International Journal of Informatics and Communication Technology (IJ-ICT)
Vol. 15, No. 1, March 2026, pp. 228~237
ISSN: 2252-8776, DOI: 10.11591/ijict.v15i1.pp228-237

Design and development of machine learning-based web application for oil palm yield prediction

Yuhao Ang[1], Helmi Zulhaidi Mohd Shafri[2], Yang Ping Lee[3], Shahrul Azman Bakar[3], Hwee San Lim[4], Rosni Abdullah[5], Yusri Yusup[6], Mohammed Mustafa Al-Habshi[2]
[1]Faculty of Sustainable Agriculture, Universiti Malaysia Sabah Sandakan Campus, Sandakan, Malaysia
[2]Department of Civil Engineering and Geospatial Information Science Research Centre (GISRC), Faculty of Engineering, Universiti Putra Malaysia (UPM), Serdang, Malaysia
[3]Geoinformatics Unit, FGV R&D Sdn Bhd, FGV Innovation Centre, Bandar Enstek, Malaysia
[4]School of Physics, Universiti Sains Malaysia (USM), Gelugor, Malaysia
[5]School of Computer Sciences, Universiti Sains Malaysia (USM), Gelugor, Malaysia
[6]School of Industrial Technology, Universiti Sains Malaysia (USM), Gelugor, Malaysia

Article Info

Article history:

Received Mar 3, 2024
Revised Jun 30, 2025
Accepted Aug 6, 2025

Keywords:

Artificial intelligence
Deep learning
Machine learning
Oil palm yields
Remote sensing
Web application

ABSTRACT

The prediction of crop yields is influenced by various factors such as weather conditions, agronomic practices, and management strategies. Accurately predicting oil palm yield is crucial for sustainable production, as it plays a significant role in global food security. Challenges such as climate change and nutrient deficiencies have adversely affected yields, highlighting the necessity for a specialized web application tailored to the oil palm industry. This study presents a machine-learning-based web application that utilizes a deep learning model to estimate oil palm yields by integrating key parameters, including weather, agronomy, and satellite data. The application features a user-friendly interface and a dashboard for comparing predicted and actual yields, enhancing user engagement and facilitating collaboration among stakeholders. By deploying this tool on the cloud, plantation managers can make informed decisions early in the yield prediction process, ultimately improving plantation management and profitability. This web application is designed to provide valuable insights to stakeholders, contributing to effective decision-making in the oil palm sector.

Corresponding Author:

Helmi Zulhaidi Mohd Shafri
Department of Civil Engineering and Geospatial Information Science Research Centre (GISRC)
Faculty of Engineering, Universiti Putra Malaysia (UPM)
43400 Serdang, Selangor, Malaysia
Email: helmi@upm.edu.my

1. INTRODUCTION

Yield prediction in oil palm is crucial in maintaining food security, as it is an important crop for producing oil and providing the world with sufficient food. Oil palm, Elaeis guineensis, is the most important oil crop, supplying about 40% of all traded vegetable oil [1]. Additionally, it is the most efficient crop as it generates an average yield of 3.8 tonnes per hectare, compared to rapeseed, sunflower and soybean oil at 0.8, 0.7 and 0.5 tonnes of oil per hectare of land respectively [2]. In terms of oil production, oil palm generates 7.6, 4.75 and 5.43 times more oil than soybean, rapeseed and sunflower, respectively [3]. In recent years, the effects of climate change have tremendously reduced the production, resulting in unstable production [4]. Nowadays, technological advances such as artificial intelligence and remote sensing play a major role in predicting crop yields [5]. Remote sensing can provide vital data on various factors that influence palm productivity and growth by using vegetation indices. Artificial intelligence plays a crucial role in predicting oil palm yields by leveraging advanced algorithms and techniques to analyze complex data and identify patterns. Therefore, these technologies are significant in detecting the degradation in oil palm yields.

Regardless of classification and regression purposes, machine learning has proven to be effective and is used for prediction across wide range of applications. Digital agriculture has been significantly improved by the advanced development of artificial intelligence [6]. Data processing with machine learning plays an important role in yield prediction of oil palm. In line with crop yield prediction, several machine learning models such as support vector regression, random forest, gradient boosting regression tree, and neural networks have been developed [7]. Since the data comes from multiple sources, deep learning algorithms are essential for solving the complexity of data. With multiple layers in the neural networks, deep learning algorithms can analyze large amounts of data related to various factors such as climate, soil conditions, agronomics, satellite imagery, and historical yield records [8]–[10].

