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ANALYSIS OF THE POTENTIAL OF SUPERIOR FOOD CROP COMMODITIES IN SIAK REGENCY WITH GEOGRAPHIC INFORMATION SYSTEM (GIS) VISUALIZATION

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ABSTRACT

Regional economic development, in rural areas, relies heavily on the identification of key sectors with the highest growth potential. In this context, the agricultural sector, especially food crop production, is the backbone of local economic resilience. The development of superior food crop commodities in Siak Regency is very important to increase agricultural productivity and the welfare of rural communities. To assess this potential, the study integrated several analysis methods, including the Sectoral Contribution Index (SCI), Growth Ratio Model (GRM), Location Quotient (LQ), and Dynamic Location Quotient (DLQ), which were combined in the Composite Index (CI). In addition, GIS is used to visualize the spatial distribution of these analyses. The results showed that Bungaraya Village and Kemuning Muda Village were the main contributors to rice production in Siak Regency, each accounting for 23% of the total rice production in the area. GRM analysis shows that Temusai Village has the highest growth rate of rice production, even though it is influenced by external factors that cause production fluctuations. The results of the LQ and DLQ analysis show that some villages, such as Bungaraya and Kemuning Muda, not only meet local needs but also have the potential to support exports. The use of GIS to visualize the results of this analysis allows mapping of the spatial distribution and identification of areas with potential for further development. These findings are expected to be the basis for policy-making that supports the development of sustainable agriculture and the improvement of community welfare in Siak Regency.

INTRODUCTION

In accordance with the mandate of Law No. 6 of 2014 concerning Villages, rural development aims to improve the welfare and quality of life of village communities. The trick is to encourage the development of independent and sustainable villages that have social, economic, and environmental resilience. One of the efforts to reduce the gap between villages and cities is to accelerate the development of independent villages and build local economic linkages between villages and cities through the development of rural areas because rural areas have a lot of potential, especially the potential of natural resources that can be used as capital in improving the economy if used optimally (Diartika & Pramono, 2021). In line with research by Lindawaty (2023), which states that development that starts from the village is an effort to improve the quality of life and especially the welfare of people living in rural areas.

According to Muta'ali (2015), the development of rural areas in general is closely related to the development of the agricultural sector. The development of regional superior commodities is generally based on basic economic activities, and the leading sectors are necessary for faster economic growth (Iwan et al., 2023). An economic activity is said to be basic if the volume of production is able to meet the needs of its own region and also meet the needs outside its territory or be exported. Meanwhile, according to Tarigan (2015), economic activities are said to be sectors that have high economic growth, absorb a lot of labor, have relationships with other sectors, and create high added value. Basic economic activities that produce superior commodities basically act as a driver of regional economic growth. For example, research by Harahap et al. (2022) shows that the development of the agricultural sector contributes significantly to poverty alleviation in rural areas. Other research also supports this argument by emphasizing the importance of technological innovation in increasing agricultural productivity. Then, Tomisa & Oktayani (2024) found that the development of superior commodities can significantly increase farmers' incomes and affect local economic growth. Finally, a study by Arham et al. (2019) revealed that the interaction between the agricultural sector and other sectors is essential to achieve sustainable development in rural areas.

Agricultural commodities, especially the food crop subsector, have high development potential because they have a strategic role, such as meeting the needs of life, supplementing animal feed, having a variety of products, having relationships with other sectors, having economic value, and adding value, as well as high absorption of labor and increasing family income (Tuminem, 2019). Thus, the development of the agricultural sector that focuses on food crop commodities is influential in the development of agricultural economic activities in rural areas.

Data from the Central Statistics Agency, Riau Province, shows a major increase in rice production. The rice harvest area grew by 8.68% from the previous year, reaching 56.42 thousand hectares. In 2024, dry grain production (DGP) will be 222.06 thousand tons, 7.81 percent higher than in 2023. This helped increase rice production to 127.44 thousand tons, which is an increase of 7.81 percent. Siak Regency has a harvest area of 5,886 hectares in 2024, down 7.86 percent compared to the previous year, which was 6,388 hectares. In the same period, Siak Regency produced 25,987 tons of DGP rice, which is a small decrease of 1.91 percent. Indragiri Hilir Regency showed better performance compared to other districts in Riau Province. Rice

production reached 57,345 tons of DGP, an increase of 8.43 percent compared to the previous year. Pelalawan Regency also showed significant figures, with an increase in rice production that reached 67.7 percent, reaching 30,557 tons of DGP. On the other hand, some districts, such as Kampar and Bengkalis, experienced a large decline in rice production, with Kampar losing 15.56% and Bengkalis losing 18.35% (BPS Provinsi Riau, 2024).

