DECISION SUPPORT SYSTEM WEB-BASED FOR VEGETABLE CROP PREDICTION BASED ON SOIL TYPE, WEATHER FORECAST AND CROP PRICE

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ABSTRACT

Malaysia is witnessing a rapid expansion of the agricultural revolution in tandem with technological progress, intending to optimize productivity while reducing resource use. Furthermore, technology such as the Decision Support System (DSS) might provide real-time crop and plant monitoring, save expenses, and enhance crop quality with the proper use. This study aims to help farmers or Malaysian residents start a new planting on their land by selecting the best vegetable crops suitable for their plots. The article explained a DSS web-based design to assist Malaysian citizens in selecting vegetable crops more wisely to be planted on their land in conjunction with soil type, weather forecasts and current crop price information. A DSS web could predict the best crop for a specific plot of land by selecting the exact place on the map given. This web shows crop suitability mapping by developing five modules: web mapping expert system, soil suitability analysis system, crop-soil-climate suitability system, crop price analysis using FAMA data with Application Programming Interface (API) and soil survey mapping system. The latest published crop price by FAMA is used in this system, while the weather forecast API from MET Malaysia is utilized for weather data on selected projected planting dates. This system will provide consulting, technical support, and professional advisory services concerning the production, encompassing issues of the suitable chosen soil, projected weather and market suitability in the selected region. This system can help farmers, agronomists, and agricultural organizations optimize farming techniques, increase crop yield, and lower risks related to weather-related events.

Key words: Decision Support System (DSS), crop suitability, weather forecast, crop price, soil suitability

INTRODUCTION

Agriculture is a crucial sector in the Malaysian economy. However, agriculture activities often face challenges due to unpredictable environmental conditions, such as climate patterns, rainfall, and temperature-humidity index (Elena et al., 2023). The fluctuation of climate change demands adopting sustainable agriculture practices, such as planting various crops and breeding specific plants better suited to the particular time frame of forecasted weather, including higher temperatures and less precipitation (Wiréhn, L. 2018). Farmers are confronted with the weather problem of agricultural production being impacted by climate change; thus, they have to take the necessary action in adaptation strategies to protect themselves from the effects of climate change (Muchuru, S. et al. 2019).

To produce a profitable crop, a farmer must be mindful of the moisture, light, rain intensity, and temperature. It is necessary to have comprehensive meteorological data, including historical records, current conditions, and projections, to expect a high yield. Decision-making technology needs to be invented to determine the suitable crops to be planted on specific land and areas at predicted times. Technology integration into agricultural decision-making has emerged as a critical avenue for ensuring food security, optimizing resource utilization, and enhancing overall crop productivity (Mohd Javaid et al. 2022). The Decision Support Systems (DSS) have played a pivotal role in this transformation, providing farmers and stakeholders with valuable insights from data analytics and machine learning. With the explosion of information, stakeholders and farmers may need a DSS to help make the right choices in agricultural management because they find it challenging and time-consuming to translate available information into a result. Therefore, to help them make accurate and evidence-based judgments, platforms such as decision support systems (DSSs) are required (Zhaoyu et al. 2020).

The decision on the right crop on suitable land, such as vegetables, is essential for optimum growth and yield productivity. Land assessment plays the function of matching land use to land quality required to minimize risk in farming. Land assessment is the process of matching the features of soil type for specific vegetable crops. Therefore, assessing a piece of land's appropriateness is crucial to deciding how to utilize its resources to maximize its carrying capacity for vegetable growth (Adewale et al. 2017).

The advent of DSS in agriculture marks a paradigm shift from traditional farming practices to a data-driven approach, offering a proactive means of mitigating risks and optimizing yield. This paper aims to develop a web-based DSS to predict the best crop for a specific plot of land by selecting the exact place on the map given with the interference data of metrological. A web-based DSS is designed to assist Malaysian citizens in selecting vegetable crops more wisely to be planted on their land in conjunction with soil type, weather forecasts, and current crop price information.

