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UNIVERSAL KNOWLEDGE AT UPM

Identifying nutrient variability in soil

THE rich yellow-green fields that yield our rice crops cover up to 300,000 hectares of land in West Malaysia alone. Every hectare is a location of delicate nutritional balance that nurtures the crops for harvesting. The optimum yield can be achieved if farmers are able to create a nutritional equilibrium in their soil through fertilisers and other enhancers.

Soil analysis is an important step in reaching this nutrient equilibrium and Universiti Putra Malaysia has developed a system called the Soil Properties Mapping System (SOILPROP) to allow local farmers to manage their paddy fields in terms of optimising fertiliser input and rice yield.

"The idea came about because paddy farmers always apply the same amount of fertiliser uniformly across the paddy field, no matter the content of the soil," says Professor Ir Dr Mohd Amin Mohd Soom, a Professor of Soil and Water Engineering at UPM's Department of Biological and Agricultural Engineering, and Head of the Smart Farming Research Centre at the Faculty of Engineering, UPM. "Applying fertilisers or any chemicals are necessary in crop production, especially with crops like rice that is grown twice per year. Some farmers think that the more fertilisers they apply, the better the crop yield, but this is not the case."

Some fields may require different nutrients in different amounts, and even this may vary within a single field. The primary nutrients that can be found in soil are nitrogen, phosphorus and potassium, with supporting nutrients being calcium, magnesium and sulphur. Micronutrients like boron, copper, iron, molybdenum, zinc and manganese also exist in the soil in trace amounts. The combinations of nutrients dictate the fecundity of the soil, and like most naturally occurring distribution, they often occur asymmetrically.

Continuing a research project on soil variability mapping using an electrical conductivity sensor for precision farming of rice by UPM researchers in 2004, the SOILPROP project is led by Professor Mohd Amin, with co-researchers Dr Aimrun Wayayok , Ezrin Mohd Husin and Mohamad Razi Mad Amin.

"What is unique about this system is that it is the only known variable rate technology available for paddy farmers here in Malaysia," Professor Amin says. "The system we have developed is the only known quick way so far that can identify nutrient variability in the soil."

FULFILLING A NEED: "There was a clear need for a variable rate treatment – a treatment that takes into account the variability in soil content – so that only the areas that require certain fertilisers will be supplied with them," Professor Mohd Amin says of the need that inspired SOILPROP. "In SOILPROP, we use bulk soil electrical conductivity (EC) mapping to create management zones of nutrients for the farmers to utilise during the application of fertilisers and other nutrients."

The setup for the SOILPROP system centres on a vehicle, usually a tractor, to which an array of plates called the ECa (electrical conductivity) sensor probe is attached, that can measure the conductivity of the soil. A DGPS antenna is placed on the probe, with a DGPS receiver situated in the tractor cab where a PC with the SOILPROP software will also be mounted.

"Usually it takes about 15-20 minutes to do the ECa mapping for one hectare of soil," explains Professor Amin. "The ECa sensor measures ECa at two soil depths, one at an average depth of one foot, another at an average depth of three feet. The reason for this is that top soil is not stable in its contents, as we aerate this layer, but at three feet the consistency is more stable and accurate. Once we run the probe, we get the data in real time on the computer screen in the tractor cab. So the farmer sitting in the cab can see the ECa variability map right there."

Once the EC mapping is completed, the SOILPROP software steps in and converts the EC zones into nutrient zones created within a geospatial information system (GIS). Farmers will use this information to regulate their fertiliser application rates. The fertiliser recommendation map is displayed on the computer screen mounted in the tractor cab on real-time basis. The fertiliser recommendation maps are also accessible by the paddy farmers through a web portal called the Web Smart Farmer.

For a new area, the SOILPROP needs to be calibrated before it can be fully utilised for that particular area. Soil samples need to be collected from the dominant EC zones and sent for laboratory analysis. Once the results of the available soil nutrients are known, the SOILPROP will standardise the soil nutrient elements for the particular area according to the EC zones. Again, the information will also be made available in the Web Smart Farmer.

BENEFITS OF SOILPROP: Currently, the UPM team has been implementing the data from the SOILPROP software in the fertilisation of paddy mainly at the paddy fields in Sawah Sempadan, Tanjung Karang, Selangor, where UPM has an external laboratory called the Smart Farming Community Centre.

"Two benefits that we have observed so far in the Tanjung Karang paddy fields is an increase in yield of up to 30 per cent, and a reduced cost of fertilisers of up to 50 per cent," Professor Amin reveals. "Although the pilot study in Tanjung Karang is considered a small-scale paddy area of about 400 hectares, it is still a considerable success story."

