PRECISION AGRICULTURE: FERTILIZER MANAGEMENT MAP PART 1: SPATIAL AND CORRELATION ANALYSIS OF YIELD AND LEAF NUTRIENT

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Precision Agriculture (PA) is an improved farming system where technologies such as Geographic Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS) are used to improve agricultural practices. Precision Agriculture system provides better management of natural resources that leads to higher potential of increasing yields and economic returns in agricultural production. In this system, the agricultural management is tailored to the variability of conditions found in each field.

Fertilization is an important major factor determining the fresh fruit bunch (FFB) production. Fertilizers account for about 24% of the agricultural cost of FFB production that is about RM 440 - RM 550 ha^{-1} of mature palm (Tan, 1988). Since fertilizer application is an important operation, it has to be carried out efficiently and judiciously to ensure optimum returns from its investment. Precision Agriculture practices are aimed to optimize the use of soil resources to compensate the external inputs of fertilizer on a site-specific application basis.

Presently, leaf analysis is used for fertilizer recommendation for oil palm because in most fertilizer trials it has been shown that yields are very significantly correlated with leaf nutrients status (Foster and Chang, 1977). Later, Foster *et al.* (1988) developed a new method of foliar diagnosis, by considering leaf nutrient ratio, total leaf bases, soil factors and climate factors to determine the optimum leaf nutrient levels in oil palm. Based on this finding, the decision support system, Oil Palm Efficient Nutrient System (OPENS) was developed. The validation of the system carried out recently showed that OPENS can be used successfully to predict the maximum site yield potential, to detect the most limiting foliar nutrient, and finally to estimate the amount of fertilizers to be used to achieve a maximum yield (Tarmizi *et al.*, 1999).

OBJECTIVES

i. To create fertilizer variable rates map from oil palm yield data and foliar analysis;

ii. To use OPENS as decision support system to create information from the foliar analysis to develop the foliar nutrient maps;

iii. To estimate the site-specific fertilizer rate requirements; and

iv. To maximize oil palm production through yield increase and efficient use of fertilizer inputs.

BENEFITS

The fertilizer variable rates map created will optimize oil palm production and save the environment through efficient fertilizer utilization. By developing the GIS database of the area, the plantation information can be efficiently utilized for management, forecasting and planning.

STAGES OF MAPS CREATION

Data Collection

Data collection for this study, initiated in year 2000, was on a study site located in Field 41, Ulu Bernam Estate. The palm being a third generation, was replanted in 1996 on Sabrang Series (Sulfic Endoaquepts) soil with cambered field system.

Data collected are for the management decision making. It is important to have an accurate and adequate sampling density numbers to ensure all the potential responsive areas are correctly classified. Prior to data collection, the area was mapped using DGPS. The GIS database of the area was then developed using the maps and data collected (*Figure 1*). Geographic Information Software, ArcView Version 3.1 was used to develop the database.

The 40 ha study site was divided into 104 plots with an area of 0.38 ha $plot^{-1}$ (*Figure 2*). Foliar and yield data were obtained from 20 recording palms $plot^{-1}$.

