, indicating that more and more poor households are doing it. Food substitutes for rice are cassava, corn, and others. In general, cassava is the main food substitute for rice in the two districts.

The study by Waha et al. (2018) stated that a more diverse agricultural system can contribute to food security for households due to the household market orientation factors and available land resources. Then, a study by Larson et al. (2019) with a focus of research on the relationship between empowerment activities, food security, and food diversity shows that high-income households have more diverse diets. In contrast, low-income families tend to experience moderate to moderate food insecurity weight.

Based on previous research related to food security, the authors, however, have yet to find a review article on food diversification as an effort to support sustainable food security among diverse island clusters that have different food characteristics. Food security supported by sustainable food diversification will be able to contribute to supporting sustainable food security in those small islands. The purpose of this study is to figure out the potential of local food diversification as the strategic step to support sustainable food security in the Maluku Islands. Food diversification is an important thing to be studied further through this article, especially related to the development of efforts in the food sector to create food security in small isolated islands. This article has an update on reviewing food security from the perspective of the relationship between food diversification and supporting sustainable food security on different island clusters with diverse characteristics.

RESEARCH METHOD

This study used a descriptive qualitative approach method to examine the actual conditions in the field and then juxtaposed them with various theories associated with the object. The focus of this research issue is food diversification and food security by interpreting the food potentials and constraints in XII Island Clusters in Maluku. Source of research data obtained through observation regarding the actual conditions that occur in the field. Data analysis was performed using an interactive model of analysis techniques that included three stages, namely, the reduction of the data, the presentation of the data, and the conclusion.

FINDINGS AND DISCUSSION

Characteristics of Small Islands' Land

Maluku Province has an average temperature of 27.3°C, a maximum of 30.46°C, and a minimum of 24.3°C. Rainfall conditions in Maluku can be divided into four categories, with rainfall of 1,000 mm/year in Babar, Tanimbar, Aru, and parts of Buru Island. Furthermore, rainfall between 2,000 – 3,000 mm/year occurs on the islands of Seram, Gorom and Kei Kecil. Rainfall of more than 3,000 mm/year is found on Lease Island, Kei Kecil Island, Ambon Island, and Kao Island, while the highest rainfall is on Mount Darlisa (West Seram Regency) at 3,384 mm/year. On the other hand, the lowest rainfall is in Tiwaker (Wetar Island) at 991 mm/year (Capital Investment Coordinating Board, 2011; Maluku Central Bureau of Statistics, 2021). Areas having low rainfall with a planting season once a year (GP X-XII) can manage food through traditional storage technology that has been passed down for generations so that the harvested yields can be stored until the next planting

season.

The topography of Maluku Province consists of 1,251,630 ha (14.6%) of flat land, 2,417,530 ha (28.2%) of wavy land, and 4,903,640 (57.2%) of hilly and mountainous land (Capital Investment Coordinating Board, 2011). The land topography of Ambon City is divided into flat, wavy, hilly, and mountainous, with the dominant slopes being slightly gentle to steep. The topography of Central Maluku, West Seram, and East Seram is generally hilly, caused by the confluence of two plates called the Pacific and Mediterranean circumps. The topography of the Southeast Maluku region consists of land, hills, and mountains. In the Buru Regency area, most of the land is hilly and mountainous, with slopes of 14-40% and > 40% (Djaenudin et al., 2002; Capital Investment Coordinating Board, 2011; Maluku Central Bureau of Statistics, 2021).

Coral reefs and volcanic ash are the main constituents of the soil for most islands in Maluku Province. The dominant soil types include complex latosol, renzina, and Mediterranean soils (Maluku Central Bureau of Statistics, 2021). The topography of Maluku Province comprises 1,251,630 ha (14.6%) of flat land, 2,417,530 ha (28.2%) of wavy land, 4,903,640 of hills and mountains (57.2%) (Capital Investment Coordinating Board, 2011). The land topography of Ambon City is flat, wavy, hilly, and mountainous, with the dominant slopes being slightly gentle to steep. The topography of Central Maluku, West Seram, and East Seram is generally hilly due to the confluence of two plates called the Pacific and Mediterranean circumps. The topography of the Southeast Maluku region is land, hilly, and mountainous. In the Buru Regency area, most of the land is hilly and mountainous, with slopes of 14-40% and > 40% (Djaenudin et al., 2002; Capital Investment Coordinating Board, 2011).

The semi-detailed 1:50,000 scale soil map of Central Maluku Regency and its legend has provided information including the distribution of soil types, soil map unit numbers (SPT), soil composition (which consists of several soil units at the subgroup level), and the area of each SPT stated in hectares and its percentage to the total area. The legend of soil map is divided into 54 soil map units (SPT) consisting of 5 soil map units developed from alluvium, colluvium, marine alluvium, beach sand, and bodies of water, and 8 soil map units shaped from limestone, sandstone/claystone, sandstone/nepal, schis/gnesia/phyllite/quartzite, metamorphic rock/limestone, basalt, and ultrabasic rock/serpertine. Based on field observations and supported by data from laboratory-based chemical analysis, the soils in Central Maluku Regency are classified according to Soil Taxonomy (Soil Survey Staff, 2010) into 6 Orders, namely: Entisols, Inceptisols, Vertisols, Alfisols, Ultisols and Oxisols, as well as the derivatives of 21 soil subgroups. The classification of soil at the subgroup level is presented in (Table 1).