Technological innovation emerges as a pivotal driver in augmenting agricultural productivity, as evidenced by research that emphasizes the need for continuous technological advancements to increase the efficiency of food production. The geographical context of agricultural development within Riau Province, particularly Siak Regency, illustrates a microcosm of these broader dynamics, showcasing the region's agricultural potential, especially in rice production. Recent statistical analysis indicates significant increases in rice production, contributing positively to the local economy and providing employment opportunities for rural residents. The data suggest that despite some declines in production in certain areas, initiatives to enhance agricultural practices are yielding favorable economic outcomes.

Technological integration of Geographic Information Systems (GIS) plays an important role in the analysis and visualization of spatial data, enabling better decision-making in agriculture (Prasetyo & Rohmatun, 2016). By leveraging GIS, stakeholders in the agricultural sector can improve resource management, increase agricultural productivity, and support sustainable development. GIS has been shown to facilitate better spatial planning and identify areas for sustainable agricultural development, thus aiding in the formulation of effective government policies and strategies (Mubarak, 2023; Kurniawan & Sadali, 2015; Irfan et al., 2023; Isa et al., 2023). The use of GIS in agricultural planning can also improve the efficiency of food commodity management, increase food security, and contribute to the overall welfare of farmers (Muryamto et al., 2016; Nugraha et al., 2014).

This research aims to improve the understanding of GIS technology in the agricultural sector, especially in mapping the production area and the potential of superior food crop commodities in Siak Regency. It also provides recommendations for developing the agricultural sector in the region.

RESEARCH METHOD

The data used in this study is secondary data, consisting of a 5-year time series of food crop production (2018-2023) from the Central Statistics Agency and the Food Security and Agriculture Service of Siak Regency. From this data, it was obtained that Bungaraya is a sub-district that produces rice plants, so the data used is data on the Bungaraya sub-district in each village (Bungaraya Village, Kemuning Muda Village, Tuah Indrapura Village, Buantan Lestasi Village, Jayapura Village, Jatibaru Village, Langsat Permai Village, Dayang Suri Village, Temusai Village, and Suak Merambai Village). Other supporting data are shapefiles of sub-districts in Siak Regency accessed through the InaGeoportal website.
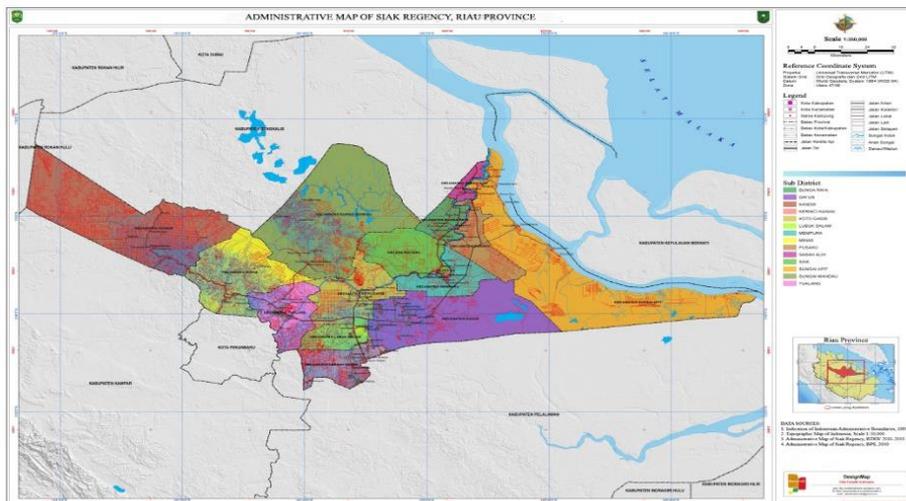
Figure 1.
Administrative Map of Siak Regency, Riau Province

The analysis methods used to determine the leading commodities of food crops include the Sectoral Contribution Index (SCI), Growth Ratio Model (GRM), Location Quotient (LQ), Dynamic Location Quotient (DLQ), and Composite Index (IK). Each of these analyses has advantages and disadvantages, so the combination of several analysis methods is expected to provide optimal analysis results. The results of the calculation are combined into the Composite Index to identify the potential of the region, and then the results are incorporated into GIS.

One of the significant advantages of employing these methods in concert is the ability to identify not just the highest-yielding commodities, but also those that can sustainably grow within the local environmental and socio-economic context. The application of composite indices in agricultural research has led to improved understanding of systemic farm sustainability and resilience (Gondek et al., 2020). Moreover, literature suggests that combining multiple analytical frameworks enhances decision-making processes in agriculture (Borthakur & Singha, 2024).

