Proceedings of the Third International Conference on Smart Electronics and Communication (ICOSEC 2022)
IEEE Xplore Part Number: CFP22V90-ART; ISBN: 978-1-6654-9764-0

2022 3rd International Conference on Smart Electronics and Communication (ICOSEC) | 978-1-6654-9764-0/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICOSEC54921.2022.9951960

A Survey on Computational Aptitudes towards Precision Agriculture using Data Mining

E.Murali[1]
School of Computer Science and Engineering
Vellore Institute of Technology
Vellore, India
emurali88@gmail.com

S.Margret Anouncia[2]*
School of Computer Science and Engineering
Vellore Institute of Technology
Vellore, India
smargretanoucia@gmail.com
smargretanoucia@vit.ac.in

Abstract— **Precision agriculture is a modern agriculture implementation technique in which analysis of numerous source data takes place for decision-making and operation in the management of crop production. The data for precision agriculture are collected through robots, sensors, satellites, and drones. The two approaches of precision agriculture are the predictive approach which is used for representing the static indicator during the crop cycle whereas the control approach is an updating of information Ontology is a demonstration of concepts and their shared association. It can be used in a wide range of contexts, including the classification of agricultural information and the development of knowledge bases. The basic steps involved in precision farming are assessing variation, managing variability, and evaluation. The various tools used in precision farming are the internet of things (IoT), a global positioning system (GPS), geographic information system (GPS), remote sensor, proximate sensor technology, grid sampling, etc. With the increase in information technology in the field of agriculture. Consequently, data mining become much essential for decision-making. This paper attempts to emphasize the coherence of data mining approaches toward helping precision agriculture as a valuable venture.**

Keywords— Precision agriculture, Data mining, Ontology, Sensor data, Agriculture.

I. INTRODUCTION

Precision agriculture is the application of modern techniques for the analysis of data for decision-making and crop management. The different new technologies used in precision agriculture are automated steering systems, Geo-mapping, remote sensing, satellite positioning system, and variable rate technology. Ultimately precision agriculture aims to introduce automation in the field of agriculture. However, these technologies are not much used by farmers as there is not much awareness about the technologies. In some cases, these technologies are cost too high which farmers are not able to afford. There is a need for farmers to get updated with technology. Despite all these issues, the farmers must get updated with the latest technologies which will make ease the agricultural process. Growth in the computation approach has paved a way for the introduction of data mining principles. Hence, this paper will help in finding the advantages and disadvantages in the right direction to improve the agriculture process.

II. PRECISION AGRICULTURE AND DATA MINING APPROACH

In general precision agriculture helps in improving crop productivity with the help of information technology. Many approaches are discussed in the following section for improving the crop yield of precision agriculture. Some of the approaches that have developed in recent times are highlighted.

A. Vandana B[1] et al(2018) developed a novel strategy with big data analytics to increase crop productivity. The information is gathered from a real-time setting. Data analyses employ classification and prediction techniques. As a result, big data analytics is used to implement an efficient decision-making system for increased crop productivity.

B. A modular approach for crop health examination, and recognition of weeds, and insects was proposed by Akhil Kumar donka[3] et. al(2020). The input data are collected through an unmanned aerial vehicle. TensorFlow is used to construct a deep learning model for weed and insect detection. Finally, a prediction accuracy of 89.5% is attained.

C. A computer vision approach for evaluating red beet plant count was proposed by A. Hassanzadeh[2] et al. (2021). Input data is collected through a multispectral sensor which is mounted on a DJI matrices 600 pro. Vegetation detection, feature generation, and feature selection are part of preprocessing. The plant count could be predicted using partial least square regression, which showed promising results.

D. In order to anticipate rainfall, J. S. A. N. W. Premachandra[4] et al. (2021) have suggested a machine learning-based method. The input dataset is collected from the metrological department of the central environmental authority. The collected dataset is preprocessed for data consolidation, data reduction, data cleaning, and data discretization which the same has been fed into four machine learning algorithms such as Multiple Linear Regression, Support Vector Machine, K Nearest Neighbors, and Random Forest. As a result, it is observed that random forest has a high accuracy of 89.16%.