Table 1. The classification of soil at the subgroup level in Central Maluku Regency

Ordo	Subordo	Group	Subgroup	Type of Soil
Entisols	Sulfaquents	Sulfaquents	Sulfaquents	Thionic Alluvial
Aquents	Typic	Haplic		Thionic Alluvial
	Psamments	Udipsamments	Typic Udipsamments	Eutric Regosol
Inceptisols	Aquepts	Endoaquepts	Sulfic Endoaquepts	Eutric Gleysol
			Aeric Endoaquepts	Thionic Gleysol
			Typic Endoaquepts	Eutric Gleysol
	Udepts	Lithic	Aquic Eutrudepts	Gleic Cambisol
	Eutrudepts	Eutrudepts	Vertic Eutrudepts	Vertic Cambisol
	Lytic Cambisol		Typic Eutrudepts	Eutric Cambisol
		Dystrudepts	Aquic Dystrudepts	Gleic Cambisol
			Typic Dystrudepts	Dystric Cambisol

Ordo	Subordo	Group	Subgroup	Type of Soil
Vertisols	Uderts	Hapluderts	Leptic Hapluderts	Haplic Grumusol
Alfisols	Udalfs	Hapludalfts	Hapludalfs Vertic Hapludalfs Typic	Vertic Mediterranean Haplic Mediterranean
Ultisols	Udults	Kanhapludults Kandiudults Hapludults	Typic Kanhapludults Typic Kandiudults Inceptic Hapludults P Typic Hapludults	Candic Podzolic Candic Podzolic Haplic Podzolic Haplic Podzolic
Oxisols Udox	Hapludox	Eutrudox	Typic Hapludox Typic Eutrudox	Haplic Oxsisol Hapic Oxsisol

Problems in Small Islands

One of the causes of low food production in Maluku is the diminishing availability of productive land due to land conversion. Productive lands are used as places to build factories, housing, sports facilities, and other public facilities. Many sago fields in Maluku have also been converted into residences and other non-agricultural uses, such as public facilities, schools, hospitals, and others.

Small islands (PPK) have unique characteristics, so the management must also use a unique approach. Adrianto (2004) suggested that PPK management strategies should link all activities and stakeholders in PPK using a coordinated approach. Small islands have different characteristics and levels of vulnerability compared to large islands. Most of the small islands have a wealth of natural resources and environmental services that have great potential for economic development.

Some of the characteristics of small islands that need attention in relation to development planning are:

a. Being vulnerable to global warming results in rising sea levels, so that its land area decreases,
b. Having an Exclusive Economic Zone (EEZ) that is wide enough so that the territorial waters are the main carrying capacity for regional development,
c. Having limited natural resources and generally experiencing excessive exploitation,
d. Being sensitive to natural disasters such as volcanism, earthquakes, and tsunamis,
e. Generally being very isolated and far from main markets,
f. Being open to small-scale economic systems but highly sensitive to outside market shocks on a larger scale,
g. Having a high population growth rate but spread unequally with high density,
h. Naturally, having a limited infrastructure,
i. Being limited in the education and skills of the population and having a strong belief in mystical matters

Distribution of Food Types in XII Island Clusters

Maluku has a fairly high diversity of food. Therefore, from the beginning, each island or region had its own staple food according to the island's agro-climate. Based on climate zones and regional characteristics, Maluku is divided into 12 Island Clusters (GP), each of which has different climate, soil, and genetic resource characteristics. GP I (Buru Island) is focused on the development of lowland upland rice and *hotong*, GP II (West Seram Island) is focused on the development of lowland upland rice and sago, GP III (North Seram Island) is focused on the development of lowland

upland rice, GP IV (East Seram Island) is focused on the development of sago, GP V (Southern Seram Island is focused on the development of sago, GP VI (Banda Island) is focused on the development of nutmeg and bananas, GP VII (Ambon Island and Lease) is focused on the development of cloves, nutmeg and tubers, GP VIII (Kei Islands) is focused on the development of *Enbal* Cassava, GP IX (Aru Island) is focused on the development of sago, GP X (Tanimnbar Island) is focused on the development of sweet potatoes and upland rice, GP XI (Babar Island) is focused on the development of sweet potatoes and bananas, GP XII (Southern Island) is focused on the development of sweet potatoes and corn. Each GP has different land characteristics, so the types of food crops and types of staple food are also different. Apart from the main types, there are also other types that accompany, such as GP I-V, VII, and IX, which consume more sago, GP VI consumes more bananas and sweet potatoes, GP VIII consumes more sweet potatoes, especially *enbal*, GP X consumes more sweet potatoes and field rice, GP XI consuming more sweet potatoes, corn and bananas, and GP XII consuming more corn, breadfruit, and beans. The distribution of island clusters in Maluku can be seen in Figure 1.

