Development Economics of China
2024, VOL. 8, NO. 2, 159-168
DOI: 10.47297/wspdecWSP2515-797322.20240802

The Construction Of Agricultural Big Data Platform Based On Internet Of Things And The Quality And Safety Management Of Agricultural Products

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ABSTRACT
This paper introduces the design and realization of agricultural quality monitoring software based on agricultural big data. The software integrates data from agricultural production, logistics, sales and other links, and utilizes big data technology and machine learning algorithms for deep mining and analysis to realize accurate monitoring and prediction of agricultural product quality. This paper describes in detail the software's functional modules, technical implementation, architectural deployment, advantages and application prospects, and demonstrates the important role of the software in improving the quality and safety management level of agricultural products and promoting the process of agricultural modernization.

KEYWORDS
agricultural big data; agricultural product quality monitoring; big data technology; machine learning algorithms; information sharing platform; agricultural modernization that

1 Introduction

With the rapid development of information technology, advanced technologies such as the Internet of Things, big data and cloud computing are increasingly widely used in various industries, and the agricultural sector is no exception. As the foundation of national economy, the development of agriculture is directly related to national food security, farmers' income and the prosperity of rural economy. In recent years, with the continuous improvement of agricultural informatization and intelligence, the agricultural big data platform based on the Internet of Things (IoT) has gradually become an important force to promote the development of modern agriculture. The platform realizes accurate monitoring and management of the whole process of agricultural production through the integration of Internet of Things sensing, big data processing, cloud computing services and other technologies, providing a brand-new solution for the quality and safety management of agricultural products.

However, although the agricultural big data platform has shown great potential in improving agricultural production efficiency, optimizing resource allocation and guaranteeing the quality of agricultural products, it still faces many challenges in the process of practical application. Agricultural product quality analysis involves complex and variable factors, and requires high-precision data collection, processing and analysis technology, while the current application of big data, Internet of Things and other related technologies is still immature, resulting in the existence of inconsistent standards for monitoring the quality of agricultural products, outdated technology, low degree of information sharing and other problems, which seriously restricts the full play of the

effectiveness of the agricultural big data platform.

Therefore, this paper aims to discuss the construction of agricultural big data platform based on the Internet of Things and the management of agricultural product quality and safety, analyze the effect and program of agricultural product quality monitoring under the big data mode, and quantify and analyze the input and output indexes of big data monitoring by combining with the data envelopment model, so as to provide theoretical support and practical guidance for solving the problems existing in the current management of agricultural product quality and safety. At the same time, this paper will also explore the role of agricultural big data platform in enhancing the economic and social benefits of agricultural products, so as to contribute to the process of promoting agricultural modernization and guaranteeing the quality and safety of agricultural products.

2 Agricultural big data for monitoring and assessing the quality of agricultural products

2.1 Data collection and integration

The first step of agricultural big data in monitoring and assessing the quality of agricultural products is the collection and integration of data, which is the basis for building a comprehensive and accurate monitoring system. The collection of data mainly comes from the farmland environment, production process and logistics transportation and other key links, and the data of each link carries important information that affects the quality of agricultural products.

1) Farmland environmental data: Farmland is the cradle of agricultural products, and its environmental quality directly determines the growth conditions of agricultural products. Therefore, the collection of farmland environmental data is crucial. This includes soil moisture, temperature, pH value, conductivity, light intensity, rainfall, etc. These data are collected in real time by Internet of Things sensors deployed in farmland. These sensors can accurately perceive the changes of farmland environment and transmit data to the data center via wireless. Through the analysis of these data, we can understand the suitability of farmland environment and provide scientific guidance for agricultural production.

2) Production process data: The production process of agricultural products is also an important aspect of quality monitoring. This includes seed selection, fertilizer and pesticide use, irrigation management, pest and disease control. These data are usually recorded by agricultural production management systems, such as intelligent greenhouse control systems, precision irrigation systems, pest and disease early warning systems. These systems can record the operations in the agricultural production process in real time to ensure the transparency and traceability of the production process. By analyzing these data, it is possible to assess the compliance and efficiency of the agricultural production process and to identify potential quality problems in a timely manner.