Recent studies have used machine learning techniques to predict oil palm yield. Oil palm yield can be influenced by many factors, such as climate change, agronomic factors, and many others. Rapid identification of yield status is essential to detect stressed areas with low yield and taking appropriate measures. Khan *et al.* [11] tested various machine learning models such as extra tree, AdaBoost, random forest, gradient boosting, decision tree, and others to predict oil palm yield. They used twelve weather and three soil moisture parameters and input into the model. Based on the findings of the study, Adaboost and extra tree algorithms achieved better performance compared to other tree-based ensemble models. Furthermore, [12] used K-nearest neighbor model to estimate oil palm yield with agrometeorological data. The accuracy of the study are mean absolute error (MAE)=0.1155, mean squared error (MSE)=0.0216, root mean squared error (RMSE)=0.1448, R2=0.7730, root mean squared logarithmic error (RMSLE)=0.0604, and mean absolute percentage error (MAPE)=0.0834 in all ten folds of hundred fits in the training process and achieved R2 of 0.781 for test data. In another study, oil palm yields were estimated using random forest, least absolute shrinkage and selection operators, extreme gradient boosting, recursive portioning, regression trees, and neural networks [13]. The model was based on the retrieval of moisture and vegetation indices from remote sensing data. The result of the study showed that the neural network achieved the most accurate performance for multispecies information.

Accessibility of the model is important to ensure the machine learning model can be accessible to the industry for oil palm yield prediction. The difficulty with prediction is that the plantation manager utilizes the tool on a private basis. Prediction tasks are usually implemented in unfriendly, too complicated web application that only developers understand how to run since they are not publicized [14]. To enhance accessibility for the oil palm industry, it is imperative to ensure that the prediction application is openly accessible and equipped with a user-friendly interface. Nevertheless, there is still a lack of studies on the development of a machine learning-based web application for implementing yield prediction in oil palm. Machine learning-supported web applications have been built for prediction in a variety of disciplines such as healthcare, civil engineering and agriculture [15]–[18]. With the advancement of digital agriculture solution, a machine-learning web-based application has been used in agricultural management such as yield prediction, crop identification, livestock health monitoring and many others [19]–[21]. The web application allows the user to enter parameters into the interface to receive the outcome of the predictions. Additionally, the trained model was chosen based on the most accurate machine learning model that includes key aspects, which influence the prediction of yield in oil palm. Therefore, it is vital to develop a machine-learning-based web tool for estimating oil palm yields utilizing key factors in order to assist plantation managers in computing the yield budget. The objective of this study is to develop the web application for the prediction of oil palm yield. Therefore, the yield prediction model should be deployed and substantially integrated into a cloud-based web application.

2. RESEARCH METHOD

2.1. The development of a web application for yield prediction

Developing a web application involves three main parts: creating a dashboard to visualize the yield outputs, designing the graphical user interface for front-end web development, and developing the web application for yield prediction. Finally, the application is published to a cloud platform. The Streamlit, an open-source Python framework for building web apps for machine learning and data science, was used to create the web application framework. The advantage of using Streamlit is that it reduces the front-end development by using built-in CSS [22]. An overview of the overall development process for a web application for yield prediction can be found in Figure 1.

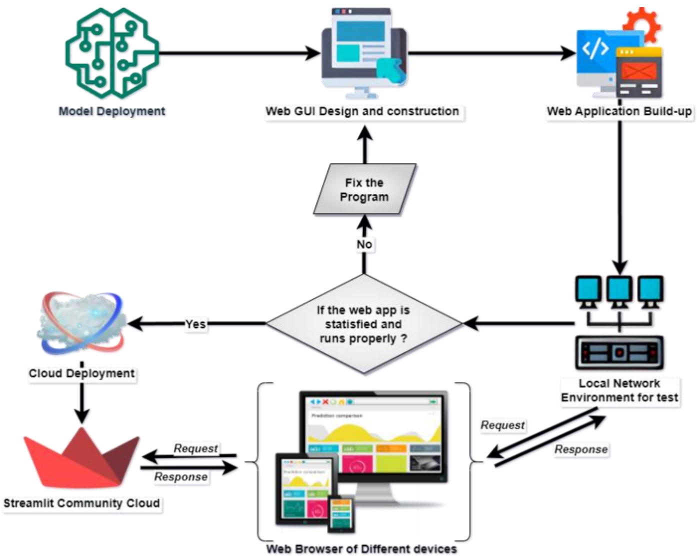

Figure 1. Overview of the development of web application used for predicting oil palm yield

2.1.1. Creating the dashboard for visualizing yield prediction trend

The yield prediction results generated from the best yield prediction model were published as a dashboard to visualize the yield prediction trend. The yield dataset from 2021 was used to compare the patterns between the actual yield and predicted yield. The yield dataset was then published in the dashboard application. Line graph was created to plot the actual yield. Multiselect option was then added to provide users with options for comparing actual and predicted yield through the display of line graph.