MATERIALS AND METHODS

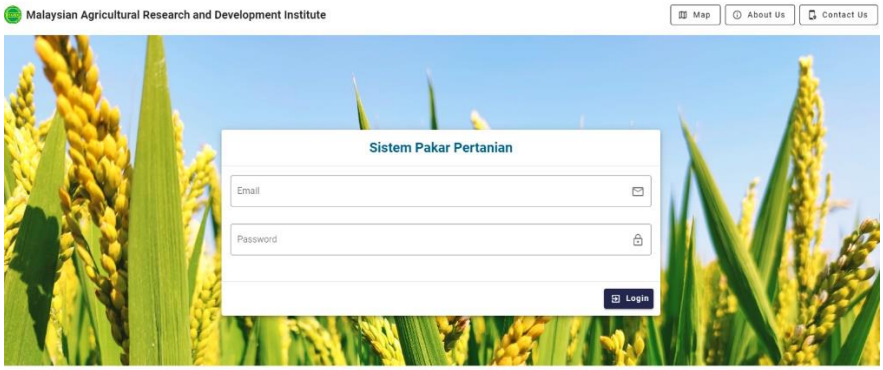
Design of vegetable crop prediction system

The vegetable crop prediction system can determine a suitable crop to be planted in Peninsular Malaysia based on soil type, elevation, climate, and current market price for the crop. As a part of the system design mechanism, DSS provides expert opinions based on datasets of vegetable crops, soil type, and climate as default options and also offers the option to suit the chosen crop with the crop market price data.

Five basic elements that make up the design of a vegetable crop prediction system include: (i) area mapping, (ii) crop requirement, (iii) soil characteristic map, (iv) climate data including rain and temperature, and (v) crop market price. The system will suggest suitable crops to be planted in the chosen area and the best period to start planting. It also gives the market price estimation to sell the crop at the end of the crop production date. In the DSS, scientific algorithms and procedures are adopted to evaluate the soil type and determine a crop list.

The DSS is a computer program designed as a web-based platform and incorporated into an intuitive user interface (Figure 1). DSS may be accessible from PCs or laptops with a guaranteed internet connection since it can be used with any primary web browser.

Figure 1: Home screen of Vegetable Crop Prediction System (https://atania.app)



Databases

Data used for system development was obtained from secondary sources, including a series of vegetable crop data extracted from publications, websites, and maps.

The dataset embedded in DSS consists of the following:

Vegetable crop information: The crop data consisting of different soil types, elevation and climate requirements, cultivated under some parameters, their evaluated measure of suitability and some other factors shall be pre-processed and cleaned up to be adaptable with the system algorithm. The primary references are from the Vegetable Book published by MARDI, journals, the website, and the Standard Operating Procedure of Vegetable Planting developed by the Department of Agriculture Malaysia (DOA).

Location information: ArcGIS Web mapping is used as the system's map tool. The function is for Map Navigation, Layer and Legend control, Searching and Identifying Locations where to cultivate the crop.

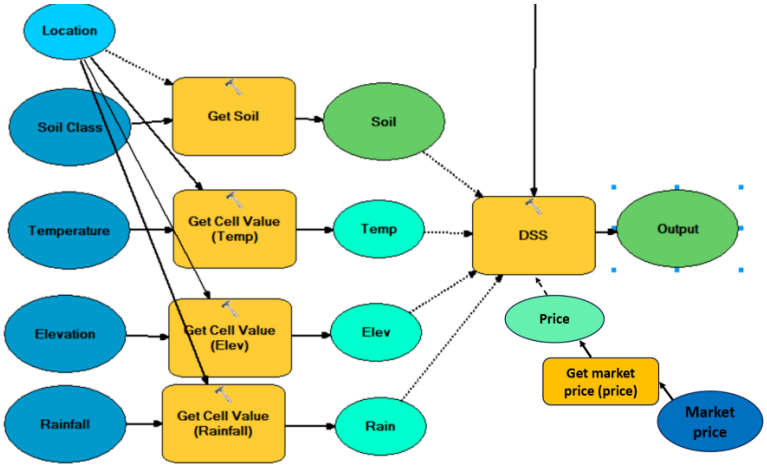
Soil information: Soil characteristic parameters were extracted from the peninsular Malaysia soil map data from DOA using Arc GIS. The district's boundary in Malaysia was overlayed and clipped from the shape file, and a new shape file was generated containing soil information for each district.

Climate forecast information: The climate data is accessed from the Malaysian Meteorological Department (MET) website for daily forecasts for one week and long-term climate forecasts (MET, 2023). The data is manually extracted, processed and interpolated.

Vegetable price information: The market price for selected crop is accessed from the Federal Agricultural Marketing Authority (FAMA) website. The web displays the average price changes for a select few veggies at the market level in relation to the average process from the previous week. This data aims to inform customers about the fluctuations in vegetable costs and the factors contributing to them. The price list shown on the website is divided by state and commodity.

The framework for DSS of vegetable crop prediction is shown in Figure 2.