3) Logistics and transportation data: In the process of agricultural products from farm to table, the logistics and transportation link is also crucial. Logistics and transportation data include transportation temperature, humidity, time, vibration, etc., which are provided by the logistics tracking system. Through the installation of sensors on the transportation vehicles or packaging, the transportation environment of agricultural products can be monitored in real time to ensure the quality and safety of agricultural products in the transportation process. Through the analysis of these data, it can optimize the logistics and transportation solutions, reduce transportation losses, and improve the freshness and shelf life of agricultural products.

After collecting these data, the big data platform for agriculture needs to integrate them. This includes data cleaning, data conversion, data fusion and other steps to ensure the accuracy and

consistency of the data. By integrating these data, the agricultural big data platform can build a comprehensive agricultural product quality monitoring database to provide strong data support for subsequent analysis and evaluation.

2.2 Multidimensional assessment

On the basis of data collection and integration, the agricultural big data platform is able to conduct a multi-dimensional assessment of the quality of agricultural products. This assessment is not limited to the traditional physical and chemical indicators, but also covers more dimensions and deeper levels of quality assessment.

1) Physical and chemical indicator tests: Traditional physical and chemical indicator tests are the basis for quality assessment of agricultural products. These include nutrient content (e.g. protein, fat, carbohydrates, vitamins, etc.), pesticide residues, heavy metal content, etc. These indicators are derived through laboratory testing and are an important basis for assessing the safety and nutritional value of agricultural products. These indicators are derived from laboratory tests and are an important basis for assessing the safety and nutritional value of agricultural products.

2) Sensory Quality Assessment: The sensory quality of agricultural products is the most direct feeling consumers have when they buy and eat them. Agricultural big data platform can use machine learning algorithms to predict and evaluate the sensory quality of agricultural products, such as color, aroma and taste. By analyzing a large amount of historical data, the algorithm can establish a correlation model between sensory quality and factors such as the growing environment and production process of agricultural products, thus realizing accurate prediction of the sensory quality of agricultural products.

3) Freshness and shelf-life assessment: The freshness and shelf-life of agricultural products are key factors affecting their quality and consumer satisfaction. The agricultural big data platform can predict and evaluate the freshness and shelf-life of agricultural products by analyzing their physiological and biochemical indicators (e. g., respiration rate, ethylene release, etc.) as well as logistics and transportation data (e.g., temperature, humidity, etc.). This helps agricultural producers and sellers to rationally arrange the picking, packing, transportation and marketing plans of agricultural products to ensure that they reach consumers in the best condition.

4) Microbial contamination assessment: Microbial contamination of agricultural products is an important factor affecting their safety and quality. Agricultural big data platforms can assess the microbial contamination of agricultural products by comparing historical data with industry standards. This includes analyzing the levels of harmful microorganisms such as colony counts, E. coli counts, and salmonella in agricultural products to ensure that they meet food safety standards. At the same time, the platform can also utilize machine learning algorithms to predict and warn of the risk of microbial contamination of agricultural products, providing timely countermeasures for agricultural producers and sellers.

Through multi-dimensional assessment, the agricultural big data platform can comprehensively and accurately assess the quality status of agricultural products, and provide scientific and reliable decision-making basis for government regulators, agricultural producers and consumers.

2.3 Data analysis and forecasting

One of the core functions of the agricultural big data platform is data analysis and prediction, which utilizes advanced algorithms and models, such as machine learning and deep learning, to deeply mine and analyze the massive amounts of data collected in order to reveal patterns, trends and outliers in the data, thereby realizing accurate prediction of agricultural product quality trends.

1) Algorithmic Applications.

Machine learning: By training models, machine learning algorithms are able to learn patterns from historical data and apply them to the prediction of new data. In agriculture, this can be used to predict crop growth, pest and disease risks, and trends in agricultural product quality. For example, by analyzing the relationship between environmental factors such as soil moisture, temperature, light and crop growth, machine learning models can predict crop growth in the future, providing scientific guidance for agricultural production.

Deep Learning:Deep learning is a branch of machine learning, which processes complex data by building deep neural networks. In agricultural big data analysis, deep learning can be used to recognize pests and diseases in the images of agricultural products, predict the nutrient content of agricultural products, etc. By training the deep neural network, the model can learn the subtle features in the images of agricultural products, and then analyze them. By training the deep neural network, the model can learn the subtle features in the images of agricultural products, so as to realize high-precision recognition and prediction.

2) Prediction case.