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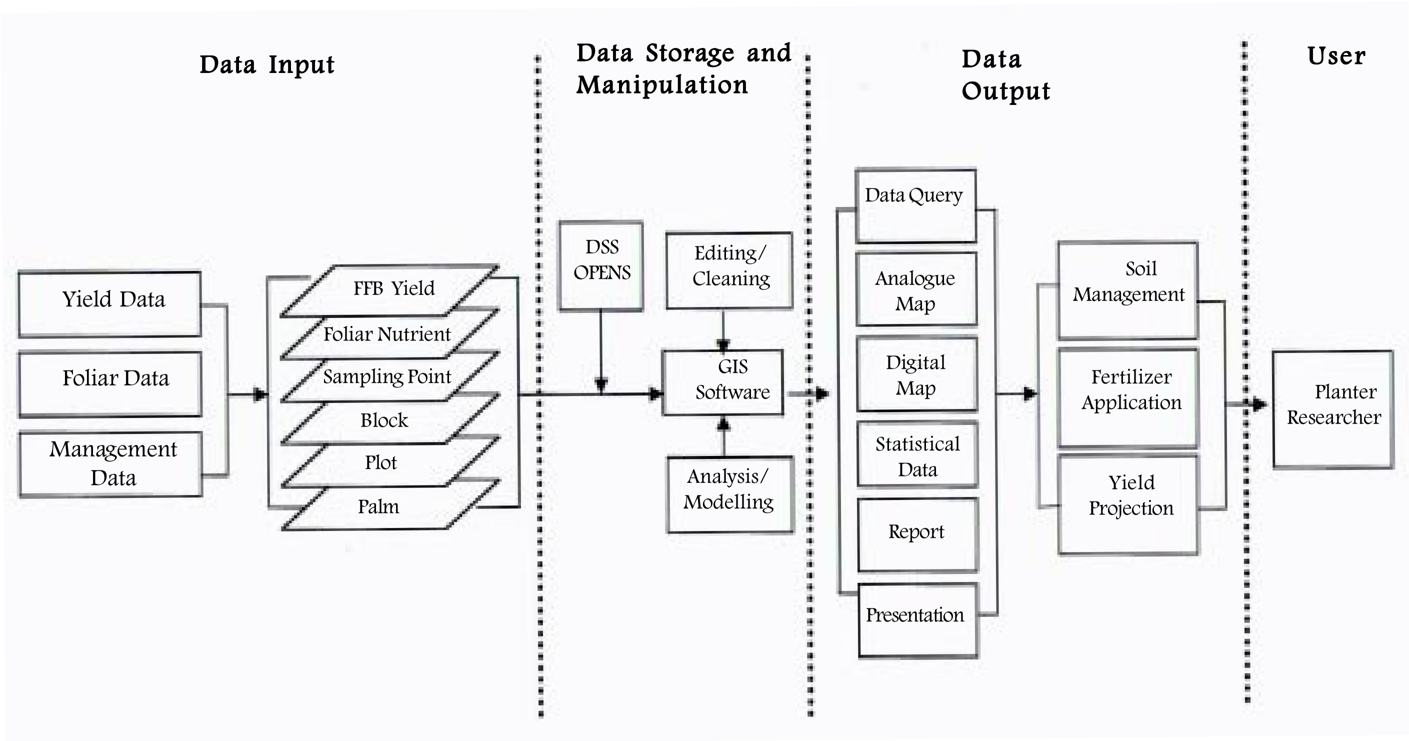

Figure 1. GIS database of the study site.