From a methodological perspective, the use of GIS to map findings derived from these analytical techniques facilitates visualization of spatial trends and patterns, which are crucial for stakeholders and policymakers in agriculture. Spatial analyses allow for the identification of geographic disparities in agricultural outputs and resource allocation, guiding interventions and investments toward areas of greatest need (Wang et al., 2022).

Sectoral Contribution Index (SCI)

Sectoral Contribution Index (SCI) Analysis is an analysis that presents information about the amount of production of a commodity in one sub-district (Xij) compared to the amount of commodity production in one district (Xin) (Muta'ali, 2015).

$$SCI = \frac{Xi_j}{Xi_n^{'}}$$

The Sectoral Contribution Index (SCI) is an indicator used to measure the contribution of a sector or subsector to the economy of a certain region. In this context, SCI is calculated based on the value of commodity production (Xij) at the village level during the 2018–2023 period. The Xin variable represents the total value of commodity production at the village level in the same period. The commodities that are the focus of the analysis (I) include rice, corn, soybeans, peanuts, cassava, sweet potatoes, and taro. The research area unit at the village level (j) consists of Bungaraya, Kemuning Muda, Tuah Indrapura, Buantan Lestari, Jayapura, Jatibaru, Langsat Permai, Dayang Suri, Temusai, and Suak Merambai. All of these villages are within the scope of the Siak Regency (n) administrative area, so that this SCI analysis can provide an overview of the contribution of the food crop subsector to regional economic development in Siak Regency.

Growth Ratio Model (GRM)

The Growth Ratio Model (GRM) aims to assess the production quality of a commodity based on the production volume of two time periods. This analysis provides an overview of the production potential of superior commodities temporally or not only at one point in time. According to Dewi & Yasa (2018) and Amalia et al., (2023), GRM is a tool used to compare the income growth of a sector in a smaller area with a larger area. The Growth Ratio model has a value of smaller, larger, or equal to one.

$$GRM = \frac{\Delta Xi_j / \Delta Xi_{jt}}{\Delta Xi_n / \Delta Xi_{nt}}$$

The GRM formula is calculated by comparing the change in the value of commodity production at the village level (ΔXij) with the value of commodity production in the same year (Xijt), then comparing the change in the value of commodity production at the Siak Regency level (ΔXin) with the value of commodity production in Siak Regency (Xint). The commodities analyzed included rice, corn, soybeans, peanuts, cassava, sweet potatoes, and taro (i). The villages that are the object of research in this model are Bungaraya Village, Kemuning Muda, Tuah Indrapura, Buantan Lestari, Jayapura, Jatibaru, Langsat Permai, Dayang Suri, Temusai, and Suak Merambai (j). This model provides insight into how the growth rate of commodity production at the village level compares to the growth occurring at the Siak Regency level, which ultimately helps in the planning and development of the agricultural sector in the region.

Location Quotient (LQ)

Location Quotient (LQ) analysis, as stated by Widyantari & Maulany (2020) and Gunawan et al., (2018), is often used as an analysis in determining superior commodities because it is considered effective in assessing the diversity of commodity production in a region. In addition, this analysis can also present an overview of the economic stability and flexibility of a region (Berawi et al., 2017), and LQ is also used to determine the concentration and/or distribution of production activities in a region, and to describe the comparative advantages of producing a commodity in a region (Saragih, 2015).

$$LQ = \frac{Xi_j / X_j}{Y_{in} / Y_n^{'}}$$

Where the LQ Formula is calculated by comparing the production value of a certain commodity at the village level (Xij) to the production value of the food crop subsector in the village (Xj), and comparing it with the ratio between the value of commodity production at the Siak Regency level (Yin) to the production value of the food crop subsector in Siak Regency (Yn). The commodities analyzed included rice, corn, soybeans, peanuts, cassava, sweet potatoes, and taro (i). The villages included in this analysis are Bungaraya Village, Kemuning Muda, Tuah Indrapura, Buantan Lestari, Jayapura, Jatibaru, Langsat Permai, Dayang Suri, Temusai, and Suak Merambai (j), which are in the Siak Regency (n) area. By using LQ, we can find out whether a village has a comparative advantage in producing certain commodities when compared to the average commodity production at the Siak Regency level.

