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IDENTIFICATION OF FOOD DIVERSIFICATION ON JAVA ISLAND USING ARCGIS

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Abstract—*Indonesia is addressing the challenges of food security and consumer preference also known as Food diversification. The research aims to analyze the potential of various local food sources as alternatives to rice, which is the dominant staple food in Indonesia, with a particular focus on geographic implications. Although local carbohydrate sources like corn, potatoes, and tubers are available, their adoption is limited and understudied in relation to geographic distribution and consumer behavior. This study integrates survey data and GIS-based spatial analysis to evaluate local food diversification potential. Findings show that while 100% of respondents consume rice, 48.7% have tried alternatives, with limited availability (41.03%) and higher costs (17.95%) as key barriers. With 94.7% expressing willingness to adopt new staples, the results suggest GIS-based decision support systems can guide effective, region-specific food policy interventions.*

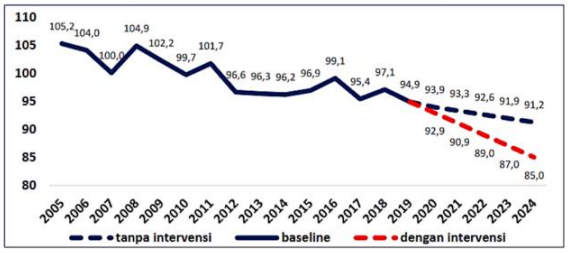
Keywords: *food diversification, geographic information system, rice.*

Abstrak—*Indonesia sedang mengatasi tantangan ketahanan pangan dan preferensi konsumen yang juga dikenal sebagai Diversifikasi pangan. Penelitian ini bertujuan untuk menganalisis potensi berbagai sumber pangan lokal sebagai alternatif beras, yang merupakan makanan pokok dominan di Indonesia, dengan fokus khusus pada implikasi geografis. Meskipun sumber karbohidrat lokal seperti jagung, kentang, dan umbi-umbian tersedia, adopsi mereka terbatas dan kurang dipelajari dalam kaitannya dengan distribusi geografis dan perilaku konsumen. Studi ini mengintegrasikan data survei dan analisis spasial berbasis GIS untuk mengevaluasi potensi diversifikasi pangan lokal. Temuan menunjukkan bahwa sementara 100% responden mengonsumsi beras, 48,7% telah mencoba alternatif, dengan ketersediaan terbatas (41,03%) dan biaya yang lebih tinggi (17,95%) sebagai hambatan utama. Dengan 94,7% menyatakan kesediaan untuk mengadopsi makanan pokok baru, hasilnya menunjukkan sistem pendukung keputusan berbasis GIS dapat memandu intervensi kebijakan pangan yang efektif dan spesifik berbasis kewilayahan.*

Kata Kunci: *diversifikasi pangan, sistem informasi geografis, beras.*

INTRODUCTION

The background of this study underlines the problems related to the urgency of fulfilling food needs in Indonesia, especialy Java Island. This is supported by the constitutional basis stated in Article 27 of the 1945 Constitution and the Rome Declaration (1996), as well as Law No. 7 of 1996 concerning Food in Indonesia. However, the gap in fulfilling food needs is still a problem that needs to be addressed, especially in areas with a wide geographical coverage and a growing population. The limitations of obtaining food equality seen from the geographical factors of a region in Indonesia can be overcome by food diversification. The food diversification means staple food variation and the reduction of the acute dependence on rice. Food diversification will broaden the food access, hence breakthrough for the less food secure countries (Maman et al., 2021). The bio diversification of agriculture has the potential to provide numerous environmental and health benefits (Renard & Tilman, 2021). The food diversification target of the Indonesian Food Security Agency can be seen in Figure 1.



Source: (Badan Ketahanan Pangan RI, 2020).

Figure 1. Food diversification targets of the Indonesian Food Security Agency

Indonesian populace continues to predominantly consume rice, which is associated with health risks like diabetes, high blood pressure, and heart attacks due to its high glycemic index (Harlina, Fitriansyah, & Shahzad, 2023). As for examining the potential use of staple food substitutes for carbohydrates as a solution to the problem of the rice commodity gap that can be adjusted based on the geographical location of the community's population and by identifying the impact of alternative staple food consumption on community welfare and productivity.