E. EL HACHIMI Chouaib[5] et. al(2021) have proposed a machine learning approach for crop suggestion and weather estimation. Input data is segregated from an online dataset which consists of 2200 instances. Machine learning models like K-nearest neighbor, decision tree, random forest, Naïve Bayes, and logistic regression are used for performance evaluation. Finally, random forest performs best in terms of precision, accuracy, and recall.

III. PRECISION AGRICULTURE DATA AND DATA ACQUISITION METHOD

Precision agriculture is an approach used for getting high yields than the traditional technique. Data plays a main role in precision agriculture. The various tools used to collect data in precision agriculture are sensors, the Internet of Things, variable rate technology, automated steering systems, global positioning systems, and geographic information systems. Each of the above tools processes a variety of data such as crop yields, weeds, soil types, weather conditions, different harvesting operations, soil moisture content, and amount of fertilizer used. The different data acquisition is shown in fig 1. The following table highlights the data and data acquisition for the last 6 years

TABLE I. DATA ACQUISITION AND PURPOSE

S No	Author	Source of Data	Data Acquisition equipment	Sector	Purpose
1.	G.Sahity[6] (2017) et. al	Wireless Sensor Network	ZIGBEE technology	Precision Agriculture	Transmission of real-time Data
2.	Lorenzo Comba[7] (2019) et. al	Sensor	Unmanned Aerial Vehicle(UAV)	Precision Agriculture	2D & 3D data fusion for crop monitoring
3.	Dimosthenis C. Tsouros[8] (2019) et. al	Sensor, Camera, GPS	Unmanned Aerial Vehicle(UAV)	Precision Agriculture	The outcome of the data analysis method and its application in a farming operation
4.	Avinash J L[9] (2020) et. al	Wireless Sensor Network	XBee technology	Precision Agriculture	Assist farmers to maintain agricultural land
5.	Jacob Høxbroe Jeppesen[10] (2020) et. al	Satellite Image	Satellite	Smart Farming	Crop type classification
6.	Yash Bhojwani[12] (2020) et. al	Sensor	Internet of Things(IoT)	Precision Agriculture	The crop that is suitable for different environmental conditions
7.	Rajani Narayan[11] (2021) et. al	Sensor	Wireless Sensor Network	Precision Agriculture	Crop yield prediction
8.	A.Bannari[13] (2021) et. al	UAV camera	Unmanned Aerial Vehicle(UAV)	Precision Agriculture	Information for application in the context of precision agriculture
9.	Gabriel da Silva Vieira[14] (2021) et. al	Public leaf image Database	Machine learning algorithm and pattern	Smart Farming	Automatic leaf analyses and reconstruction of it
10.	Danilo Cavaliere[15] (2021) et. al	Sensor	Normalized Difference Vegetation Index (NDVI)	Precision Agriculture	Environmental monitoring of vegetation status
11.	Hamid Bagha[16] (2021) et. al	Optical sensor	Unmanned Aerial Vehicle(UAV) & Internet of Things	Precision Agriculture	Plant health analysis
12.	Ila Kaushik[17] (2021) et. al	Sensor	Internet of Things(IoT)	Precision Agriculture	Emphasize the significance of Integrating blockchain technology with smart farming
13.	Virupaxappa G[18] (2021) et. al	Sensor	Internet of Things(IoT)	Smart Agriculture	Role of IoT in agribusiness

IV. USING DATA MINING FOR AGRICULTURE DATA PROCESSING

Different data processing methods that are used in precision agriculture in data mining are highlighted in this section.

A. A study has been conducted by Kristoffer O. Flores[19] et. al(2016) to observe the agriculture field. The input data are collected through low-cost sensors such as humidity, temperature, moisture, luminosity, electrical conductivity, and pH are used. All sensors are linked to a single Arduino microcontroller board with an Xbee shield for wireless communication. The sensor node is divided into three parts (i)sensor, (ii)microcontroller, (iii)RF transmitter. Finally, each sensor collects the data at the base station. The main server displays the data in a visualized form to a farmer about the status of the environment through a GUI(Graphical user interface) and soil condition which in turn helps for better productivity.