Dynamic Location Quotient (DLQ)

DLQ analysis, or Dynamic Location Quotient, is the result of development, as well as being able to overcome the weakness of LQ analysis, which tends to be static, because it only describes conditions at one specific point in time, so that it does not provide a dynamic picture of changes in economic sectors from time to time. With DLQ, this analysis is able to provide a deeper and more dynamic understanding of the leading sectors in a region, taking into account changes that occur over time. For example, in research (Yurliana et al., 2015), DLQ is used to analyze leading sectors by paying attention to data from several periods. The results of this analysis show that the agricultural sector and the processing industry sector are the base sectors in Siak Regency, with a DLQ value of more than 1, which indicates a higher growth potential compared to other industries in the region. Thus, DLQ provides more comprehensive and dynamic information in analyzing changes in economic sectors, which cannot be achieved by using only the static LQ method. According to Oksatriandhi & Santoso (2014), mathematically, the DLQ formula is as follows:

$$DLQ = \frac{(1 + g_{ij}) / (1 + g_j)}{(1 + G_{in}) / (1 + G_n)}$$

The DLQ formula is calculated by comparing the average growth ratio of certain commodities at the village level (gij) with the average growth of the food crop subsector in the village (gj), and comparing the average growth of these commodities at the Siak Regency (Gin) level with the average growth of the food crop subsector in Siak Regency (Gn). Mathematically, this formula measures the dynamics of commodity growth at the village level relative to the changes that occur at the larger regional level. The commodities analyzed include rice, corn, soybeans, peanuts, cassava, sweet potatoes, and taro (i), and the villages referred to in this analysis are Bungaraya Village, Kemuning Muda, Tuah Indrapura, Buantan Lestari, Jayapura, Jatibaru, Langsat Permai, Dayang Suri, Temusai, and Suak Merambai (j), all of which are within the Siak Regency (n) area. DLQ provides an overview of how quickly or slowly a village is changing in its contribution to the food crop subsector compared to other regions.

It is further said by Tutupoho (2019) to cover the weaknesses of the LQ model, it is overcome by using the variance of LQ called the Dynamic Location Quotient (DLQ). DLQ is used by introducing the growth rate on the assumption that each sectoral added value has its own average annual growth rate during the period of the initial year and the gap years. The Dynamic Location Quotient (DLQ) method is a development of LQ by accommodating the growth rate of economic sector output from time to time (Basuki & Mujiraharjo, 2017).

Composite Index (CI)

The results of the analysis of the Sectoral Contribution Index (SCI), Growth Ratio Model (GRM), Location Quotient (LQ), and Dynamic Location Quotient (DLQ) were then combined into the Composite Index by summing and searching for the average. Before calculating the composite index value, the value of each analysis is first scaled.

$$y = \frac{(\bar{X}_{in} - \bar{X}_{inMin})}{(\bar{X}_{inMax} - \bar{X}_{inMin})},$$

Where y is the scaling value obtained by subtracting the average value of a commodity at the village level ($\bar{X}_{in}$) by the average value of the lowest commodity ($\bar{X}_{inMin}$) and dividing it by the difference between the average value of the highest ($\bar{X}_{inMax}$) and lowest ($\bar{X}_{inMin}$) commodity at the village level. The average value of the commodities used ($\bar{X}_{in}$) is the result of calculating the average value for each commodity in all villages in Siak Regency. This process aims to equalize the values obtained from various indicators (such as SCI, GRM, LQ, and DLQ) that have different scales, with the aim of making the comparison between values easier and more effective. The commodities analyzed included rice, corn, soybeans, peanuts, cassava, sweet potatoes, and taro (i), and the data used covered the Siak Regency area (n). This scaling makes it easier to analyze the changes or contributions of each commodity in the context of the agricultural sector in the region.

According to Lindén et al., (2021), the Composite Index (CI) is a mathematical aggregation of several different indicators, which aims to provide an overall picture of a complex social phenomenon or problem. By combining various variables, CI can assess and evaluate alternative performance in a multidimensional context. Meanwhile, according to Silalahi (2015), the index is a combination of various items into a single numerical score.

The calculation on the Composite Index uses the following formula (Muta'ali, 2015):

$$CI = \frac{X_1 + X_2 + X_3 + X_4}{n}$$

CI is calculated by summing the values of four main indicators, namely Sectoral Contribution Index (X1), Growth Ratio Model (X2), Location Quotient (X3), and Dynamic Location Quotient (X4), then dividing by the number of indicators used (n). Thus, the CI value will provide an overview of the contribution of the agricultural sector or sub-sector of food crops in a region, based on the results of the analysis of

these various indicators. This composite index integrates various aspects, including sector contributions, growth ratios, comparative advantages of location, as well as dynamics of change, to produce a single number that can be used for evaluation or comparison between regions.

