An Estimation Method for Oil Palm Replanting Potential in Kampar Regency, Province of Riau

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Abstract. Kampar regency is assumed to have a palm tree land as big as 14 thousand ha with more than 25-years-old plants. The no longer productive age of those plants should have gone through the rejuvenation process or known as replanting oil-palm potential (ROPP). In order to simplify ROPP inventory, research can be done using remote sensing technology and field verification to determine the oil palm age. The research result shows 647,290 ha oil palm field and 426,982 ha non-oil palm field. Beside that, it is known the width of private companies-owned oil palm field is 97,653 ha, and smallholder farmers-owned field with plant age < 25 years (SW2 = 66,866 ha), and > 25 years (SW3 = 482,770 ha). The potential smallholder farmers-owned width of oil palm replanting (ROPP) at Kampar regency is at around 7.05 thousand hectares.

Keywords: Rejuvenation, Oil Palm Age, Smallholder Farmers, Kampar

1. Introduction

Oil palm is a top garden plant that has become an excellent (called: primadonna) in Indonesia. In 2017, Public oil palm plantation had produced around 13.19 million tons and was predicted to rise in 2019 with productivity degree of 2,492 kg/ha [1]. That productivity value will not be accomplished if it is plagued by plant age entering unproductive phase.

Oil palm has a phase as a productive plant starting from 3 years old, it is often to produces maximum amount at 15 years old. According to [2], oil palm plant productivity in an optimal condition can produce 20-25 ton FFB/ha/year and will decrease until 17.50 ton FFB/ha/year from 16-25 years old plant. Therefore, a rejuvenation program is needed in order to keep the national palm oil production stabilized.

Kampar Regency has the width of oil palm land by 225,916 ha, or around 20% of the width of the regency [3]. It is assumed that more than 14 thousand ha among them are beyond 25 years old oil palm plants. Thus, there will be many farmer groups, especially from the public plantation that will propose an oil palm rejuvenation program.

| Plantation area by type of plant (ha) 2018 in Kampar Regency |
|-------------------------------------------------------------|
| Oil Palm | Coconut | Rubber | Coffee | Cocoa |
|----------|---------|--------|--------|-------|
| 225,916  | 1,716   | 89,930 | -      | 335   |

Speculation of replanting oil-palm potential (ROPP) can be done using remote sensing technology by doing data analysis from specific time and place with or without direct contact with reviewed object. Besides that, remote sensing technology that is connected with vegetation index analysis can provide data quickly, and relatively accurate depending on the data source [4]. In general, data that is used in the
The form of the digital image recorded with a non-camera censor such as satellite like SPOT 6 as well as unpaid satellite image with high spatial resolution like Google Earth. Nevertheless, the utilization of Google Earth. Has its own drawbacks because it is still not georeferenced because there is no metadata information regarding data acquisition, image accuracy, and the image is stored not in JPEG form [5].

The weaknesses of remote sensing technology must be anticipated by doing field verification. It acts as a reminder of how hard to determine oil palm plant by only looking at a satellite image. Plant age assumption is done based on color sighting and vegetation density from the satellite image. Therefore, field verification must be done until assumption formulation regarding plant age through satellite image is found.

The main purpose of this research is to produce a smallholder farmers-owned palm oil class map based on plant age for ROPP. Furthermore, this research will produce palm oil and non-palm oil maps, as well as data information of the width of private companies-owned oil palm land.

2. Materials and Methods

2.1. Research Location

The research location, Kampar Regency (Figure 1), is located between 01°00'40" North Latitude and 00°27'00" South Latitude and between 100°28'30" - 101°14'30" East Longitude. The Regency has 21 subdistricts with a total width of 11,289.28 km² or around 1,13 million ha [3].

![Figure 1. Research location in Kampar Regency, Province of Riau](image)

2.2. Research Materials and Methods

The material based on this research are administration spacial data and HGU bound in year of 2015 from BPN, SPOT 6's satellite image, and Basemap image, as well as other supporting data. This activity consists of three phases: 1.) Gather of secondary data, 2). while doing spatial analysis and image interpretation, 3). Field verification, and 4). Data management and forming oil palm class map.