Realizing sovereign food, a healthy generation, and a dignified nation (Rahardjo et al, 2023) requires a comprehensive problem analysis from various multidisciplinary perspectives. Several studies, one of which is "Analysis of Food Diversification Policy in Overcoming the Food Crisis" in 2021 (Widiastuti & Himawan, 2021) from the perspective of non-formal education science, identify climate change as the main cause of the threat of a global food crisis, followed by declining food production and decreasing land, rising prices and food demands, inflation due to population growth, and people's lifestyles. To overcome this, it is necessary to stabilize food prices and stocks, especially rice which is concentrated in only a few provinces in Indonesia.

In the study (Rahmanto, Purnomo, & Kasiwi, 2021), it aises the fundamental problem of Indonesia's declining food security with increasing population and imbalance in rice supply. The Food Security and Vulnerability map is depicted, which shows that districts with larger areas tend to have higher levels of food insecurity compared to urban areas. Most areas in western and central Indonesia show higher levels of food security than eastern Indonesia, influenced by uneven infrastructure. Good infrastructure plays a crucial role in equitable food distribution, enabling better access to food for people in need.

According to BPS (2021), rice consumption, which is currently the national staple food, reaches 96–97%. Food diversification is an important strategy in overcoming food security challenges and reducing social disparities in Indonesia. Maximizing the potential of local foods will facilitate people's access to food and provide economically affordable solutions, thereby reducing food insecurity and poverty. Based on data from the Food Security Agency & Ministry of Agriculture of the Republic of Indonesia (2019), it is stated that there are 77 species of local food plants in Indonesia which are sources of carbohydrates. However, data on local food production is still incomplete, not all local foods are widely studied or cultivated by the community, and local food consumption is still low compared to non-local foods. Meanwhile, dependence on food imports can make national resilience vulnerable (Rahmanto et al., 2021). Therefore, efforts are needed to increase domestic food production to meet the country's needs. However, food diversification in Indonesia is not optimal; rice consumption is still high so that the achievement of the Expected Food Pattern (PPH) is not optimal. There is a need to reduce rice consumption followed by an increase in local food consumption, which is supported by affordable prices and easy availability. Therefore, food security is achieved with an approach that focuses on local food development and increasing public interest in consuming diverse foods. Galuh Octania emphasized, in her book The Role of Government in the Rice Supply Chain 2021, to expand the production of staple foods which are highly concentrated on the island of Java (Octania, 2021). Although the retail price of this food product continues to increase, farmers' incomes have not increased. In her research, Indonesia's geographical conditions result in a complex rice supply chain that slows down production.

Building food security becomes an effort to reduce social disparities in the aspect of food availability, efforts to encourage an increase in the availability of diverse food based on local potential resources are needed. Utilization of food from local resource potential makes the community have easy access to food and enter from an economic perspective, the community is able to meet food needs at a more affordable price household expenses so that food needs for all levels of society are guaranteed. The increasing need for this type of guarantee, will certainly reduce the level of food insecurity so that cases of hunger can be reduced and can reduce the number of poverties by expanding the scope and considering socio-economic factors and cultural influences of community consumption patterns based on their geographical conditions.

The information technology approach using spatial analysis will be an effective applied strategy that can improve social resilience of communities and the sustainability of local non-rice food ecosystems, where farmers generally do not

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understand the effects of climate change, although in practice mitigation and adaptation have been carried out in simple forms. Geographic Information System (GIS) supports the design of increasing agricultural production in order to map local superior agricultural products. The results of this study are expected to support government policies in increasing food diversification and national food security. In its development, the decision support system modeling of the spatial analysis can be a container for community-based approach targets and the dissemination of appropriate information.