Hot Spot (Getis-Ord Gi*)

One of the GIS-based spatial pattern analysis methods is Hot Spot (Getis-Ord Gi*). Hot Spot Analysis (Getis-Ord Gi*) is a GIS-based spatial statistical analysis used to determine spatial distribution patterns (Kurniawan & Sadali, 2015). The results of data processing with Hot Spot analysis (Getis-Ord Gi*) are determined based on the Z-Score value, which is the standard deviation value, while the p-value is the degree of confidence or probability. Hotspot analysis using the Getis-Ord Gi* method in geographic information systems (GIS) is an effective technique to visualize and analyze the distribution of key commodities that have been identified through previous calculations, such as Location Quotient (LQ), Diversified Location Quotient (DLQ), and Growth Ratio Model (GRM). This approach is able to reveal spatial spreads and high or low concentrations of values in a wide range of data, providing important insights for planning and decision-making in related sectors. Mathematically, the formula for Hot Spot analysis (Getis-Ord Gi*) is:

$$Gi^* = \frac{X_i - \bar{X}}{SD^{'}}$$

Gi* is calculated by subtracting the value of commodity production in each sub-district (Xi) from the average value of commodity production ($\bar{X}$) in all sub-districts in 2023, then dividing it by the standard deviation (SD) of the value of commodity production in all sub-districts during the period 2018-2023. Thus, Gi* provides information about how much deviation the production of a commodity in a given sub-district is compared to the average production of a commodity in all sub-districts. If the Gi* value is higher than 1, it indicates a high concentration of production (hot spots) in the region, while a lower Gi* value indicates a low or less significant concentration of production. This method is useful in identifying areas that have great potential or shortages in the production of certain commodities.

According to Wibowo et al., (2015), the characteristics of GIS, are as follows: With GIS it will be easier to see earth phenomena with a better perspective. GIS is able to accommodate the storage, processing, and broadcasting of digital spatial data and even the integration of diverse data, ranging from satellite imagery, aerial photographs, maps, and even statistical data.

RESULT AND DISCUSSION

Sectoral Contribution Index (SCI)

Bunga Raya District in Siak Regency is recognized as a key rice-producing area in Riau Province. The contribution of each village to rice production in this district shows considerable variation, influenced by differences in agricultural capacity, resource management, and cultivation practices.

The table below illustrates the average SCI for each village over the period from 2018 to 2023. This data underscores the significance of each village in rice production and sheds light on the regions that make the most substantial contributions to the district's overall rice output.

Table 1.   Average Sectoral Contribution Index to Rice Crop Commodities in Bunga Raya District, Siak Regency, in 2018 – 2023.

No	Village	Sectoral Contribution Index
1	Bungaraya	0.23
2	Kemuning Muda	0.23
3	Tuah Indrapura	0.17
4	Buantan Lestari	0.10
5	Jayapura	0.15
6	Jatibaru	0.04
7	Langsat Permai	0.06
8	Dayang Suri	0.02
9	Temusai	0.01
10	Suak Merambai	0.00

Bungaraya Village and Kemuning Muda Village in Bunga Raya District were designated as villages with significant contributions to rice commodities in the area, although the exact contribution figures may require further data. Previous reports showed that the two villages had a role in GKP rice production with total production of 2,689.07 tonnes and 2,723.56 tonnes, respectively, during the relevant period (Adha et al., 2024) The total rice production harvested in Bunga Raya District is reported to be around 11,816.77 tons. This shows the important role of these villages in agricultural products (Yusuf et al., 2019).

Factors that affect agricultural productivity, including rice, such as geographical conditions and the use of post-harvest processing technology. This has been identified by previous research (Razali et al., 2024). For example, the importance of proper rice processing equipment to improve rice productivity and quality has been discussed (Razali et al., 2024). With the right development of agricultural technology, it is hoped that Bungaraya and Kemuning Muda Villages can continue to maintain and increase their production. In addition, efficiency in the rice supply chain can contribute to increasing farmers' income (Saptana & Suryani, 2019).

Growth Ratio Model (GRM)

Rice production performance in Bunga Raya District, Siak Regency, differs from one village to another, reflecting varying growth trends over the years. To evaluate the relative growth in rice commodity production for each village, the Average Growth Ratio Model (GRM) was applied. This model provides a measure of the average growth rate in each village compared to the overall growth rate across the district.

The table below presents the Average Growth Ratio Model for rice commodities in villages within Bunga Raya District during the 2018–2023 period. The

data identifies villages with higher or lower growth rates, offering valuable perspectives on the agricultural development patterns in the region.

Table 2.   Average Growth Ratio Model in Rice Crop Commodities in Bunga Raya District, Siak Regency, in 2018 – 2023.