The first phase is to collect the secondary data in the form of tabular data, spatial data, and other supporting data. Tabular data in the form of production data, productivity, and oil palm farmer group. While spacial data used are Business Use Right oil palm plantation limit spatial data or called "HGU (Hak Guna Usaha)" in Bahasa, from BPN, paddies/blocks of oil palm land (smallholder farmers-owned/Koperasi Unit Desa in Bahasa) and private companies-owned oil palm.

The second phase is performed spatial analysis and interpretation of high resolution satellite imagery on screen to determine the spread area of the oil palm and overlay with HGU boundary-spatial data and region status. This phase is done in order to interprate oil palm age based on ownership and age of the plant to: SW1 (private companies-owned oil palm field), SW2 (smallholder farmers-owned oil palm
field with plant age 0<25 years), SW3 (smallholder farmers-owned oil palm field with plant age >25 years) dan N (Not an oil palm field). There is also an output of this first phase in the form of ownership map and oil palm plant age that would turn into field verification source.

![Figure 2. Examples image of oil palm plantation (SW1, SW2 dan SW3) on satellite imagery](image)

The third phase is doing field verification, it is intended to acquire accurate width of the land for rejuvenation. The primary verification is the SW3 oil palm map from the first phase. The output from this second phase is oil palm land width data that is in need of replanting. Furthermore, other data such as actual width of the oil palm plantation based on ownership and plant age can be achieved.

The fourth phase is to do data management and framing palm oil class map based on field verification. This last activity is to make sure that the produced map has great accurate data.

3. Result and Discussion

3.1. Spread of Oil Palm Plantation and Replanting Oil Palm Potential

Based on Table 2, the width of oil palm in Kampar Regency is 647,290 ha (60.25%), while non oil palm field has a width of 426,982 ha (39.75%). Therefore, the land uses in Kampar Regency is dominated by oil palm plantation. Approximately 3/5 part of Kampar Regency is used for the domestication of oil palm, and the remainder of 2/5 is used for non oil palm field. It strengthens with Kampar Regency's oil palm map, the dominated palm oil part is marked with green, and non palm oil is marked with pink (Picture 3).

After knowing the extension of palm oil field in Kampar Regency, the next process is to ensure/divide those extention based on ownership status (private companies or smallholder farmers-owned) and oil palm plant age. Therefore, it is discovered that private companies-owned oil palm land width (SW1 = 97,653 ha), and smallholder farmers-owned with plant age < 25 years (SW2 = 66,866 ha) and > 25 years (SW3 = 482,770 ha). Based on that, The total of Kampar Regency is approximately around 482,770 ha of smallholder farmers-owned oil palm plantation that has the potential to be rejuvenated (Table 3). Beside that, it can be concluded that the total width of private companies-owned plantation is lower compared to smallholder farmers-owned. It shows the growth rate of public oil palm plantation areal
width keep on increasing every year. From 2004 to 2009, the growth rate of public oil palm plantation areal width in Riau Province was 15.92%, while the growth rate of big private plantation only grew for 6.93% [6].

**Table 2.** Spread of oil palm plantation and Non oil palm field in Kampar Regency

| Land Uses       | Area  | %    |
|----------------|-------|------|
| Oil palm       | 647,290 | 60.25 |
| Non oil palm   | 426,982  | 39.75 |
| Total          | 1,074,272 | 100.00 |

**Figure 3.** Map of Oil Palm and Non Oil Palm Spread in Kampar Regency, Province of Riau

XIII Koto Kampar Sub-district is a county with the widest administrative area in Kampar Regency. That sub-district has at least 137,265 ha wide of field or as much as 12.78% from the total width of Kampar Regency area. Subsequently, decreasing respectively followed by Sub-district of Tapung (12.73%), Kampar Kiri Hulu (12.10%), Tapung Hulu (11.54%), and other 19 sub-district with the administrative width area less than 10%.