The development of decision-making technology integrated with geographic data analysis using Geographic Information System (GIS) technology is expected to support efforts to improve the food needs fulfillment system and the availability of staple foods in Indonesia, such as related studies (Bao, Tong, Plane, & Buechler, 2020) (Jeong & Li, 2020). Through statistical modeling with a GIS approach developed to determine the relationship between the potential availability of staple foods to replace rice with related variables such as market demand factors, consumer culture towards potential staple foods in their residential areas, risk control strategies if staple foods in the area experience a decrease in the amount of harvest so that they cannot help meet consumer needs. This technology is expected to assist the government in increasing food security and reducing the gap in consumption of staple foods that are appropriate for all levels of society (Hutagaol & Sinaga, 2022). By integrating GIS technology and a data approach through macro analysis to understand the big picture of regional potential, and micro analysis to provide deeper insights into decision making related to food diversification. This research is also in line with the government's efforts to advance the food and agro-industry sectors by optimally supporting the production of local resources from the national agricultural industry (Trilaksono, Riza, Jarin, Darmayanti, & Liawatimena, 2023) (Suirlan & Nurnaningsih, 2024).

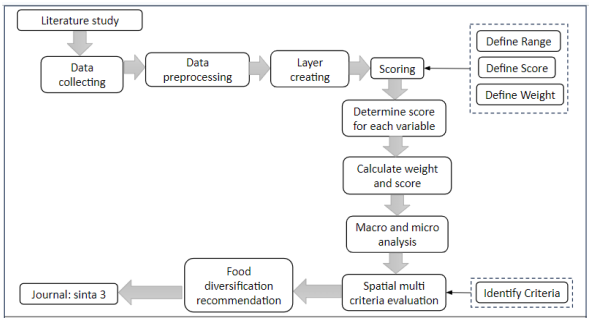
The specific objectives of this study are to develop a decision-making model that considers geographic factors and local natural resources in food diversification, as well as to identify the potential of regions in Indonesia that can be utilized for the production of diverse local food ingredients. A feasibility study was conducted to evaluate the effectiveness and relevance of GIS-based decision-making technology and the use of razor data techniques to filter and process data to improve the accuracy of analysis in making efficient decisions in supporting the implementation of food diversification policies in order to improve national food security.

MATERIALS AND METHODS

This study analyzes natural resource diversification using spatial data and questionnaire data on local food potential in Java collected through ArcGIS Survey123 (Survey123, 2024). More in-depth spatial data to identify the potential and constraints of food diversification and to develop recommendations that are in accordance with the geographical characteristics of the region, especially those with low food security. Based on a literature review, a number of variables that are considered influential include agricultural and horticultural potential, soil/agricultural land type, environmental characteristics, topography, water conditions/availability, rainfall, vegetation data, local food consumption patterns, identification of diet and nutritional status of the community, local food availability, market demand, market accessibility, and local agricultural policies.

Geographic Information System (GIS) technology will be the main foundation, where researchers will use ArcGIS and Python for the analysis process. The GIS approach with statistical modeling will look for correlations between food potential and existing variables. The data that has been collected is analyzed together through two main approaches: macro analysis and micro analysis. Macro analysis involves mapping agricultural potential, environmental conditions, and land distribution at a larger regional level to understand the potential for food production in general. Meanwhile, micro analysis is carried out to gain a more detailed understanding of conditions at the local level, such as sub-districts or villages, by mapping agricultural infrastructure, land distribution, and land use patterns in more detail. After the results of the two analyzes are obtained, the relevant criteria are combined and weighted through Spatial Multi Criteria Evaluation (SMCE) (Wijayati, Harianto, & Suryana, 2019). SMCE will be used as a decision support tool to evaluate food potential according to regional conditions.

By integrating these approaches, research can provide a comprehensive and accurate understanding and decision support system on local food diversification in a particular region based on its geographical conditions. These steps ensure that all important aspects of the region are considered. The flowchart of the stages of this research can be seen in Figure 1. This diagram visualizes the process from literature review to publication of research results, ensuring that each step and stage is clearly defined. With this methodology, research can provide a comprehensive understanding of local food diversification in Indonesia. The stages of the research can be seen in Figure 2.



