Implementation of Ranko Tracker Data Collection for Oil Palm Productivity Census

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Abstract

Current data collection for census in oil palm plantation produces only plantation data and block data. Lower level data, tree level data is not available. Tree level data needed for particularistic purpose, such as deep observation on a low yield block for production intensification purpose and higher accuracy in production projection. This research aim to produce digital spatial data to enable efficient productivity analysis by collecting a full population production census using Ranko Tracker method of data collection. Sets of color coding map successfully produced with this method, accurately locating specific area requires immediate action plan within efficient and effective manner.

Keywords: oil palm, intensification, spatial data, color coding map, census, mobile application, decision support system

1. Background

“Palm oil is the most widely used vegetable oil in the world – it’s used for cooking, as a source of energy, and can be found in half the products on supermarket shelves. Palm oil is an edible vegetable oil derived from the fruit of the oil palm tree (Elaeis guineensis). Oil palm trees are planted and harvested on more than 15 million hectares of tropical area around the world – mostly in Indonesia and Malaysia where 86% of all palm oil is produced, but increasingly in South and Central America, Africa, as well as other parts of Asia [1]

Oil palm is grown by both smallholders and on large plantations. Trees begin bearing fruit after three years and have a productive life of up to 25 years [2]. Trees produce continuously and fruit bunches are harvested every few weeks. Fresh fruit bunches (FFB) are then taken to a mill, where the oil is extracted with pressure and steam from both the fruit itself (which yields crude palm oil, or CPO) and the kernel or seed (which yields palm kernel oil, or PKO). Indonesia is the biggest producer of CPO, contributing 53% of world production and the largest exporting countries with 44% shares of world market [3].

2. Statement of the Problem

When extension of plantation by enlarging the area (deforestation) is not an option, plantation management must come with intensification alternatives. Among many alternatives, is to focus on recovering lower yielding blocks to improve their harvest yield to meet the average plantation standard and even higher. Treatment of unhealthy trees can be costly because it means extra fertilizer, extra nutrient and more resources. Management need to evaluate in a lower yielding blocks, which trees or group of trees that are sick or need special treatment but the fact is management can’t determine precisely which trees or group of trees in a certain low yield block, requires special treatment to improve its productivity.

There are three problems we identified after rounds of interview with our industry collaborator:

- No accurate tree identification scheme; there is no convenient method to uniquely identify
- Manually recording the census data; recording process is usually done manually and record them in a log book. This method is prone to human error and is also very labor intensive specially on the reconciliation data
- Inaccurate analyzed data; achieving accurate analyzed productivity information for the whole plantation is difficult as it requires manual sorting through the whole manual records.
2.1 Objective of the Research

- To propose new data collection method on production census to identify high-low yield trees in low yielding blocks that is significantly more accurate for better decision making
- Analyze data produced from proposed data collection method.

2.2 Hypothesis

The proposed method of data collection able to provide management with data to identify condition and more accurate and efficient production projection

3. Research Methodology

3.1 Primary Data

Data is a critical component in any research has been gathered through various resources. The researcher is using primary data for this research. Primary Data are being collected using mobile application as data collection tool.

3.2 Data Collection Flow

Figure 1. Data Collection Flow Technology and Architecture

3.3 Application Flow Chart

Figure 2. Application Flow Chart
3.4 Ranko Tracker Mobile Application

![Ranko Tracker Interface](image)

Figure 3. Ranko Tracker Interface

3.5 Data Collection and Management

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Table 1. Census Data Table from Ranko Tracker

Census data retrieved from the server are analyse using Microsoft Excel to determine:

- Number of female and male flowers, red fruits and black fruits
- Determine the sex ratio using formula:
  \[
  \text{Sex Ratio} = \frac{\text{red fruit} + \text{black fruit} + \text{female flowers}}{\text{red fruit} + \text{black fruit} + \text{female flowers} + \text{male flowers}}
  \]

  (Red fruit + black fruit + female flowers + male flowers)

- Categories tree based on the number of bunch
- Distribution of the group in the trial block
- Colour coding of the group
4. Research Limitation

This research has limitations on the area of the research is one block of 28 hectares, located in Kabupaten Agam, Sumatera Barat, elevation of 11 meters, histosols land and we choose to conduct the research on September until December 2016 according to the period given by our industry collaborator. The trees are 8 years old, using Bina Sarana Makmur seed with are 6,384 mm of rainfall. Research conducted during rainy season.