2.1.2. Designing the graphical user interface for the frond-end web development

The first page of the web application contains a brief introduction that describe the structure of the application. To add a background image to the web, markdown presentation was combined with CSS. In this case, controlling the layout and style of a webpage written in a markup language such as HTML or XML required a basic understanding of HTML and CSS. Elements such as color, font, text size, and the layout of elements are designed in accordance with the oil palm-related background image. To create multipage applications, the dashboard application was then designated as the main page, followed by prediction application. In order to facilitate the end-user in making the prediction, a set of values as inputs for all the parameters were designed. To increase interactivity, text input and sliders widgets were developed in order to increase interactivity by allowing users to enter parameter values and select values based on multiple selections.

2.1.3. Developing the web application and publishing the app to a cloud platform

Applying the best yield prediction model to predict is the vital stage in production. The yield prediction model was exported and loaded to use the model into the program. We deployed deep neural network (DNN) that achieved the highest accuracy as the best prediction model. A more detailed explanation of how the model was constructed can be found in [23]. First, web application was firstly launched in local host in order to ensure the program is properly run. Then, web application was published in the Streamlit cloud for the general public to access. Figure 2 shows how the developed machine learning-based web application works in predicting oil palm yields. First, the process starts from the user inputting the parameters that currently affects yields. Then, the system will process the data to be ready for the prediction process, which is done by the deployed yield prediction model. The user of the application can access the application using a browser, in a mobile phone, desktop, or any device.

2.1.4. Usability testing

The usability test was conducted and used questionnaire with 9 subjects. This number has exceeded the threshold of five subjects that can correctly identify 80% of software application problems, which is considered to minimize the cost and benefit ratio of evaluation [24], [25]. Most of the subjects were researchers and academicians. In this part, the classic Likert scale was selected for the questionnaire. Table 1 shows questionnaire questions and their scales. The questions were set to determine the satisfaction behaviors of users on specific features of web application.

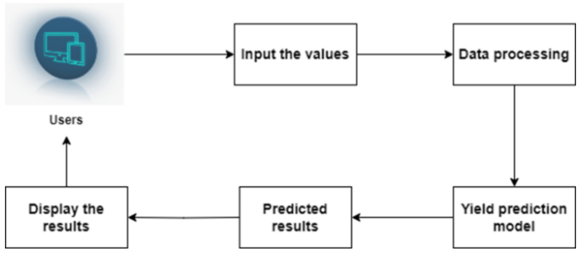

Figure 2. The process of predicting oil palm yield using a machine learning-based web application

Table 1. Questionnaire sorted in five-point Likert scale

ID	Questions	Scale				
Q1	The way the user interface is designed is easy to understand	5	4	3	2	1
Q2	Multiselect options enable me to show the trend of predicted and actual yields on the graphs.	5	4	3	2	1
Q3	This application for predictions is easy to use with the slider and input values.	5	4	3	2	1
Q4	The application would be useful to me in my daily routine job if I needed to know the yield status of mature oil palm trees	5	4	3	2	1

3. RESULTS AND DISCUSSION

3.1. The pages of web application

Web application comprises two main pages: dashboard and yield prediction. For the first page, dashboard is created using the panel yield data and the trend. On the following page, yield prediction consists of graphical user interfaces for the key variables used to perform the prediction.

3.2. The dashboard for yield prediction pattern

Figure 3 shows the panel data and yield prediction output, as shown on the dashboard. In order to visualize the panel data and yield prediction output, the user can display panel data obtained in 2021 across blocks by using multi-selection options. As an outcome of the selection, the line graph showed the patterns between the prediction and actual yield in the Figure 4.

