# GPS AND GIS FOR MAPPING AGRICULTURAL ROADS FOR OIL PALM PLANTATION MANAGEMENT

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**ABSTRACT:** In Asia, the main oil palm producing country is Malaysia. Malaysian oil palm industry recorded impressive performance in 2008 and 2009. Malaysia oil palm industry is the leading commodities and one of the major contributors to the Malaysia economic after oil and gas sector. Malaysia and Indonesia palm oil plantations are the major commodity producer with Malaysia currently being the world's second-largest area of oil palm plantation after Indonesia. Together these two countries account about 84% of total world production and 88% of global exports. With the increasing price and demands for the Crude Palm Oil (CPO) and with the 4.69 million hectares that were planted with oil palm trees, plantation industry and estate managers has to look into the most crucial factor that will decide the yield and quality of the CPO that is being sent to the mill. Typically, palm oil plantations include production areas requiring supporting infrastructure such as buildings, roads and services/management. When there is a better management of the roads in the estates, better Fresh fruit Bunch (FFB) and CPO quality will be sent to mill and processed. Road transport has a fundamental meaning for the sustainable agriculture. Poor quality and inadequate coverage of roads, lack of maintenance operations and outdated road maps continue to hinder economic development in the plantation. Accurate and reliable roads information is needed for a sustainable oil palm plantation management. Therefore the road infrastructure of the Felda Trolak Utara, Perak was studied by using GPS and GIS. The results of this work were used to road infrastructure mapping in oil palm plantation in general context, although with certain limits.

## 1. INTRODUCTION

Palm oil is an excellent natural ingredient with special properties that are suitable for many manufacturing products. In Asia, the main oil palm producing country is Malaysia. The total oil palm planted areas in 2006 were 4.69 million ha. While, the total exports of oil palm products were 20.13 million tons in 2008 and 2009. The industry also saw exciting developments shaping up in the local bio-fuel industry with the Honorable Prime Minister of Malaysia launching the "Envo-Diesel" which are combination of palm olein blend with diesel (MPOB, 2002). Due to the importance of oil palm to the country, accurate and reliable information is needed for oil palm plantation management, not just on plant quality, but also on phenology, health and yield prediction. It also involved the maintenance of agriculture road network in certain plantation area. Agricultural road are an important factor in plantation management. Agricultural road network deals with all aspects of everyday works of a well manage estates. It includes FFB evacuation from trees to platform, from platform to loading FFB loading ramp and from loading ramp to mill. Agricultural road also is a crucial and critical factor in determining the quality of FFB that was being sent to mill. Appropriate combination of primary agricultural road, secondary and tertiary can determine the effectiveness of the FFB evacuation in a particular estate and contributing in the high yield and oil extraction rate (OER).

Economic development and production of palm oil yield is multi-phases series of events which influenced greatly by infrastructure and transport services. Infrastructure can deliver major benefits in economic development and reduction of waste and environmental sustainability (World Bank, 1994). Improvement of the productivity and quality of oil palm in operation is one of the toughest challenges for the oil palm mangers. A basic road network in oil palm plantation is considered absolutely essential. The construction or improvement of the road network is rightly regarded as one of the most effective ways of promoting production rate and quality of yield. In fact infrastructure promotes economic development most effectively in the way where there is already a high level of economic activity. Geographic Information System (GIS) is a branch of geoinformatics, become indispensable in modern agriculture. GIS is a technique that is quite relevant in agricultural development. There are numerous definitions of GIS in the literature (Maguire et al., 1990; Ayeni, 1998; Abumere, 1997). For instance the

biophysical components of the soil and agricultural environment can readily be deduced from information collected in the field and, which will in turn serve as the basis for determining site suitability for specific agricultural purposes when analyzed in a GIS (Iyalla, 2004).

In management system technology such as GPS and GIS provides an important tool for the management of plantations. With GIS spatial data collected are handled, manipulated, analyzed and interpreted with more flexibility. Data collected in the field were difficult to obtain and in many cases inaccurate. Typical examples include plantation boundaries varying from government permits, and applied production areas different from actual. This has been a result of the problems in measurement and mapping of difficult terrain and remote, inaccessible locations. Furthermore, plantation management has to consider the changing nature of an estate that extends from initial land clearing, the production stage and finally the re-planting or conversion phase. GIS differs from traditional methods to provide alternative tools which can monitor and analyze data. The objective of this work is map and updating oil palm plantation roads in the Felda Trolak Utara using GPS and GIS.

