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An Analytical Hierarchy Process-Based Evaluation of Food Estate Location Selection: A Case Study in Central Java

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Abstract. *The food estate program is a governmental initiative designed to facilitate the integrated development of food systems within a designated area, including agriculture, plantations, and animal husbandry. The objective of the present study is first to identify the most suitable agricultural crop according to local determining characteristics; and second, to evaluate the land's suitability for each chosen agricultural crop. This study employed a combination of qualitative and quantitative methodologies. The qualitative study focused on the identification and analysis of the criteria used for the selection of suitable food estate locations and the determination of promising commodities within the study area. This was achieved through a series of focus group discussions (FGDs). Three FGDs were conducted with participants comprising provincial and regency-level government decision-makers and experts from local universities. Their insights contribute to the formulation and refinement of the selection indicators relevant to local conditions. The quantitative study employed the Analytical Hierarchy Process (AHP), enabling a systematic evaluation of expert priorities. To assess and rank the importance of key criteria influencing location selection decisions, eleven experts were interviewed. The AHP results have identified seven main criteria as being essential for determining the suitable locations for food estates in Purbalingga Regency. Pineapple has been identified as the most suitable, promising commodity for food estate development in Purbalingga Regency, as determined by the integrated assessment. This determination is based on the compatibility of pineapple with local environmental conditions, its market potential, and stakeholder preferences.*
Keywords: *Coconut; eigen value; food estate; land suitability; feature product; pineapple.*

Type of the Paper: Regular Article.

1. Introduction

The Economy Group [1] has positioned Indonesia at the 63rd out of 118 countries with regard to current food security status. In response, President Joko Widodo has introduced a range of policies and programs aimed at strengthening national food security. A notable initiative is the food estate (FE) program, launched in 2020 as part of the government's strategy to bolster food resilience [2]. The government has adopted a proactive stance on the matter, actively promoting the establishment of additional food estates with the aim of meeting domestic food needs. The Ministry of Agriculture is responsible for implementing the FE program as a national strategic initiative. The objective is to develop corporate-based food production centers that incorporate

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farmer-level business entities. These entities are expected to manage agricultural operations from upstream to downstream in an integrated and sustainable manner. The food estate program represents a promising approach to achieving food self-sufficiency. It does so by advancing agriculture as an industrial system. This advancement is based on scientific and technological innovation, capital investment, and modern organizational and managerial practices, as stipulated in Government Regulation No. 109 of 2020 on National Strategic Programs (PSN) [3]. The program has been expanded to several provinces, including North Sumatra, Central Kalimantan, South Sumatra, South Papua, and East Nusa Tenggara, with the aim of strengthening national food security, particularly through the promotion of crops like rice as a staple food [4]. Food security is essential for national development, particularly in the context of supporting economic growth through the production of agricultural commodities [5].

The food estate (FE) program is a governmental initiative that aims to promote an integrated development of food production systems, including agriculture, plantations, and livestock, within designated areas. It has been incorporated into the National Strategic Programs (PSN) for the 2020–2024 period. The core objectives of FE development are to enhance the value-added within the local agricultural sector, to optimize agricultural labor utilization, to foster small-scale farming enterprises and entrepreneurial capacity, and to integrate production, processing, and marketing systems [6–8]. The FE program has demonstrated positive contributions to food production. However, several studies have also highlighted potential negative impacts. These include environmental risks such as deforestation and biodiversity loss, disregard for local community rights, rising social inequality, the risk of social unrest, and long-term sustainability challenges [9–11]. In certain instances, such impacts have led to community resistance, which jeopardizes the success of the program [9,12].

According to Yeny et al. [10], the FE program in Central Kalimantan Province, particularly its implementation on degraded peatlands, carries with it a risk of negative impacts that range from moderate to high. The activities contributing most significantly to the risk include local community land-use practices and shifts in agricultural methods that rely more heavily on external inputs and mechanized equipment. The study recommends mitigating the risk through strengthened natural resource protection and the substitution of exotic cultivated species with native peatland plants that possess strong agronomic potential. Similarly, Juhandi et al. [11] reported that the sustainability status of FE cultivation in the Pollung District of North Sumatra remains at a moderate level. In order to achieve national objectives related to food security, it is essential for the government to enhance all dimensions of FE agricultural management. This will improve the program's overall sustainability performance.