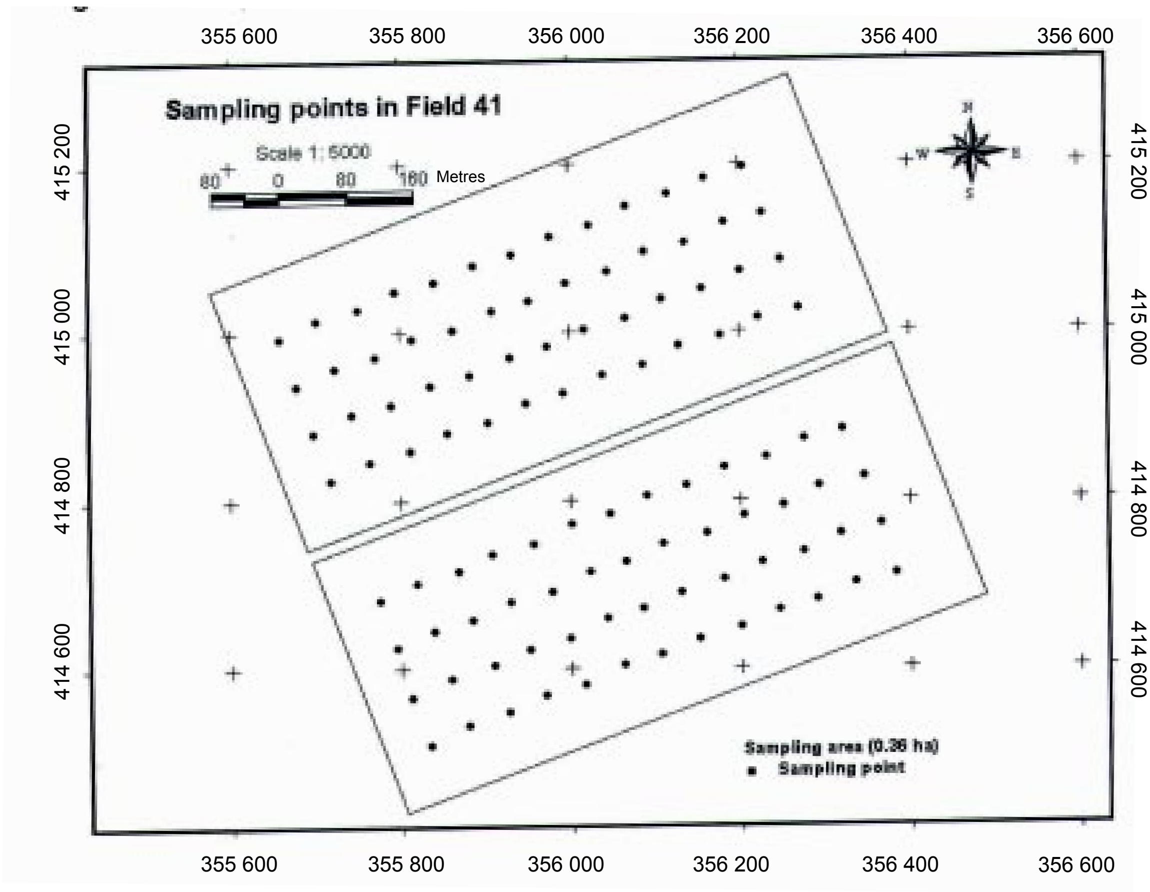

Figure 2. Sampling points.

Data Analysis

At this stage, the data collected were analysed and evaluated to determine the best course of action to overcome variable palm yield of the area. The yield map was plotted from yield data of each plot using Spline Interpolator of ArcView Spatial Analyst (*Figure 3*).

OPENS was used to predict the maximum site yield potential of the area and determine the most limiting foliar nutrient of each plot. The foliar nutrient maps were then plotted from the foliar nutrient information determined by OPENS, using Spline Interpolator of ArcView Spatial Analyst (*Figures 4* to *7*).

The variable fertilizer rates map was created by overlying the yield map on the foliar nutrient maps. The rates of the fertilizer were determined based on the yield map, foliar nutrient maps and current fertilizer management practices (*Figure 8*).