Source: (Research Results, 2024)

Figure 2. Research Stages

The description of the stages in Figure 2 is as follows:

1. Literature Review: The initial stage of the research involved a literature review to collect relevant data and information regarding food diversification, influencing variables, and the technologies used.
2. Data Collection: The data collected includes spatial data and data on the potential distribution of local food in Indonesia. Variables considered influential include agricultural and horticultural potential, soil/agricultural land type, environmental characteristics, topography, water conditions/availability, rainfall, vegetation data, local food consumption patterns, identification of diet and nutritional status of the community, local food availability, market demand, market accessibility, and local agricultural policies.
3. Data Processing: The collected data will be processed and prepared for further analysis. This process includes data cleaning, data transformation, and integration of various types of data into a format that can be analyzed using GIS.
4. Layer Creation: At this stage, layers on the map will be created based on the data that has been processed. This layer includes various variables that have been identified as important factors in the study.
5. Scoring: This stage involves assigning a score to each variable that has been identified. The score is determined based on the range, weight, and value of each variable.
6. Macro and Micro Analysis
   - Macro Analysis: Includes mapping of agricultural potential, environmental conditions, and land distribution at a larger regional level to understand the general food production potential.
   - Micro Analysis: Conducted to gain a more detailed understanding of conditions at the local level such as sub-district or village. This includes detailed mapping of agricultural infrastructure, land distribution, and land use patterns.
7. Spatial Multi Criteria Evaluation (SMCE): After macro and micro analysis, relevant criteria are combined and weighted using Spatial Multi Criteria Evaluation (SMCE). SMCE will be used as a decision support tool to evaluate food potential according to regional conditions.
8. Food Diversification Recommendations: Based on the results of the SMCE evaluation, food diversification recommendations will be prepared. These recommendations are adjusted to the geographical characteristics and local potential of each region.

RESULTS AND DISCUSSION

Food Diversification

Efforts to increase the availability and consumption of Local Food Ingredients as Carbohydrate Sources to Replace Rice have been developed by the Indonesian government as part of its readiness to face the challenges of national food security. In this case, the Indonesian people, especially those in Java, have known various types of calorie-providing foods other than rice, such as various types of tubers, taro, potatoes, porang, wheat and corn.

Optimization of the development of Local Food Diversification needs to be carried out in order to accelerate the increase in public awareness and interest so that the target of Local Food Diversification activities can be achieved, namely to create healthy and productive human resources through sufficient, diverse, nutritious, balanced and safe food, availability and distribution of production and consumption of alternative local carbohydrate sources of rice, anticipating the global food crisis and other economic threats.

The current food consumption pattern of Indonesian people is still not diverse, which is reflected in the achievement of the expected food pattern (PPH) score in 2019 of 90.8 (Badan Ketahanan Pangan RI, 2020). In an effort to determine the distribution of consumption patterns and the relevance of the distribution of production of Local Food commodities as Carbohydrate Sources Substitutes for Rice in Java, it can be seen in Table 1, which is the result of the conversion of the distribution graph of consumption and production of Local Food commodities as Carbohydrate Sources Substitutes for Rice, the data of which was obtained from the Food Security Agency.

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Table 1. Distribution of Consumption and Production of Local Food Ingredients

Area	Consumption (*thousand tons*)				Production (*thousand tons*)			
	Sweet Potato	Corn	Potato	Taro	Sweet Potato	Corn	Potato	Taro
Banten	8.1	0.5	2.66	0.2	73	174	13	0
Jakarta	6.7	1.0	4.78	0.1	0	0	0	0
West Java	8.7	0.8	3.37	0.3	1,635	1,551	245,418	0
Central Java	8.0	0.8	1.93	0.2	3,267	3,688	294,015	0
East Java	10.0	3.7	2.30	0.3	2,552	6,543	320,209	0
In Yogyakarta	7.4	0.8	2.73	0.1	859	314	0	0

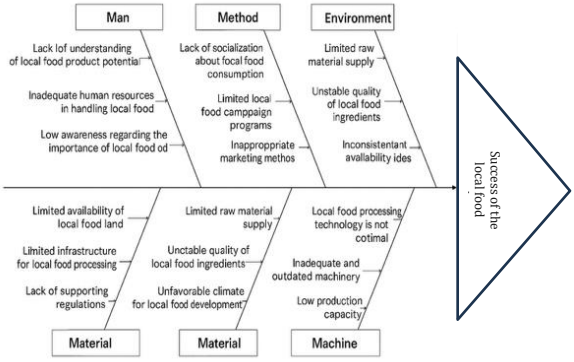
Source: (Badan Ketahanan Pangan RI, 2020)

If the consumption and production figures are compared based on Table 1, it can be concluded that most local food commodity production is lower than per capita consumption needs. This shows that there is a potential for increased food consumption for the four commodities as an impact of the increase in rice prices and the decline in rice consumption which is currently trending. In response to such conditions, steps to make the plan for Local Food Diversification of Carbohydrate Sources Substitute for Rice on Java Island a success will be a fruitful opportunity.