In Central Java,particularly in Temanggung Regency and Wonosobo Regency, the development of the FE program was ongoing at the time of the present study. In Temanggung Regency, the FE area encompasses the districts of Bansari, Bulu, Parakan, Kledung, and Ngadirejo, covering a total of 339 hectares. The commodities cultivated include potatoes (1 ha), shallots (137 ha), garlic (179 ha), and chilies (22 ha). In Wonosobo Regency, the FE program is distributed across four districts: Watumalang, Kertek, Garung, and Kejajar. In the region, the cultivation of garlic is predominant, with a total area dedicated to this crop amounting to 308 hectares. In addition, cultivates red curly chili peppers and red cayenne peppers are cultivated on 25.5 hectares of land, shallots are cultivated on 1 hectare, and potatoes are cultivated on 5 hectares. Beyond the two regencies referenced, other regencies in Central Java, namely Banjarnegara, Purbalingga, Banyumas, Cilacap, and Kebumen, collectively known as the Barlingmascakeb area, harbor considerable potential for FE development. This is due to their aptitude for various agricultural activities, including plantations, livestock farming, and aquaculture. Accordingly, the present study aims to identify suitable FE locations in Purbalingga Regency and to determine suitable crops for cultivation using a partial Analytical Hierarchy Process (AHP), a ranking analysis [13], and a land suitability analysis [14].

The present study focuses on Purbalingga Regency, a region situated within a basin surrounded by mountain ranges, including Mount Slamet and the Dieng Plateau to the north. The region is traversed by two major rivers, Serayu River and Klawing River, which contribute to its ecological and agricultural characteristics. The processing industry constitutes the largest share of the regional economy, accounting for 27.24% of total output. The agriculture, forestry, and aquaculture sectors follow. These sectors are supported by the regency's diverse topography, comprising both highland and lowland areas. Agriculture plays a vital role in the livelihoods of Purbalingga Regency's population, and the regency possesses considerable agricultural potential. Rice, corn, and sweet potatoes are the primary food crops cultivated in the region. The selection of Purbalingga Regency as the study area is further supported by its designation as a potential FE expansion location by the Office of Investment of One-Stop Integrated Service (DPMPTSP) of Central Java Province.

The Analitycal Hierarchy Process (AHP) is a decision-making methodology developed by Thomas L. Saaty to address complicated situations [15,16]. The fundamental principle of AHP is to assign numerical values to ascertain the comparative significance of numerous sets of priorities. The establishment of priorities is achieved through the comparison of two options simultaneously using a specific ratio scale [17]. The Analitycal Hierarchy Process (AHP) is frequently employed to evaluate impediments encountered by micro-, small-, and medium-sized enterprises (MSMEs) in obtaining halal certification and to rank hazards within the halal food chain based on their

importance [18]. The ranking method is a simple approach to evaluating options based on predetermined criteria [13]. Land suitability is determined through a systematic evaluation and classification of land based on its capacity to support specific uses, such as agriculture, forestry, or development. The suitability of land for agricultural use is determined by evaluating its capacity to support agricultural activities. This evaluation involves the consideration of factors like rainfall, temperature, slope percentage, soil types, and the distribution of groundwater wells [19,20]. The overlay multi-criteria evaluation generates land suitability maps, which are re-classified into suitability classes (S1, S2, S3 and N) denoting levels of land suitability ranging from from highly suitable to less suitable. This process is crucial for optimizing agricultural productivity and facilitating more accurate food estate mapping, especially in arid regions. Most previous studies have focused on geospatial and temporal variability for site-specific farming in various plantations and farming types [21,22]. According to Mishra et al. [22], the application AHP is also considered in the selection of factors influencing the selection of location for organic farming. However, all factors are still related to geo-spatial and temporal variability. The present study provides a comprehensive analysis of the multiple dimensions influencing food estate development, including government policies, external stakeholders, legal frameworks, technology, human resources, infrastructure, and the interaction between geospatial and temporal variability. Specifically, this study aims to identify and examine the key factors that determine the selection of suitable locations for food estates.

2. Materials and Methods

2.1. Data collection

The present study was conducted in four stages. The first stage involved conducting three focus group discussions (FGDs) to identify the determining factors that influence the location of the food estate. The participants in the FGDs were the experts and decision-makers of the FE at the provincial and regency levels. These participants represented various offices and agencies, such as the Office of Investment and One-Stop Integrated Services (DPMPTSP) of Central Java Province, the Office of Manpower, Cooperatives, and MSMEs, the Regional Coordinating Body, and the Office of Agriculture. The first FGD aimed to explore the factors that influence the selection of food estate locations and to identify promising crops for cultivation. The second and third FGDs were conducted to validate the factors that emerged in the first FGD with different stakeholder groups. The DPMPTSP of Central Java Province, in collaboration with the Institute for Research and Community Service of Jenderal Soedirman University, deliberately extended invitations to relevant stakeholders to participate in the FDGs. The FGDs were held at Jenderal Soedirman University during the first semester of 2023. The total number of participants in each

FDG ranged from 10 to 12. Thereafter, the AHP was used, wherein eleven participants were tasked with assigning values to the pairwise matrix of variables. The data analysis comprised decomposition, creation of a pairwise matrix, calculation of priority weights, and determination of the consistency ratio. The third stage entailed the ranking of the variables selected during the FGDs, as well as the utilization of the rank method to refer to the data and literature reviewed. The final stage involved the creation of land suitability maps for the selected agricultural commodities.