5. Analysis and Findings

5.1 Current Data Collection

Production census normally held every 4 (four) months to obtain data for production projection for the next upcoming 4 months, collecting information on:

- Quantity of male and female flowers
- Quantity of red and black fruits

Although it’s called a census, the activity is a sampling. Best practice for the sampling is 10 – 15% of total plantation area. All blocks are visited but the in each block data collection is maximum 15%.

5.2 Sex Ratio Analysis

Ranko is 100% tree census; we can identify accurately condition of each tree in trial block. One is the sex ratio of each tree. This block was chosen for the research based on industry collaborator yield data as this block’s yield is lower than the average in Juliet afdeling. Based on that information, common assumption when yield is low, sex ratio is bad.

We use industry collaborator criteria of sex ratio where 75% -100% is good, 50% - 74% is average/medium and 1% - 49% is consider bad/low; male only are good with range of maximum 2% per hectare and resting tree 3% are consider normal.

From Table 2, we conclude in term of sex ratio, trial block falls in category of good with 90.56% are in the range of healthy sex ratio. This is an indication the production potential in trial block is high. The male flower only trees are also enough, especially looking at the distribution. Per hectare male flower only is 2 – 3 trees considered good. The resting trees are high, plantation need to observe more on the physical condition of those resting trees and the soil and surrounding conditions.

<table>
<thead>
<tr>
<th>Sex Ratio Range</th>
<th>Quantity</th>
<th>%</th>
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<tr>
<td>75% - 100%</td>
<td>3743</td>
<td>90.56%</td>
</tr>
<tr>
<td>50% - 74%</td>
<td>134</td>
<td>3.24%</td>
</tr>
<tr>
<td>1% - 49%</td>
<td>15</td>
<td>0.36%</td>
</tr>
<tr>
<td>Male Only</td>
<td>32</td>
<td>0.77%</td>
</tr>
<tr>
<td>Resting Tree (-1)</td>
<td>209</td>
<td>5.06%</td>
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<tr>
<td>Total</td>
<td>4133</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Sex Ratio
5.3 Color Coding Analysis

The main benefit of having data down to the level of trees is we can have a very detail analysis and exercise variations of output and reporting. We highlight the analysis that can only be executed with tree level data. Color coding reporting and analysis can be done conveniently with existing Ranko Tracker data.

5.4 Sex Ratio Color Coding Analysis

We extract data on trial block and the color coding present in Figure 4. We examine conveniently and easily on the positions and coordinate of the categories we want to observe.

We use industry collaborator criteria to group the categories of sex ratio for Q4 2016 in this block as shown in Table 3.

<table>
<thead>
<tr>
<th>Sex Ratio Range</th>
<th>Quantity</th>
<th>%</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
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<td>75% - 100%</td>
<td>3743</td>
<td>90.56%</td>
<td>Good</td>
</tr>
<tr>
<td>50% - 74%</td>
<td>134</td>
<td>3.24%</td>
<td>Average</td>
</tr>
<tr>
<td>1% - 49%</td>
<td>15</td>
<td>0.36%</td>
<td>Bad</td>
</tr>
<tr>
<td>Male Only</td>
<td>32</td>
<td>0.77%</td>
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<td>Resting Tree (-1)</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>4133</td>
<td></td>
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</tr>
</tbody>
</table>

Table 3. Sex Ratio Legend and Criteria

5.5 Production Census Color Coding

Having census on 100% of population of the blocks, we discover detail and interesting data on the trial block, which by our industry collaborator was labeled as a low yielding block and refer as ‘patience block.’ We can collect data that shows on Figure 5 that based on industry collaborator site specific criteria, the trees that are consider good scattered majority in that block consisting of 53.16% of population and 26.64% are average. The number of bad trees which only has 1 – 2 bunches/tree is only 11.61%. As a normal cycle, we also have 7.79% resting tree and we have 33 missing data (0.8%).