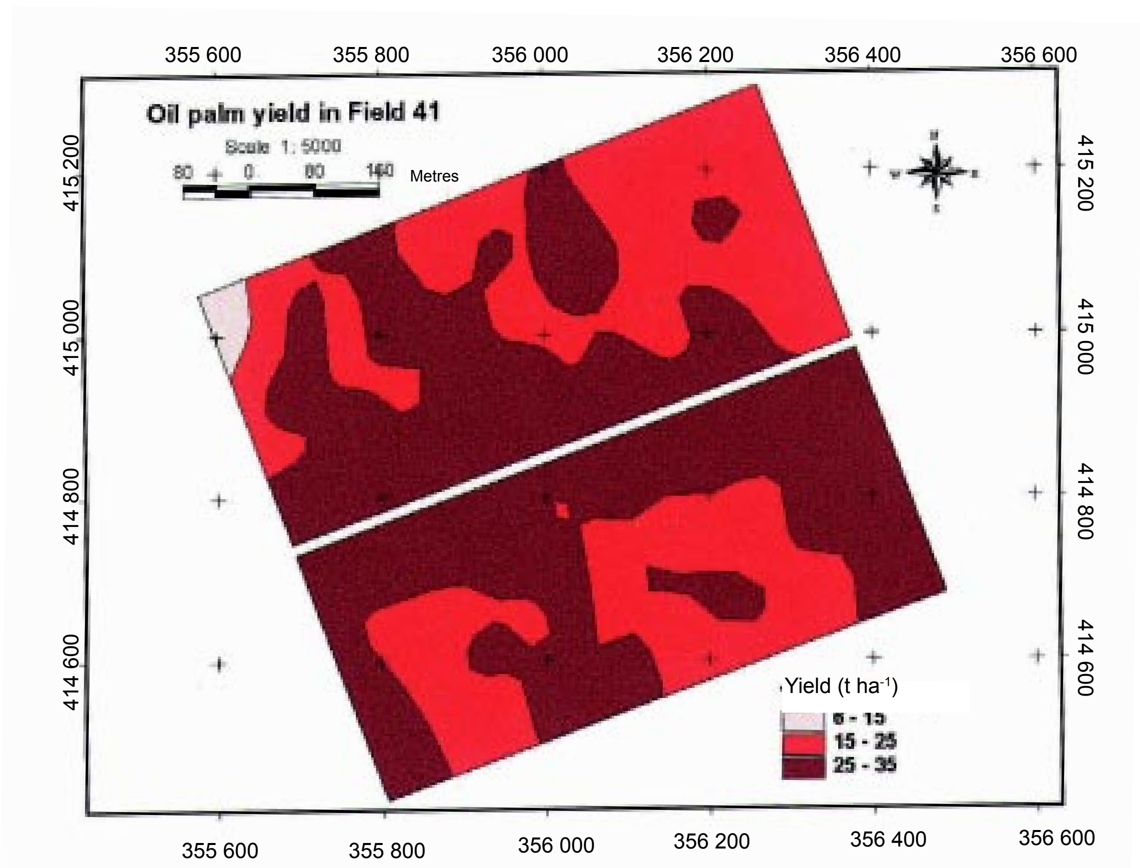

Figure 3. Yield map.