2.2. Data analysis

2.2.1. Analytical Hierarchy Process (AHP)

The FGDs yielded seven key criteria for the selection of food estate locations. In order to evaluate the relative importance of these criteria, the selected participants conducted pairwise comparisons of all criteria at each hierarchical level using the standard 1–9 scale of the AHP. This procedure allowed participants to express their degree of preference for one criterion over another, thereby generating the comparison matrices necessary for subsequent weighting and consistency analysis (Table 1) [15,23,24].

Table 1. Scale of pairwise matrix [15]

Scale	Description
1	Equally important
3	Moderately more important
5	Strongly more important
7	Very strongly more important
9	Extremely more important
2,4,6,8	Intermediate values

The priority weight of each element was determined through a process of priority synthesis. In this stage, the local priority weights derived from each pairwise comparison matrix were combined to produce the overall priorities across the hierarchy. A priority scale for the strategic planning alternatives was then generated by calculating the principal eigenvalues of the comparison matrices and propagating these weights through the hierarchical structure. This process involved the multiplication of the eigenvector-derived weights at each level by the corresponding weights of the upper-level criteria, resulting in a coherent and integrated set of priority values for all alternatives [15].

$$A = [aij] = \begin{bmatrix} 1 & a12 & \cdots & a1n \\ \frac{1}{a12} & 1 & & a2n \\ \vdots & \vdots & \cdots & \vdots \\ \frac{1}{a1n} & \frac{1}{a2n} & \cdots & 1 \end{bmatrix} \quad (1)$$

If A is a consistent matrix, the comparative assessment is denoted by *aij*. *aij* is 1/*aij* (reciprocal) if *aij* is 1. In this context, *i* and *j* represent 1, 2, …, *n* as mentioned in Eq. (1). The weights of *wi* and *aij* are determined by employing the following Eq. (2).

$$aij = \frac{wi}{wj}, i, j = 1,2,\ldots,n \quad (2)$$

In the formula, *n* denotes the number of criteria being compared, *wi* denotes the weight allocated to criterion *i*, and *aij* denotes the ratio of weights assigned to criteria *i* and *j*, respectively. The eigenvalues and eigenvectors of each consistent matrix are subsequently determined by calculating the maximum eigenvalue as mentioned in Eq. (3) [15,22,25].

$$\lambda max = \sum_{j=1}^{n} aij \left(\frac{Wj}{Wi}\right) \quad (3)$$

Nevertheless, it is very important to ensure the consistency of the process for determining relative importance. The decision-making process is subjective and iterative, and it has the potential to diminish respondents' interest and lead to problems with how values are assigned to relative importance. The Consistency Index (CI) represents the consistency evaluation (Eq. (4)). The Random Index (RI) displays the random consistency index for a variety of priority matrix sizes, as delineated in Table 2. The maximal eigenvalue obtained from the consistent matrix is represented by the λmax value, while the size of the comparison matrix is represented by *n*.

$$CI = \frac{\lambda max - n}{n - 1} \quad (4)$$

The consistency ratio (CR) in Eq. (5) is used to evaluate consistency decisions, which is calculated by dividing the consistency index (CI) by the random index (RI). In order to demonstrate consistency and accountability in the evaluation of paired matrices by respondents, the CR value must be less than or equal to 0.1 [15,24].

$$CR = \frac{CI}{RI} \quad (5)$$

Table 2. Random index value for matrix with *n* criteria [15]

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

2.2.2. Ranking method

The ranking method was applied to determine the relative importance of the priority crops deemed suitable for the FE. In this stage, the criteria identified through the FGDs, in conjunction with their corresponding eigenvalues derived from the AHP analysis, served as the basis for the evaluation. Each criterion was then assessed using an ordinal scale ranging from 1 to 5, where 5 indicates a very good or highly suitable condition, 3 represents a neutral or moderate condition, and 1 signifies a less suitable condition. In order to enhance the robustness of the ranking results, the evaluation process incorporated feedback from six key stakeholders representing relevant institutional and technical backgrounds. In addition, a comparison with secondary data and other

credible information sources was conducted for the purpose of validating the scores and ensuring that the final rankings reflected both expert judgment and empirical evidence [13,26].

