Farmer's Knowledge in Land Suitability Evaluation and Farmers’ Awareness in Organic Farming for Sustainable Agriculture: A Case Study in Perlis

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Abstract. Sustainable agriculture is the heart of organic farming, and human resources are playing a vital role in directing the community toward sustainable development in agricultural practices. The research objective is to evaluate the Farmer's Knowledge (FK) in land suitability variables for crop type’s suitability in Perlis. After that, the collected spatial information variables applied to allocate the spatial distribution for four main crop types in Perlis. Besides that, to investigate farmer’s awareness in organic farming in achieving sustainable agriculture and at the same time to identify young participants in the agriculture field. Participatory Geographical Information System (PGIS) practices and mixed-method approach has applied to collect spatial data information in the study area. Spatial data interpolated using the Kriging method in GIS software. It found that soil types and soil suitability are the most important variables that classed by farmers in land suitability evaluation. The spatial distribution map of crop suitability has the potential to indicate agreement or conflict with a land resource development for the study area. The results show the farmer's awareness in applying organic farming still low, with the percentage of applying organic fertilizer is 18%. Besides, the results indicate that the young generation has a small contribution, with 30% involved in the agriculture sector. Nowadays, the participation of the young farmers is more realistic in applied new technology for instance Precision Agriculture (PA) practices.

1. Introduction

Precision Agriculture is providing reliable tools to achieve sustainable agriculture with different types of sensors, positioning and navigation systems, digital mapping, remote sensing, GIS and variable rate technology. The incorporate geostatistics (ordinary kriging), remote sensing, and geographic information system (GIS) technologies to improve the qualitative land suitability assessment [1]. Based on the Human Development Index (HDI) report initiates a 0.804 index for the 2018 year. Higher HDI, higher adoption rate, and success of using new technologies, like those involved in precision agriculture systems [2]. The term Farmers' Knowledge (FK) refers specifically to the
knowledge of farmers in the study area, whether this knowledge is traditional, modern, or mixed traditional, and modern knowledge [6].

Ministry of Agriculture and Agro-Based Industry Malaysia has implemented Malaysian Good Agricultural Practices (myGAP) certification and (MyOrganic) certification to initiate the farmers in producing quality and safe agricultural products and reducing environmental pollution.

Usually, knowledge of farmers in agriculture is not taken into account in decision-making plans, especially in land suitability evaluation. Matching crop requirements with the resource available through land suitability analysis has become an urgent need to sustain the productivity of agricultural land in the study area [8]. Land suitability evaluation can contribute towards better land management, mitigation of land degradation, and designing land use pattern that prevents environmental problems through segregation of competing land uses [4]. The agro-food sector becomes very crucial to fulfil the food demand in the next decade with safe food. Agriculture in Malaysia is categorized using high levels of fertilizer and manure applications and cause environmental pollution [7]. It found that 80% of farmers practice unsustainable farming practices, including exceeding the recommended amount of pesticide application and not following the pesticide application schedule [5]. Economic growth in the agricultural sector has been less favourable, the migration of people between the ages of 20 and 34 is significant, and this process could disrupt the activities of the agricultural sector in Perlis state [3].

This research is conducted in Perlis as the agricultural industry is the leading economy contribution. Perlis, located along the equatorial path with a tropical monsoon climate, enables agronomic activities to be carried out throughout the year. Figure 1 shows the statistic data of land-use types reported by the Perlis State Government. It exposed the importance of the agriculture sector for the Perlis economy and essential for the next generation to sustain this sector.

![Figure 1. Total area in a hectare (ha) of land-use types in Perlis for the 2017 year.](image)

2. Methodology

2.1. Site Visit and Data Sampling
Mixed method research has applied during data sampling to do more observation and understanding of the research study. The spatial information of the farmer's land unit had recorded in the GIS database for further analysis. A total of 142 farmers were interviewed, having an agricultural background, and have their own orchard or farm. The selection point was choose surrounding Perlis area and based on permission of the land unit’s owner to conduct the interview. Figure 2 shows the point sampling of the farmer's land unit of rubber, *harumanis* mangoes, paddy and oil palm that overlay with Digital Elevation Model (DEM) as references.
Figure 2. Point sampling of farmer's land unit location.