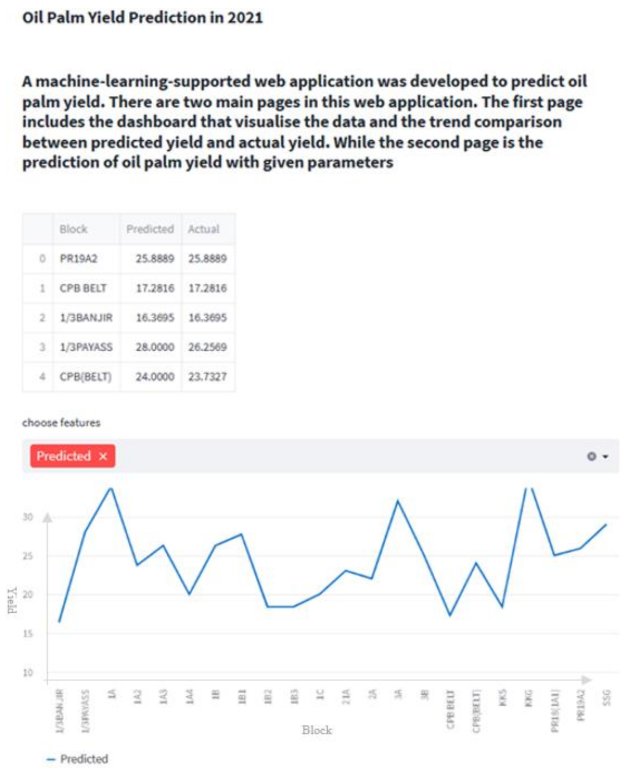

Figure 3. The dashboard shows the comparison of predicted and observed yield and the predicted trend

Figure 4. The trend comparison between predicted yield and the actual yield

3.3. Web app

The most accurate yield prediction model is selected for the development of the web application. The DNN model has highest accuracy to the model evaluation and can be used as a systematic framework for yield prediction by end users. The DNN model was used and integrated into a user-friendly interface where users can input values and receive predictions. To allow end-users to interact with the model efficiently, Streamlit is used to integrate the machine learning model into a web interface for oil palm yield prediction. Figure 5 shows the web interface for the key parameters used to predict yields.

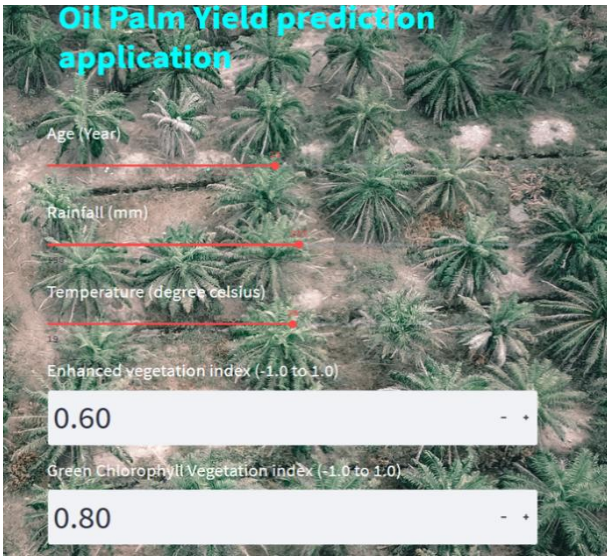

Figure 5. Web application implementation for input parameters

The inputs were provided to include all the parameters that influence the yield of oil palm in the web interface, as shown in Figure 6. The input parameters used for the prediction are age, rainfall, temperature and vegetation indices (EVI, GCVI, GNDVI, MSAVI, NDVI, and SAVI) and nitrogen content. The program query machine learning analysis by collecting the user's request, include the input values. The model uses the input data to predict the yield through computation. The outcome is subsequently retrieved by the server and send back to the user. The outcome for the yield prediction is shown in Figure 5.

Figure 6. The output generated from the web application

3.4. Usability testing

In overall, the web application obtained average score for the first question (Question 1, mean 3.66) although two of the participants could not agree with the understandability of the web application. This means that the web application attained a very good understanding of how the web application of yield prediction is performed. Most of them agreed that the application can be adopted to the daily routine job (Question 4, mean 3.555), while three of them stand neural. Similarly, most of the subjects believe that the interfaces of the designed slider and input values are easily used for the user (Question 3, mean 3.444). Despite the lower score in average for (Question 2, mean 3.22), there is dissatisfactory of the multiselect options shown for showing the trend of prediction. Hence, there is still a room of improvement regarding this outcome.

In general, the feedback received in the usability test shows that the web application has been moderately received by the subjects and that it needs further improvement as there were plenty of subjects who felt less comfortable using the web application. There were moderate in overall regarding the presentation and usability of the application. Subject critically commented that the web application is difficult to interpret by plantation management since it requires the knowledge of remote sensing and the skill of processing the satellite data in order to acquire the input values for each vegetation indices. In order to encounter this problem, further improvement will focus on providing the references for vegetation indices that can guide the user to understand better the terms and the implementation. Apart from this, some subjects also commented on the background and the font and the placement of the labels that is quite difficult to be seen by the user. Furthermore, the subject suggests to put a map of plantation that can be used to show predicted and actual yield for each block for improved data visualization. Based on the responses to the web-specific questionnaires, we found that the subjects appreciated the web application that was built for oil palm yield predictions with parameters. Nevertheless, further improvements will be made based on the feedback provided by the subjects.

