# **State of the Art**

## **Journal Article: Crop yield prediction using machine learning: A systematic literature review.**

The exploration of machine learning applications in the agricultural sector, specifically in the realm of crop yield prediction, has seen a significant surge in recent years. A systematic review of the literature by (Klompenburg, Kassahun, & Catal, 2020) offers an in-depth examination of this rapidly evolving field. The authors scrutinized 50 studies out of 567 studies published over a decade, all of which employed machine learning methodologies for crop yield prediction. Their findings revealed that the most utilized machine learning techniques in this context were regression-based models, Artificial Neural Networks (ANN) [most used algorithm for crop prediction], Support Vector Machines (SVM), and Decision Trees (DT). This trend underscores a shift towards the adoption of advanced, data-driven models for crop yield prediction, moving away from traditional methods that often fall short in terms of accuracy and efficiency (Klompenburg, Kassahun, & Catal, 2020)

The paper also highlights the recent application of Deep Neural Networks (DNN) as an improvement on ANN with more and more research papers using the DNN algorithms due to the different hidden layer types such as convolutional layer and pooling layer instead and more hidden layers instead of a single layer (Klompenburg, Kassahun, & Catal, 2020).

The most applied deep learning algorithm found by the researchers was the Convolutional Neural Networks (CNN) and other widely used algorithms were Long-Short Term Memory (LSTM) and Deep Neural Networks (DNN) algorithms (Klompenburg, Kassahun, & Catal, 2020).

The review also highlighted that the most frequently predicted crops were wheat, rice, and maize. The features used for prediction varied considerably across the studies since crop yield depends on many different factors such as climate, weather, soil, use of fertilizer and seed variety. Notably, the most common features used were climate data (temperature and rainfall) and soil data (soil type, pH value, area of production) were commonly used as inputs for the models with crop yield being the dependent variable. This underscores the critical role of environmental factors in crop yield prediction and the capacity of machine learning models to encapsulate the intricate relationships between these factors and crop yield (Klompenburg, Kassahun, & Catal, 2020).

The performance of the machine learning models was generally reported to be satisfactory, with many studies reporting high accuracy rates. However, the authors also pinpointed several challenges, including the need for high-quality data, the complexity of agricultural systems, and the interpretability issues of some machine learning models. This suggests that while machine learning offers immense potential for enhancing crop yield prediction, further research is required to identify the most suitable machine learning techniques for different crop types and to pinpoint the most critical features for prediction (Klompenburg, Kassahun, & Catal, 2020).

In the context of the proposed project, this literature review offers invaluable insights. The project aims to augment the potato value chain in Kenya through a data-driven platform. The findings from the literature review suggest that machine learning techniques could be employed to predict potato yield, which could be a valuable feature of the proposed platform. For instance, accurate yield predictions could enable farmers to plan their production and marketing strategies more effectively, potentially leading to increased income and improved livelihoods. It could also assist other actors in the value chain, such as processors and retailers, in planning their operations more efficiently.

However, the literature review also highlights some of the challenges that need to be addressed. It underscores the need to identify the most important features for prediction. In the case of the proposed project, this could involve collecting and analysing data on various factors that may influence potato yield, such as weather conditions, soil quality, and farming practices. This data could then be used to train a machine learning model to predict potato yield.

The literature review also emphasizes the need for more standardized reporting of results in future studies. This is a point that the proposed project will consider when designing its data collection and analysis procedures. The project will aim to adhere to best practices in data reporting, to ensure that the results are transparent and can be compared with other studies.

## **Journal Article: Predictive Analytics in Agriculture: Forecasting Production**

The research paper "Predictive Analytics in Agriculture: Forecasting Production" by (Sabu & Kumar, 2020) has made a significant contribution to the field of agricultural research, particularly in the application of predictive analytics for forecasting production. The authors have meticulously examined the use of predictive analytics in agriculture, focusing on the forecasting of production, which is a critical aspect of agricultural planning and management.

(Sabu & Kumar, 2020) have highlighted the challenges that the agricultural sector faces, such as unpredictable weather patterns, pests, and diseases. These factors can significantly impact agricultural production and cause price fluctuations, creating uncertainty for farmers and policymakers. This is a challenge potato farming in Kenya currently faces as well. To address these challenges, the authors propose the use of predictive analytics, a method that involves the use of data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes based on historical data (Sabu & Kumar, 2020).

The authors provide a comprehensive overview of various predictive analytics techniques that can be employed in agriculture. Notably, they discuss the ARIMA model, a variation of Box Jenkins models used for predicting or understanding stationary or non-stationary time-series data (Sabu & Kumar, 2020). They also discuss the Holt-Winter Seasonal Method, a variation of Exponential Smoothing used for seasonal data (Sabu & Kumar, 2020).

Furthermore, (Sabu & Kumar, 2020) delve into the use of the LSTM model, a deep learning model used for forecasting. They note that LSTM is particularly useful for time series forecasting due to its ability to consider the complex temporal dependence, making it fit for both stationary and non-stationary data (Sabu & Kumar, 2020).

In their study, the authors aimed to investigate the performance of these models in predicting the prices of arecanuts. They found that the LSTM model was the most parsimonious model that fit the data for predicting the price of arecanuts in Kerala (Sabu & Kumar, 2020). This finding underscores the potential of LSTM models in agricultural forecasting.