Figure 2: The framework for the DSS of Vegetable crop prediction



RESULT AND DISCUSSION

Implementation and Results

The DSS has an interactive Graphical User Interface and responsive web-based system. The user has to input the required information. The system provides the mapping area, crop specifications, and climate parameters based on developed algorithms and scientifically accepted formulas, as in the DSS engine.

These are the required inputs for DSS.

(a) Location information: The user has to enter or select the state or district. State and district are required parameters as the agroclimatic information is based on the district (Figure 3). ArcGIS Web mapping tools enabled the identification of suitable

locations for crop cultivation, utilizing functions such as map navigation, layers, and legend control. Mapping tools facilitated the identification and visualization of specific zones suitable for cultivation in the selected districts.

(b) Soil information: Based on the selected district, the type of soil is displayed on the right panel. The system extracts the weather information from a selected area to process the suitable list of crops to be cultivated at that area (Figure 3). The system used soil characteristic parameters extracted from soil map data to determine soil suitability for various crops in each district. Generation of new shape files with soil information for each district provided a foundation for tailored crop recommendations. 6 main soils in Malaysia has been categorized to be suit with crop

(c) Crop information: There are several types of crops such as horticulture, and vegetable crops that are suitable to be cultivated in the corresponding district. The user has to select among the crops listed to start a cultivation. Evaluation of crop suitability measures from vegetables book published by MARDI, Department of Agriculture Malaysia, journal and other resources. The system offered specific crop recommendations based on the pre-processed data. All suitable crops will be listed based on location and soil information.

(d) Climate information: Based on the crop selection, the user can obtain a timely planting date in Malaysia based on the climate forecast for a year. Users can select the best month to start planting based on a suitable forecast climate to be suited to the crop chosen in that month. (Figure 4). The manual extraction and processing of this climate data ensure that the system can account for upcoming weather conditions in decision-making of planting activity to be done in the next 6 months to 1 year.

(e) Price information: Based on crop selection, market price data can be seen from the system so that users can select the most profitable crop to be planted in the selected area. (Figure 5). This information is crucial for understanding market trends and the economic viability of different vegetable crops. Potential farmer can decide which crop to be cultivated and produce high profit based on current price of crop orice.

The integration of data sources which are soil, climate and price provides a comprehensive framework for the decision support system. The system can offer detailed and accurate recommendations for vegetable crop cultivation based on the processed data. By utilizing real-time and recent data climate forecasts the system can deliver up-to-date advice to farmers and agricultural planners. This enhances the relevance and accuracy of the recommendations. While the method specifies that data is manually extracted and processed, this can be time-consuming and potentially error-prone. Automating data extraction and processing where possible could improve efficiency and reliability.

This system has potential for future improvements; by leveraging additional data sources, such as remote sensing data for soil and vegetation monitoring, or integrating machine learning models for predictive analytics, the system could offer even more nuanced and tailored recommendations.

Figure 3. A mapping tool for location selection and the soil and the crop suitability displays

