

## **Clustering Analysis of Plantation-Potential Area in South Kalimantan Province, Indonesia**

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**Abstract:** *There is a strong role of natural resources in driving the economy of South Kalimantan Province, namely mining-quarrying and agriculture. But in 2016-2021 South Kalimantan Province's Regional Medium-Term Development Plan (Rencana Pembangunan Jangka Menengah Daerah-RPJMD) shows that the government prioritizes the development of agriculture and agro-industry rather than mining. More specifically the agricultural sub-sector is the plantation, which has direct linkage with agro-industry. This study aims to identify the potential of the South Kalimantan region according to the regency/ municipality, so there will be identified as superior and unseeded areas in cultivating the plantation subsector. The next objective is to detect whether there is a business agglomeration in the plantation subsector in South Kalimantan..*

*This research uses cluster determinant variables, namely variable production of plantations, farmers, height of land, fertile land, and contribution of plantations in GRDP. Cluster analysis with non-hierarchical methods resulted in 3 (three) clusters. The first cluster was characterized as a non-superior area of plantation, consisting of Barito Kuala, Tapin, HSS, HSU, Banjarmasin and Banjarbaru Regencies. Cluster 2 is a superior plantation area, consisting of Kotabaru Regency and Tanah Bumbu. Cluster 3 is a potential plantation area, consisting of Tanah Laut, Banjar, HST, Tabalong and Balangan Regencies.*

**Keywords:** *Clustering Analysis, Plantation subsector, potential plantation area, superior plantation area.*

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### **I. Introduction**

Development is a multidimensional process that includes a variety of fundamental changes to social structure, attitudes of the community and national institutions to move forward towards a better living condition both materially and spiritually. While the purpose of its own development is to increase the availability of basic needs such as clothing, food, house, health, and security protection. Development also aims to improve decent living standards and expand economic and social choices (Todaro and Smith, 2011: 26-29).

The process of development depends on various factors such as natural resources, human resources, capital formation, technology, social systems and attitudes of the community. The availability of natural resources is often used as a force in building a region, especially in newly established regions or in developing countries.

Indonesia as a developing country, is still dependent on natural resources. Natural resources for Indonesia can become a capital in building Indonesia to become more prosperous. The wealth of Indonesia's natural resources that have been managed is also reflected in the economic structure of Indonesia. In 2017 BPS-Statistics Indonesia recorded more than one-fifth of Indonesia's Gross Domestic Product (GDP) contributed by the agricultural and mining sectors, two sectors that directly exploit Indonesia's natural wealth.

This condition was not much different from the province of South Kalimantan, even with greater contributions. 35 percent or more than one third of the total value added of all economic activities in South Kalimantan in 2017 was formed by the agriculture and mining sectors. Both of these sectors as well as the main sector as the biggest contributor to the economic performance of the Province. This condition places South Kalimantan as an agricultural area and at the same time as a coal producer area.

However, South Kalimantan Provincial Government prioritizes sustainability such as agriculture and its agro-industry and tourism sector rather than develops mining. This is reflected in the 2016-2021 Regional Medium-Term Development Plan Document in the 5th Mission, which is to develop regional economic competitiveness based on local resources. The goal of this mission is the realization of self-sufficiency and the contribution of the agricultural sector by developing agro-industry (Provincial Government of South Kalimantan, 2016).

Agro-industry associates with plantation production, which has become the belle of the people of South Kalimantan recently. Those background illustrates that agriculture in the plantation subsector in particular has

an important role in the economy of South Kalimantan. Therefore this research will take the agricultural potential of the plantation subsector up.

Specifically there are three important reasons to discuss this plantation subsector. First, the share of South Kalimantan's agricultural sector GDP is very large. Its contribution is the second largest after food crop agriculture. Secondly, smallholder households increased considerably, as indicated by the growth of plantation farmer households which reached 18 percent. The plantation sector along with the agricultural services subsector are sub-sectors whose numbers have increased based on the results of the 2003 Indonesian Agricultural Census (ST2003) and 2013 (ST2013) conducted by the BPS-Statistics Indonesia. While other sub-sectors experienced negative growth. Third, plantation commodities have a large linkage to the industry. This is in the line with South Kalimantan's development priorities towards agriculture with its agro-industry.