2.2. Spatial Analysis Processing
Digital analysis processing is the most common process in any spatial data and raster image. The data points and raster images compulsory projected into the same coordinates system. After that, the farmer's knowledge in land suitability evaluation for four crop types, represented in the spatial distribution map. This process had run using the Kriging model, which interpolate the spatial variables data of a Farmer's Knowledge. The formula for the interpolators formed in equation (1) as a weighted sum of the data.

\[ \hat{Z}(s_0) = \sum_{i=1}^{N} \lambda_i \, Z(s_i) \]

Where:
- \( Z(s_i) \) = the measured value at the \( i \)th location
- \( \lambda_i \) = an unknown weight for the measured value at the \( i \)th location
- \( s_0 \) = the prediction location
- \( N \) = the number of measured values

3. Results and Discussions

3.1. Land Suitability Variables
There are several land suitability variables of those farmers able to evaluate and identify. These variables represent in table 1 below. It showed soil types are the most critical criteria, with 37% followed by soil suitability 22%, climate 19%, land use 13%, and topography 9%. Farmers distinguish soil types indicator based on soil color and indigenous soil names. For the soil suitability factors, the farmers appraise the topsoil content such as PH level, soil depth, and soil texture. For the climate factors, farmers evaluate based on weather conditions throughout the year. Besides that, farmers
appraise land-use variables as the suitability area for agriculture land, drainage network, and access road. Lastly, farmers evaluate topography for crops suitability based on a flat, medium, or hilly area.

**Table 1.** Land suitability variables used by farmers for ranking crop suitability evaluation.

| Suitability Variables | Importance Criteria (%) | Participants (n=142) |
|-----------------------|-------------------------|----------------------|
| Soil Types            | 37                      | 52                   |
| Soil Suitability      | 22                      | 31                   |
| Topography            | 9                       | 13                   |
| Land use              | 13                      | 19                   |
| Climate               | 19                      | 27                   |
| **Total**             | **Σ100**                | **Σ142**             |

3.2. Percentage of Fertilizer Used in Agriculture Activities
From the analyse data quantitatively, the percentage of farmers applied chemical fertilizer for the crop is 75%, as represented in figure 3. Several factors influence the farmer's awareness in organic farming, such as lack of information on organic agriculture practices, less exposure to the benefits of organic foods, and insufficient organic manure. Fortunately, most of the farmers have knowledge in preparing the perfect amount of fertilizer, soil management, and crop treatment as guided by relevant agencies and support by the government. Besides that, these crops require the right treatment and care because of the sensitivity treatment based on different soil types. However, it was virtuous if the farmers have their awareness of organic agriculture. This research found some small-scale farmers in Perlis have their initiative using organic fertilizer for their crops, and some of them knowledgeable in producing their own organic manure to cure the soil fertility of their land and increase the yield production.

![Figure 3. Types of fertilizer used in agriculture for the study area.](image)

3.3. Age Participants Distribution in the Agriculture Field
From the observation, young farmers more prepared to explore new technology, but undoubtedly, the older farmers have tremendous experience and shared valuable input for this research. Figure 4 shows the results of the age distribution of participants in agriculture for the Perlis area. It's showing there is a low contribution from young farmers compared to older farmers. Relevant agencies should implement the strategies and support the community to fascinate the young generation to involve in the agriculture sector.
3.4. Spatial Distribution of Crop Types Suitability

The farmers can evaluate the land suitability based on their experience and knowledge. The spatial distribution map for crop type’s suitability classed based on the participatory Farmers Knowledge approach shown in figure 5. The map produced using a spatial interpolation method that interpolates point sampling. It proved the south region most suitable for paddy and north area ideal for rubber, oil palm, and harumanis mangoes. The farmers evaluate that the north area is highly ideal for mangoes and rubber because of suitable soil type and soil suitability. From the site visit and observation, the production yield of oil palm crops inconsistent because of unsuitable soil and low water resources. The harumanis mangoes also need proper water resources and less suitable planted within the paddy area. For paddy, the production is high with suitable soil type with an appropriate system of irrigation. The rubber crop does not tolerate flood or wet areas but ideal in a hilly area with good soil structure. Several factors found to impact the sustainability in yield production that reported by farmers there are poor soil suitability, lack of agriculture knowledge, poor soil management, improper drainage network, soil infertility, and land degradation.
4. Conclusions

In conclusion, farmer's knowledge of agriculture can evaluate land variables for crop suitability but limited in the topsoil surface. The spatial output information of farmer's knowledge can be integrated with an expert to communicate local expertise to the planning authorities and development planning in Malaysia. Besides, able to contribute theory and practice in improving the communication between farmers and experts as well as contributes towards an improved land suitability recommendation.

Lately, agriculture has been challenging with a high cost in the maintenance of fertilizer and pesticide, pest attacks, and climate changes. Besides that, the lack of promotion of organic food awareness and organic farming awareness will impact the environment and health. The organic way becomes a solution in the same way-increasing yield but undoubtedly needs more hard work. The findings establish that is low organic farming applied, but the farmer's awareness in organic agriculture is increasing. So, the strategies should approach to minimize the usage of chemical fertilizer and pesticides among farmers.

The National Agrofood Policy (NAP4) highlights the direction to transform the agricultural sector to become more dynamic, progressive, and sustainable. The findings found that the low contribution of the young generation but they have high potential and awareness in using new technology. The author suggests that the government might develop a policy and awareness activity to appropriately inform the young generation of the benefit and returns from the agricultural business. From the research findings, the success of sustainable agriculture relies on government support, adoption of new technology, farmers' attitude, and awareness, community support, and agriculture knowledge.
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