A 30 per cent reduction in costs can have a large impact on a paddy farmer. Professor Amin points out that one of their farmers harvesting six lots is able to rake in three to four thousand in profit at the end of the day.

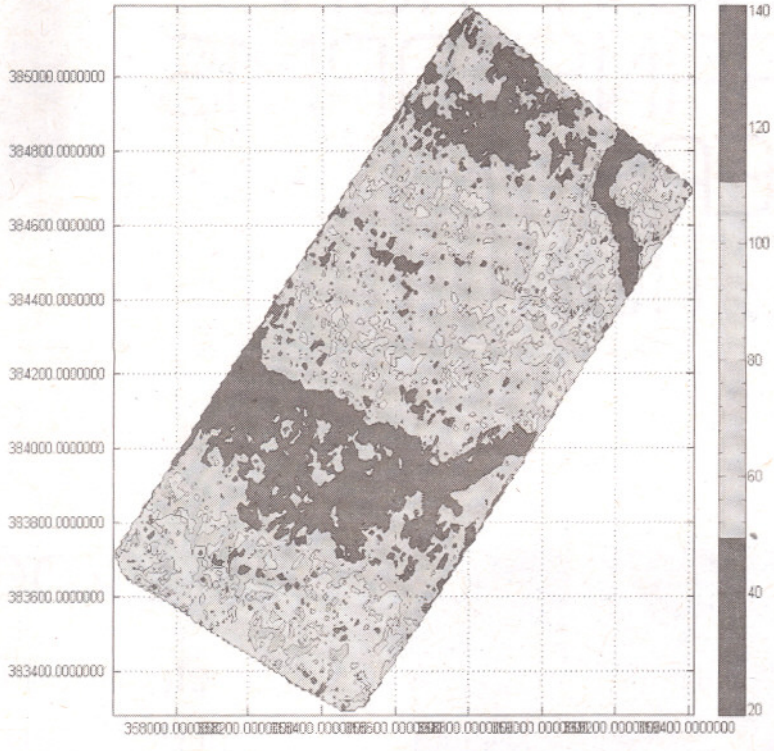
"We are trying to extend our success story to a wider number of farmers," Professor Amin says. The SOILPROP software can be used on any crop whose variability the farmers wish to iden-

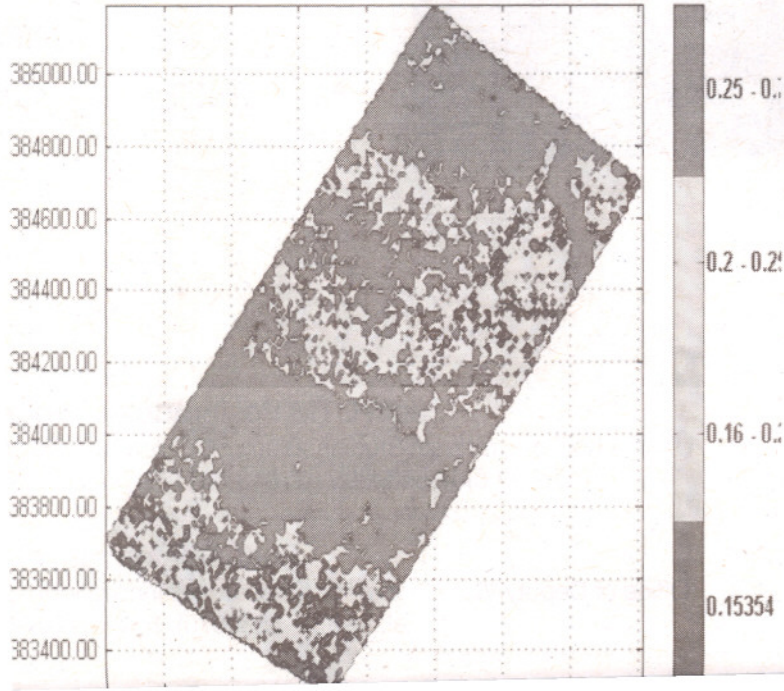
tify, as long as the soil is not too wet as moisture would affect the accuracy of the soil electrical conductivity. "This would require the involvement of government bodies, as running the machine and the analyses carried out comes at a price. The SOILPROP system would be a convenient facility for our farmers if they were able to access it easily, and at a subsidised cost."

The implementation of SOILPROP does not only provide monetary benefits, but environmental ones as well. Over application of chemical fertilisers increases environmental degradation if no action is taken to control the superfluous use of chemicals and fertilisers. SOILPROP guards against over-fertilising and provides accurate information on precise application rates of the required nutrients, thus avoiding the potential for environmental detriment.