No	Village	Average MRP
1	Bungaraya	0.7
2	Kemuning Muda	0.9
3	Tuah Indrapura	-0.4
4	Buantan Lestari	0.3
5	Jayapura	-0.5
6	Jatibaru	-2.4
7	Langsat Permai	-1.5
8	Dayang Suri	0.5
9	Temusai	1.0
10	Suak Merambai	0.0

Temusai Village emerged as the village with the highest growth rate in rice production in Bunga Raya District, Siak Regency, with a growth ratio value that shows that during the period 2018 to 2023, rice production in this village grew faster compared to other villages in the district (Siswanto et al., 2018). Throughout these years, despite fluctuations, GKP rice production in Temusai experienced an increasing trend, although specific data on the annual production tonnage needed to be obtained from valid sources.

Rice production data collected from Temusai Village showed a positive performance, despite the decline in production in 2021 and 2023, which may have been influenced by external factors such as weather and agricultural policies that impacted crop sustainability (Ilyas et al., 2020) and in his research also discusses the factors that affect the availability of rice in Indonesia, emphasizing the importance of stability in production to achieve sustainability (Ilyas et al., 2020).

Location Quotient (LQ)

The Location Quotient (LQ) serves as a method to identify the comparative advantage of rice production in each village within Bunga Raya District, Siak Regency. This measure determines whether a village specializes in rice cultivation compared to the overall production pattern in the district. Villages with an LQ value above 1 are categorized as "basis" areas, signifying that their production exceeds local needs and can potentially support other regions. On the other hand, villages with an LQ value below 1 are labeled as "non-basis" areas, indicating that their production is insufficient to meet local demands.

The following table provides the average LQ values for rice commodities across villages in Bunga Raya District from 2018 to 2023. The results identify villages with a comparative advantage and highlight their contributions to the district's overall rice production.

Table 3. Average Location Quotient on Rice Crop Commodities in Bunga District, Siak Regency in, 2018 – 2023.

No	Village	LQ	Information
1	Bungaraya	0.99	NON BASIS
2	Kemuning Muda	0.99	NON BASIS
3	Tuah Indrapura	1.04	BASIS
4	Buantan Lestari	1.03	BASIS
5	Jayapura	1.02	BASIS
6	Jatibaru	1.04	BASIS
7	Langsat Permai	0.96	NON BASIS
8	Dayang Suri	0.83	NON BASIS
9	Temusai	0.07	NON BASIS
10	Suak Merambai	0.00	NON BASIS

There are 4 villages that have an average LQ value of > 1 on rice commodities, namely Tuah Indra Village (1.04), Buantan Lestari Village (1.03), Jayapura Village (1.02), and Jatibaru Village (1.04). The four villages have a comparative advantage, where the results can not only meet the needs in their area but can also be exported to other villages. According to Anto et al (2024), if LQ >1, then the village has abundant resources that can meet the needs of the area itself and even outside the area.

Dynamic Location Quotient (DLQ)

The Dynamic Location Quotient (DLQ) is an analytical tool used to assess the growth potential and development prospects of rice crop commodities in specific regions over a given period. Unlike the static LQ, which evaluates specialization at a single point in time, the DLQ focuses on changes over time, providing insight into whether a region's economic focus on a particular sector is strengthening or weakening.

In Bunga Raya District, Siak Regency, villages with a DLQ value exceeding 1 are identified as having strong growth potential in rice production and promising prospects for future development. Conversely, villages with a DLQ value below 1 may indicate a reduction in specialization or face challenges in maintaining or expanding their rice production capabilities.

The table below presents the average DLQ values for rice commodities in the villages of Bunga Raya District during the 2018–2023 period. This evaluation highlights areas with significant potential for further growth in rice production.

Table 4.   Average Dynamic Location Quotient on Rice Crop Commodities in Bunga
Raya District 2018 – 2023

No	Village	Average DLQ
1	Bungaraya	1.02
2	Kemuning Muda	1.05
3	Tuah Indrapura	1.01
4	Buantan Lestari	1.03
5	Jayapura	1.01
6	Jatibaru	-0.06
7	Langsat Permai	0.00
8	Dayang Suri	-0.01
9	Temusai	-0.22
10	Suak Merambai	0.00

There are 5 villages that have an average DLQ value of > 1 in rice commodities, namely Bungaraya (1.02), Kemuning Muda (1.05), Tuah Indrapura (1.01), Buantan Lestari (1.03), and Jayapura Village (1.01). The five villages show that rice commodities in the region have the potential to be developed or are prospective. In addition, according to research conducted by Jauhari (2020), the criterion DLQ >1 has criteria to be used as a leading region in economic development efforts with the development of rice commodities in the future because the specialization value is the highest.

Composite Index (CI)

The IC score is obtained by scaling each analysis method (SCI, GRM, LQ, DLQ) and calculating the average to produce the IK score. These composite metrics offer a more holistic view of each village's involvement and capacity in rice production. Research on productivity growth and its factors shows that indicators such as location, size, and sectoral contribution are crucial in understanding the dynamics of food production in the affected areas (Liu et al., 2020).