The use of palm oil land is wide spread throughout Kampar Regency. Sub-district of Bangkinang, Kampar Kiri Hilir, Kampar Kiri Hulu, Kampar Utara, and Rumbio Jaya are the areas that do not have a private companies-owned oil palm plantation (SW1). Based on Table and Picture 7, SW1 is marked with brown on the map many people found in Tapung Hulu Sub-district with 31,170 ha wide, and at least in Kampar Regency 5 ha wide. Beyond 25 years old, smallholder farmers-owned oil palm (SW2) is marked with yellow on the map. The widest SW2 is located at XIII Koto Sub-district of Kampar (14,177 ha), while the least one can be seen at West Bangkinang Sub-district (29 ha). The green on the map shows the smallholder farmers-owned oil palm field beyond 25 years old (SW3). 100,059 ha SW3 field can be seen at Tapung Sub-district, and the least with 181 ha wide is at Kampar Kiri Hulu Sub-district.

The most use of non-oil palm field can be seen at Kampar Kiri Hulu Sub-district with 129,386 ha wide. In this sub-district, the use of palm oil field is relatively smaller compared to other 22 sub-districts. While the least use of non-oil palm field can be seen at Kampar Utara Sub-district (741 ha), where the total of administrative width of Kampar Utara Sub-district only at around 0.75% from the total width of Kampar Regency.

**Table 3.** Spread of width area of oil palm and Non-oil palm plantation by Sub-district
| Sub-district          | Oil Palm | Non-Oil Palm | Area |
|----------------------|----------|--------------|------|
|                      | SW1      | SW2          | SW3  | Ha    | %    |
| Bangkinang           | -        | 234          | 5,475| 2,330 | 8,039| 0.75 |
| Bangkinang Barat     | 2,444    | 29           | 18,298| 6,512 | 27,283| 2.54 |
| Bangkinang Seberang  | 220      | 213          | 14,367| 1,343 | 16,143| 1.50 |
| Gunung Sahilan       | 6,386    | 189          | 18,717| 11,766| 37,058| 3.45 |
| Kampar               | 5        | 626          | 15,026| 5,593 | 21,250| 1.98 |
| Kampar Kiri          | 2,268    | 9,405        | 17,762| 61,244| 90,679| 8.44 |
| Kampar Kiri Hilir    | -        | 6,572        | 36,188| 32,841| 75,600| 7.04 |
| Kampar Kiri Hulu     | -        | 396          | 181   | 129,386| 129,962| 12.10 |
| Kampar Kiri Tengah   | 166      | 109          | 24,211| 8,698 | 33,185| 3.09 |
| Kampar Timur         | 3,154    | 1,026        | 11,103| 2,166 | 17,450| 1.62 |
| Kampar Utara         | -        | 588          | 6,690 | 741   | 8,019 | 0.75 |
| Perhentian Raja      | 81       | 43           | 9,587 | 1,308 | 11,019| 1.03 |
| Rumbio Jaya          | -        | 96           | 6,642 | 1,160 | 7,898 | 0.74 |
| Salo                 | 6,836    | 287          | 11,769| 2,498 | 21,390| 1.99 |
| Siak Hulu            | 1,779    | 4,184        | 22,497| 15,689| 44,148| 4.11 |
| Tambang              | 2,505    | 5,260        | 18,156| 10,664| 36,585| 3.41 |
| Tapung               | 12,585   | 11,858       | 100,059| 12,266| 136,769| 12.73 |
| Tapung Hilir         | 27,884   | 1,181        | 54,676| 6,830 | 90,571| 8.43 |
| Tapung Hulu          | 31,170   | 10,392       | 67,984| 14,413| 123,959| 11.54 |
| XIII Koto Kampar     | 171      | 14,177       | 23,383| 99,534| 137,265| 12.78 |
| **Total**            | **97,653**| **66,866**   | **482,770**| **426,982**| **1,074,272**| **100.00** |