## 2. MATERIALS AND METHODS

### 2.1. Description of the Study Area

Felda Technoplant Sdn Bhd (FTPSB) incorporated in 2005 as private limited company under the plantation group fully owned by FELDA. In this study, the specific site is a Felda Trolak Utara located at Sungkai, Perak, Malaysia. Felda Trolak Utara consists of 475 registered FELDA settlers and 2,300 ha area planted with oil palm. Felda Trolak Utara geographical coordinates is $3^0$ 57' 12" N to $101^0$ 27' 38" E (Figure 1). The production of oil palm is affected by deteriorated o roads network over time due to poor maintenance. Maintenance of roads in Felda Trolak Utara is very challenging process. With an average rainfall between 2300 mm to 3000 mm of rainfall, it was almost impossible for an agricultural road networks can be used for more than a year. Currently, there is 117.67 km of agricultural road network is being maintained by FELDA and another 134.35 km of road which is not well maintained.


Figure1: Location of the Felda Trolak Utara in Perak, Malaysia

### 2.2. Methodology

Mapping Process: The equipment used for mapping is a Garmin 60CSX. Mapping was referenced to the WGS84 datum and Universal Transverse Mercator (UTM) projection, zone 47 north. Data collection is supported by five Felda Trolak Utara personnel. Collection of data involves acquiring geographical information of the study site such as Felda Trolak Utara topographical map, rainfall chart, costing involved in building agriculture road network, 2008 and 2009 yield data, and satellite image of Trolak Utara Phase 3.

In mapping process the GPS receiver was switched on at a fairly level area at the boundary of estate. The receiver established a list of satellites (more than 4) that are currently above the local horizon. When the GPS device begins to acquire the satellite signals and when it has a good connection by displaying the signal strength from three satellites are being received, it may perform a first, rough calculation of the geographical position and give information about the longitude and latitude. It may also give the first estimation of the uncertainty. The 1st

position established, and staffs walks along with GPS receiver along the agricultural road network in the estates boundary. Agricultural road were mapped by using Tracks menu in GPS device. With a track, the GPS unit automatically recorded GPS coordinates along agricultural road direction of travel at a predefined distance. A route shows a path of waypoints that were collected. Perimeter of the estate is being plotted and saved. Return to the starting point, and stop the tracking feature through GPS unit's menu. Upload the GPS coordinates data to the computer. Data were stored, processed and displayed in ArcGIS 9 (ArcMap Version 9.2). Once drawing files were imported and converted into an ArcGIS geodatabase. Individual layers created and layers attributes table was edited to include additional fields for estate, year of planting, administrative division, road type, ect. Roads lengths in each phase were calculated.