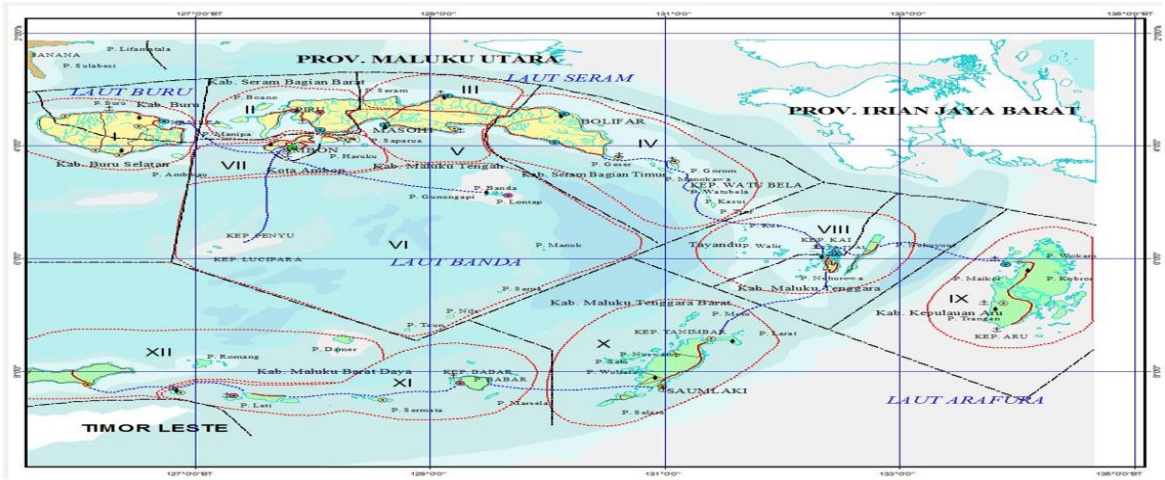

Figure 1. Distribution of Island Clusters in Maluku Province: I (Buru), II (West Seram), III (North Seram), IV (East Seram), V (Southern Seram), VI (Banda), VII (Ambon and PP Lease), VIII (Kei Islands), IX (Aru Islands), X (Tanimbar), XI (Babar), XII (Southern Islands).

Food Potentials in Maluku

To maintain food availability in Maluku Province, the Maluku Province Food Security Agency organizes three programs, which are (a) Village with Food Resilience, (b) Villages' Food Barns, and (c) Development of Island with Food Resilience. Village with Food Resilience and Villages' Food Barns are programmed to ensure the availability of food in the community and for the sake of economic turnover. Meanwhile, Island with Food Resilience is targeted at small islands or island clusters in Maluku. This is specifically to anticipate food insecurity during bad weather and seasons, which result in delays in the supply of food through sea transportation. The program to be developed is to make PPK a center for local food production, including tubers, sago, bananas, corn, and breadfruit, which are used as a source of carbohydrates equivalent to rice (Maluku Central Bureau of Statistics, 2021).

Each location has a different climate, soil, and biotic environment depending on its latitude and altitude. Maluku Province is an archipelagic province connected to the sea, which has high biodiversity, including genetic resources for food. Each island or region has its own special food; this is also in accordance with the agro-climatic characteristics of the area, where plants can adapt to the soil and climate conditions of the area. Seram, Ambon, and Buru islands generally consume

sago, hotong, and tubers, and Tanimbar Island generally consumes tubers, grains (upland rice and hotong), and nuts. The Southwest Maluku Islands generally consume tubers, bananas, corn, breadfruit, and other fruits.

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Several types of food in Maluku that are often consumed by the people of Maluku and can be developed into island food include:

Sago (Metroxylon spp.)

Sago is a traditional food source that can strengthen national food security. The food diversification program aims to support local and national food security. This traditional food has nutritional value that is not inferior to other food sources such as rice, corn, cassava, and potatoes. Sago flour and its processed products can be classified as functional food because they contain carbohydrates (84.7%), quite high dietary fiber (3.69-5.96%), low glycemic index (28), as well as resistant starch, polysaccharides not starch, and short chain carbohydrates which are very useful for health.

The Maluku people consume sago as a traditional food ingredient in the form of staple foods (*papeda, sinoli, tutupola,* sago plates, and *buburne*) as well as snacks (*sarut, bagea, sago tumbu*, and sago sugar and various types of cakes). Based on the results of the study, it was found that the area of sago land in Tuhaha Land was 167 ha, with a whole-tree harvesting (MT) of 24 trees/ha. To determine starch production per tree, three types of sago trees were logged, which were used as samples, namely *sago tuni, molat, and ihur*. Starch production per tree, apart from depending on the conditions of the land where it grows, also depends on the diameter of the stem and the height of the stem free of leaves (Flach & Schuiling, 1988; Louhenapessy, 1994). The calculation results showed that the production of wet starch for sago tuni was 631 kg/tree, molat sago was 535 kg/tree, and sago ihur was 510 kg/tree. Thus, the average value of wet starch production per tree was 560 kg/tree. Based on the area of sago land, from the number of whole-tree harvesting (MT) per hectare and wet starch production per tree (kg), the potential for sago starch production in Tuaha Land can be calculated with the equation:

$$P = L \times MT \times Pp$$

Remarks:
P = Starch production (kg/ton)
L = Sago land area (ha)
MT = The average whole-tree harvesting/ha (tree)
Pp = Wet starch production/tree (kg/ton)

Sago area in Maluku from 2017 to 2021 were respectively 36,484, 36,478, 36,484, 36,502, and 37,081, with a growth of 0.00 percent (Maluku Central Bureau of Statistics, 2021). The total consumption of sago in Maluku has only reached 70,220 tons/year, less than the total production of sago flour, which is 888,025 tons/year. The potential types of sago in Maluku can be seen in Table 2 below:

Table 2. Potential Types of Sago in Maluku

No.	Types of Sago	Scientific Name	Island Cluster
1.	*Sago Tuni*	(*Metroxylon rumphii* Martius)	I, II, III, IV, V, VII, IX
2.	*Sago Molat*	(*Metroxylon sagu* Rottbol)	II, III, IV, V, VII,
3.	*Sago Ihur*	(*Metroxylon sylvester* Martius)	I, II, III, IV, V, VII,
4.	*Sago Makanaru*	(*Metroxylon longispinum* Martius)	I, II, III, IV, V, VII,
5.	*Sago Duri rotan*	(*Metroxylon microcothium* Martius)	IV, VII

Source: Botanri et.al. (2011)

Corn (Zea mays L.)