The potential of this plantation is certainly spread in the regency/municipality area. The important thing to do is how to find out the distribution of this potential throughout the South Kalimantan region. By looking at the potential distribution and spatial analysis, policies and programs can be carried out effectively and efficiently. There are various variables that can be used to see the potential and superiority of a region's plantations. However, the research was limited to five selected variables based on the urgency, availability of data and references obtained, namely plantation production, the number of households engaged in the plantation subsector, height of land, fertile land, and contribution of the plantation subsector in GRDP.

Thus, this study aims to identify which areas in the South Kalimantan region are superior and have not excelled in cultivating the plantation subsector according to districts / municipalities. This study will also detect whether the business agglomeration of the plantation sub-sector is occurring in the South Kalimantan region.

## **II. Methods**

### **Research Time and Place**

This research was conducted from May 2018 to October 2018, which was carried out on all districts / municipalities in South Kalimantan.

### **Type and Data Sources**

The data used in this study is the cross section data in 2017 for all cluster determinants, except for the farmer variable that uses data from the 2013 Indonesian Agriculture Census. This is due to the unavailability of the number of households that labor in the latest plantation subsector. Plantation production data comes from the Plantation and Livestock Service Office of South Kalimantan Province, through South Kalimantan Publication in Figures 2018. Data on land height and fertile land are obtained from the National Land Agency, also through South Kalimantan Publication in Figures 2018. While plantation contributions in GRDP and total farmer households is from BPS-Statistics Indonesia.

### **Research Variables**

The variables used in this study were the amount of plantation production (tons), farmers who labor on plantations (households), high land above 100 masl (percent), fertile land (percent), and plantation contributions in GRDP (percent). All of these variables become determinants in forming clusters.

### **Data Analysis**

This study uses cluster analysis. Cluster analysis is a multivariate technique that has the main purpose of classifying objects based on their characteristics. Cluster analysis classifies objects so that each object closest to other objects is in the same cluster. The formed clusters have high internal homogeneity and high external heterogeneity.

The most common methods in cluster algorithms is hierarchical methods and non-hierarchical methods. Determining which method to use depends on the researcher and the research context without ignoring the substance, theories and concepts that apply. Both methods have their own advantages. The advantage of the hierarchical method is that it is fast processing, but this method could cause errors and not recommended to analyze large size samples. While non-hierarchical methods have more advantages than the hierarchical method. But the outlier data, the size of the distance used, and irrelevant variables are affecting the analysis result.

This study uses a non-hierarchical method by considering the purpose of the study to get at least one area that will be identified as a superior plantation area, not a superior area for plantations and areas with the potential to develop the plantation subsector.

Furthermore, this research will classify regency/city based on cluster determinants that have been determined using the K-Means algorithm. The k-means algorithm is an algorithm used for iterative grouping, this algorithm partitions the data set into a number of K clusters that have been set at the beginning. The data set partition is carried out to determine the characteristics of each cluster, so that clusters that have the same

characteristics are grouped into one cluster and that have different characteristics grouped into other clusters (Citradevi and Geetharamani, 2012)

The calculation steps in k-means are:

1. Determine the number of clusters and the threshold for changing objective functions.
2. Determine the initial centroid used
3. Calculate the distance of each data to each centroid using the euclidean distance to get the closest distance to the data with the centroid
4. Determine the new centroid by calculating the average value of the data in the same centroid
5. Repeat step 3 and step 4 until the convergent conditions are reached, ie changes in objective functions are below the desired threshold, or there is no data that moves clusters, or changes in centroid position are below the specified threshold.

After calculating the distance from each data to the centroid, then the smallest distance is chosen or that approaches the value of 0 as the cluster that will be followed as the relocation of data to the cluster in an iteration. Relocation of a data in a cluster that is followed can be expressed with a membership value of a value of 0 or 1. A value of 0 if it is not a member of a cluster and 1 if it is a member of a cluster. K-means classifies data explicitly in only one cluster, then there is only one value of a data in all clusters which has value 1. Calculation of distance between data and centroid can be done using the euclidean distance equation, the equation is as follows

$$d(x_i, x_j) = \sqrt{(|x_{i1} - x_{j1}|^2 + |x_{i2} - x_{j2}|^2 + \dots + |x_{ip} - x_{jp}|^2)}$$