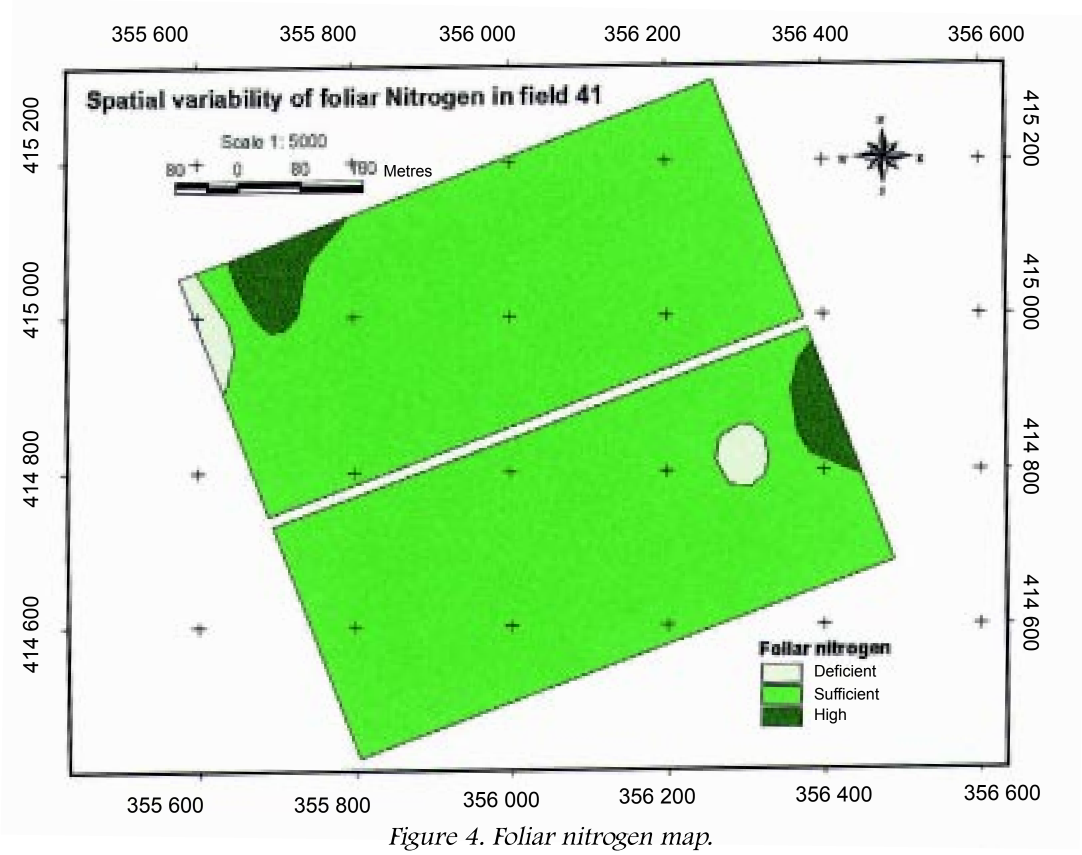

Figure 4. Foliar nitrogen map.