In Maluku, especially in the Southwest Maluku Regency (MBD), corn is a staple food for most people (Susanto & Sirappa, 2005). Based on data from the Central Bureau of Statistics of MBD Regency and the Department of Agriculture, Plantation, Forestry and Animal Husbandry of MBD Regency in 2011, the average maize productivity in MBD was still very low, which was 1.0 t/ha with a harvested area of 16,460 ha (Maluku Central Bureau of Statistics, 2021; Capital Investment Coordinating Board, 2011), while in Maluku corn productivity only reached 2.43t/ha (Maluku Central Bureau of Statistics, 2021). The low productivity of corn occurs because the cultivation techniques applied by farmers are still conventional, as the corn is planted together with several other food crops with irregular and wide enough spacing without fertilization and pest control. Some research results showed that the yield of some local cord in West Southeast Maluku (now Southwest Maluku), with spacing and fertilization arrangements, could provide yields between 3.79 - 5.43 t/ha, while superior varieties were 5.44 - 7.76 t/ha (Pesireron & Senewe, 2003; Kaihatu et al., 2012; Department of Agriculture, 2008). Potential Types of Corn in Maluku can be seen in Table 3 below:

Table 3. Potential Types of Corn in Maluku

No.	Types of Corn	Scientific Name	Island Cluster
1.	Yellow Corn	*Zea mays ssp. mays*	X, XI, XII
2.	White Corn	*Zea mays var. amylacea*	VIII, X, XI, XII
3.	Onion Corn	*Zea mays, Sp*	VIII, XI, XII
4.	Red Corn	*Zea mays L.*	VIII, XI, XII
5.	Purple Corn	*Zea mays L.*	XI, XII
6.	Waxy Corn	*Zea mays var.* ceratina	VIII, XI, XII
7.	*Brondong*	*Zea mays sp*	XI, XII
8.	*Hulaliu Corn*	*Zea mays, sp*	VII

Source: Sirappa, et.al. (2013)

Hotong (Setaria italica L.)

Hotong is a grain plant similar to rice, which is a local food product that is generally consumed by people on Buru Island, South Buru Island, Selaru Island, and Tanimbar Kei Island. The carbohydrate content of hotong is similar to the carbohydrate content of rice in Indonesia, while the protein content is higher when compared to that of other carbohydrate source foods such as rice and potatoes. *Hotong* seeds have a moisture content of 9.03%. These conditions meet the storage standards for cereals, but in the form of flour, the water content is much lower (6.82%). This is due to the flouring process, which causes heat, resulting in a decrease in water content. Hotong fat content (3%) is equivalent to sorghum (3%) and higher than rice and wheat fat content

(1%), while hotong seed protein (14%) and hotong flour (13%) are higher when compared to rice (6-10%), sorghum (8-10%) and wheat (8-12%). Hotong seeds generally contain bioactive components that have antioxidant properties, such as tannins and vitamin E. The content of vitamin E in the seeds and hotong flour was 44.5 ppm and 50.9 ppm, respectively, while the tannin content in the seeds and hotong flour was respectively 0.22% and 0.06% (Department of Agriculture, 2008). The potential of Hotong in Maluku can be seen in Table 4 below:

Table 4. Potential Types of Hotong in Maluku

No	Types of Hotong	Scientific Name	Island Cluster
1.	*Hotong Buru*	*Setaria italica* (L) Beauv.	I
2.	*Hotong Buru Selatan*	*Setaria italica* (L) Beauv	I
3.	*Hotong Tanimbar Kei*	*Setaria italica* (Var.) Metzgeri.	IX
4.	*Hotong Werain*	*Setaria italica* (Var.) Stramiofructa.	IX
5.	*Hotong Namtabung*	*Setaria italica, sp*	IX

Source: Herodian (2000).

Upland rice (Orisa zativa L.)

Upland rice is a type of plant that does not need much water. Its growth depends only on rainwater. Upland rice is planted on several islands, such as Seram Island, Tanimbar Island, Aru Island, and Leti Island. Planting upland rice on dryland is very suitable for the characteristics of the Maluku region, which is generally mountainous and has limited water, so it is not suitable for lowland rice, despite the fact that every year, the government opens up new land for lowland rice. The potential of upland rice in Maluku can be seen in Table 5 below:

Table 5. Potential Types of Upland Rice in Maluku

No.	Types of Upland Rice	Scientific Name	Island Cluster
1.	*Pulo lenso*	*Oriza sp*	X, XI
2.	*Gamtala*	*Oriza sp*	XI
3.	*Pangalo*	*Oriza sp*	XI, XII
4.	*Bidoi*	*Oriza sp*	X, XI
5.	*Padi aluss*	*Oriza sp*	II
6.	*Kayeli/bugis*	*Oriza sp*	I, II, III
7.	*Fas Memeye*	*Oriza sp*	X

Source: Mahmud (2021)

Tubers (Dioscorea spp.)