B. A study has been conducted by E.Murali[20] et. al(2018) to emphasize the data mining approaches for precision agriculture. The data are collected through variable rate technology, unmanned aerial vehicles, global positioning system, mapping technology, and guidance technology. Different data mining algorithms are studied which helps the farmers for an effective decision model. Finally, the study highlighted soil database maintenance, pest control, rainfall prediction, and crop recommendation.

C. Grigore Stamatescu[21] et. al (2019) proposed a data analysis and processing approach to crop and soil monitoring for precision agriculture. The system architecture consists of a field layer, fog computing layer, cloud computing layer, and data presentation layer. The data are collected through sensors. To compute the performance evaluation methods like the common linear interpolant and two closely related interpolants, cubic spline and shape-preserving Piecewise Cubic Hermite Interpolating Polynomial are used. Finally, an extensive assessment of online decision-making by domain experts is obtained.

D. A prototype IoT-based smart farming for soil moisture monitoring and analysis has been proposed by Supachai Puengsungwan[22] et. al(2020). The IoT device consists of cloud technology, user interface, and data analytics. The input data are real-time data. The data are fed into MATLAB for evaluation. As a result, soil moisture analysis and monitoring have been implemented using real-time data.

E. A data processing for sentinel-1 SAR data and crop type classification with visualization has been proposed by Jacob Høxbroe Jeppesen[23] et. al(2020). The input data are collected from sentinel-1A and sentinel-1B satellites. Data visualization is done for three different crop types such as forestry, maize, and rapeseed are discussed. Six machine learning classifiers, including decision tree, random forest, logistic regression, linear SVM, RBF SVM, and neural network classifiers, are used to evaluate the data. Finally, RBF SVM performs better concerning individual crops with an overall accuracy of 94.02%.

F. To determine the stage of a cotton leaf, Zekai Feng[24] et al. (2021) suggested an object detection technique based on a faster RCNN. The data used as input are taken from a public dataset. The convolutional layer, pooling layer, activation layer, fully connected layer, and output layer make up the system architecture. The convolutional neural network, candidate layer extraction, and detecting object identification make up the algorithm. Finally, 80% of the cotton leaf stage can be recognized by the system.

V. ONTOLOGY-BASED KNOWLEDGE MINING MODEL FOR PRECISION AGRICULTURE

Ontology-based Knowledge mining model for precision agriculture that provides a recommendation system, soil mineral classifications, ontology-based prototype model, and plant domain knowledge model are highlighted in this section.

A. FAN Jing[25] et al(2008) suggested an ontology-based plant domain knowledge model. Plant knowledge and environment knowledge were separated from the plant domain knowledge ontology. Finally, an effective approach to knowledge modeling that makes use of ontologies was shown.

B. A farmer helping system was proposed by Shyamaladevi[26] et. al(2012) which integrates web services such as soil information, crop disease information, plant information, pesticides, and fungicides information. The input data is semantically annotated data collected by the sensor. The architecture consists of sensor ontology to form a system ontology for knowledge representation. For determining which soil is better for crop planting and describing the pesticides and fungicides of a specific disease, a rule-based engine is developed. As a result, application enterprises and communities share and reuse data.

C. Ontology-based knowledge management framework was proposed by Patrizia Ribino[27] et. al(2009). Two ontology domain model is represented which is based on structure and modeling the concept of project development. Finally, the Knowledge management system prototype makes a rule-based system that can adapt its result to the possible change in system ontology and document management system to improve document searching, sharing, and discovery.

D. A knowledge management approach for e-agriculture has been proposed by Muhammad Ahsan[28] et. al(2014). The data are collected through interviews, questionnaires, observations, expert advice, observed data, image documents, and reports. A prototype model is built to demonstrate the result. As a result, ontology-based knowledge management has more benefits than traditional knowledge management techniques.

E. Ontology-based data access and integration for farming in Nepal are proposed by Suresh Pokharel[29] et. al(2014). The input data are agriculture production statistics, weather information, crop growing days information, soil information, and administration data of Nepal. An ontology-based vocabulary is created from the dataset to integrate data. As a result, AgriNepaldata is linked to an additional dataset that provides one structured dataset for agricultural information.