3.5. Advantages of using web application for predicting oil palm yields

We proposed low-code web solution using Streamlit, which can effortlessly deploy machine learning models into interactive data driven web apps. The advantages of using this solution for predicting oil palm yields is embracing python scripting, treating widgets as variables, and instantly deploying apps with Streamlit cloud [26]. This solution works upon growing Streamlit app line by line instead of starting with a predefined layout [27], [28]. Using fewer codes generated by the open-source Python-based framework and adopting a small amount of the HTML/CSS languages to build a web application may not require a large amount of effort on the front-end web development.

An effort was made to bridge the knowledge and experience of experts in order to create a web application that supports the yield prediction process on an equal footing. It is important for the plantation management responsible to make an early yield prediction to accurately determine the problems that affect the yield based on the given factors. The development of the web application has the advantage of facilitating communication between researchers and stakeholders. With the development of a web application, stakeholder and plantation managers can interact with the graphical user interface to display the updated prediction output and input the required parameters for the prediction. Therefore, the stakeholders and plantation managers can know the current status of yield in particular areas within plantations and make a prediction based on the input parameters. From the perspective of optimizing agricultural economic resources, the most crucial aspect for stakeholders to consider when preparing the profit and loss yield budget is the estimated oil palm yield, which is influenced by external factors or the practices implemented throughout the year. This information is of great of interest for planning and executing the next round of schedule for plantation management.

4. CONCLUSION

In this study, a low-code web framework was proposed and developed to construct machine-learning-based web applications that display trends of oil palm yields and facilitate the prediction of oil palm yields. The dashboard was displayed to show the current prediction that can be used to compare with the actual yield. This will facilitate the interactions between the researchers and stakeholders during the presentation. Furthermore, the online dashboard can be timely updated depending on the demands and the requirements in the particular area. A web application for oil palm yield prediction was built from the published deep learning model with key parameters. The web application allows user to input the values of parameters and estimate yield for next cycle. Additionally, a usability test was run to determine the web application's usability. According to this usability test, users have a moderate level of acceptance for the product, but there is still room for development. It was suggested by a number of subjects that the web background and font-end can be changed to one with greater visibility. Furthermore, some individuals stated that the building of the web application may be unknown to the plantation administration because most of the elements was established with geospatial domain. As for web-specific questions, they have been very optimistic and test subjects generally found the web application to be useful. Therefore, as a future development, a clear explanation and guide will be included to assist plantations in better understanding the structure of the prediction. Future studies will also include more important aspects that can affect the yield closely and are in line with the actual situation in plantations. Plantation map will be added into the web application as a map reference in future studies. Future studies will also consider the established cloud services such as Amazon web service, AZURE and Google Cloud for large-scale yield forecasting. With the adoption of machine-learning-based web application, the plantation management is able to conduct accurate yield prediction and make informed decisions regarding the root cause indicating a decline in yield given the available parameters for effective plantation management and planning.

ACKNOWLEDGEMENTS

We would like to thank the Malaysian Ministry of Higher Education (MOHE) for funding through the Malaysian Research University Network's (MRUN) Long-Term Research Grant Scheme (LRGS). The FGV team members are also acknowledged for their contributions to the research.

FUNDING INFORMATION

The study was funded by the Ministry of Higher Education Malaysia, under the Malaysian Research University Network's (MRUN) Long-Term Research Grant Scheme. It is included in the research programme 'A Big Data Analytics Platform for Optimizing Oil Palm Yield via Breeding by Design' (Grant Number: 203.PKOMP.6770007) as the project 'Geoinformatics Data for Palm Oil Yield Prediction Using Machine Learning' (Vote Number: 6300268-10801).

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Yuhao Ang	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Helmi Zulhaidi Mohd Shafri	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yang Ping Lee				✓	✓	✓	✓	✓	✓	✓	✓	✓		
Shahrul Azman Bakar				✓	✓	✓	✓	✓	✓	✓	✓	✓		
Hwee San Lim				✓	✓	✓	✓	✓	✓	✓	✓	✓		
Rosni Abdullah				✓	✓	✓	✓	✓	✓	✓	✓	✓		
Yusri Yusup				✓	✓	✓	✓	✓	✓	✓	✓	✓		
Mohammed Mustafa Al-Habshi				✓	✓	✓	✓	✓	✓	✓	✓	✓		

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

In accordance with the research agreement between UPM and FGV, the datasets generated during and/or analyzed during the present study are not publicly available and cannot be disclosed to third parties for the time being.