2.2.3. Land suitability data analysis

The development of a land suitability map for pineapple cultivation in Central Java involved a series of systematic steps. First, a set of criteria specific to the land suitability for pineapple cultivation were identified. These criteria were drawn from a variety of biophysical requirements, such as administrative map, soil type, elevation, slope, and rainfall. Second, optimal threshold ranges for each factor were established based on relevant agronomic guidelines and literature. Third, spatial data were processed and analyzed using QGIS software. This stage included organizing the data into compatible formats, generating thematic layers for each criterion, and ensuring spatial alignment and consistency across datasets. Fourth, a multi-criteria evaluation (MCE) approach was applied through a weighted overlay analysis. Each criterion was assigned a weight reflecting its relative importance for pineapple growth, informed by expert judgment and the results of the earlier AHP analysis. Finally, the weighted overlay output was classified into four standard land suitability categories: highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and unsuitable (N). The resulting land suitability map was validated through field visits and ground-truthing to compare model predictions with actual on-site conditions, thereby enhancing the reliability of the spatial assessment. This comprehensive procedure supports more informed agricultural planning and strategic decision-making. The research methodology employed in this study is illustrated in Fig. 1 [14,27,28].

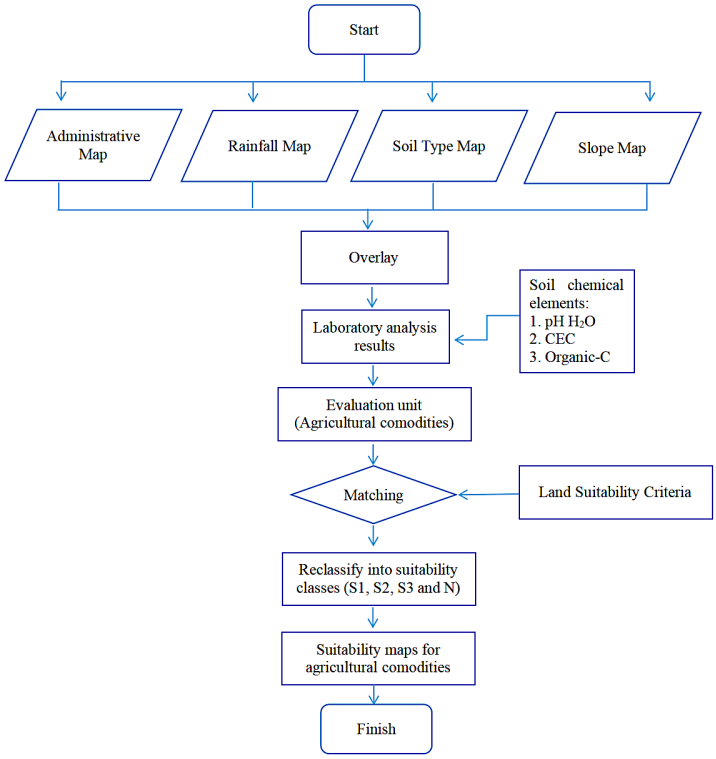


Fig 1. Flowchart of the procedures and techniques employed in the assessment land suitability [29]

3. Results and Discussion

3.1. Socio-demographic characteristics of the participants

The study's participants were 11 experts from universities and governmental bodies at the provincial and regency levels relevant to food estate planning and agricultural development. The governmental bodies included the Office of Investment and One-Stop Integrated Service Office (DPMPTSP), the Office of Manpower, Cooperatives, and MSMEs, the Regional Coordinating Body, the Office of Agriculture, and the Office of Animal Husbandry. In addition, district heads or their designated representatives also participated. As shown in Table 3, the majority of participants were male (64%) and above 40 years of age (73%). The majority of them (90%) had over a decade of professional experience, indicating a high degree of institutional knowledge and sector-specific expertise. Regarding educational attainment, 64% of the participants held a master's degree or higher, further substantiating the credibility of their contributions to the study. The average age of the participants was 48.58 years, and the average length of their service was 22.25 years. This suggests that the group consisted of senior experts with extensive experience in regional planning, agriculture, and public administration, as illustrated in Table 3.

Table 3. Participants' sociodemographic characteristics

Characteristics	Category	Number (n=11)	
		Frequency	Percentage (%)
Gender	Male	7	64
	Female	4	36
Age (year)	< 30	1	9
	< 40	2	18
	< 50	2	18
	≥50	6	55
Educational attainment	Undergraduate degree	4	36
	Master's degree or higher	7	64
Professional experience (years)	< 10	1	9
	< 20	5	45
	< 30	3	27
	≥30	2	18
Occupation	Expert (academic)	4	36
	Government staff	7	64