F. An ontology-based knowledge management system for soil mineral classification and crop recommendation has been proposed by E. Murali[30] et al. (2021). An online database is used to gather the input data. The framework comprises knowledge gathering and validation, the development of an agricultural knowledge model, the design of agricultural rules, and knowledge visualization. A mechanism for recommending crops has finally been created.

G. E.Murali[31] et. al(2021) have proposed multiple ontology-based knowledge mining models for agriculture. The framework consists of different ontologies like soil, crop, location, and season ontology. Soil ontology provides soil type as output, crop ontology provides crop type as output, location ontology provides a different location in which crop can be grown, and season ontology provides season in which crop can be grown. As a result, a multiple ontology-based ontology model for agriculture has been developed.

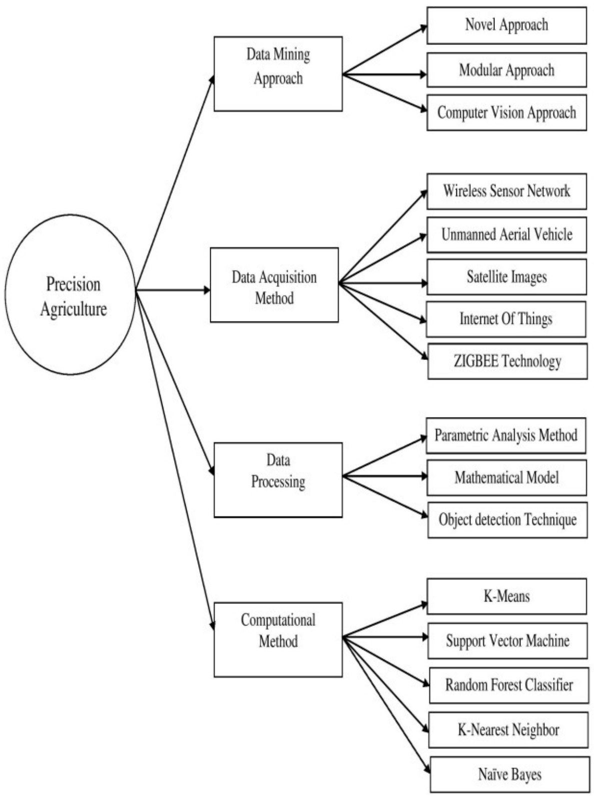

Fig.1 Contributions of computational toward agriculture to make precision agriculture

VI. CONCLUSION

This study highlighted the different data mining approaches, data processing, data acquisition, and ontology-based knowledge management model discussed. It is observed study focuses on pest management, rainfall prediction, crop recommendation, crop, and field monitoring system, soil moisture detection, and crop health monitoring. Technology integration with agriculture help in the success of precision agriculture with the possibility of extending the technology of further computerization. Existing research has focused solely on a single type of vegetation, which is considered a limitation. As a future scope, multiple vegetation can be focused on.

REFERENCES

[1]. B. Vandana and S. S. Kumar, "A Novel Approach using Big Data Analytics to Improve the Crop Yield in Precision Agriculture," *2018 Third IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, 2018, pp. 824-827, DOI: 10.1109/RTEICT42901.2018.9012549.

[2]. A. Hassanzadeh, J. van Aardt, J. Kikkert, S. Pethybridge, S. Murphy and D. Cross, "Plant Counts in Dense Red Beet Crops: A Computer Vision Approach," *2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS*, 2021, pp. 6508-6511, DOI: 10.1109/IGARSS47720.2021.9553481.

[3]. A. K. Donka, J. A. R. Seerapu, S. Verma, A. Sao, G. Shukla, and S. Tripathi, "Unmanned Aerial Vehicle for Precision Agriculture in a Modular Approach," *2020 IEEE 7th Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)*, 2020, pp. 1-5, DOI: 10.1109/UPCON50219.2020.9376521.

[4]. J. S. A. N. W. Premachandra and P. P. N. V. Kumara, "A novel approach for weather prediction for agriculture in Sri Lanka using Machine Learning techniques," *2021 International Research Conference on Smart Computing and Systems Engineering (SCSE)*, 2021, pp. 182-189, DOI: 10.1109/SCSE53661.2021.9568319.