$x_i, x_j$  is the two data that the distance will be calculated and  $p$  is the dimension of the data used. Determination of cluster center points can be seen from the equation below:

$$C_{m(q)} = \frac{1}{n_m} \sum_{i=1}^{n_m} x_i(q)$$

$c_{m(q)}$ : center of the group- $m$  variable- $p$

$m$  : 1, 2, ...,  $k$

$n_m$  : Number of object in group- $m$

$k$  : Number of cluster

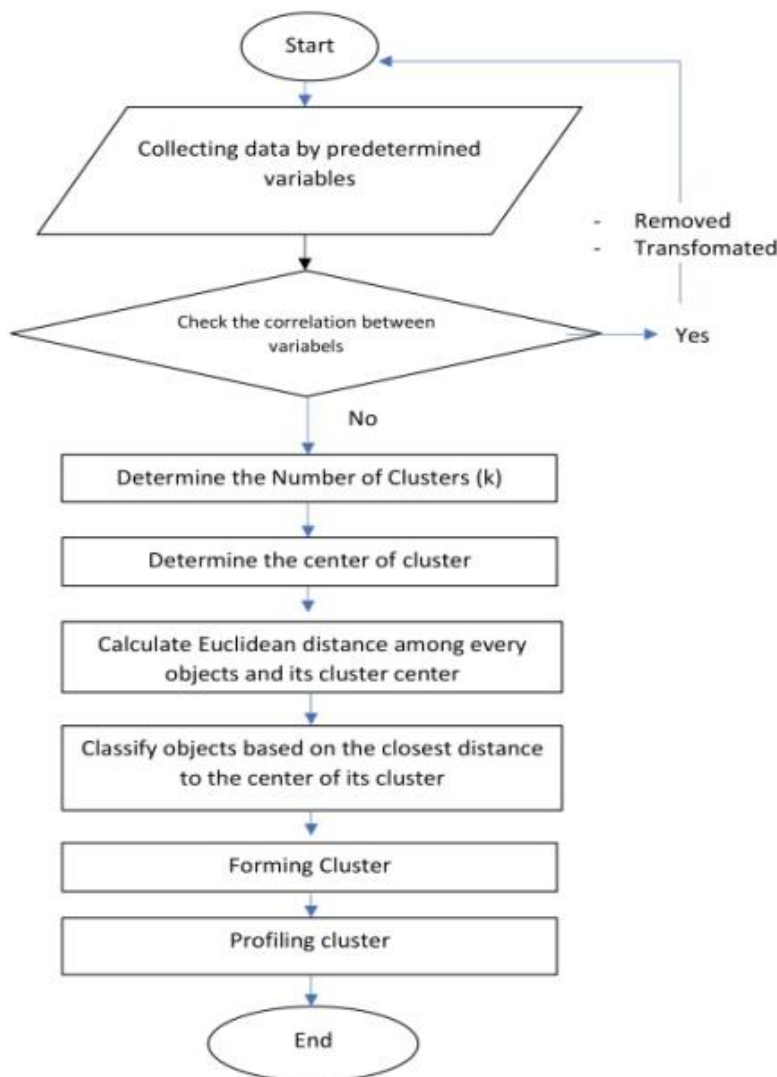
$q$  : 1, 2, ...,  $p$

$x_i$  : Value of object- $i$ variable- $q$

$i$  : 1, 2, ...,  $n_m$

The steps for clustering analysis with the *k-means* algorithm in this study as below:

**Figure1.**  
**Clustering Analysis Flowchart with k-means algorithm**



### III. Result And Discussion

#### General Information of South Kalimantan Province

South Kalimantan is one of the provinces in Indonesia which is located in the southeastern part of Kalimantan Island. It has a low land in the west and east coast, and a high plateau in the middle. The total area of South Kalimantan Province is 37,530.52 square kilometers. This province consists of 11 regency and 3 municipalities. About 30.90 percent of land in South Kalimantan is alluvial and the other part is swamp / peat land located along the watershed.