Creating consumers who leave their dependence on the consumption of old staple foods, namely rice, is a new hope for increasing local food consumption openly and sustainably. The steps needed by the government are policies that require prioritizing local food as an important food component nationally, including placing local processed food products used as components of food aid (routine and emergency disasters) that are adjusted to regions with their respective staple food production potential.

The opportunity for success of the Local Food Diversification Program as a Carbohydrate Source Substitute for Rice in Java Island is also supported by the habit of community consumption patterns in meeting daily carbohydrate needs. This awareness will help realize the program because the approach taken to the community is the application of food cultivation as a carbohydrate source other than rice, although on a limited scale and not as a staple food. However, it should be noted that the challenges to this program have quite a significant influence on the sustainability of the Local Food Diversification Program as a Carbohydrate Source Substitute for Rice, namely the availability of local food raw materials for the processing industry and consumption which are still limited in terms of quantity, quality and continuity.

Therefore, strategic efforts are needed to enhance local food production and productivity through technological approaches while positioning local food as a central focus in both regional and national programs. These efforts are essential for achieving national food security standards. Beyond ensuring the availability and accessibility, the success of local food diversification programs also depends on shifting community preferences, which are often shaped by cultural norms and beliefs. One of the key challenges in the prevailing assumption that local food is inferior to rice, which affects its acceptance as a staple food. Furthermore, the continued provision of in-kind food aid in the form of rice reinforces this preference, making it crucial to realign aid programs and public messaging to support the adoption of diverse local staple foods. Fishbone Diagram Analysis (Zhou, Y., Lentz, E., Michelson, H., Kim, C. and Baylis, 2022) of the Local Food Product Diversification Program can be seen in Figure 3.



Source: (Research Results, 2024)

Figure 3. Local Food Product Diversification Program with Fishbone Diagram

Before determining and conducting a more detailed assessment of the chances of success of the Local Food Product Diversification Program in Java, it is a good idea to know the target for providing land and production to increase consumption of local non-rice food that has been designed by the government through data on the action plan for providing local non-rice food as stated in the 2020-2024 action plan matrix (Badan Ketahanan Pangan RI, 2020) of the Ministry of Agriculture in Table 2 and Table 3.

Table 2. Land Provision and Production Targets for Increasing Consumption of Local Non-Rice Foods on Java Island

Commodity	Target					Location
	2020	2021	2022	2023	2024	
Sweet Potato						West Java, DI Yogyakarta, Banten, Central Java
Land Area (Ha)	5,563	5.043	4.816	4.956	4.619	
Production(Ton)	52,683	53.165	53.108	54,835	54,708	
Corn						East Java
Land Area (Ha)	2.436	2,489	2,497	2,535	2,539	
Production(Ton)	10,310	10.455	10,469	10,630	10,624	
Potato						West Java
Land Area (Ha)	3.105	3.157	3.210	3.261	3.311	*Note: land provision & production in Jakarta is the*
Production(Ton)	46,066	46,846	47,633	48,392	49.131	*responsibility of West Java*
Taro						West Java, East Java, Central Java
Land Area (Ha)	532	585	594	603	611	
Production(Ton)	5.320	5,848	5,939	6,028	6.111	

Source: (Badan Ketahanan Pangan RI, 2020)