We determine by these figures in Q4 2016, in terms of bunch quantity and female flower, majority population of this block falls in the category of ‘good.’
Bunch Quantity | Quantity | Percentage | Criteria 
--- | --- | --- | --- 
6 - 12 | 2197 | 53.16% | Good 
3 - 5 | 1101 | 26.64% | Average 
1-2 | 480 | 11.61% | Bad 
0 | 322 | 7.79% | Resting Tree 
- | 33 | 0.80% | No Data 
Total | 4133 | | 

Table 4. Production Census Legend and Criteria

5.6 Intermediate Analysis – Moving Average

Having spatial data on trees with color coding in the block helps industry collaborator identify efficiently and accurately on which precise trees or a group of trees are achieving high, moderate or low yield. Projections of production based on census are also more accurate with the total population being census. Having large plantation to be review, we see this first level data analysis can be improve to make it easier for management to identify with more focus on what is the main issue in certain block.

Based on this consideration, we extend further our analysis with deeper and more focus analysis using existing data. We conduct second level of data analysis using 28 days moving average. We use 28 days instead of 7 days moving average referring to the pattern of harvest interval in plantation where each tree is harvested average of once a month and maximum twice a month due to the morphology of oil palm tree maximum number of bunch harvested in a year is 18-24 bunches [2].

5.7 Sex Ratio – Moving Average

Result of moving average analysis on sex ratio in Figure 6 is very promising. Colour coding identifies line no 5 on trees number 11 to 25 shows as the ‘bad ‘or worse sex ratio in trial block. This will make the plantation management can work efficiently and accurately in identifying the group of trees that needs focus and immediate actions. These will safe many budget, time and resources in plantation. Faster and accurate input will trigger a faster and precise action plans for the management to increase the plantation yield productivity.

![Figure 6. Sex Ratio with Moving Average](image)

We validate our valuable data by having field staff visit trial block, line no 5, trees no 11-25. We ask our staff for physical observations on those trees and took pictures. We validate our moving average data with evidence of potassium deficiencies on majority of trees. Symptoms shown to be associated with potassium deficiency were given various names, particularly ‘confluent orange spotting’ [3]. This consisted of pale green spots that became more coloured through yellow to orange and that expanded both across and between veins, with fusion into larger irregular areas. Necrotic spots then appeared also, with possible fungus invasion. We also found symptoms of algae attack as indicates by the black dots on the leaves [2].

Below in Figure 7 are pictures taken by field staff to validate the findings in the sex ratio moving average.
5.8 Production Census – Moving Average

Moving average in production census shows we can zoom in to group of trees that has the lowest bunch quantity efficiently. From total 135 tree lines, we can identify accurately in only 9 lines which contains significant number of trees that fits in the criteria of ‘bad’ trees. We can save many resources using this analysis.
6. Conclusions

Current data collection has its limitation on zooming in, in the scale of per tree yields. This implicate in limitations of analysis. Ranko Tracker data collections prove it ability to explore more on block condition until the lowest tree analysis. These make it more accurate and produce more valuable data analysis and detail action plan. Ranko Tracker method enables an accurate way of monitoring the Fresh Fruit Bunch productivity.

Color coding analysis for production census shows its accuracy. It is higher due to 100% population census. It can create efficiency and possibility of combining annual tree census with production census held every 4-6 months and monthly census for early warning system.

Intermediate moving average analysis, this is the main achievement of this research, as a tool for Decision Support System (DSS). It pins point’s exact and accurate location using spatial data where to go in response to identifying issues in production projection. This analysis wills safe budget, time and resources in plantation. Faster and accurate input will trigger a faster and precise action plans for the management to increase the plantation yield productivity. In the end this method will make plantation management works more effectively and efficiently.

7. Suggestions

We recommend Ranko Tracker data collection for production census on a larger scale, 30 blocks with a two years’ research to obtain an appropriate sampling amount and going through the full cycle of oil palm morphology of 20-22 months[2]. This long period of research is needed to ensure suitability of this method in a production/large scale plantation. This method can be assessed for smallholders using less costly devices and simplified method.

Color coding analysis, we recommend plantation to use this to monitor and analyze production projection in line with their plan to increase plantation productivity.

Intermediate moving average analysis, we recommend this analysis on a much larger area for higher accuracy in discovering issues in production effectively and efficiently.

References