REFERENCES

[1] D. J. Murphy, K. Goggin, and R. R. M. Paterson, "Oil palm in the 2020s and beyond: challenges and solutions," *CABI Agriculture and Bioscience*, vol. 2, no. 1, p. 39, Oct. 2021, doi: 10.1186/s43170-021-00058-3.

[2] D. Khatiwada, C. Palmén, and S. Silveira, "Evaluating the palm oil demand in Indonesia: production trends, yields, and emerging issues," *Biofuels*, vol. 12, no. 2, pp. 135–147, Feb. 2021, doi: 10.1080/17597269.2018.1461520.

[3] G. Yue, B. Ye, and A. A Suwanto, "The unavoidable palm oil can be sustainable," *International Journal of Oil Palm*, vol. 3, no. 2, pp. 29–39, May 2020, doi: 10.35876/ijop.v3i2.50.

[4] A. Abubakar, M. Y. Ishak, and A. A. Makmom, "Impacts of and adaptation to climate change on the oil palm in Malaysia: a systematic review," *Environmental Science and Pollution Research*, vol. 28, no. 39, pp. 54339–54361, Oct. 2021, doi: 10.1007/s11356-021-15890-3.

[5] N. N. Misra, Y. Dixit, A. Al-Mallahi, M. S. Bhullar, R. Upadhyay, and A. Martynenko, "IoT, big data, and artificial intelligence in agriculture and food industry," *IEEE Internet of Things Journal*, vol. 9, no. 9, pp. 6305–6324, May 2022, doi: 10.1109/JIOT.2020.2998584.

[6] I. Dasgupta, J. Saha, P. Venkatasubbu, and P. Ramasubramanian, "AI crop predictor and weed detector using wireless technologies: a smart application for farmers," *Arabian Journal for Science and Engineering*, vol. 45, no. 12, pp. 11115–11127, Dec. 2020, doi: 10.1007/s13369-020-04928-2.

[7] A. Chlingaryan, S. Sukkarieh, and B. Whelan, "Machine learning approaches for crop yield prediction and nitrogen status estimation in precision agriculture: a review," *Computers and Electronics in Agriculture*, vol. 151, pp. 61–69, Aug. 2018, doi: 10.1016/j.compag.2018.05.012.

[8] S. T. Arab, R. Noguchi, S. Matsushita, and T. Ahamed, "Prediction of grape yields from time-series vegetation indices using satellite remote sensing and a machine-learning approach," *Remote Sensing Applications: Society and Environment*, vol. 22, p. 100485, Apr. 2021, doi: 10.1016/j.rsase.2021.100485.

[9] A. K. Srivastava *et al.*, "Winter wheat yield prediction using convolutional neural networks from environmental and phenological data," *Scientific Reports*, vol. 12, no. 1, p. 3215, Feb. 2022, doi: 10.1038/s41598-022-06249-w.

[10] L. Zhang, Z. Zhang, Y. Luo, J. Cao, R. Xie, and S. Li, "Integrating satellite-derived climatic and vegetation indices to predict smallholder maize yield using deep learning," *Agricultural and Forest Meteorology*, vol. 311, p. 108666, Dec. 2021, doi: 10.1016/j.agrformet.2021.108666.

[11] N. Khan *et al.*, "Prediction of oil palm yield using machine learning in the perspective of fluctuating weather and soil moisture conditions: evaluation of a generic workflow," *Plants*, vol. 11, no. 13, p. 1697, Jun. 2022, doi: 10.3390/plants11131697.

[12] N. Khan, M. A. Kamaruddin, U. U. Sheikh, Y. Yusup, and M. P. Bakht, "Environment-based oil palm yield prediction using K-Nearest neighbour regression," in *2022 IEEE International Conference on Artificial Intelligence in Engineering and Technology (IICAIET)*, Sep. 2022, pp. 1–6, doi: 10.1109/IICAIET55139.2022.9936752.

[13] F. Watson-Hernández, N. Gómez-Calderón, and R. P. da Silva, "Oil palm yield estimation based on vegetation and humidity indices generated from satellite images and machine learning techniques," *AgriEngineering*, vol. 4, no. 1, pp. 279–291, Mar. 2022, doi: 10.3390/agriengineering4010019.

[14] J. J. Cubillas, M. I. Ramos, J. M. Jurado, and F. R. Feito, "A machine learning model for early prediction of crop yield, nested in a web application in the cloud: a case study in an olive grove in Southern Spain," *Agriculture*, vol. 12, no. 9, p. 1345, Aug. 2022, doi: 10.3390/agriculture12091345.