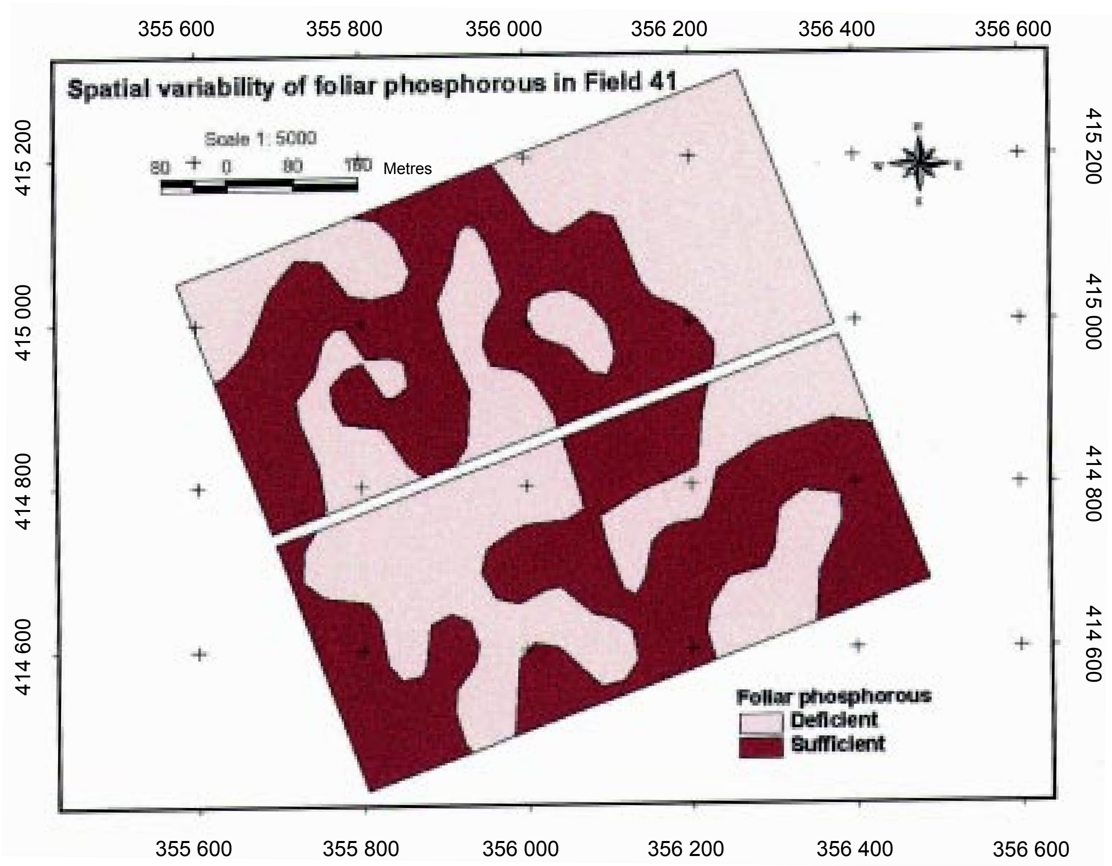

Figure 5. Foliar phosphorus map.

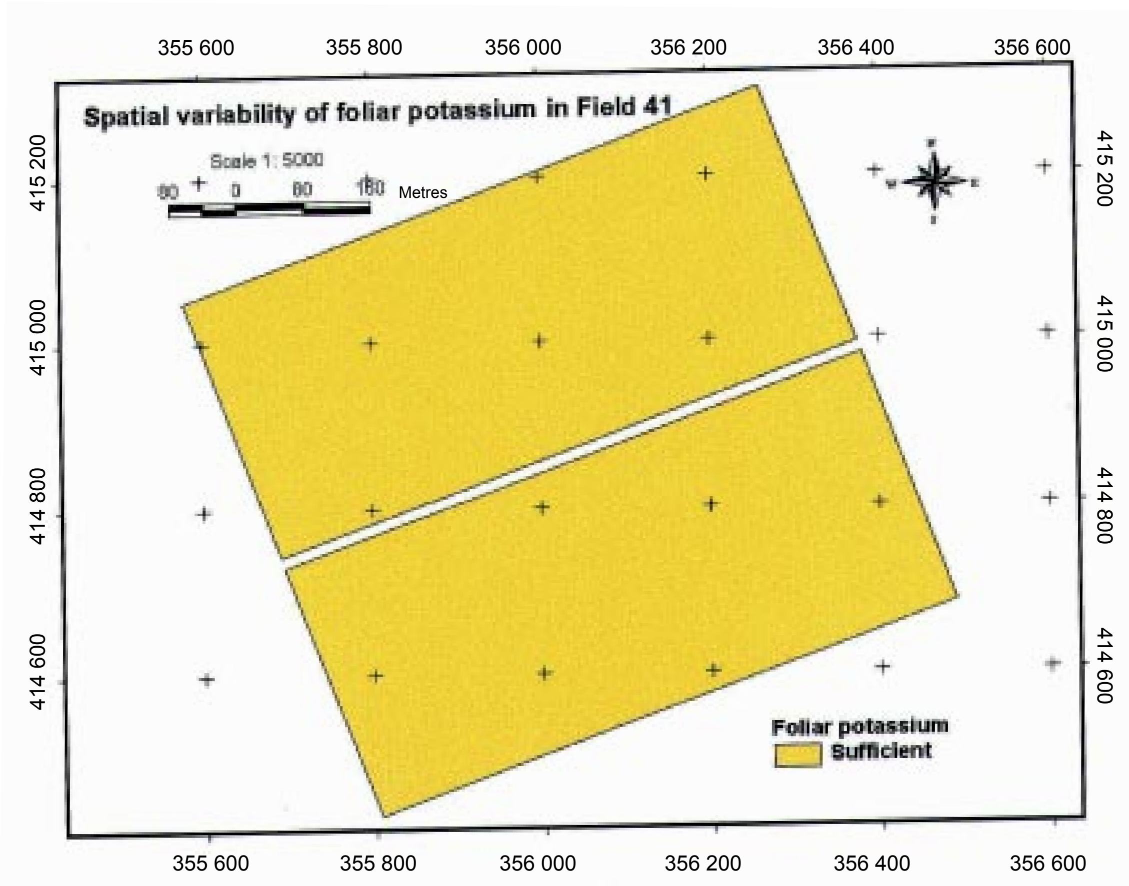

Figure 6. Foliar potassium map.