3.2. Factor influencing the selection of a location for a food estate

The findings generated, which were derived from the focus group discussions (FGDs) with key stakeholders and an extensive literature review, resulted in the identification of seven distinct categories of criteria relevant to food estate location selection. To systematically evaluate the relative importance of these criteria, the Analytical Hierarchy Process (AHP) was employed. This method enables structured decision-making by incorporating expert judgment to determine the factors that most strongly influence location suitability. In accordance with the AHP framework, experts assessed pairs of criteria using a specially designed pairwise comparison matrix. For each pair, the participants indicated which criterion was more important and the intensity of that

importance using Saaty's 1–9 scale. These comparisons formed the basis for calculating priority weights, allowing the criteria to be ranked according to their perceived significance. The resulting computations generated eigenvalues, which quantify the priority weight assigned to each criterion. Table 4 presents these eigenvalues—the scalar values derived from the principal eigenvector of each comparison matrix—range from 0 to 1, consistent with AHP conventions [30] and Table 5-7 represents the ranking analysis for product selection. Fig. 2 visually illustrates the priority ranking, highlighting the relative weight of each criterion in influencing food estate location selection. This structured approach ensures that the final prioritization is both transparent and grounded in expert knowledge.

Table 4. Criteria established for the selection of a location for the food estate

No	Category	Description	Eigenvalue
1	Government's commitment	Policy consistency and government support for the success of the food estate program	0.191
2	Investors	The prospects for collaboration among investors in agriculture, animal husbandry, and fisheries suggest that those seeking to invest can find valuable partnerships. By establishing connections with individuals in these fields, they can expand their investment opportunities and share expertise.	0.167
3	Availability and suitability of land	Availability and suitability of land	0.159
4	Technology and human resources	The issue focuses on human resources and their demographics, farmer groups, wage levels, employment, technology, the sustainability of on-farm and off-farm industries, and the availability of production factors.	0.140
5	Infrastructure and facilities	The areas of focus include roads and transportation, markets and marketing, water systems, energy and electricity availability, and internet and telephone networks.	0.136
6	Formal legal criteria	Land ownership and management status	0.132
7	Incentives	The fiscal benefits, integrated farming opportunities, added value of products, and the existence of an agricultural processing industry are all important aspects for the "incentive" theme.	0.074

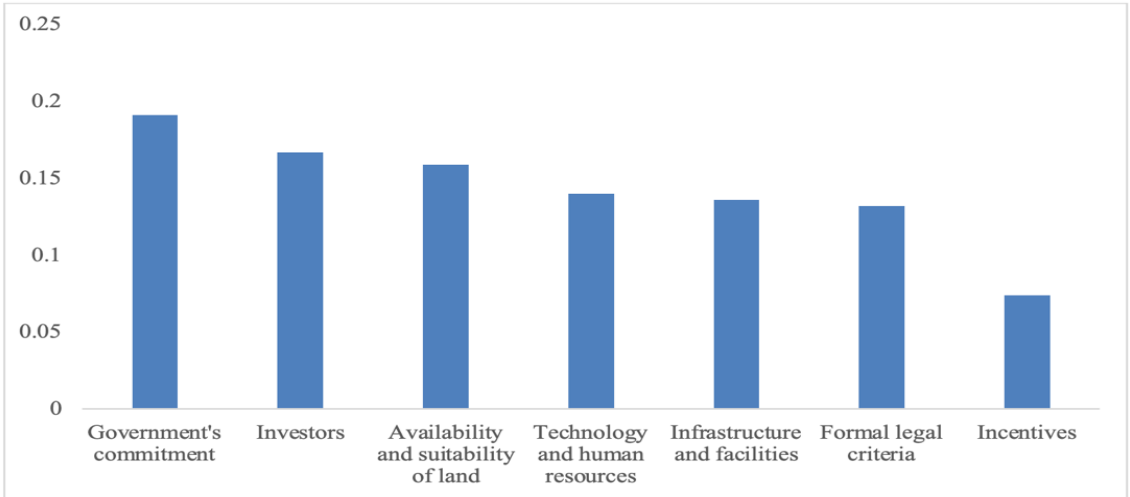


Fig 2. Ranking of criteria for the selection of food estate locations

The consistency ratio (CR) analysis of matrices demonstrated consistent values (<0.1) and satisfied the standards established by Saaty and Setiono [15].