[5]. C. El Hachimi, S. Belaqziz, S. Khabba, and A. Chehbouni, "Towards precision agriculture in Morocco: A machine learning approach for recommending crops and forecasting weather," *2021 International Conference on Digital Age & Technological Advances for Sustainable Development (ICDATA)*, 2021, pp. 88-95, DOI: 10.1109/ICDATA52997.2021.00026.

[6]. G. Sahitya, N. Balaji, C. D. Naidu, and S. Abinaya, "Designing a Wireless Sensor Network for Precision Agriculture Using Zigbee," *2017 IEEE Seventh International Advance Computing Conference (IACC)*, 2017, pp. 287-291, DOI: 10.1109/IACC.2017.0069.

[7]. L. Comba, A. Biglia, D. R. Aimonino, P. Barge, C. Tortia and P. Gay, "2D and 3D data fusion for crop monitoring in precision agriculture," *2019 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)*, 2019, pp. 62-67, DOI: 10.1109/MetroAgriFor.2019.8909219.

[8]. D. C. Tsouros, A. Triantafyllou, S. Bibi and P. G. Sarigannidis, "Data Acquisition and Analysis Methods in UAV- based Applications for Precision Agriculture," *2019 Fifteen International Conference on Distributed Computing in Sensor Systems (DCOSS)*, 2019, pp. 377-384, DOI: 10.1109/DCOSS.2019.00080.

[9]. J. L. Avinash, K. N. Sunil Kumar, G. B. Arjun Kumar, G. R. Poornima, R. Gatti, and S. Santosh Kumar, "A Wireless Sensor Network Based Precision Agriculture," *2020 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT)*, 2020, pp. 413-417, DOI: 10.1109/RTEICT49044.2020.9315578.

[10]. J J. H. Jeppesen, R. H. Jacobsen, and R. N. Jørgensen, "Crop Type Classification based on Machine Learning with Multitemporal Sentinel-1 Data," *2020 Twenty-third Euromicro Conference on Digital System Design (DSD)*, 2020, pp. 557-564, DOI: 10.1109/DSD51259.2020.00092.

[11]. R. Narayan and N. Nageshwari, "A Wi-Fi Based Smart Energy Efficient Wireless Sensor Network for Yield Prediction in Precision Agriculture," *2021 International Conference on Circuits, Controls and Communications (CCUBE)*, 2021, pp. 1-5, DOI: 10.1109/CCUBE53681.2021.9702713.

[12]. Y. Bhojwani, R. Singh, R. Reddy, and B. Perumal, "Crop Selection and IoT Based Monitoring System for Precision Agriculture," *2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE)*, 2020, pp. 1-11, DOI: 10.1109/ic-ETITE47903.2020.123.

[13]. A. Bannari, A. Selouani, M. El-Basri, H. Rhinane, A. El-Harti, and A. El-Ghmari, "Multi-Scale Analysis of DEMs Derived from Unmanned Aerial Vehicle (UAV) in Precision Agriculture Context," *2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS*, 2021, pp. 8285-8288, DOI: 10.1109/IGARSS47720.2021.9554020.

[14]. G. D. Silva Vieira, N. Maria de Sousa, B. Rocha, A. U. Fonseca, and F. Soares, "A Method for the Detection and Reconstruction of Foliar Damage caused by Predatory Insects," *2021 IEEE Forty Fifth Annual Computers, Software, and Applications Conference (COMPSAC)*, 2021, pp. 1502-1507, DOI: 10.1109/COMPSAC51774.2021.00223.

[15]. D. Cavaliere and S. Senatore, "A multi-agent knowledge-enhanced model for decision-supporting agroforestry systems," *2021 IEEE*

Symposium Series on Computational Intelligence (SSCI), 2021, pp. 01-08, DOI: 10.1109/SSCI50451.2021.9660056.

[16]. H. Bagha, A. Yavari, and D. Georgakopoulos, "IoT-based Plant Health Analysis using Optical Sensors in Precision Agriculture," *2021 Digital Image Computing: Techniques and Applications (DICTA)*, 2021, pp. 01-08, DOI: 10.1109/DICTA52665.2021.9647066.

[17]. I. Kaushik, N. Prakash and A. Jain, "Integration of Blockchain& IoT in Precision Farming: Exploration, Scope and Security Challenges," *2021 IEEE 12th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, 2021, pp. 0854-0859, DOI: 10.1109/UEMCON53757.2021.9666554.