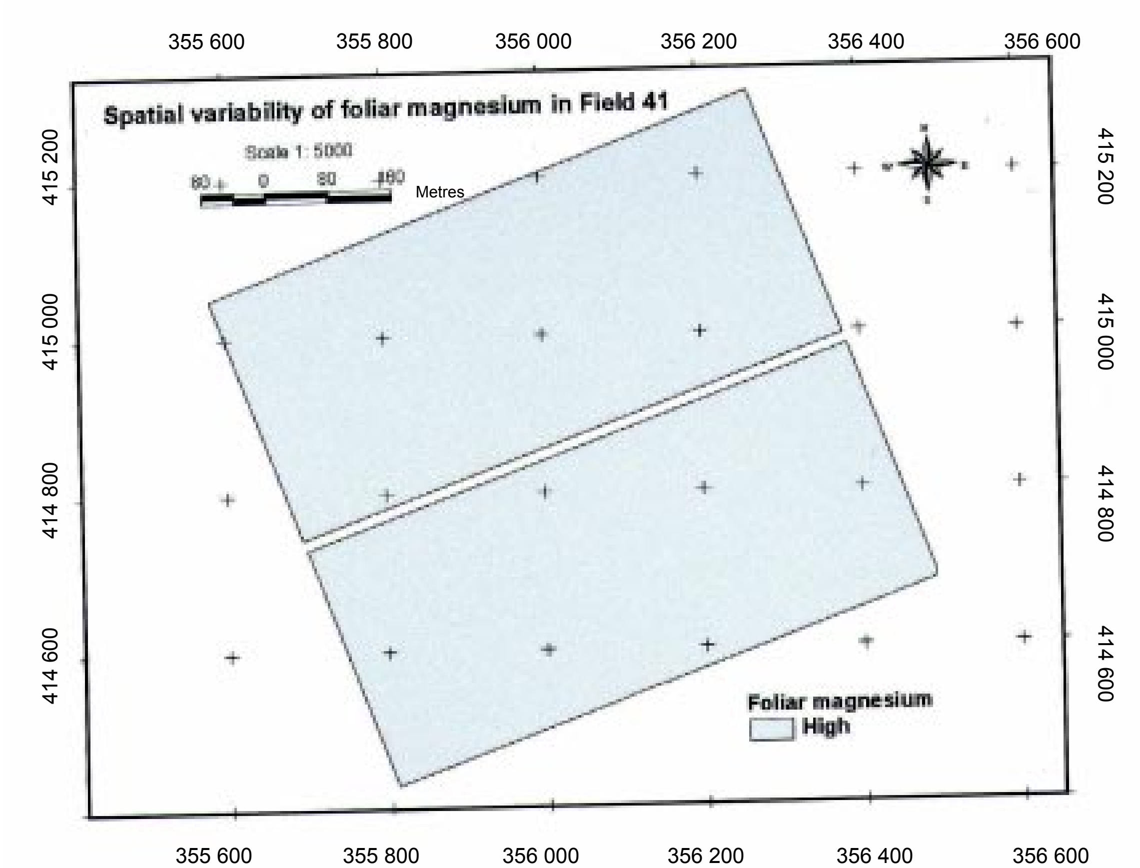

Figure 7. Foliar magnesium map.