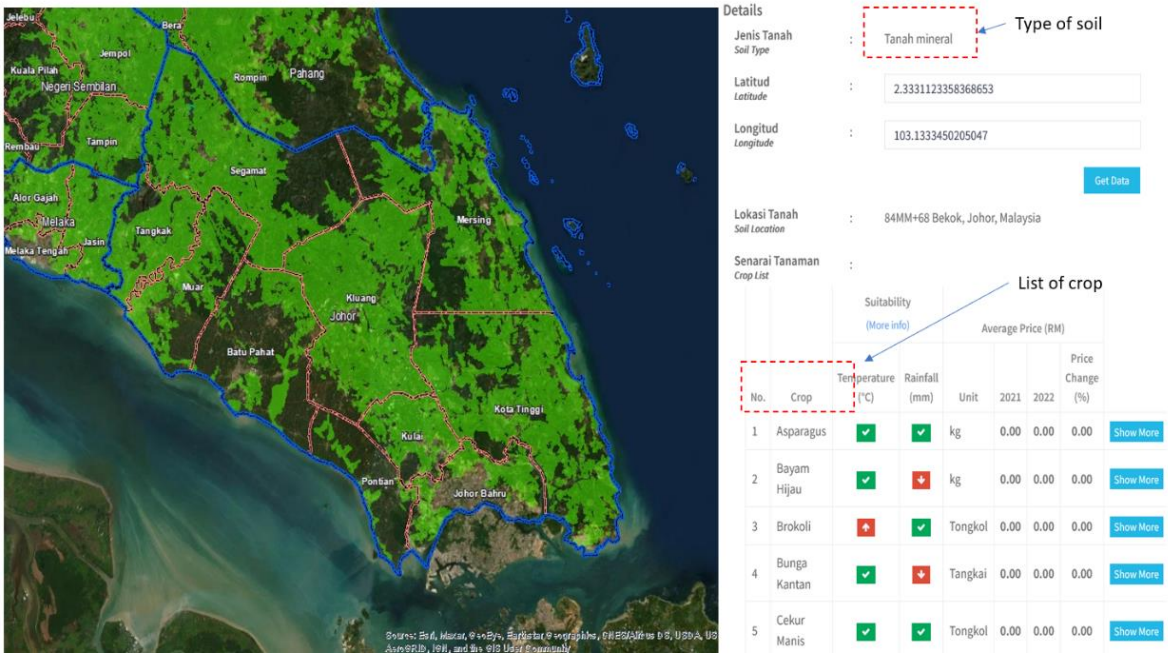


Figure 4: Climate information for users to choose the date to start planting

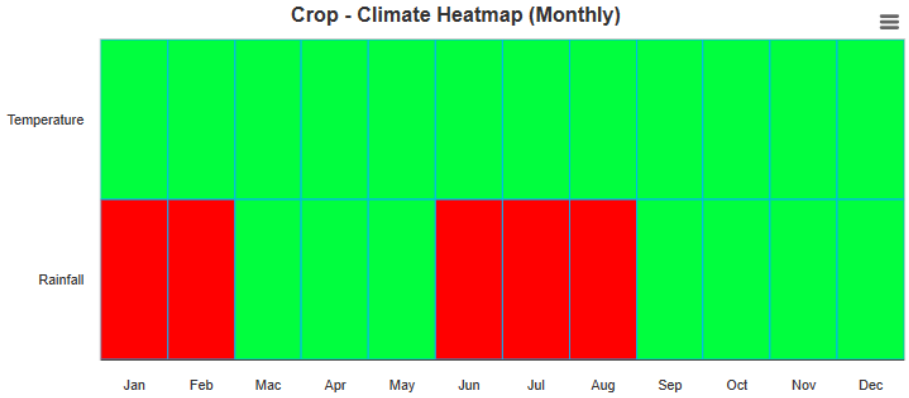
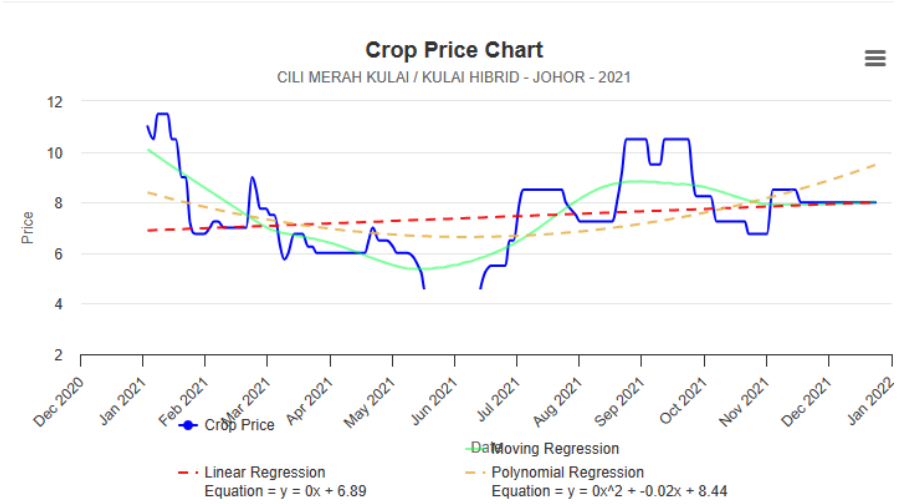


Figure 5. The display of crop price at selected month and district



CONCLUSION

The DSS model for identifying crop suitability to be planted on specific land with the assistance of climatic and economic models is a helpful tool for predicting better production yield due to climate change impacts and formulating adaptation strategies. This system will provide consulting, technical support, and professional advisory services concerning the production, encompassing issues of the soil suitability, projected weather and market suitability in the selected region. The web-based system uses data from expertise in the horticulture area, prediction climate data from the meteorology department, and a collective market price gathered from farmers by FAMA. It is believed that stakeholders in the agricultural sector, industry, researchers, and farmers would find this system beneficial.

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