There are four *Dioscorea* groups scattered in the Maluku Islands: *D. alata, D. esculenta, D. pentapylla, and D. hispida Dennst.* According to Leunufna (1987), one species of *D. hispida* was found, which is a semi-wild and poisonous species, whereas *D. pentaphylla* is a semi-wild species that is less cultivated. Only 2 (two) cultivars, *D. alata* and *D. esculenta*, which are the most species of cultivars that spread in the Maluku Islands. More than 50 cultivars of each of these species were discovered in the joint study. In general, Dioscorea spp. grows and spreads throughout Maluku Province, although the number of cultivars differs from one area to another. The research results found 120 cultivars of sweet potato, more than 70 tubers spread in Central Maluku Regency, and more than 40 tubers spread in Southeast Maluku Regency (Leunufna, 2020).

Types of tubers in Maluku are very diverse, including cassava (kasbi), sweet potatoes (patatas), lesser yam, and taro. Lesser yam is a very rare type of tuber in Maluku. In Maluku, one

type of tubers that have been developed is cassava (*Dioscorea alata. L*) and lesser yams (*D. esculenta Burk*). There are more than 60 species of Dioscorea, but only about 20 of them are cultivated, which are *D. alata, D. esculenta, D. cayenensis, D. trifida, D. catundata,* and others. Tuber, which is only cultivated in Maluku, is *D. alata* and *D. esculenta*. The ones that grow and spread in the forest, *D. hispida and D. pentaphylla,* have a bitter taste because they contain diosgenin (birth control drug). The Ambonese call this wild species *ahei* (Wattimena, 2011). The potential of tubers in Maluku can be seen in Table 6 below.

Table 6. Potential Types of Tubers in Maluku

No.	Types of Tubers	Scientific Name	Island Cluster
1.	Cassava	*Manihot esculenta Crants*	I-XII
2.	Sweet potatoe	*Ipomea batatas L.*	I – XII
3.	Taro	*Colocasia esculeata L.*	I – IV
4.	Lesser yam	*Diascorea esculenta L.*	II, III, IV, XI, XII
5.	Minor Tuber or *uwi*	*Dioscorea alata*	X - XII
6	Guinea yam, yellow yam	*Dioscorea cayenensis*	X - XII
7.	Indian Yam	*Dioscorea trifida*	X - XII
8.	Yam	*Dioscorea rotundata*	II, X-XII
9.	Asiatic bitter yam	*Dioscorea hispida*	I - IV
10.	*Tomboreso*	*Diodcorea pentaphylla*	II – IV
11.	Air Yam	*Diodsprea bulbifera*	II-XII
12.	*Ubi Enbal Bintang*	*Manihot esculenta, sp*	VIII
13.	*Ubi Enbal Siaputih*	*Manihot esculenta,sp*	II, VIII
14.	*Ubi Enbal Tayando*	*Manihot esculenta,sp*	VIII

Source: Leunufna (1987), Wattimena (2011), Bunyani et al. (2020).

Banana

The Maluku Islands have also been categorized as one of the areas with high biodiversity, especially banana germplasm, because of their geographical situation within the Wallacea Line. Exploration and collection conducted in 2012 in North Sulawesi and North Maluku reported 29 accessions (species and cultivars) (Central Bureau of Statistics and Directorate General of Horticulture, Ministry of Agriculture, Republic of Indonesia, 2014; Hermanto et al., 2012). Based on other survey results, there were 37 banana genotypes in North Maluku (Sutanto et al., 2013) and 34 genotypes in Central Maluku (Sutanto et al., 2013). The potential for bananas in Maluku can be seen in Table 7 below:

Table 7. Potential Types of Bananas in Maluku

No.	Types of Banana	Scientific Name	Island Cluster
1.	*Pisang Dewaka*	*Musa balbisiana*	I – VI, XI
2	*Pisang Tongkat langit*	*Musa troglodytarum* L	II – VII
3.	*Pisang Tongkat Langit Panjang*	*Musa fehi.* L	II – VII
3.	*Pisang Abu-Abu*	*Musa X paradisiaca.* L	I – VI, XI
4..	*Pisang Tanduk*	*Musa Paradisiaca*	II – V
5.	*Pisang Susu Tarnate*	*Musa acuminate*	II - IV
6.	*Pisang Ambon (Ambon)*	*Musa acuminate*	I – IX
7.	*Pisang Jarum*	Musa acuminata Colla	I – V

No.	Types of Banana	Scientific Name	Island Cluster
8.	*Pisang Tembaga*	*Musa Sp*	I – IV
9.	*Pisang Emas*	*Musa Sp*	II - VI
10.	*Pisang Raja Hitam*	*Musa, Sp*	I – X
11.	*Pisang Raja Putih*	*Musa, Sp*	I - VI
12.	*Pisang Susu Putih*	*Musa acuminata* Colla	I – VI
13.	*Psang Susu Hitam*	*Musa acuminata* Colla	I - VI
14.	*Pisang Empat Puluh Hari*	*Musa acuminata* Colla	I - IX
15.	*Pisang Nona*	*Musa acuminata* Colla	I-V

Source: Leunufna et al. (2019), Makaruku et al. (2022), Hendaru et al. (2017).

In 2015, Maluku was ranked 17th out of 34 provinces in Indonesia in banana production. The production in Maluku decreased by around 10,000 tons from 2011 to 2012 but increased to more than 50,000 tons in 2015 in a production area of 439 ha (Central Bureau of Statistics and Directorate General of Horticulture, Ministry of Agriculture, Republic of Indonesia, 2014). Growth production reached 32% from 2014 to 2015 (Central Bureau of Statistics and Directorate General of Horticulture, Ministry of Agriculture, Republic of Indonesia, 2014). The Maluku Islands have also been categorized as one of the areas with high biodiversity, especially banana germplasm, because of their geographical situation within the Wallacea Line. Exploration and collection conducted in 2012 in North Sulawesi and North Maluku reported 29 accessions (species and cultivars) (Hermanto et al., 2012). Based on other survey results, there are 37 genotypes of bananas in North Maluku (Sutanto et al., 2013) and 34 genotypes in Central Maluku (Sutanto et al., 2013).