The research conducted by (Sabu & Kumar, 2020) provides valuable insights into the application of predictive analytics in agriculture. Their work serves as a solid foundation for further exploration in this field. The authors' detailed examination of various predictive analytics techniques, their application in agriculture, and their potential for forecasting production, provide a valuable resource for researchers and practitioners in the field. Their work underscores the potential of predictive analytics in addressing the challenges faced by the agricultural sector and enhancing agricultural planning and management.

## **Conference Proceedings: Empowerment of rural farmers through information sharing using inexpensive technologies.**

The application of mobile technology in agriculture, particularly in the context of rural farming, has been a subject of interest in recent years. The advent of technologies such as Unstructured Supplementary Service Data (USSD) and mobile applications has opened new possibilities for addressing information access issues in agricultural communities (Iraba & Venter, 2011).

In the realm of information access, the use of mobile phones has emerged as a powerful tool. Most rural farmers have access to mobile phones and are conversant with basic functions such as making a phone call, sending an SMS, and even accessing the internet (Iraba & Venter, 2011). This technology has been instrumental in providing farmers with timely and accurate information, which is crucial for their business growth.

The development of mobile applications tailored to the needs of rural farmers has also been a significant advancement. A prototype designed by (Iraba & Venter, 2011) demonstrated the potential of such applications in providing farmers with relevant information, such as seller details and market prices. The application was found to be user-friendly, with most respondents finding it easy to navigate and use.

This type of technology could possibly be leveraged to allow farmers and other secondary users of the proposed solution to access their personal data and recommendations on how they could improve their overall value in the potato value chain.

Despite these advancements, gaps and limitations still exist in the current state of the art. For instance, the uptake of these technologies among rural farmers remains low due to factors such as limited internet access and digital literacy (Iraba & Venter, 2011). Furthermore, the customization and localization of these systems to suit specific contexts are areas that require further exploration.

In conclusion, the state of the art in the application of mobile technology in rural farming is promising, with advancements in mobile phone usage and the development of user-friendly mobile applications. However, there is a need for further research and development to address existing gaps and limitations, particularly in terms of technology uptake among rural farmers and system customization for specific contexts.

In the context of the proposed project, the findings from (Iraba & Venter, 2011) provide valuable insights into the potential of mobile technology in enhancing the potato value chain in Kenya. The project aims to leverage similar technologies, such as USSD messaging and a data-driven system, to address the inefficiencies and lack of transparency in the potato value chain. By doing so, it seeks to build upon the current state of the art and contribute to the field of data-driven systems in agriculture.

## **Journal Article: Do phone-based short message services improve the uptake of agri-met advice by farmers? A case study in Haryana, India**

In addition to USSD development, Phone-based short message applications (also called SMS in common parlance) as a medium of sending agricultural information to farmers is considered important in the context of a developing country as it makes information accessible to a large number of farmers economically (Sharma, et al., 2021).

The existing literature suggests that the use of SMS for agri-met advisory services has been found to improve the uptake of advice by farmers. This is primarily because SMS allows for timely and efficient communication of crucial information (Sharma, et al., 2021).

A case study done by (Sharma, et al., 2021) in Haryana, India, revealed that the use of SMS for agri-met advisory services led to a significant increase in the uptake of advice by farmers. This was particularly evident in the case of farmers who had previously shown low levels of engagement with traditional advisory services (Sharma, et al., 2021).

The study also found that the use of SMS for agri-met advisory services was associated with improved agricultural productivity and income among farmers. This suggests that SMS-based advisory services can play a crucial role in promoting sustainable agricultural practices and improving livelihoods in rural areas (Sharma, et al., 2021).

However, the study also highlighted some challenges associated with the use of SMS for agri-met advisory services. These include issues related to the accessibility and reliability of SMS, as well as the need for training and support to help farmers effectively use and interpret the advice provided via SMS (Sharma, et al., 2021).

In the context of the proposed project, which aims to enhance the potato value chain in Kenya, the findings from the case study in Haryana, India, provide valuable insights. The use of SMS for agri-met advisory services, as demonstrated in the case study, aligns with the project's goal of leveraging the RapidPro solution combined with SMS technology to improve agricultural practices and outcomes.

However, the challenges identified in the case study, particularly those related to the accessibility and reliability of SMS, highlight the need for careful consideration in the design and implementation of the proposed system. The project will need to ensure that the system is accessible and reliable, and that users are provided with the necessary training and support to effectively use and interpret the information provided through introductory messages on the platform.

Moreover, the project's focus on data-driven solutions aligns with the emerging trend in the field of agri-met advisory services. The use of data to inform and enhance agricultural practices is becoming increasingly prevalent, and the proposed project represents a significant contribution to this trend.

However, there are gaps in the current state of the art that the proposed project aims to address. One of the key gaps is the lack of comprehensive, data-driven platforms that integrate various aspects of the value chain, from production to marketing. The proposed project aims to fill this gap by developing a comprehensive platform that enhances the potato value chain in Kenya.

In summary, the proposed project aligns with the current state of the art in the field of agri-met advisory services and aims to address identified gaps through the development of a comprehensive, data-driven platform. The project represents a significant contribution to the field and has the potential to significantly enhance agricultural practices and outcomes in Kenya.