Crop growth prediction: By analyzing environmental factors such as soil moisture and temperature, combined with historical crop growth data, the agricultural big data platform can predict the growth rate and health of crops. This helps agricultural producers to adjust irrigation, fertilization and other management measures in a timely manner to ensure healthy crop growth.

Prediction of pest and disease risk: By analyzing the pattern of occurrence of pests and diseases and the factors affecting them in the course of crop growth, the agricultural big data platform can predict the risk of the occurrence of pests and diseases in the future. This will help agricultural producers to take preventive and control measures in advance to minimize the impact of pests and diseases on crop growth.

Agricultural product quality trend prediction: By analyzing data on the nutritional composition, pesticide residues and microbial contamination of agricultural products, the agricultural big data platform can predict the quality trend of agricultural products. This will help government regulators, agricultural producers and consumers to understand the quality of agricultural products in a timely manner and formulate countermeasures.

2.4 Visualization and early warning

The agricultural big data platform presents the quality status of agricultural products to government regulators, agricultural producers and consumers through visualization and early warning systems, so that they can understand the quality dynamics of agricultural products in a timely manner and take corresponding measures.

1) Visualization.

Charts: The agricultural big data platform displays key information on the quality distribution and trends of agricultural products in the form of bar charts, line graphs, pie charts, etc. These charts can visualize the quality status of agricultural products and help the relevant personnel quickly understand the dynamics of agricultural products. These charts can visualize the quality status of agricultural products and help relevant personnel quickly understand the quality dynamics of agricultural products.

Maps: Maps show the distribution of agricultural products, quality and other information, and help the relevant personnel to understand the regional characteristics and quality differences of agricultural products. This will help government regulators to formulate targeted regulatory measures to ensure the quality and safety of agricultural products.

Dashboard: Dashboard is a commonly used visualization tool in agricultural big data platform,

which integrates several key indicators, such as the nutrient content of agricultural products, pesticide residues, microbial contamination status. Through the dashboard, relevant personnel can understand the quality status of agricultural products at a glance and take timely countermeasures.

2) Early warning systems.

Real-time monitoring: The agricultural big data platform detects the quality of agricultural products in a timely manner through real-time monitoring of abnormal values in the data. When the quality of agricultural products is close to or exceeds the preset threshold, the platform will issue an early warning signal to remind the relevant personnel to take countermeasures.

Multi-level early warning: According to the quality and risk level of agricultural products, the agricultural big data platform can set up a multi-level early warning mechanism. Different levels of warning signals correspond to different countermeasures to ensure the quality and safety of agricultural products.

Early warning notice: when the early warning system sends an early warning signal, the agricultural big data platform will notify relevant personnel in a timely manner through SMS, email, APP push, etc. This will help relevant personnel to respond quickly and take countermeasures to reduce the quality loss of agricultural products.

3 Analysis of Agricultural Big Data Agricultural Product Quality Monitoring Strategies, The

3.1 Enhancing data collection and integration

In the agricultural big data agricultural quality monitoring strategy, strengthening data collection and integration is the foundation. Through the establishment of a perfect Internet of Things (IoT) sensing network, we can realize the collection of data in the whole process of agricultural production, including environmental parameters such as soil humidity, temperature and light, as well as production information such as crop growth, pests and diseases. The real-time collection and accurate monitoring of these data can provide basic data support for monitoring the quality of agricultural products. At the same time, the integration of data from logistics, sales and other links to form a complete data chain for monitoring the quality of agricultural products, which will help to fully understand the quality of agricultural products. To this end, it is necessary to increase the application of Internet of Things (IoT) technology, improve the accuracy and efficiency of data collection, and strengthen the data integration and analysis capabilities, so as to provide comprehensive and accurate data support for agricultural product quality monitoring.

3.2 Optimizing data analysis and prediction models that

Data analysis and prediction modeling is the core of agricultural big data agricultural product quality monitoring strategy. Using big data technology and machine learning algorithms, the collected data are deeply mined and analyzed to establish accurate agricultural product quality prediction models. These models can predict the quality trend of agricultural products based on historical data and real-time data, and detect potential quality problems in time. Through continuous iteration and optimization of the models, the prediction accuracy and reliability can be improved to provide a scientific basis for monitoring the quality of agricultural products. In this regard, it is necessary to strengthen the research and application of big data technology and machine learning algorithms to continuously improve the prediction ability and accuracy of the model, so as to provide more accurate and reliable prediction results for agricultural product quality monitoring.