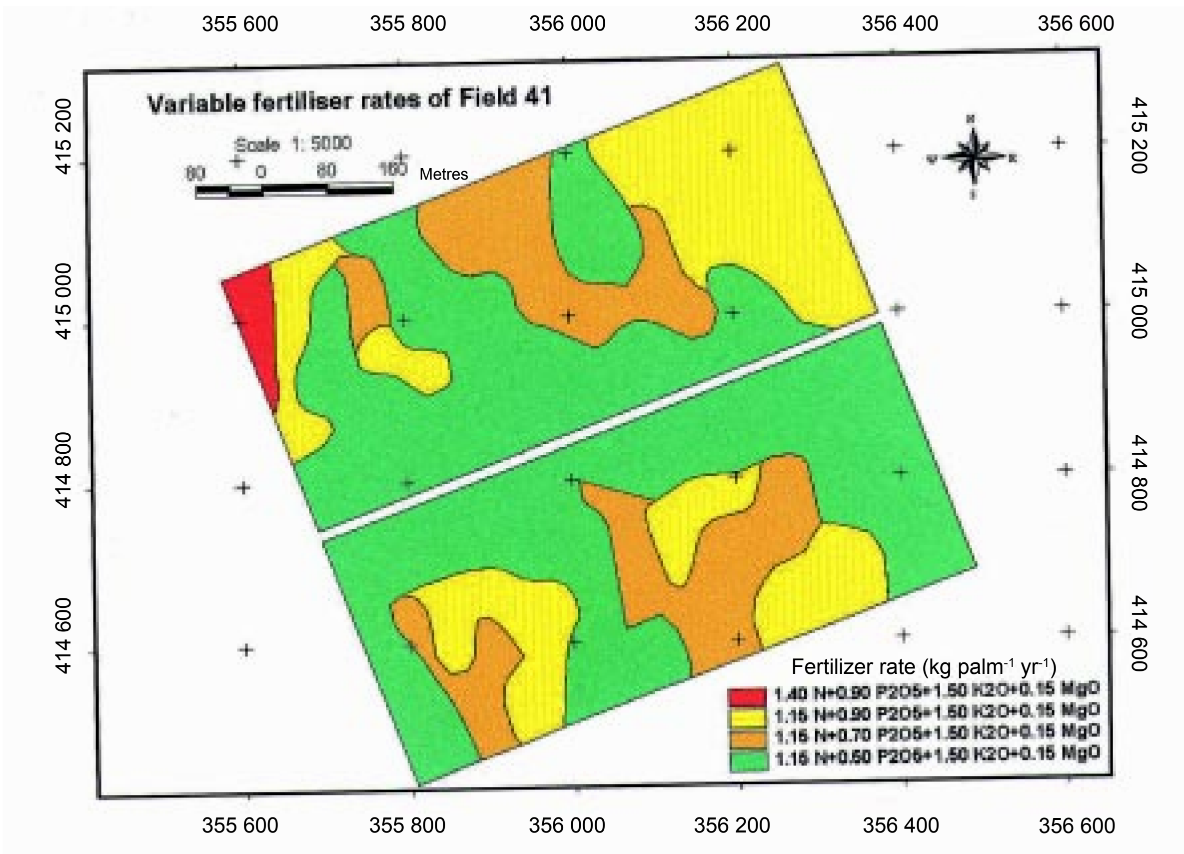

Figure 8. Fertilizer variable rates map.

Results Application

The information and fertilizer rates map created will guide the actual application of fertilizer in the field in such a way that will optimize fertilizer usage and maximize yield production.

CONCLUSION

The availability of the GPS, GIS, and RS technologies has eased field and agronomic data collection and their manipulation to improve efficiency in planning, implementing, and monitoring of oil palm plantation management. These improvements will be beneficial to the plantations both economically and environmentally. Studies that are being carried out will help to understand better on the factors such as size of management unit and intensity of foliar and yield sampling for the PA management. The fertilizer variable rates map created will help to optimize the fertilizer usage and maximize the oil palm production. This is the first part of the PA study. More studies are still on going especially to relate the soil characteristic factors to the fertilizer management of oil palm.

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