In general, bananas are divided into 2 groups, which are those that can be directly eaten as a dessert (Banana) and those that must be processed before eaten (Plantain). Several types of bananas found in Ambon Market are presented in Table 7-9.

Table 7. Inventory of Banana Types in Ambon Market

No	Local Name	Synonym	Scientific Name	Genome
1	Pisang Dewaka (Dewaka Banana), Pisang Jawaka (Jawaka Banana), Pisang Abu-Abu Jawaka (Jawaka Gray Banana)	Pisang Kepok Besar (Indonesia), Pisang Chematu, Malaysia), Gardaba (Philippines), Gardaba (Internasional), Chuoi Mat (Vietnam)	*Musa balbisiana/M. acuminate x M. balbisiana*	Triploid-BBB/ABB
2	Pisang Abu-Abu (Gray Banana)	Pisang Kosta (Indonesia), Matavia (Philippines), Pisang Abu Keling (Malaysia), Kluai Hak Muk Khieo (Thailand), Choui NgopLun (Vietnam), Bluggoe, Chato (International)	*Musa X paradisiaca* L.	Triploid-ABB

No	Local Name	Synonym	Scientific Name	Genome
3	Pisang Abu-Abu Surabaya (Surabaya Gray Banana)	Pisang Kosta Putih (Indonesia), Katsila (Philippines), Pisang Abu Perak (Malaysia), Kluai Hak Muk Khao (Thailand), Silver Bluggoe, Cenizo (International)	*Musa paradisiaca* L. *X*	Triploid-ABB
4	Pisang Raja Hitam	Pisang Raja (Indonesia, Malaysia), Radja (Philippines, International), Kluai Khai Boran (Thailand), Raja (International)	*Musa paradisiaca* L *X*	Triploid-AAB
5	Pisang Raja Putih	Radja (Philippines), Pisang Raja (Malaysia), Kluai Khai Boran (Thailand), Raja (International)	*Musa paradisiaca* L *X*	Triploid-AAB
6	Pisang Tanduk	Pisang Lang (Malaysia, PisangTanduk in Malaysia wasdifferent type!); Daluyao (Philippines), Kluai Nga Chang (Thailand), l Chuoi Sung Bo (Vietnam)	*Musa paradisiaca* L *X*	Triploid-AAB
7	Pisang Tongkat Langit Panjang	Endemik Maluku dan Papua	*Musa fehi. Musa troglodytarum L.*	Diploid-AA
8	Pisang Tongkat Langit pendek PisangTongkat Langit Bulat	Endemik Maluku dan Papua	*Musa fehi. Musa troglodytarum L.*	Diploid-AA
9	Pisang Susu Putih (White Milk Banana)	Pisang Susu (Malaysia) Kluai Nam Nom (Thailand)	*Musa acuminata* Colla	Triploid-AAA
10	Pisang Susu Hitam	Pisang Susu (Malaysia) Kluai Nam Nom (Thailand)	*Musa acuminata Colla*	Triploid-AAA
11	Pisang Susu Tarnate	Pisang Susu (Malaysia) Kluai Nam Nom (Thailand)	*Musa acuminata Colla*	Triploid-AAA
12	Pisang Meja, Pisang Ambon (Ambon)	Pisang Ambon Kuning (Indonesia), Ambon (Philippines), Pisang	*Musa acuminata Colla*	Triploid-AAA

No	Local Name	Synonym	Scientific Name	Genome
		Embun (Malaysia), Kluai Hom Thong (Thailand), Chuoi Tieu Cao (Vietnam), Gros Michel (Internasional)		
13	Pisang Warangan Merah, Pisang Tambaga	Pisang Barangan Merah (Indonesia) Pisang Berangan Merah (Malaysia), Lakatan (Philippines), Kluai Ngang Phaya (Thailand)	*Musa acuminata Colla*	Diploid/Triploid-AA/AAA
14	Pisang Warangan Kuning	Pisang Barangan Kuning (Indonesia) Pisang Berangan Kuning (Malaysia), Lakatan (Philippines), Kluai Hom Maew(Thailand)	*Musa acuminata Colla*	Diploid/Triploid-AA/AAA
15	Pisang Empat Puluh Hari, Pisang Tujuh Bulan	Pisang Lampung (Indonesia); Inarnibal (Philippines)	*Musa acuminata Colla*	Diploid-AA
16	Pisang Nona	Pisang Gadis (Indonesia), Morong Princesa (Philippines), Kluai Thong Ruang (Thailand), Choui NguThoc (Vietnam)	*Musa acuminate Colla*	Diploid-AA
17	Pisang Jarum	Ea-an (Philippines), Pisang Jarum (Malaysia), Pisang Cici Merah, Pisang Cici Kuning (Indonesia), Kluai Nam Thai (Thailand)	*Musa acuminata Colla*	Diploid-AA

Source: Leunufna et al. (2019)