3.3 Improving information sharing and synergy mechanisms

Information sharing and synergistic mechanism is an important guarantee for agricultural big data agricultural product quality monitoring strategy. The establishment of an agricultural product quality information sharing platform realizes information sharing and exchange among government regulatory departments, agricultural producers and consumers. Through collaboration and cooperation, we can jointly promote the in-depth development of agricultural product quality monitoring and improve the management level of agricultural product quality and safety. To this end, it is necessary to establish and improve the information sharing and coordination mechanism, strengthen communication and cooperation among all parties, and form a synergy to jointly promote the work of agricultural product quality monitoring. At the same time, it is necessary to strengthen the openness and transparency of agricultural product quality monitoring information, so as to enhance consumers' trust and satisfaction with the quality of agricultural products.

3.4 Strengthening policy support and guidance

Policy support and guidance is an important driving force for agricultural big data agricultural product quality monitoring strategy. The government should increase the support for agricultural big data platform, introduce relevant policies and measures, and encourage agricultural enterprises and scientific research institutions to strengthen technology research and development and application promotion. Through policy guidance and financial support, the government should promote the wide application of agricultural big data technology in agricultural product quality monitoring. At the same time, we should strengthen the supervision and law enforcement of agricultural product quality and safety to ensure the smooth implementation of agricultural product quality monitoring. To this end, it is necessary to improve the relevant laws, regulations and policy systems, strengthen the supervision and enforcement of agricultural product quality and safety, and ensure the effectiveness and authority of agricultural product quality monitoring.

3.5 Continuously improving technological innovation and application capabilities

In the strategy of agricultural big data quality monitoring of agricultural products, continuous improvement of technological innovation and application capacity is the key. With the continuous progress of science and technology and the continuous development of big data technology, it is necessary to continuously strengthen technological innovation and application capacity to promote the in-depth application of agricultural big data technology in agricultural product quality monitoring. Through strengthening technical research and development and talent training, the technical level and application ability of agricultural big data platform can be improved. At the same time, actively promote the advanced application cases and successful experience, drive more agricultural enterprises and scientific research institutions to participate in the application of agricultural big data technology, and jointly promote the continuous development and improvement of agricultural product quality monitoring work.

4 software simulation to implement the program

4.1 Simulation Purpose and Background

This software simulation program aims to simulate the core functions of agricultural quality monitoring software based on agricultural big data, including data collection and integration, data analysis and prediction, information sharing and collaboration, and visualization display. Through

the simulation, we can verify the rationality and effectiveness of the software design, and provide important reference and basis for the subsequent practical development.

4.2 Simulation environment and tools

Programming language: Python, because of its powerful data processing ability and rich library support, is the preferred programming language for this simulation.

Big data processing: use PySpark (Spark's Python API) to simulate Hadoop and Spark's data processing process.

Machine learning algorithm: implement machine learning algorithms such as multiple linear regression, support vector machine, etc. using the scikit-learn library.

IoT technology: Due to the limitations of the actual hardware environment, the data acquisition process of IoT sensors will be simulated by means of analog data generation.

Visualization technology: Matplotlib and Plotly libraries are used to realize the visual display of data.

4.3 Simulation program structure

1) Data Collection and Integration Module

Analog IoT sensor data acquisition to generate soil moisture, temperature, light and other environmental parameters data.

Simulate logistics and sales data, such as transportation time and sales location.

Integrate these data into a complete data chain for monitoring the quality of agricultural products.

2) Data analysis and forecasting module

PySpark is used to process the integrated data, clean and preprocess the data.

The machine learning algorithm in the scikit-learn library is applied to establish the prediction model of agricultural product quality.

The model was trained and tested to assess the predictive accuracy and reliability of the model.

3) Information Sharing and Collaboration Module

Create a simple information-sharing platform that simulates the sharing and exchange of information between government regulators, agricultural producers and consumers.

Realization of collaborative functions, such as task assignment and progress tracking.

4) Visualization and presentation modules

Use Matplotlib and Plotly libraries to visually display the results of data analysis and prediction models.

Generate line charts, bar charts, pie charts and other charts, as well as more complex maps and relationship diagrams.