Table 5. The ranking of promising plant product in Purbalingga Regency

Criteria	**Product 1: Pineapple**	**Product 2: Pepper**	**Product 3: Coconut**
1. Government's commitment (eigenvalue = 0.191)			
Government consistency	There are investment promotions in line with the study's analysis of promising plant products. At present, regional regulations that govern the cooperation between local governments and investors are in effect. These regulations establish formal institutional prerequisites, such as those necessary to acquire government financing. Legislation concerning incentives designed to encourage collaboration with farmers, such as facilities, as well as permits, promotions, and financial considerations has already been established at the regional level.		
Location	Location for pineapple farm proposed by the local government: the districts of Karang Jengkol, Karangreja, Siwarak, and Karang Jambu	Areas with the potential for the cultivation of pepper: the districts of Pegadengan and Kejobong, as well as the entirety of Purbalingga Regency	Coconut has been extensively cultivated in various districts within Purbalingga Regency.
Having the potential to be successful?	Yes	Yes	Yes
Weight (value x priority)	5 × 0.191= 0.955	5 × 0.191= 0.955	5 × 0.191= 0.955
2. Investor (0.167)			
Opportunities or data available to investors in aquaculture or livestock farming	An investor for pineapple crop products has existed and an investment opportunity has developed. .		An investor for coconut products has existed and an investment opportunity has developed.
Opportunity for matchmaking event with industries, academic institutions, and other relevant stakeholders	Matchmaking events for funding opportunities have been conducted several times, for example, between farmers and processing factories.		
Weight (value × priority)	0.167 × 5 = 0.835	0.167 × 4 = 0.668	0.167 × 5 = 0.835

Table 6. The ranking of promising plant product in Purbalingga Regency (continued)

3. Availability and suitability of land (0.159)			
Area of land designated for agricultural use (ha) in 2010 (based on the available data)	77.765 https://jateng.bps.go.id/staticTabel/2015/02/09/656/luas-penggunaan-lahan-menurut-kabupaten-kota-di-jawa-tengah-tahun-2010-ha-.html		
Area of land designated for aquaculture (m^2) in 2021	4,245,000 https://statistik.kkp.go.id/home.php?m=luas_lahan_kabupaten&level=kabupaten#panel-footer		
Area of land designated for rice-fish culture (m^2) in 2021	67,000 https://statistik.kkp.go.id/home.php?m=luas_lahan_kabupaten&level=kabupaten#panel-footer		
Number of cattle (cows) in 2021	12,642 https://jateng.bps.go.id/indicator/24/75/1/populasi-ternak-menurut-kabupaten-kota-dan-jenis-ternak-di-provinsi-jawa-tengah-ekor-.html		
Weight (value x priority)	0.159 × 4 = 0.636	0.159 × 4 = 0.636	0.159 × 4 = 0.636
4. Technology and human resources (0.140)			
Technology and human resources	The production of processed pineapple products has increased significantly, with the establishment of processing factories. Pineapples also have the potential to stimulate the development of local tourism.	The potential for the development of pepper processing factories is high.	The coconut sugar industry has been well established for some time.
Workforce in 2022	Employed individuals: 473,232 Unemployed individuals: 30,450 https://jateng.bps.go.id/indicator/6/82/1/jumlah-angkatan-kerja.html		
Minimum wage (IDR) in 2025	2,338,283.12 https://jatengprov.go.id/wp-content/uploads/2024/12/Lampiran-UMK.pdf The Central Java Governor's Decree No. 561/45, issued in 2025 pertaining to the determination of the minimum wage for 35 regencies or cities, as well as structural minimum wages for regencies and cities within Central Java Province for the year 2025		
Weight (value × priority)	0.140 × 5 = 0.70	0.140 × 3= 0.42	0.140 × 5 = 0.70

Table 7. The ranking of promising plant product in Purbalingga Regency (continued)