Table 3. Ministry of Agriculture's 2020-2024 Action Plan Matrix for Java Island

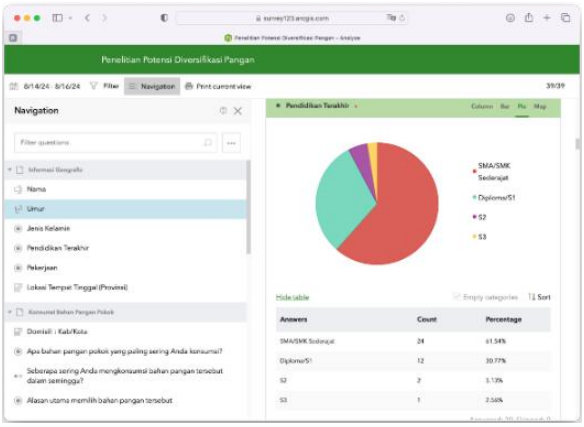
Commodity	Target					Location
	2020	2021	2022	2023	2024	
Sweet Potato						West Java, DI Yogyakarta, Banten, Central Java
Land Area (Ha)	-	5.100	4,850	5,000	4,650	
Production(Ton)	-	48,297	45,930	47,350	44,036	
Corn						
Land Area (Ha)	4,000	4,087	4.176	4.267	2,500	East Java
Production(Ton)	16,920	17,289	17,666	18,051	18,444	
Potato						West Java
Land Area (Ha)	25,535	26,038	26,395	26,833	27,356	
Production(Ton)	530,599	540,691	548,040	557,081	567,882	
Taro						West Java, East Java, Central Java
Land Area (Ha)	100	500	515	520	530	
Production(Ton)	1,000	5,000	5.150	5,200	5,300	

Source: (Badan Ketahanan Pangan RI, 2020)

The strategy and role of the government in determining the direction of the policy of Diversification of Local Food Sources of Carbohydrates Substitute for Rice for the past few years has not shown rapid progress. The selection and determination of a more appropriate strategy will affect the achievement of local food diversification according to the expected vision.

Respondent Demographic Results

In the study of consumer preferences and views on food diversification in Java Island, the respondents involved had diverse demographic backgrounds. Based on the survey results, the majority of respondents came from the 18-40 year age group, reflecting a productive age population with a high level of awareness of healthy eating patterns and nutritional needs. Visualization of the age group data of respondents to the Food Diversification Potential Research survey can be seen in Figure 4.



Source: (Research Results, 2024)

Figure 4. Distribution of Respondents' Education

In terms of education, most respondents have a secondary to tertiary education background, and the majority of respondents come from students and college students, this reflects the high participation of the younger generation in providing views related to food diversification. These data also show that students and college students have good

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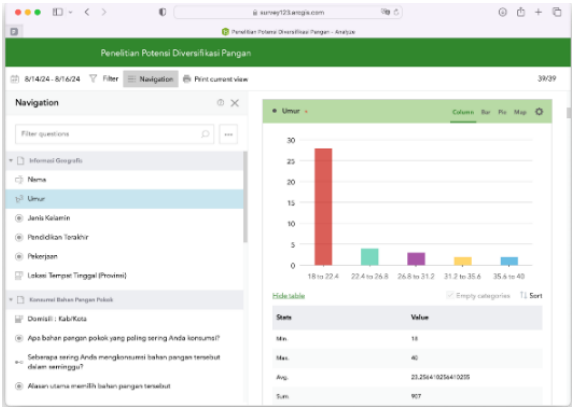
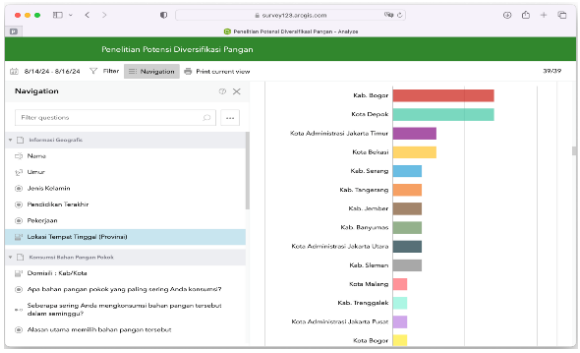
awareness of the issues of food security and food diversification as an effort to increase the diversity of food sources. Data on the educational background of respondents to the Food Diversification Potential Research survey can be seen in Figure 4 and Figure 5.