Explanation: *(SW1 = Private Companies-owned oil palm plantation; (SW2 = smallholder farmers-owned oil palm with age <25 year; and *(SW3 = smallholder farmers-owned oil palm with age >25 year

Figure 4. The Map classes of oil palm in Kampar Regency, Provinsi of Riau
The size of smallholder farmers oil palm plantation replanting potential shown with green on the map in Picture 4 is expected to be addressed for the rejuvenation process. It is related to the production continuation (production quantity) as well as palm oil enterprise at Kampar Regency. The activity must focus on Good Agriculture Practices (GAP) that is consistent with determined criteria. One of which is to clean the field without burning anything, follow the farmer group, and use conflict-free field [7], [8].

3.2. Spread of propose and Replanting Oil Palm Potential (ROPP)

Around five sub-districts at Kampar Regency propose a palm oil plant rejuvenation program to local agency. Those areas include Bangkinang Seberang Sub-district, Kampar Timur Sub-district, Rumbio Jaya Sub-district, Tapung Sub-district, and Tapung Hulu Sub-district. The spread date of Palm Oil Field Replanting Proposal on five Sub-districts at Kampar Regency is detailed as follow:

| Sub-district       | Village            | Propose of ROPP (ha) |
|--------------------|--------------------|---------------------|
| Bangkinang Seberang| Pasir Sialang      | 150                 |
| Kampar Timur       | Sungai Putih       | 420                 |
|                    | Batang Batindih    | 600                 |
| Rumbio Jaya        | Bukit Kratai       | 820                 |
|                    | Tambusai           | 800                 |
|                    | Kinantan           | 800                 |
|                    | Pancuran Gading    | 600                 |
| Tapung             | Pelambaian         | 520                 |
|                    | Sari Galuh         | 300                 |
|                    | Sei Putih          | 100                 |
|                    | Sumber Makmur      | 827                 |
| Tapung Hulu        | Rimbo Makmur       | 598                 |
| **TOTAL**          |                    | **6,535**           |

Based on Table 4, there is 6,535 ha wide total of palm oil that follows replanting program. Tapung Sub-district was the one who propose the widest replanting at around 3.1 thousand ha, while the smallest one is at Bangkinang Seberang Sub-district at 150 ha.

Oil palm rejuvenation spread potential value analysis includes five sub-districts at Kampar Regency is taken from the difference of total old oil palm field width (SW3) with total of oil palm oil field width that propose ROPP. The ROPP value spread width is detailed at Table 5.

Beyond 25 years old oil palm plant has gone through its productive phase, but is still able to produce until the result become very low. Therefore, This ROPP Program become very important to execute so that palm oil plant productivity can rise again. Based on Table 5, the total width of potential palm oil field of five sub-districts at Kampar Regency that can be proposed into replanting program is 7,048 ha. Oil palm field width that potentially able to join the ROPP program from each highest village is at Sumber Makmur Village located at Tapung Hulu Sub-district (3,156 ha).

The height of ROPP field width shows quite low people participation to do replanting. It can happen because of both internal factor and external characteristic of oil palm farmers. Funding problems, access to credit-constrained aspect of ownership legality [9], different administration limit with ownership letter, as well as low motivation of the farmers and counseling degree are some of the obstacle of ROPP process. According to [10], economy degree and the lack of counseling cause farmers low participation for replanting while farmers education degree and the appearance of a large plantation affect the perception towards farmers replanting innovation.