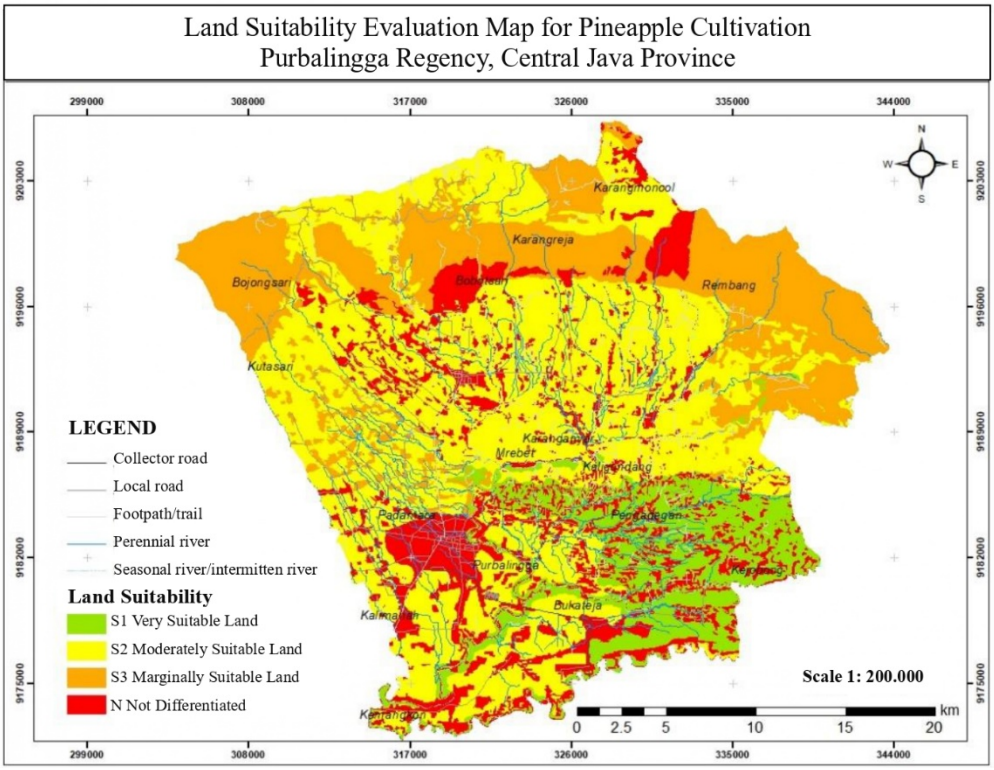
5. **Infrastructure and facilities** (0.136)			
Road length (km) in 2023	951.602 https://purbalinggakab.bps.go.id/id/statistics-table/2/NDAyIzI=/s.id		
Access to toll road	1. Pejagan–Brebes Toll Gate at KM 429; 2. Brebes Barat Toll Gate at KM 262; 3. Brebes Timur Toll Gate at KM 268; 4. Adiwerna Tegal Toll Gate at KM 278.		
Energy availability (kVA)	Purwokerto 1,128,680		
Number of villages that have been connected to the internet in 2021 (4G/LTE)	224		
Weight (value × priority)	0.136 × 4 = 0.544	0.136 × 4 = 0.544	0.136 × 4 = 0.544
6. Formal legal criteria			
Status of land ownership	Local government-owned or individual-owned		
Management of land	Managed by local government or by individuals		
Weight (value × priority)	0.132 × 4 = 0.528	0.132 × 4 = 0.528	0.132 × 4 = 0.528
7. **Incentive** (0.074)			
Opportunity for the development of integrated farming	High	Medium	Medium
Added value of the product	High	High	High
The development of agricultural food processing industries	The establishment of pineapple processing factories have started.	The potential exists for the establishment of factories for the processing of pepper into pepper powder.	A substantial number of enterprises are engaged in the production of brown sugar, exhibiting different scale and market specialization (domestic or export-oriented).
Market demand	Medium	High	High
Weight (value × priority)	0.074 × 5 = 0.37	0.074 × 5 = 0.37	0.074 × 5 = 0.37
Total weight for each product	4.568	4.121	4.568

Scale: 5= very good; 4=good; 3= neutral; 2=not good; 1=not very good

3.3. Selection of promising crops for food estate

Based on the results of the FGDs conducted with relevant stakeholders, the selection of prospective, high-promising crops for the food estate in Purbalingga Regency was narrowed down to pineapple, pepper, and coconut. Each crop was subsequently evaluated using an ordinal scale ranging from 1 to 5, where a score of 1 indicates "not very good," 3 represents "neutral," and 5 denotes "very good." These scores were assigned during the FGDs and were further substantiated

by additional data obtained from local government records as well as from external secondary sources. The consolidated assessment for each commodity is presented in Table 5.



Class describes the level of land suitability within the order. At the class level, land classified as suitable (S) is further subdivided into three categories: very suitable land (S1), moderately suitable (S2), and marginally suitable land (S3). Meanwhile, land classified as "unsuitable" (N) is uncategorized.

Fig 3. Evaluation map of land suitability for pineapple cultivation in Purbalingga Regency, Central Java Province

Pineapple and coconut have emerged as two promising agricultural commodities in Purbalingga Regency. Coconut, in particular, has long supported a well-established processing industry, with coconut sugar serving as the primary value-added commodity. The commodity's economic significance is reflected in its strong integration into international markets, with coconut sugar from Purbalingga being exported to countries such as the United States, Malaysia, and the former Czechoslovakia [31]. The maturity of this industry indicates that coconut-based value chains in the regency have achieved a relatively advanced level of technological, organizational, and market development. Pineapple, while also recognized as a leading local product, remains less developed in comparison to coconut. There are opportunities to expand cultivation areas, strengthen linkages between upstream and downstream, and enhance value-added processing. In contrast to the well-established and competitive status of coconut, pineapple offers a greater potential for strategic intervention through coordinated agricultural development programs. Therefore, pineapple was identified as the primary commodity for food estate (FE) development in Purbalingga Regency. The prioritization of pineapple aligns with the broader objectives of the FE program, which include enhancing regional competitiveness, promoting diversified value-

added agro-industries, and strengthening local agricultural systems to ensure long-term food security.