The table below presents the scale values for each indicator and the Composite index score for villages in Buantan Lestari District from 2018 to 2023. This composite score is then grouped into five categories, namely: very low, low, medium, high, and very high. To identify villages with scattered potential for further expansion of paai production. This is in line with findings that the identification and measurement of relevant agricultural variables can support risk analysis and data-driven decision-making (Njuki et al., 2018).

Table 5. Scaling SCI, GRM, LQ, DLQ & Composite Index Assessment on Rice Commodities in Buantan Lestasi District, Siak Regency.

Village	SCI	GRM	LQ	DLQ	Skala IKS	Skala MRP	Skala LQ	Skala DLQ	IK
Bungaraya	0.23	0.68	0.99	1.00	99.59	90.02	95.16	100	96.19
Kemuning Muda	0.23	0.86	0.99	1.00	100	95.29	95.21	100	97.62
Tuah Indrapura	0.17	-0.40	1.04	1.00	73.14	58.55	99.34	100	82.76
Buantan Lestari	0.10	0.29	1.03	1.00	44.02	78.56	99.11	100	80.42
Jayapura	0.15	-0.49	1.02	1.00	62.59	55.93	98.28	100	79.20
Jatibaru	0.04	-2.40	1.04	-0.06	17.16	0.00	100	13.33	32.62
Langsat Permai	0.06	-1.53	0.96	0.00	22.95	25.43	91.25	18.24	39.47
Dayang Suri	0.02	0.47	0.83	-0.01	4.44	83.73	78.65	17.59	46.10
Temusai	0.01	1.03	0.07	-0.22	0.00	100	0.00	0.00	25.00
Suak Merambai	0.00	0.00	0.00	0.00	-2.99	70.09	-6.67	18.26	19.67

Table 6. Classification of Composite Index in the Rice Subsector in Bunga Raya District, Siak Regency.

No	Village	IK	Information	Symbol
1	Bungaraya	96.2	Very High	🟩
2	Kemuning Muda	97.6		
3	Tuah Indrapura	82.8	High	🟩
4	Buantan Lestari	80.4		
5	Jayapura	79.2		
6	Jatibaru	32.6	Very Low	🟥
7	Langsat Permai	39.5	Low	🟨
8	Dayang Suri	46.1		
9	Temusai	25.0	Very Low	🟥
10	Suak Merambai	19.7		

After all villages in Bunga Raya District, Siak Regency are classified, then visualized on a map, so that the distribution of superior production can be seen. The determination of the superior area of the food crop sub-sector, namely rice, can be seen in the Figure 2.
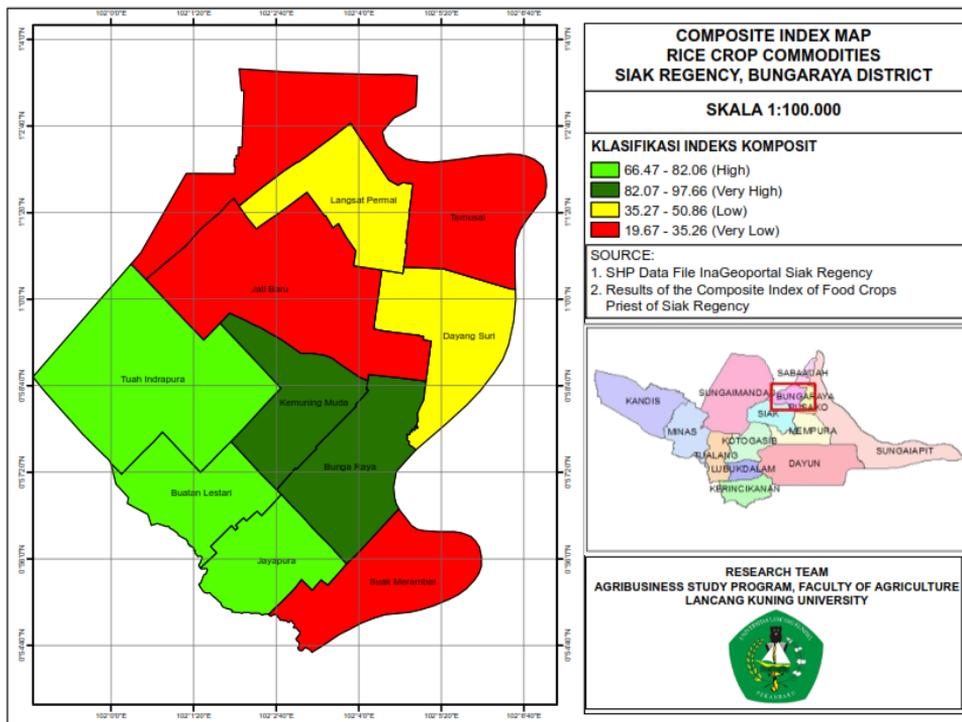
Figure 2.
Classification Map of Rice Crop Commodity in Bungaraya District