[15] N. Absar *et al.*, "The efficacy of machine-learning-supported smart system for heart disease prediction," *Healthcare*, vol. 10, no. 6, p. 1137, Jun. 2022, doi: 10.3390/healthcare10061137.

[16] Z. M. Alhakeem, Y. M. Jebur, S. N. Henedy, H. Imran, L. F. A. Bernardo, and H. M. Hussein, "Prediction of ecofriendly concrete compressive strength using gradient boosting regression tree combined with GridSearchCV hyperparameter-optimization techniques," *Materials*, vol. 15, no. 21, p. 7432, Oct. 2022, doi: 10.3390/ma15217432.

[17] R. Boselli *et al.*, "WoLMIS: a labor market intelligence system for classifying web job vacancies," *Journal of Intelligent Information Systems*, vol. 51, no. 3, pp. 477–502, Dec. 2018, doi: 10.1007/s10844-017-0488-x.

[18] S. Iniyan, V. Akhil Varma, and C. Teja Naidu, "Crop yield prediction using machine learning techniques," *Advances in Engineering Software*, vol. 175, p. 103326, Jan. 2023, doi: 10.1016/j.advengsoft.2022.103326.

[19] X. Ni, F. Takeda, H. Jiang, W. Q. Yang, S. Saito, and C. Li, "A deep learning-based web application for segmentation and quantification of blueberry internal bruising," *Computers and Electronics in Agriculture*, vol. 201, p. 107200, Oct. 2022, doi: 10.1016/j.compag.2022.107200.

[20] P. S. Nishant, P. Sai Venkat, B. L. Avinash, and B. Jabber, "Crop yield prediction based on indian agriculture using machine learning," in *2020 International Conference for Emerging Technology (INCET)*, Jun. 2020, pp. 1–4, doi: 10.1109/INCET49848.2020.9154036.

[21] H. Wang *et al.*, "PreCowKetosis: a Shiny web application for predicting the risk of ketosis in dairy cows using prenatal indicators," *Computers and Electronics in Agriculture*, vol. 206, p. 107697, Mar. 2023, doi: 10.1016/j.compag.2023.107697.

[22] P. Singh, "Machine learning deployment as a web service," in *Deploy Machine Learning Models to Production*, Berkeley, CA: Apress, 2021, pp. 67–90.

[23] Y. Ang *et al.*, "Oil palm yield prediction across blocks from multi-source data using machine learning and deep learning," *Earth Science Informatics*, vol. 15, no. 4, pp. 2349–2367, Dec. 2022, doi: 10.1007/s12145-022-00882-9.

[24] R. Alroobaea and P. J. Mayhew, "How many participants are really enough for usability studies?," in *2014 Science and Information Conference*, Aug. 2014, pp. 48–56, doi: 10.1109/SAI.2014.6918171.

[25] J. K. Sarriegi *et al.*, "COLAEVA: visual analytics and data mining web-based tool for virtual coaching of older adult populations," *Sensors*, vol. 21, no. 23, p. 7991, Nov. 2021, doi: 10.3390/s21237991.

[26] T. Richards, *Getting started with streamlit for data science: create and deploy streamlit web applications from scratch in Python*. Packt Publishing, 2021.

[27] K. P. K. Devan, B. Swetha, P. U. Sruthi, and S. Varshini, "Crop yield prediction and fertilizer recommendation system using hybrid machine learning algorithms," in *2023 IEEE 12th International Conference on Communication Systems and Network Technologies (CSNT)*, Apr. 2023, pp. 171–175, doi: 10.1109/CSNT57126.2023.10134662.

[28] N. V. S. Krishna, P. Neeraj, B. Surya, B. V. Prudhvi, and V. H. Deepthi, "Machine learning algorithms for crop yield prediction in real-time scenarios," in *2023 4th International Conference on Signal Processing and Communication (ICSPC)*, Mar. 2023, pp. 377–381, doi: 10.1109/ICSPC57692.2023.10126011.

BIOGRAPHIES OF AUTHORS

Dr. Yuhao Ang obtained a Doctor of Philosophy in remote sensing from Universiti Putra Malaysia, in 2024. He is currently a senior lecturer in Universiti Malaysia Sabah. He received his bachelor degree in applied science in Universiti Sains Malaysia, in 2015. Then, he obtained master degree in remote sensing and geographical information system from Universiti Putra Malaysia. He is currently focused on the research in artificial intelligence, remote sensing, and geographical information system. He utilized geospatial and artificial intelligence technology to estimate yield in oil palm. He can be contacted at email: vincentangkhun@gmail.com.