3.4. Land's suitability for pineapple cultivation

The majority of Purbalingga Regency, Central Java Province, experiences high rainfall during the rainy season. Based on the land suitability classification, the region is classified as S2, which is characterized by limitations in rainfall and soil chemical properties (pH), cation exchange capacity (CEC), and exchangeable potassium (K^+). This observation has been made in the districts of Rembang, Bojongsari, Pengadegan, Kaligondang, Padamara, Purbalingga, Kejobong, Kalimanah, Bukateja, and Kemangkon. These districts have conditions that are conducive to pineapple cultivation, but soil amendments and appropriate management practices may be necessary to optimize crop growth. In contrast, land classified as S3 in terms of suitability is characterized by high rainfall and steep slopes, and is located in the districts of Karangmoncol, Karangreja, Bobotsari, Mrebet, Karanganyar, and Kutasari. The topography of these districts is characterized by steep terrain and high precipitation levels, resulting in the classification of land as marginally suitable. To prevent soil erosion and to optimize land use, conservation measures must be implemented. The classification of lands in some districts as class N indicates their unsuitability for pineapple cultivation under current conditions. A comprehensive understanding of the land classifications is essential for effective strategic agricultural planning. Such understanding will inform decisions on soil management practices, ensuring that these are tailored to the specific conditions presents in each local area. In order to increase field productivity, measures can be implemented to improve the land's suitability. For instance, the application fertilizers or ameliorants, especially those that supply additional potassium to the soil, can be considered. Organic fertilizer can be used to optimize the effectiveness of nutrient uptake in plants [32]. Fig. 3 illustrated the land suitability for pineapple cultivation.

4. Conclusion

This study makes two main contributions. First, it establishes a comprehensive framework for determining suitable locations for food estate (FE) development. Seven key criteria have been classified into three categories for the purpose of guiding the selection of optimal locations. These categories are government factors (commitment, legal framework, infrastructure, and incentives); natural conditions (land availability and suitability); human resources and technology; and external factors (investors). Collectively, these criteria provide a structured and systematic framework for evaluating a region's capacity to support FE development. The formulation of these criteria contributes to the broader literature by offering a replicable decision-making tool that may be applied in various contexts across Indonesia. Second, using the developed criteria, pineapple has

been identified as the most suitable commodity for FE development in Purbalingga Regency. While both pineapple and coconut have been identified as promising local products, the analysis has indicated that pineapple offers greater potential for expansion and value-added processing, thus aligning with FE strategic objectives. The selection of pineapple as the most promising crop commodity is indicative of both its agronomic suitability and its potential to strengthen local agricultural competitiveness and stimulate rural economic development.

The application of the criteria to Purbalinga Regency has revealed that several districts have moderate suitability for the development of pineapple-based food estates. The districts in question are Rembang, Bojongsari, Pengadegan, Kaligondang, Padamara, Purbalingga, Kejobong, Kalimanah, Bukateja, and Kemangkon. These districts evince favorable biophysical characteristics, supportive socio-economic conditions, and adequate institutional readiness for integration into the FE program. The criteria and analytical approach developed in the present study can serve as a foundational framework for subsequent studies in other regions of Indonesia in terms of selecting locations for food estates. This framework can be utilized as a practical reference for policymakers, planners, and stakeholders in these regions as they endeavor to evaluate and prioritize locations for FE development. By proposing a clear and adaptable framework, the present study contributes to more evidence-based and strategic decision-making in national food security planning.

Abbreviations

AHP	analytical hierarchy process
CEC	cation exchange capacity
CI	consistency index
CR	consistency ratio
DPMPTSP	department of investment and one-stop integrated services
FE	food estate
FGD	focus group discussion
MCE	multi-criteria evaluation
MSME	micro, small, and medium-sized enterprises
RI	random index
pH	potential of hydrogen
PSN	National Strategic Programs

Data Availability Statement

Data will be shared upon request by the readers.

CRediT Authorship Contribution Statement

Poppy Arsil: Conceptualization, Supervision, Methodology, Data analysis, Data curation, Writing – original draft, review & editing. **Rifda Naufalin**: Conceptualization, Supervision, Methodology, Writing – original draft. **Hana Hanifa** and **Ratna Satriani**: Methodology, Project administration, Data curation, Data analysis, Writing – original draft. **Dhifan Kemal Akbar**:

Methodology, Data analysis, Writing – original draft, review & editing. **Icuk Rangga Bawono**: Conceptualization, Supervision, Funding acquisition, Writing – original draft. **Rifky Dwi Prastomo**: Project administration, Data curation.

Declaration of Competing Interest

The authors of this manuscript declare no conflict of interest or competing interest.

Declaration of Use of AI in the Writing Process

Nothing to disclose

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