SOILPROP is but one of the agriculture-based products developed by researchers at UPM, as the institution has taken on the mandate to improve food security for the country and ensure the sustainability and accessibility of crops, systems and land throughout Malaysia

Example of maps of EC zones and fertiliser recommendations produced by the SOILPROP.





*Educating farmers on the **Web Smart Farmer** portal user-friendly interface.*

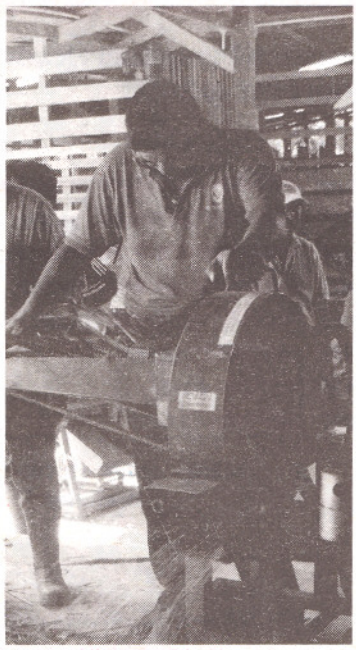
*Researchers and farmers **analysing the paddy fields**.*

The PREFERD way for smart farming

The Precision Farming Engineering and Research Group (PREFERD) was formed in 2004 to conduct a study on the precision farming of rice financed by the Malaysian Centre for Remote Sensing (MACRES), now known as the Malaysian Remote Sensing Agency. With a RM1 million budget, PREFERD conducted studies in five specific components, namely soil variability mapping, rice yield mapping, geospatial information system (GIS) modelling, improving paddy field water management and variable rate treatment of agricultural inputs. The study was carried out under the Tanjung Karang Rice Irrigation Scheme (TAKRIS), located on a flat coastal plain in the Northwest Selangor Integrated Agricultural Development Area (IADA).

The PREFERD group was formerly operating under the Smart Farming Technology Laboratory in the Institute of Advanced Technology (ITMA) at Universiti Putra Malaysia, but was recently upgraded to its own premises known as the Smart Farming Research Centre (SFRC) located in the Faculty of Engineering at UPM. The SFRC provides consultancy services to government agencies as well as the public in their area of expertise, and carries out research activities in the precision farming discipline in the rice and oil palm industry.

PREFERD consists of researchers, academicians and scientists with various relevant backgrounds with more than 10 years under their belts. All members of the SFRC are staff of UPM, and it currently hosts three professors, three associate professors, seven lecturers with doctorates and three research officers. Successful products resulting from SFRC research are marketed through UPM Holdings, UPM's business arm. For smart farming products like Web smart Farmer, Viras-Rader and SOILPROP, PIDMAMS Smartfarming, a subsidiary of UPM, takes over the marketing. turned into organic fertiliser.



Professor Ir Dr Mohd Amin Mohd Soom

Ezrin Mohd Husin

The UPM research team.

*The **Sawah Sempadan** Smart farming community centre.*

Inventions under PREFERD/SFRC

WEB SMART FARMER (WEB PETANI PINTAR): The Web Smart Farmer is a web-based information system that allows farmers to view their soil variability maps. Logging onto the web portal gives farmers a chance to facilitate smart farming practices based on the ECa variable rate map available online; it acts as a book-keeping site for activities carried out by the farmers, generates individual reports of farmer's lots to show costs and acts as a prompt for farmers to carry out activities at the right place and time, and with the correct amount.

Easily accessible and readily updateable, the web smart farmer portal is an opportunity for the farmers involved to keep track of their production costs, remind them to carry out important agricultural activities and help them to increase profitability by optimising their inputs like fertilisers and chemicals. The web portal also acts in an educational way by helping bridge the divide between urban and rural communities through its user-friendly interface and easy-to-use applications.

VIRAS RADER: VIRTUAL RAINFALL STATIONS WITH RADAR DERIVED RAINFALL: A new technique improving on previous attempts at runoff modelling, Viras Rader is based on a weather-derived rainfall estimation and hydrological model for a whole watershed (a basin-like-landform). Once again GIS steps in and with the information, creates uniform virtual rainfall stations throughout the watershed. RaDeR is the newly-developed programme that estimates rainfall from the raw weather data.

Thus far, the virtual rainfall stations have produced results proving a more representative rainfall distribution in the chosen areas, culminating in more accurate river runoff estimations.

The Viras Rader has the potential to provide early warning of impending floods due to heavy rain, more accurate data for rainfall-runoff modelling and hydrologic studies of river basins, as well as predicting the amount of rainfall at un-gauged locations. The product has commercial potential for river basin authorities, water resources specialists, the agriculture industry in general, land development authorities and the water management industry.