Table 5. Width Area of Replanting oil palm potential (ROPP) in 5 Sub-district in Kampar Regency
### Table 5. Replanting Propose, SW3, and Potential Replanting

| Sub-district               | Village          | Replanting Propose* | SW3** | Potential Replanting*** |
|----------------------------|------------------|----------------------|-------|-------------------------|
| Bangkinang Seberang        | Pasir Sialang    | 150                  | 1,781 | 1,631                   |
| Kampar Timur               | Sungai Putih     | 420                  | 261   | - 159                   |
|                           | Batang Batindih  | 600                  | 1,334 | 734                     |
| Rumbio Jaya                | Bukit Kratai     | 820                  | 540   | - 280                   |
|                           | Tambusai         | 800                  | 576   | - 224                   |
|                           | Kinantan         | 800                  | 1,294 | 494                     |
| Tapung                     | Pelambaian       | 520                  | 1,043 | 523                     |
|                           | Sari Galuh       | 300                  | 202   | - 98                    |
|                           | Sei Putih        | 100                  | 807   | 707                     |
| Tapung Hulu                | Pancuran Gading  | 600                  | 369   | - 231                   |
|                           | Sumber Makmur    | 827                  | 3,983 | 3,156                   |
| Tapung Hulu                | Rimbo Makmur     | 598                  | 1,393 | 795                     |
| **TOTAL**                 |                  | **6,535**            | **13,583** | **7,048** |

*Explanation: Replanting Propose* = widht area propose of oil palm replanting; **SW3** = smallholder farmers-owned oil palm with age >25 year; and *** Potential Replanting = farmers area wider potentially

Based on Table 5, farmers participation in replanting is very low (propose 6,535 ha), from total SW3 13,583 ha. This is because they are worried about losing their income caused by rejuvenation methods. The oil Palm farming income who applied underplanting method is lowest than the conventional method [11].

### 3.3. Soil pH

The range of soil actual pH in Kampar Regency is shown in Table 6, also shown mean, median, and modus data of interval soil pH. From 227 representative data of soil pH in Kampar Regency, it was known that the dominance of soil pH value is 3.88. That mean in Kampar Regency, especially area of ROPP has very acid soil properties.

#### Table 6. Range of soil pH in Kampar Regency

| Number | Interval Class of pH | Middle Value of pH | Frequency |
|--------|----------------------|--------------------|-----------|
| 1      | 3.56 – 3.86          | 3.71               | 22        |
| 2      | 3.87 – 4.17          | 4.02               | 77        |
| 3      | 4.18 – 4.48          | 4.33               | 46        |
| 4      | 4.49 – 4.79          | 4.64               | 55        |
| 5      | 4.80 – 5.10          | 4.95               | 10        |
| 6      | 5.11 – 5.41          | 5.26               | 9         |
| 7      | 5.42 – 5.72          | 5.57               | 3         |
| 8      | 5.73 – 6.03          | 5.88               | 1         |
| 9      | 6.04 – 6.34          | 6.19               | 2         |
| 10     | 6.35 – 6.65          | 6.50               | 2         |
| **Total** |                     | **227**            |           |
| **Mean** |                     | **4.33**           |           |
| **Median** |                   | **4.23**           |           |
| **Modus** |                   | **3.88**           |           |
Table 6 shown that the frequency occurrence of soil in very acidic conditions reaches 63.88%, 32.60% is acidic soil, and 3.52% is slightly acid. They caused root damage to the oil palm, and decreased quality and quantity of crop. It can be seen when the plant changes from the vegetative to the generative phase. Therefore, application of lime or ameliorant material rich in Ca and Mg needs to be considered by farmers before planting and also included in ROPP planning.

4. Conclusion
There was a difference of oil palm field width at Kampar Regency with BPS data. The investigation result of this research is 647,290 ha palm oil field, while BPS recent data is 225,916 ha. From around 647.3 thousand hectares of that palm oil field, it is known that the width of private companies-owned palm oil field is 97,653 ha, while smallholder farmers-owned with plant age < 25 years (SW2 = 66,866 ha), and > 25 years (SW3 = 482,770 ha). That caused the replanting oil palm potential (ROPP) at Kampar Regency has the width at around 482.8 thousand hectares. However, replanting proposal that was proposed by five sub-districts in Kampar Regency is 6,535 ha with ROPP value 7,048 ha wide. As much as 63.88% area of ROPP has very acid soil properties and requires liming.

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