The leading areas of rice commodities with a very high category are Kemuning Muda Village and Bunga Raya Village. The high categories are Buantan Lestari Village, Jayapura Village, and Tuah Indrapura Village. The low category is Langsat Permai Village and Dayang Suri Village. The very low categories are Suak Merambai Village, Temusai Village, and Jati Baru Village.

CONCLUSION

Based on the explanation above, it was obtained that the agricultural landscape of rice crop commodities in Siak Regency, precisely in Bunga Raya District, which is the district that produces the largest rice crop in Siak Regency, shows various contributions to rice production, which is characterized by a very significant gap between villages. Using analytical approaches such as the Sectoral Contribution Index (SCI), Average Growth Ratio Model (GRP), Location Quotient (LQ), Dynamic Location Quotient (DLQ), and Composite Index, this study identified that some villages are the main contributors to rice production while others have difficulty in meeting existing production requirements.

The Sectoral Contribution Index (SCI) measures the percentage of rice production that comes from each village, which shows that Bungaraya Village and Kemuning Muda Village are the main contributors to rice production in Bunga Raya District. Each village is responsible for 23% of the total rice production in Siak

Regency, with a contribution of 2,689.07 tons from Bungaraya Village and 2,723.56 tons from Kemuning Muda Village. The total rice production of Bunga Raya Regency was recorded at 11,816.77 tons, which shows the important role of the two villages in producing local rice.

The Average Growth Ratio (GRP) model shows that Bungaraya Village and Kemuning Muda Village can maintain a stable production level. Temusai Village recorded the highest growth rate with a ratio of 1.0. This reflects the trend of increasing rice production even though the village has faced challenges in recent years. These fluctuations in production are likely influenced by external factors, such as changing climatic conditions and the impact of policies related to sustainable agriculture. These findings highlight the importance of the complex relationship between environmental factors and agricultural performance, which can affect the productivity and resilience of the agricultural sector at the village level.

The Location Quotient (LQ) analysis further revealed the comparative advantages in rice production in each village. Villages such as Tuah Indrapura, Buantan Lestari, Jayapura, and Jatibaru recorded LQ values greater than 1, indicating that these villages are not only able to meet local needs but also able to supply rice outside their area. This assessment illustrates the different patterns of specialization between each of these regions, which can be used as a basis for formulating more targeted and specific agricultural policies and interventions. These findings provide important insights for designing resource management modeling strategies that support comparative advantage and strengthen rice production resilience in the region.

On the other hand, the Dynamic Location Quotient (DLQ) analysis allows the evaluation of spark plug content from time to time, identifying villages such as Bungaraya and Kemuning Muda Villages as areas with stable growth potential, because the DLQ value is greater than 1. These findings are in line with the existing literature, which suggests the importance of strategic development in areas that have the potential for sustainable growth through the specialization of their agriculture. On the other hand, the fluctuations observed in other villages such as Jatibaru and Temusai suggest that these areas may benefit from improved agricultural support mechanisms, including more supportive policies and strengthening of agricultural systems that are adaptive to changing external conditions.

The Composite Index comprehensively further synthesizes previous analyses into overall performance metrics, allowing for a clear categorization of villages into color forms. This categorization not only serves to highlight high-performing villages, such as Kemuning Muda and Bungaraya, but also identifies underdeveloped villages, such as Suak Merambai and Temusai, thus providing a basis for targeted investment and development initiatives. The mapping of these results visually underlines the spatial distribution of agricultural capabilities throughout Siak Regency.

Finally, the various contributions to rice production in Bunga Raya District explain the complex agricultural conditions and the potential for growth in all villages. Using a combination of analytical metrics, clear patterns emerge that can inform regional development strategies aimed at improving the agricultural economy.

AUTHOR CONTRIBUTION STATEMENT

[Author 1]: research design, data collection, the initial manuscript draft; [Author 2]: research supervision, analytical guidance, edited the manuscript; [Author 3]: research conceptualization, data analysis, addressed reviewers' comments. All authors reviewed and approved the final version of the article.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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ETHIC STATEMENT

Ethical review and approval were waived for this study as it did not involve any intervention and posed minimal risk to participants. Nevertheless, informed consent was obtained from all respondents prior to participation, and all data were anonymized and kept confidential.

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