Table 8. Typical Phenotypes of Different Banana Genotypes

No.	Number of hands of bananas per bunch	Number of fingers of banana per hand	Length of a finger of banana (cm)	Diameter of a finger of banana (cm)	Color of unripe banana	Color of ripe banana
1	(5 -12) 9.25	(15 -20) 18.25	(19 -23) 21.5	(16 – 18) 17	Dark green	Yellow
2	(6 -15) 10	(17-20) 18.75	(12 – 17) 15.5	(15 -16) 15.5	Light green	Yellow
3	(8 – 11) 9.5	(10 – 19) 15	(14 – 19) 15.75	(12 -13) 12.38	grayish green	Yellow
4	(5 – 10) 7.75	(14-16) 14.5	(13- 17) 15	(13- 17) 14.75	Dark green	Yellow
5	(6 – 20) 15.5	(13 – 18) 15.25	(17 – 19) 17.5	(112– 14) 12.63	Light green	Yellow
6	(2 – 3) 2.25	(6 – 14) 10.5	(20 – 37) 29	(15-20) 17.25	Green	Yellow
7	(4-8) 6	(5-11) 7.5	(23 – 27) 25.13	(8-19) 15	shiny green	Yellowish red

No.	Number of hands of bananas per bunch	Number of fingers of banana per hand	Length of a finger of banana (cm)	Diameter of a finger of banana (cm)	Color of unripe banana	Color of ripe banana
8	(8 – 10) 9.75	(8 – 10) 7.5	(12 – 13) 12.25	(13-14) 13.75	shiny green Light green	Yellowish red
9	(6-10) 8	(14 – 25) 18.5	(11 – 13) 11.88	(11-12.5) 11.5	Green	White
10	(7 – 10) 8.5	(14 – 18) 15.75	(15 – 17) 15.75	(12 – 14) 12.75	Green	Yellow tainted with black spots
11	(8-18) 12	(15 – 43) 31	(10 – 17) 14	(11 -13) 11.8	Light green	Yellow
12	(4 -10) 7	(14-15) 14.25	(14 – 22) 19.25	(13-16) 14.75	Purplish red	Yellowish green to white green
13	(5 – 10) 7.25	(7-12) 11.5	(15 – 18) 16.5	(15 – 20) 17	Shiny green	Purplish red
14	(5 – 7) 6.25	(9-12) 10	(16 -18) 16.75	(16-19) 18		Shiny yellow
15	(8-10) 9.25	(16-23) 20.75	(7,5 – 13) 11.38	(10-12) 10.5	Light green - green	Yellow
16	(8 – 10) 7.75	(11 - 25) 20	(10-11.5) 10.88	(11 -11.5) 11.25	Green light	Yellow
17	(8-10) 9	(13 - 21) 12.25	(9 – 14) 12.5	(8,5 – 10) 9.13	green	Yellow

Source: Leunufna et al. (2019)

Table 9. Characteristics of Various Banana Genotypes on Ambon Island

No.	Raw/ Processed	Consumption Type	Price (Rp)	Nutritional content and Taste	Availability in the Market	Market Acceptance
1	Processed	Boiled	20.000/Hand	Carbohydrate	Frequent	Moderate
2	Processed	Boiled, Fried, Processed into Compote	10.000 / Hand	Carbohydrate	Frequent	Moderate
3	Processed	Boiled, Fried, Processed into Compote	20.000/bunch	Carbohydrate	Rare	Low
4	Processed	Boiled, Fried,	20.000/bunch	Sweet	Very frequent	Very high
5	Processed	Boiled, Fried,	15.000-20.000/bunch	Not too sweet	Rare – frequent	Low
6	Processed	Boiled, Fried, Smoked	10.000 /finger	Carbohydrate	Frequent	Low-Moderate
7	Processed	Boiled, Fried, Smoked	10.000/hand	As medicine	Rare – frequent	Low
8	Processed	Boiled, Fried, Smoked	15.000 - 20.000/ bunch	As medicine	Rare	Low
9	Raw	Dessert	10.000 - 15.000/ bunch	Sweet	Frequent	High
10	Raw	Dessert	10.000 - 15.000/ bunch	Sweet	Frequent	High
11	Raw	Dessert	20.000 /bunch	Sweet and sour	Rare	Low
12	Raw	Dessert	20.000 - 35.000/bunch	Sweet	Frequent	Moderate
13	Raw	Dessert	25.000/bunch	Sweet	Very rare	Low
14	Raw	Dessert	20.000/bunch	Sweet	Rare	Low
15	Raw	Dessert	10.000 - 15.000 /bunch	Sweet	Very frequent	Very high
16	Raw	Dessert	20.000/bunch	Sweet	Rare	Low
17	Raw	Dessert	10.000 - 15.000 /bunch	Sweet/ As medicine	Frequent	Moderate

Source: Leunufna et al. (2019)

Information about the type of *tongka langit banana* has been widely published because a lot of research is being done at this time. *Tongka langit* banana can be used as fresh food, processed drinks, or medicine. As the name implies, the position of the bunches is not like other types of bananas that hang, but the bunches of *tongka langit* bananas remain upright, facing the sky. *Tongkat Langit* banana or Fe'i Banana (*Musa troglodytarum* L.) has a T genome and a very high beta-carotene content. These bananas grow and spread throughout the Maluku Islands and Papua. For the Ambonese or Moluccans, the existence of these bananas is not something extraordinary. Its existence can be found in traditional markets in Ambon City and its surroundings. People call it the Tongka Langit Banana. Tongka Langit is a name given to the people of Maluku. The origin of the name Tongka Langit banana is given because the growth of banana bunches, in general, will lead to the ground (below), but not with Tongka Langit. When fruiting, the bunches of bananas point towards the sky (above) while the banana stems are upright like sticks.