The geographical conditions, climate, and favorable weather, make 3,989,793 people in South Kalimantan, 36.01 percent work in the agricultural sector. Even though South Kalimantan Province actually has other potential, if seen from the GRDP share, which is almost 30 percent of all South Kalimantan's GRDP, the mining sector is not the main priority of the government's development. This is because the South Kalimantan Provincial Government considers mining to have a long-term negative impact on the geographical conditions of South Kalimantan. In addition, the Provincial Government of South Kalimantan also prioritizes sustainability. BPS-Statistics Indonesia data in 2015, showed that the growth rate of this sector has decreased. It means that mining and quarrying sector will eventually run out of deposits because the natural resources in this sector are not sustainable. So that government chooses to give more attention to the agricultural sector as outlined in the 2016-2021 Medium Term Development Plan Document by making efforts to realize the independence and contribution of the agricultural sector by developing agro-industry.

In 2015, the agricultural food subsector experienced a production increase of 45,583 tons or 2.18 percent. This increase occurs because the planting area increases but productivity decreases compared to the previous year (BPS, 2015).

In addition to the food crop subsector, the plantation subsector was the sub-sector with the second largest contribution to rubber and oil palm as plantation crops that had the potential to dominate, namely production of 1,220,186 tons and 181,785 tons in 2015. Those products can become superior commodities if the processing is carried out appropriately. Plantation commodities have a close linkage to the industry and have the potential to bring South Kalimantan towards agro-industry.

**Variable Correlation Assumptions Checking**

Before analyzing the variables, it is necessary to examine the correlation between the variables that are used as determinants of the cluster. Cluster analysis requires no correlation between cluster determinants. The occurrence of multicollinearity can be detected through the results of VIF (Variance Influenced Factor) and tolerance values. VIF is a variant value that is influenced by other factors which means that it is influenced by other variables. The tolerance value must be greater than 0.1 and the VIF value must be less than 10, because multicollinearity has occurred if the value is above 10. The results of processing data can be seen in the following table:

**Table 1.**  
Tolerance Value and VIF Cluster Determining Variables

Variables	Colinearity Statistics	
	Tolerance	VIF
Production	0,299	3,341
Farmers	0,183	5,476
Altitude	0,150	6,681
Fertile Land	0,877	1,141
Plantation Contributions in GRDP	0,192	5,206

Source: processed data

All variables have tolerance values above 0.1 and VIF values below 10. It shows that the variables of production, farmers, land height, fertile land, and plantation contributions in GRDP are not significantly correlated. Thus these five variables can be used in the subsequent cluster analysis as a determinant of cluster formation.

**Formed Cluster**

**Table 2.**  
Member and Cluster Number by Type Formed

Cluster	Number of Member	Areas	Profile
1	6	Barito Kuala, Tapin, HSS, HSU, Banjarmasin, Banjarbaru	Not Superior Plantation
2	2	Kotabaru, Tanah Bumbu	Superior Plantation
3	5	Tanah Laut, Banjar, HST, Tabalong, Balangan	Potential Plantation Areas

Source: processed data

By using the non-hierarchical cluster method, 3 (three) clusters are formed with their respective members. These three clusters have certain characteristics. **Cluster 1** can be expressed as a non-superior area of plantation, consists of 6 (six) regencies/ municipalities, namely Barito Kuala, Tapin, Hulu Sungai Selatan, Hulu Sungai Utara, Banjarmasin Municipality and Banjarbaru Municipality. It is called not a superior plantation area because plantation production is the lowest, the number of households that cultivate plantations is the least, the topography of the area does not support plantations (lowland and not suitable for plantations), the contribution in the GRDP is the smallest.

On the contrary **Cluster 2** is a superior plantation area, consist of two regenciesnamely Kotabaru and Tanah Bumbu. The superiority of this region is because they are the highest plantation production, the highest plantation productivity, and have the most extensive arable land for agriculture, and the highest contribution of plantations in GRDP.

**Cluster 3** consists of Tanah Laut, Hulu Sungai Tengah and Balangan. These three regenciesare very potential areas for plantation development due to natural topography that supports plantations (altitude and land fertility) as in cluster 2 and the number of farmers is greater than cluster 2, but the production and contribution of plantations in GRDP is still below cluster 2 .