Source: (Research Results, 2024)

Figure 5. Distribution of Respondents' Age

Geographically, respondents are evenly distributed in urban and semi-urban areas in various provinces in Java Island, including Banten, West Java, DKI Jakarta, Central Java, East Java and DI Yogyakarta with the largest concentration in urban areas such as Depok City, East Jakarta Administrative City and Bekasi City (see Figure 6). Meanwhile, respondents from the largest district areas are in Bogor Regency, Serang Regency and Tangerang Regency. These results provide a comprehensive picture of the demographic characteristics of respondents and how these factors influence their views on food diversification in Java Island.



Source: (Research Results, 2024)

Figure 6. Geographical Distribution of Respondents

Research Respondents

As part of the research, which is aimed at finding out and analyzing consumer preferences for local staple foods in Java Island, a survey has been conducted to obtain coherent and relevant data with the current conditions related to the responses and views of the Javanese people towards the Local Food Product Diversification Program in Java Island. Data from respondents that have been entered, managed and findings that have not been previously researched or studied can be obtained as a renewed development of previous research.

The main part studied in the survey is the Local Food Consumption Pattern in Java. The data shows the categories that determine the pattern or distribution of local staple food consumption in Java. Respondents in the Food Diversification Potential Research survey numbered 39 people. The data shows that consumer habits are dominated by the selection of rice as the most widely consumed staple food every day. However, the urge to replace staple foods with rice is only one number lower than the percentage of respondents who have never tried to replace non-rice staple foods. The data can be seen in the following Table 4:

Table 4. Local Staple Food Consumption Patterns on Java Island

Category	Java Island	
	Amount	Percentage (%)
Often consume rice as a staple food		
Yes	39	100
No	0	0
Have you ever tried replacing staple foods (non-rice)?		1.0
Yes	19	48.7
No	20	51.2
Substitute food ingredients		
Potato	13	
Corn	6	
Wheat	4	
tubers	8	

Source: (Research Results, 2024)

Other sub-concentrations in the data from respondents indicate that there is heterogeneity of local food ingredients in areas that stretch across Java Island. Heterogeneity of food ingredients is the diversity of characteristics possessed by a food ingredient. Heterogeneous food ingredients have benefits in maintaining the existence and diversity of food ingredients consumed. The Local Food Product Diversification Program in Java Island that has been realized can increase food security by being developed into staple foods in each region adjusted to the potential for local food production to replace rice in their area. Various local carbohydrate foods based on data from surveys per district and city area in Java Island can be seen in Table 5.

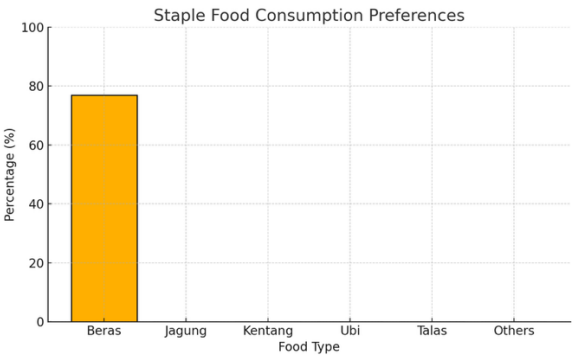
Table 5. Consumer Preferences and Distribution of Local Staple Food Production

Category	Java Island	
	Amount	Percentage (%)
Open to trying new staple foods		
Yes	37	94.7
No	2	5.13
Are there any types of staple carbohydrate food crops (non-rice) in the area where you live?		
Yes	30	76.92
No	9	23.08
Locally produced substitute food ingredients		
Potato	7	17.95
Corn	9	23.08
Taro	2	5.13
tubers	11	28.21
Porang	1	2.56
The main reason for not consuming local food as a staple food		
Limited availability	16	41.03
Price	7	17.95
Hard to find	3	7.69
Habit	13	33.33
Local food ingredients that have not been optimally utilized		
Yes	33	84.62
No	6	15.38

Source: (Research Results, 2024)

Analysis and Discussion

In this study, a survey was conducted to collect data related to consumer preferences for local food substitutes for rice in Java Island. This survey aims to determine the extent to which people are interested in trying alternative foods, as well as to understand how deep their understanding of the concept of food diversification is. The questionnaire distributed includes several key questions asked to respondents to find out; desire to try rice substitutes, understanding of food diversification, and preferences for local food types such as sweet potatoes (ubi), corn (jagung), and potatoes (kentang). The data obtained were then processed and analyzed to gain insight into the potential for local food development. Figure 7 shows that 76.92% of respondents always consume rice (beras) for reasons of habit or culture.