## 3. RESULTS AND DISCUSSION

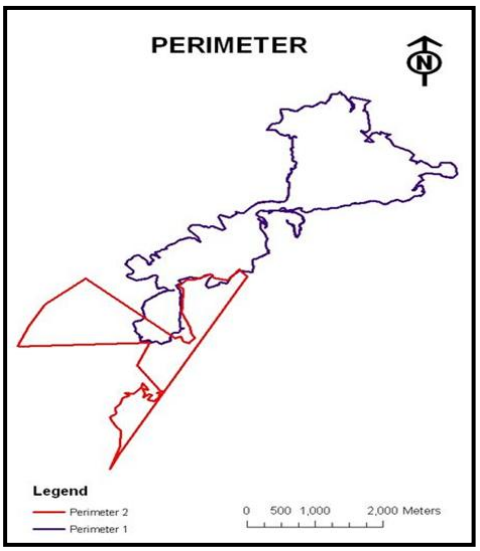


Fig. 2 Perimeter of the Felda Trolak Utara

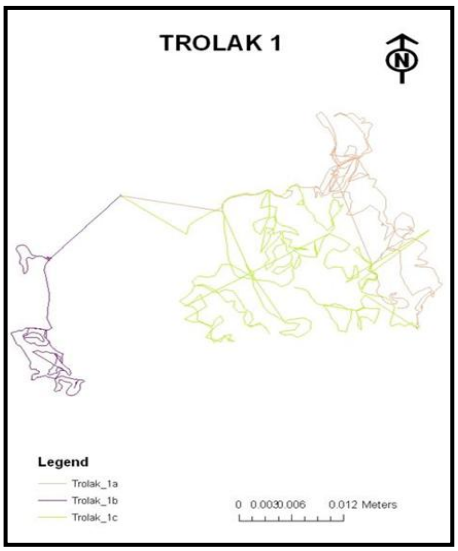


Fig. 3 Plantation road in Phase 1

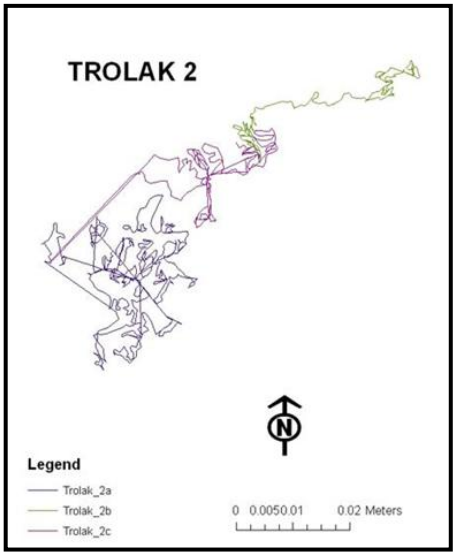


Fig. 4 Plantation Road in Phase 2

Figure 2, 3 and 4 showing the result of the mapping work. There are perimeters of the area, plantation roads in phase 1 and in phase 2. In general the initial mapping problem involved collecting data from the field to produce maps, which require intensive survey work by plantation staff. Due to difficulties in differentiating crop perimeter/area in field the task was done by the division assistant.

In this work satellite imagery might not be suitable for plantation boundaries, because tree coverage hindered boundary, divisional and block demarcations, especially when adjoining boundaries had similar crop type and/or encroachments. From the maps that have been created, and the time it took to complete the ground data collection, it seems that just phase 1 that being control by a junior plantation assistant manage to complete the ground data collection within time. Another three senior plantation staff unable to complete the task within time and the data is not accurate compared to the topographical map.

The benefit of using GIS in mapping agricultural roads is it is efficient for oil palm management and resource planning (Nordiana et al., 2008). Map from this study give reliable information to oil palm managers into meaningful information via GIS solution. Plantation companies have some awareness of using GPS, which give positional accuracy of +/-10m. Difficulties are encountered when transferring information from GPS units [usually in the form of waypoints] to map or GIS software. Plantation staffs typically do not have the software, hardware or enough knowledge to successfully complete this operation. This is one of the factors restricting the implementation of a GIS. Another factor is the general lack of knowledge concerning GIS and its potential benefits by management.

Concern should be focused to the human resources allocation for field/data collection and preparation of GIS database. Considerable time is required in verifying field data and design of the GIS database. However, once this phase is complete, mapping and graphical data display can easily be generated to suit the needs of management. The process of keeping data up to date should not be overlooked as results produced directly relate to the accuracy of the database. It is suggested that FELDA would spend some initiative on making staff and personnel aware on the important of using GPS and GIS in estates.

## 4. CONCLUSIONS

The preliminary works by the principles of GIS and GPS is suited for the diverse road infrastructure. Methods are practical, straightforward and cost-effective, appropriate, feasible and effectively utilized in the plantation operation. The focus is on the general road mapping. The data could be then completed by manual editing and used for updating the existing road data layer of the Felda Trolak Utara. These technologies were welcomed by plantation management, as GIS technology established a dependable basis on which to make decisions. The approach should expand and emphasis the provision of data for the management of in-field variability in soil fertility status and crop conditions. This is the goal f geoinformatic techniques. What is required now is the will, particularly on the part of the industry, financial and research institutes as well as tertiary institutions of learning to actualize the application of these techniques in agricultural development.

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