**Inter-cluster Difference**

There is one statistical test on the average value of the cluster determinant variables between the formed clusters. This test result can give a general information of a statistical difference, but the results do not invalidate variables that are not significant. The reason is that the variables entered in theory are appropriate and have passed a series of assumption tests. This test is based on the Anova table, as is the average test for some other numerical variables.

**Table 3.**  
ANOVA Tables

Variabel*	Means Square		Nilai F	Nilai P
	Cluster	Error		
Produksi	4,687	0,263	17,842	0,001
Petani	4,527	0,295	15,360	0,001
Ketinggian Lahan	4,013	0,397	10,098	0,004
Lahan Subur	0,784	1,043	0,752	0,497
Share Perkebunan dalam PDRB	5,001	0,200	25,026	0,000

\*in a z-score (standardized)

Source: processed data

The greater the F value of a cluster determinant variable shows the greater the variable difference in the three clusters formed. The processing output shows that the production, farmer, altitude, and plantation contribution in the GRDP are significantly different between clusters (p value is smaller than 5%). While fertile land, although not statistically significant, can still be included in the cluster analysis, because the significance is only to describe the differences between clusters according to variables, not to abort variables.

**Table 4.**  
Average Variable Value Between Clusters

Variables (unit)	Cluster		
	1 (Not Superior)	2 (Superior)	3 (Potential)
Production (ton)	26.494	521.876	84.900
Farmers (household)	6.668	17.745	24.145
Altitude > 100 masl (percentage)	6,28	27,59	39,39
Fertile land (percentage)	25,40	56,08	33,12
Plantation contribution in the GRDP (percentage)	1,25	8,15	4,31

Source: processed data

There are three highest values of the average cluster determinant variable in cluster 2 as the superior area. These variables are plantation production, fertile land area, and plantation contribution in GRDP. The average cluster 2 plantation production is 521 thousand tons in 2017 per regions. It shows a very large number compared to other clusters which are 26.5 thousand tons in cluster 1 and 84.9 thousand tons in cluster 2. The percentage of the area of fertile land owned also outperforms other clusters. More than half of the areas in each regencies in Cluster 2 are very suitable for cultivating plantation crops. Contrary, the area in cluster 1 is only a quarter of the total area. The same thing also happened to the contribution of plantations to total GRDP. The average plantation subsector contributes around 8.15 percent to GDP in 2017. Much higher than other clusters.

While the potential areas of plantations has greater value in the number of farmers and land area with altitudes above 100 meters above sea level. The average number of farmers in cluster 3 is 24 thousand households, greater than cluster 1 which is only 17 thousand households, but has lower production than cluster 1, indicating that the productivity of cluster 3 is still lower than the other cluster. It strengthens that the regions in cluster 3 are potential plantation areas that can be developed. Moreover, the topography of the land above 100 masl in this cluster area is also greater than the other. On average 39 percent of the district in this cluster has altitudes above 100 meters above sea level.

In cluster 1, which is identified as a non-superior plantation area, it does not have an advantage in any variable. The average value of the five determinant variables used is recorded as the smallest. Areas that are dominated by low and watery areas such as in Barito Kuala Regency, Hulu Sungai Utara and Banjarmasin

cannot be planted plantation commodities. Some areas that are low in Barito Kuala Regency can still be planted with certain commodities such as Oil Palm, even though oil palm grows well at an altitude of 400-600 masl. While other agricultural commodities needs altitudes above 100 masl for planting. Economic structure in 6 (six) districts cluster 1 also does not rely on plantations. Banjarmasin and Banjarbaru are engaged in the services sector, Barito Kuala, Tapin, Hulu Sungai Selatan and Hulu Sungai Utara districts are driven by food crop agriculture.