The fruit that points to the sky is what makes this banana called Tongka Langit. The height is, on average, five to seven meters. The fingers of bananas are large. It is about 20-30 cm long and 5-10 cm in diameter. The skin is thick, and when eaten directly, it tastes like butter, is soft, and is not as sweet as Cavendish Bananas. This banana has yellow or orange flesh because it contains very high beta-carotene. Beta-carotene is an organic compound or natural chemical substance that is found in various types of fruits and vegetables and is a strong pigment in plants that gives red, orange (yellow), purple, and dark green colors. Beta-carotene is an early form of vitamin A. Beta-carotene is a substance rich in vitamin A, which is often found in carrots. The function of beta carotene, among others, is as an antioxidant, communicating between cells to maintain the immune system and provitamin A. The Tongka Langit Banana contains around 4960 µg beta-carotene/100 grams, meaning that only by consuming 250 grams of Tongka Langit banana one's daily need for vitamin A will be fulfilled. The high beta-carotene in Tongka Langit Banana makes this plant a potential alternative food source.

The results showed that there was a high nutritional content in Tongka Langit banana flour, which is 331.03 calories of energy, 4.66 percent protein, 83.72 percent carbohydrates, and 16.59 percent total food fiber. This banana flour also contains 7.92 milligrams of carotenoids with a beta carotene content of 18.56 percent. In addition, according to research findings uploaded in the Gadjah Mada University Journal, these bananas also contain antioxidant components in the form of flavonoids of 0.35 milligrams per 1 kilogram and have quite high antioxidant activity. The high starch content of Tongka Langit banana makes it suitable for processing into flour.

These bananas are known to have properties as a traditional medicine to relieve heartburn, cleanse the kidneys, treat diabetes, maintain immunity, and maintain digestive health. Tongka Langit bananas cannot be eaten directly but must be processed first because even though the bananas are ripe, they tend to taste sour. The local people who produce Tongka Langit Banana usually consume bananas by boiling, baking, or frying them (Hiarie et al., 2015).

Tongkat Langit banana or *Pisang Fe'i* (*Musa troglodytarum* L.) is a favorite type of banana because it has high economic value due to the presence of the T genome and very high beta-carotene content. For the Ambonese or Moluccans, the existence of these bananas is not something extraordinary. The name of the *Tongka Langit* is seen from the growth of the banana bunches in general, which will point to the ground (below), but not with Tongka Langit. When fruiting, the bunches of bananas point towards the sky (above) while the banana stems are upright like sticks. The fruit that points to the sky is what makes this banana called Tongka Langit.

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Community Wisdom in Overcoming Climate Problems in Maluku

Most of the islands in Maluku are small islands, and according to island physiography, only Seram Island is classified as a medium island because it has an area of >2,000 km^2. Because small islands have limited land and water, the people must be wise in managing the very limited rainfall so that they can be used for farming in order to get food ingredients, which are generally obtained once a year so that they can meet their food needs for one growing season. Maluku often experiences extreme seasons, and bad weather makes it difficult for people to do gardening or fishing because of the high waves. Such conditions make people have to be wise in managing the food they have, either field produce or marine products in the form of fish. Many areas have wisdom in the supply of food even though the harvest is limited because the planting season is only once a year. Some of the pre-preserved food storage technologies are: *Mandekar, Sagu taku, Enbal Nam'o, jagung sukun and Inasua. Mandekar* is a tuber preservation technique carried out by the people living in GP X-XII as a food reserve to be used until the next harvest season. GP II-V is often faced with a prolonged rainy season, making it difficult for the community to do farming, so some people process sago for long-term storage, which is called *Sago taku*.

Sago Taku is a technique for preserving sago plates, in which sago is dried and then wrapped again in sago leaves and placed in a cooking area to anticipate the transition season or famine when people find it difficult to leave their homes. *Sago Taku* is generally carried out by people who live in GP II-V, where *sago taku* can be stored for a long time until it is more than a year old. *Enbal Nam'o* is a food ingredient made from enbal cassava, which is processed into cooked *enbal*, dried, and can be stored for years to anticipate the prolonged dry season that often occurs. The age of *enbal* cassava is quite long, reaching a year or even more. *Enbal nam'o* can be stored until the next harvest. Breadfruit corn is a storage technique for dried corn, and breadfruit is put together and stored in sealed cans. Breadfruit corn can be stored for more than a year and is used during famine. *Inasua* is a technique for preserving raw fish by the people living in GP. IX and X, in which raw fish is washed clean, sprinkled with salt, and stored in bamboo or jerricans. Inasua is an animal protein food reserve that is prepared to face the high-wave season, which makes it difficult for fishermen to go to sea. Inasua can be stored for more than a year.

CONCLUSIONS

Based on the findings and discussion above, it can be concluded that Maluku has narrow productive land, thin cultivation layers, and high land conversion, so there is a high level of vulnerability to food availability. Maluku has a large potential for food genetic resources as there are six types of local food that dominate each island, namely sago, corn, hotong, upland rice, tubers, and bananas. Maluku has XII clusters of islands, and each cluster has its own staple food.

LIMITATION & FURTHER RESEARCH

It can be suggested for future research conduct: A study of the potential of each island in managing in-situ resources for sustainable community life is urgently needed, especially for the outermost, poorest, and disadvantaged areas. Study of the limiting factors of each island to be able to overcome these factors

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