Source: (Research Results, 2024)

Figure 7. Most Frequently Consumed Staple Foods

The survey results show that the level of public desire to try rice substitutes is quite varied. From Figure 8, it was found that some people are more interested in familiar foods such as potatoes and corn. This is due to habit factors and ease of access to these commodities.

Source: (Research Results, 2024)

Figure 8. Food variants

Source: (Research Results, 2024)

Figure 9. Understanding and response to Food Diversification

In Figure 9, it can be seen that the public's understanding of the concept of food diversification also shows mixed results. Most respondents who have a higher level of education tend to have a better understanding of the importance of food diversification. However, the majority of respondents still consider rice as a staple food that is difficult to replace, even though they are open to other alternatives. This means that there is a correlation between the level of understanding of food diversification and the desire to try new staple

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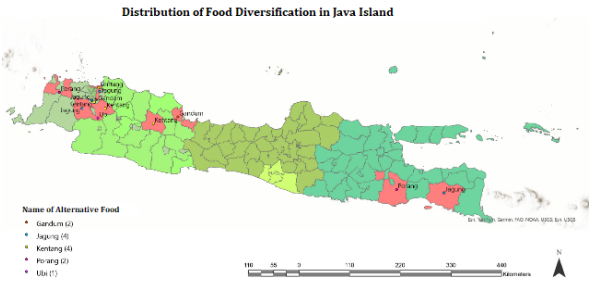
food alternatives, where 94.87% of respondents are open to this for health reasons.

Mapping using ArcGIS Pro

Mapping using the ArcGIS Pro application can be seen in Figure 10. The legend on the lower left side of the map shows the legend of the name of alternative food ingredients according to the respondent's results. Each color indicates a different point, wheat (gandum) food ingredients are marked with brown, corn (jagung) with blue, potatoes (kentang) with yellow, porang with orange, and sweet potatoes (ubi) are represented by purple. The number next to the commodity is the number of respondents' preferences answered. The six provincial boundaries are associated with different green colors. The green color gradation is given to all undetected areas to distinguish them from areas with alternative food potential and provide deeper visualization, where in this case the color red is used.



Source: (Research Results, 2024)

Figure 10. Map of Distribution of Alternative Foods on Java Island

From the mapping data and survey results, several commodities such as corn and sweet potatoes were found to be favorites in certain areas. However, commodities such as porang and wheat still require further socialization to increase consumer preferences. Efforts to divert staple food from rice have become a target and concrete plan of the government, but socialization and education have not been carried out comprehensively and research on its geographical implications has not been done visually, so that people's preference for consuming rice remains dominant when compared to rice harvest production. Food production data published by the Ministry of Agriculture and Food Security is not yet available continuously, which causes limitations in mapping food potential. Continuous data prediction models can be one step to overcome this, using machine learning algorithms such as regression methods or time series to estimate local commodity production in a particular year.

CONCLUSION

The findings of this study emphasize the importance of food diversification efforts in Java Island as a means to enhance food security and reduce overreliance on rice. While every respondent surveyed (100%) reported regular rice consumption, nearly half (48.7%) had experience trying local alternatives such as potatoes, corn, and tubers. Despite this positive indication, several barriers remain—most notably, limited availability of these alternatives (reported by 41.03% of respondents) and relatively higher prices (17.95%). Meanwhile, a strong majority (94.7%) expressed willingness to adopt new staple foods, driven largely by health concerns. Spatial analysis using GIS revealed that the distribution and production capacity for alternatives such as corn, sweet potatoes, porang, and potatoes differ across regions, reflecting both environmental potential and cultural preferences. These insights point to the critical role of location-based strategies in designing food policies. Therefore, the development of a GIS-based decision support system—tailored to local resource potential and demographic profiles—is recommended as a key instrument for supporting the implementation of sustainable food diversification programs in Indonesia.

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