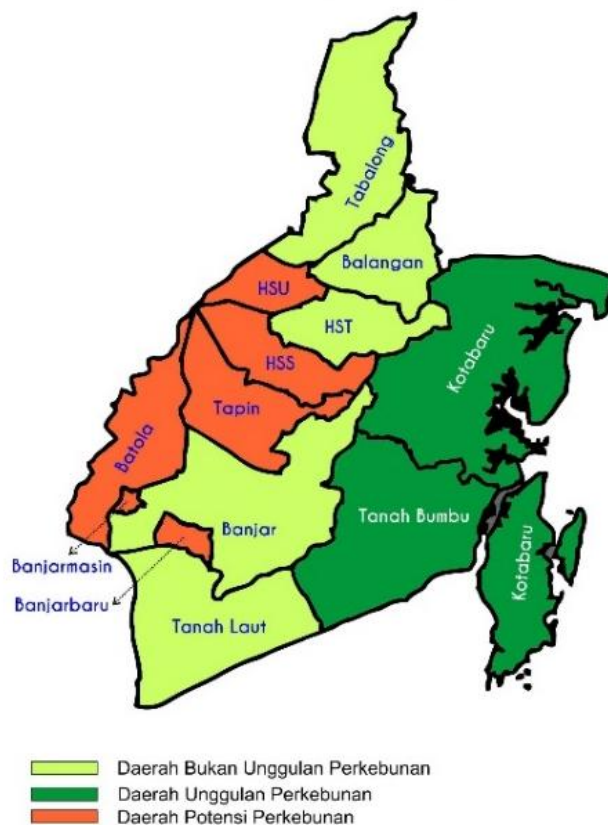
### **Plantation Agglomeration**

Agglomeration can be interpreted as centralizing or grouping several elements. Agglomeration in a common refers to industrial agglomeration which means centralization of industry in a particular area to optimize the management. By referring to this term, plantation agglomeration can be interpreted as concentration of plantation business in a particular area to optimize the management. This study, focused on regencies/ municipalities as the area.

Based on the cluster formed, the superior areas of the plantation are Tanah Bumbu Regency and Kotabaru Regency. Geographically, the two districts bordered on each other. Thus, it can be concluded that there has been centralization or agglomeration of superior plantations. By identifying the occurrence of agglomeration, government can develop supportive policies / programs. In fact, plantation products in South Kalimantan have not been fully processed as industrial raw materials. Palm oil in South Kalimantan is still processed into Crude Palm Oil (CPO) or still crude palm oil. Likewise, rubber products are still processed into crumb rubber products. Derivative products from crude palm oil and raw rubber can still be processed to become other finished goods. It is time for South Kalimantan to develop agro-industry as mandated from the South Kalimantan Government's Plan in 2016-2021.

While the districts identified as plantation potential areas can still be developed for plantation production. It is based on the availability of fertile land owned although the productivity of plantations is still low. So, it is important to increase the production. Tanah Laut Regency has a big opportunity to be a superior plantation area, because the area is directly adjacent to Tanah Bumbu Regency. In addition, the topography of the land such as altitude is almost similar to Tanah Bumbu and Kotabaru. The same thing also applies to some areas of Banjar Regency which borders Tanah Bumbu Regency and Tanah Laut Regency and has the potential to be planted with plantation crops.

**Figure 2.**  
**Cluster Distribution Map Formed according to Regional Geographies**



Kotabaru Regency and Tanah Bumbu Regency have a pattern of distribution of sub-districts according to the level of plantation production. The subdistrict area is classified into 3 (three):

1. Low for plantations which are less than 1,500 tons
2. Medium for the plantation production 1,500 to 5,000 tons
3. High for plantations which are above 5,000 tons

All sub-districts in Kotabaru Regency and Tanah Bumbu Regency produce plantation commodities which are both community crops and private and state plantation companies.

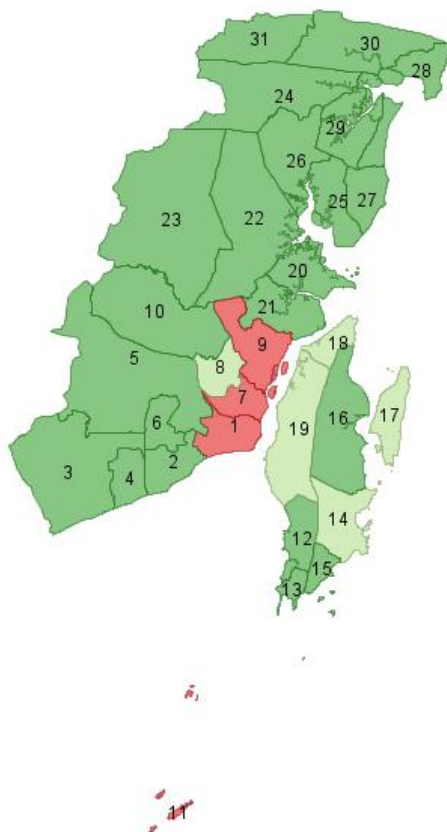
Production in Tanah Bumbu regency in the range of 408 tons (Batulicin sub-district) to 103.000 tons (Satui sub-district). Whereas in Kotabaru from 1,400 tons (Pulau Sembilan) to 72.000 tons (Kelumpang Selatan sub-districts). The high plantation production in Satui and Kelumpang Selatan Districts is because in these two sub-districts there are several national scale oil palm companies. They planted oil palm massively on a fairly extensive planting area.