[18]. V. G and S. Thangam, "Smart agriculture and role of IoT," *2021 Third International Conference on Inventive Research in Computing Applications (ICIRCA)*, 2021, pp. 1-6, DOI: 10.1109/ICIRCA51532.2021.9545042.

[19]. K. O. Flores, I. M. Butaslac, J. E. M. Gonzales, S. M. G. Dumlao, and R. S. J. Reyes, "Precision agriculture monitoring system using wireless sensor network and Raspberry Pi local server," *2016 IEEE Region 10 Conference (TENCON)*, 2016, pp. 3018-3021, DOI: 10.1109/TENCON.2016.7848600.

[20]. Murali, E., & Anouncia, S.M, "A comprehension of rational in the computational aptitudes towards precision agriculture". *Indian Journal of Public Health Research and Development(2018), 9*(10) 1025. DOI: 10.5958/0976-5506.2018.01136.1

[21]. G. Stamatescu, C. Drăgana, I. Stamatescu, L. Ichim, and D. Popescu, "IoT-Enabled Distributed Data Processing for Precision Agriculture" *27th Mediterranean Conference on Control and Automation (MED) 2019*, 286-291, DOI: 10.1109/MED.2019.8798504.

[22]. S. Puengsungwan," IoT based Soil Moisture Sensor for Smart Farming" *International Conference on Power, Energy, and Innovations (ICPEI) 2020*, pp. 221-224, DOI: 10.1109/ICPEI49860.2020.9431455.

[23]. J. H. Jeppesen, R. H. Jacobsen, and R. N. Jørgensen, "Crop Type Classification based on Machine Learning with Multitemporal Sentinel-1 Data" *Twenty-third Euromicro Conference on Digital System Design (DSD)2020*, pp.557-564, DOI: 10.1109/DSD51259.2020.00092.

[24]. Z. Feng, G. Kang, F. Zeng, and X. Yue, "Identification of Cotton Growing Stage Based on Faster-RCNN," *2021 IEEE International Performance, Computing, and Communications Conference (IPCCC)*, 2021, pp. 1-6, DOI: 10.1109/IPCCC51483.2021.9679423.

[25]. J. Fan, X. Zhang, and T. Dong, "Research of Plant Domain Knowledge Model Based on Ontology," *2008 Third International Conference on Innovative Computing Information and Control*, 2008, pp. 108-108, DOI: 10.1109/ICICIC.2008.451.

[26]. K. Shyamaladevi, T. T. Mirnalinee, T. E. Trueman and R. Kaladevi, "Design of ontology-based ubiquitous web for agriculture — A farmer helping system," *2012 International Conference on Computing, Communication and Applications*, 2012, pp. 1-6, DOI: 10.1109/ICCCA.2012.6179214.

[27]. P. Ribino, A. Oliveri, G. L. Re, and S. Gaglio, "A Knowledge Management System Based on Ontologies", *International Conference on New Trends in Information and Service Science* 2009, pp.1025-1033, DOI: 10.1109/NISS.2009.105.

[28]. M. Ahsan, Y. H. Motla and M. Asim," Knowledge modeling fore-agriculture using ontology". *International Conference on Open Source Systems & Technologies*, 2014, pp.112-122, DOI: 10.1109/ICOSST.2014.7029330.

[29]. S. Pokharel, M. A. Sherif and J. Lehmann,"Ontology Based Data Access and Integration for Improving the Effectiveness of Farming in Nepal" *IEEE/WIC/ACM International Joint Conferences on Web Intelligence (WI) and Intelligent Agent Technologies (IAT) 2014*, pp.319-326, DOI: 10.1109/WI-IAT.2014.114.

[30]. E.Murali, Anouncia, S.M, "Development of soil mineral classification using ontology mining", *Arabian Journal of Geoscience 2021, Vol.14*, 1371. https://doi.org/10.1007/s12517-021-07651-w

[31]. E. Murali & S. Margret Anouncia, "An Ontology-based Knowledge Mining Model for Effective Exploitation of Agro Information". *IETE Journal of Research, 2022* DOI:10.1080/03772063.2022.2058629