Dr. Helmi Zulhaidi Mohd Shafri is currently a professor and remote sensing and Geographic Information Systems (GIS) programme coordinator at the Department of Civil Engineering, Faculty of Engineering, Universiti Putra Malaysia (UPM). He was previously the Head of the Department of Civil Engineering and the Deputy Dean of Postgraduate Studies at the Faculty of Engineering, UPM. He obtained his bachelor degree from Royal Melbourne Institute of Technology (RMIT) University, Melbourne, Australia and Ph.D. from the University of Nottingham, United Kingdom. His fields of specialization include geomatics engineering, remote sensing, machine learning, and data science. He can be contacted at email: helmi@upm.edu.my.

Dr. Yang Ping Lee obtained a Doctor of Philosophy in plant molecular ecophysiology from the University of Basel, Switzerland, in 2004. Currently, he serves as the Head of Precision Agriculture and Genomics at FGV R&D Sdn Bhd. His research focuses on oil palm genomics, bioinformatics, and breeding techniques aimed at developing advanced oil palm planting materials with desirable traits. In his field studies, Dr. Lee employs remote sensing, precision tools, and geographical information systems to enhance yield and replanting efficiency, as well as to detect diseases early and minimize crop loss in oil palm plantation management. He can be contacted at email: yangp.lee@fgvholdings.com.

Shahrul Azman Bakar is currently a researcher at Geoinformatics unit, FGV R&D Sdn Bhd, a subsidiary company for one of the biggest oil palm companies in the world. He obtained his BSc Remote Sensing from Universiti Teknologi Malaysia (UTM) and MPhil Geography from Universiti Kebangsaan Malaysia (UKM). He has more than 10 years of experience in remote sensing and GIS in various types of applications. He can be contacted at email: shahrul.b@fgvholdings.com.

Hwee San Lim Dr Hwee San Lim has been a lecturer at Universiti Sains Malaysia (USM) since completing his PhD in 2006. He obtained his B.Sc. (Hons) in Geophysics from USM in 2001, and subsequently pursued his M.Sc. and PhD degrees in environmental remote sensing at the same institution under the supervision of Prof. Dr. Mohd. Zubir Mat Jafri and Assoc. Prof. Dr. Khiruddin Abdullah. He received his M.Sc. in 2003 and his PhD in 2006. His research interests encompass optical remote sensing-both passive and active and digital image processing, with particular emphasis on spectral image data. His work focuses on applications such as water and air quality monitoring, land cover and change detection, land surface property analysis, and digital image classification. He is also involved in modeling the optical properties of atmospheric aerosols. His current research emphasizes the use of ground-based and satellite-based LiDAR data (including CALIPSO and AIRS) for studies related to air pollution and greenhouse effects. He can be contacted at email: hslim@usm.my.

Rosni Abdullah Professor Rosni Abdullah is a professor in parallel computing and one of the national pioneers in the said domain. She was appointed Dean of the School of Computer Sciences at Universiti Sains Malaysia (USM) in June 2004, after having served as its Deputy Dean (Research) since 1999. She is also the Head of the Parallel and Distributed Processing Research Group at the School since its inception in 1994. Her main interest lies in the data representation and the associated algorithms to organize, manage and analyse biological data which is ever increasing in size. Particular interest is in the development of parallel algorithms to analyse the biological data using Message Passing Interface (MPI) on message passing architectures and multithreading on multicore architectures. Currently, the new interest is in neuroinformatics, i.e. the management and analysis of neuroscientific data. She can be contacted at email: rosni@usm.my.

Dr. Yusri Yusup is an associate professor in the Environmental Technology program of the School of Industrial Technology, Universiti Sains Malaysia. He received his B.Eng. (Hons.) degree in Chemical Engineering (2002) and M.Sc. degree (awarded in 2004) in Chemical Process Technology from Universiti Sains Malaysia. His Ph.D. degree (2008) was in chemical and process engineering, awarded by Universiti Kebangsaan Malaysia. In 2017, he was the principal data analyst in a Department of Environment (DoE) study to develop an air pollution emission inventory for Malaysia. He can be contacted at email: yusriy@usm.my.

Dr. Mohammed Mustafa Al-Habshi is an accomplished researcher specializing in GIS and Geomatics Engineering. With a diverse educational background and extensive experience, he has made significant contributions to the field through his expertise in remote sensing, artificial intelligence, machine learning, and deep learning. His research focuses on utilizing geospatial technologies to address real-world challenges, including the monitoring of oil palm yields. He works is characterized by the development of web applications that leverage advanced analytical techniques for data analysis and decision-making processes. His expertise and dedication to the scientific community make him a valuable contributor in the intersection of GIS, remote sensing, and artificial intelligence. He can be contacted at email: alhabshi3k@gmail.com.