Plantation production in Tanah Bumbu Regency in 2017 amounted to 331.000 tons. Most of them come from Kusan Hulu, Mantewe, Satui, Kuranji and Angsana sub-districts with production of each sub-district above 10,000 tons. Satui sub-district reached more than 103 tons. The five sub-districts look like they are clustered, because all of these sub-districts border each other. Thus, when viewed from the distribution pattern, it is clear that agglomeration is also formed at the sub-district level.

The agglomeration in sub-district level also happened in Kotabaru Regency. With a total production of more than 712.000 tons during 2017, most of them are located in sub-districts located on the island of Borneo. There are 12 sub-districts from 15 sub-districts including sub-districts classified as high production (production above 10,000 tons) located on the Borneo island. The sub-districts are South Kelumpang, Kelumpang Hilir, Kelumpang Hulu, Hampang, Durian, Central Kelumpang, West Kelumpang, North Kelumpang, South Pamukan, Sampanahan, North Pamukan, and West Pamukan. This distribution clearly shows that plantation agglomeration also occurs in Kotabaru District at the sub-district level.

Sub-district level agglomerations in each district, both in Kotabaru and Tanah Bumbu, also form larger agglomerations when those area are combined. It is because Mantewe sub-district in Tanah Bumbu Regency is directly bordered by Kelumpang Hulu sub-district and Hampang sub-district in Kotabaru Regency. These facts strengthen the occurrence of plantation agglomeration in the superior cluster of this plantation.

**Figure 3.**  
**Thematic Map of Plantation Production in Kotabaru and Tanah Bumbu Regency**  
**by the sub-district, 2017**







#### IV. Conclusions And Recommendations

##### Conclusion

1. By using a non-hierarchical cluster method, 3 (three) clusters are formed. These three clusters have certain characteristics; **Cluster 1** can be expressed as a non-superior area of plantation. **Cluster 2** is a superior plantation area consists of two regencies namely Kotabaru and Tanah Bumbu. **Cluster 3** formed consists of Tanah Laut, Hulu Sungai Tengah and Balangan Regency. These three districts are very potential areas for plantation development
2. The superior areas of the plantation are in the Tanah Bumbu and Kotabaru Regency. Geographically, these two regencies bordered on each other. Thus, it can be concluded that there has been centralization or agglomeration of superior plantations.
3. Plantation agglomeration has also been established in sub-district level both in Kotabaru and Tanah Bumbu Regencies. Agglomeration at this sub-district level when the area are combined, also forms larger agglomerations. It is because Mantewe sub-district in Tanah Bumbu Regency is directly bordered by Kelumpang Hulu sub-district and Hampang sub-district in Kotabaru Regency. These conditions strengthen the occurrence of plantation agglomeration in the superior cluster.

##### Suggestion

1. The role of the plantation subsector in the province of South Kalimantan are very wide open. There are at least five regencies that have great plantation potential, namely Tanah Laut, Banjar, Hulu Sungai Tengah, Balangan and Tabalong. There needs to be supported to be a superior area for plantations. The extent of available fertile land is very supportive for plantation crops to be developed. The private sector can take the role developing the plantation in Tanah Bumbu and Kotabaru Regency.
2. The results of this study have relevance to South Kalimantan Government's Plan in driving agro-industry. Government need to improve the facilities in the leading areas of plantations which are Tanah Bumbu and Kotabaru Regencies to support the agro-industry activities. The government can also take the role of a regulator who guarantees the ease of the investment. While the private sector can play a role in the construction of industrial plants made from plantation products. The existing companies can also add a variety of industrial products to increase product value added.

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