4.4 Simulation program implementation

The following is a simplified example of the simulation program, which demonstrates the basic process of data collection and integration, data analysis and prediction, and visualization.

```python
import numpy as np
import pandas as pd
from pyspark.sql import SparkSession
from sklearn.linear_model import LinearRegression
import matplotlib.pyplot as plt
```

```
import plotly.express as px
Initialize Spark Session
spark = SparkSession.builder.appName("AgriculturalBigDataSimulation").getOrCreate()
analog data acquisition and integration
Generating data on environmental parameters such as soil moisture, temperature, light, etc. that
np.random.seed(0)
environment_data = pd.DataFrame({
'soil_moisture': np.random.uniform(0, 100, 100),
'temperature': np.random.uniform(10, 30, 100),
'light_intensity': np.random.uniform(0, 1000, 100)
})
generating data for logistics and sales
logistics_data = pd.DataFrame({
'transport_time': np.random.uniform(1, 5, 100),
'sales_location': np.random.choice(['North', 'South', 'East', 'West'], 100)
})
Integration of data
combined_data = pd.concat([environment_data, logistics_data], axis=1)
Convert data to Spark DataFrame
spark_df = spark.createDataFrame(combined_data)
data analysis and forecasting
```

Predicting the quality of agricultural products using linear regression modeling (this is an example only, the actual model may be more complex)

```
X = spark_df. select('soil_moisture', 'temperature', 'light_intensity', 'transport_time'). rdd. map (lambda row: tuple(row)).collect()
Y=np.random.uniform (0, 1, 100) assumed agricultural product mass fraction
Convert to NumPy array
X_np = np.array(X).astype(float)
Training a linear regression model that
model = LinearRegression().fit(X_np, y)
Predicting the quality of agricultural products
predictions = model.predict(X_np)
Visual presentation
Use Matplotlib to show the distribution of environment parameters
plt.figure(figsize=(12, 6))
plt.subplot(1, 3, 1)
plt.hist(environment_data['soil_moisture'], bins=10)
plt.title('Soil Moisture Distribution')
plt.subplot(1, 3, 2)
plt.hist(environment_data['temperature'], bins=10)
plt.title('Temperature Distribution')
plt.subplot(1, 3, 3)
plt.hist(environment_data['light_intensity'], bins=10)
plt.title('Light Intensity Distribution')
plt.tight_layout()
plt.show()
Use Plotly to show the comparison between predicted results and actual values
fig = px.scatter(pd.DataFrame({'Actual': y, 'Predicted': predictions}), x='Actual', y='Predicted', title=
```

```
'Actual vs Predicted Quality Scores')
    fig.show()
    Stop Spark Session
    spark.stop()
    ```
```

### 4.5 Analysis of simulation results

Data Collection and Integration: Successful integration of data from agricultural production, logistics and marketing through simulated data generation.

Data analysis and prediction: The quality of agricultural products was predicted using linear regression model. Although the linear regression model is relatively simple, the simulation results verified the basic process of data processing and model training.

Visual display: through Matplotlib and Plotly libraries, the distribution of environmental parameters and the comparison between predicted results and actual values are successfully displayed.

## 5 Conclusion

With the rapid development of information technology, the application of agricultural big data in agricultural product quality monitoring is becoming more and more widespread, which provides powerful support for improving the management level of agricultural product quality and safety and promoting the process of agricultural modernization. This paper discusses the design and implementation of agricultural quality monitoring software based on agricultural big data, from the software overview, functional introduction, technical implementation, architecture deployment to the advantages and application prospects, comprehensively demonstrates the core value and potential impact of the software system.

Through the research of this paper, we deeply realize the important role of big data technology and machine learning algorithms in agricultural quality monitoring. These technologies can not only help us realize real-time data collection, efficient integration and in-depth analysis, but also discover potential quality problems in time through accurate prediction models, and provide comprehensive, accurate and timely information on the quality of agricultural products for government regulators, agricultural producers and consumers.

At the same time, we also see the great potential of the software system in information sharing and synergy. By establishing a platform for agricultural product quality information sharing and realizing information sharing and exchange among all parties, it can greatly promote the in-depth development of agricultural product quality monitoring and improve the overall regulatory efficiency.

In the future, we will continue to optimize and improve the functions and technical implementation of the software system, and continuously improve its intelligence level and user experience. At the same time, we will also actively seek opportunities for cooperation with more partners to jointly promote the widespread application of agricultural big data in the field of agricultural product quality monitoring, so as to contribute more to guaranteeing the quality and safety of agricultural products and promoting the development of agricultural modernization.

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