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PRAGMATIC - INNOVATIVE IT PLATFORM FOR YIELD AND COST PREDICTION OF AGRICULTURAL PRODUCTION

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Abstract.

The project aimed to develop an innovative IT platform for predicting crop yields and production costs of three reference crops: blueberries, apples, and potatoes, across the supply chain from field to processing. The platform integrates machine learning and artificial intelligence models using agronomic, economic, meteorological, soil, phenological, and satellite data.

The system consists of five modules: a Knowledge Base for data integration, an Anomaly Detection module for identifying inconsistent records, a Yield Prediction module, a Cost Prediction module, and a Visualization Library for presenting results and prediction confidence levels.

Project objectives included: (1) acquisition and integration of multi-source datasets, including satellite, proximal, public, and private data; (2) development of hybrid AI-based predictive models with and without varietal information; and (3) creation of tools for optimization, testing, and fraud detection.

The platform is designed for medium and large farms producing apples, potatoes, and blueberries, providing decision-support tools that improve production efficiency, optimize costs, and support environmentally sustainable agricultural practices.

Keywords.
yield prediction, data fusion, hybrid models, potato, apple, blueberry

Introduction

Agricultural producers increasingly require accurate decision-support tools capable of forecasting both crop

yields and production costs under changing environmental and market conditions. The PRAGMATIC project addressed this challenge through the development of an innovative information technology platform integrating satellite Earth Observation data, ground observations, and artificial intelligence methods.

The objective of the project was the development of predictive models for yield and cost estimation for three reference crops: potato (*Solanum tuberosum L.),* apple *(Malus domestica Borkh.),* and blueberry (*Vaccinium corymbosum L.*).

System Architecture and Data Sources

The developed platform consisted of five functional modules:

- Knowledge Base (BW) module for continuous storage and synchronization of agricultural datasets;
- Violation and Anomaly Detection (WNA) module for identification of inconsistent or abnormal data records;
- Yield Prediction (PPL) module for crop yield forecasting;
- Cost Prediction (PPK) module supporting production planning and optimization;
- Visualization and Configuration Library (WWK) providing graphical presentation of results and confidence levels.

The platform integrated agronomic, meteorological, soil, phenological, and economic data obtained from satellite observations, proximal sensing systems, private databases, and publicly available repositories.

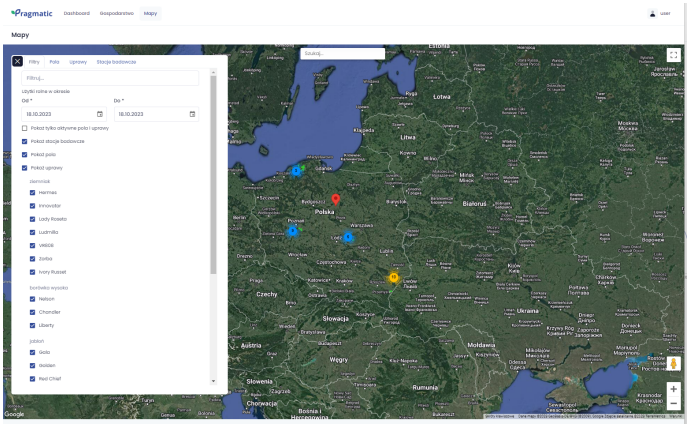

Fig 1. Dashboard of the PRAGMATIC platform presenting spatial visualization of agricultural fields, crop varieties and experimental sites

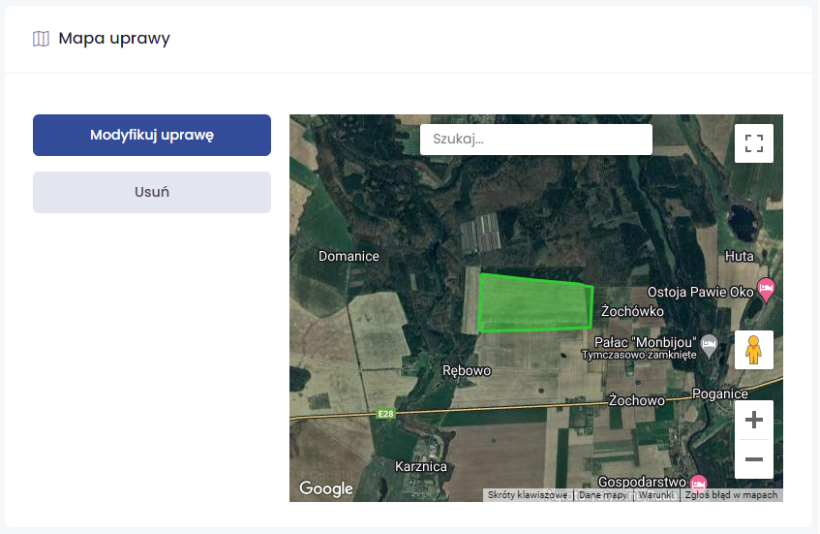

Fig 2. Agricultural plot identification and boundary definition used for yield and cost prediction modelling

Artificial Intelligence Framework

Data preprocessing included handling of missing values, data normalization, feature selection, and anomaly detection.

Three categories of predictive models were developed and evaluated:

- non-satellite models,
- satellite-based models,
- hybrid models combining satellite and ground data.

Machine learning algorithms investigated during model development included Linear Regression, Ridge Regression, Lasso Regression, Elastic Net, Random Forest, XGBoost, Support Vector Regression (SVR), Multilayer Perceptron (MLP), and Stochastic Gradient Descent (SGD).

Feature selection techniques included Pearson Correlation Analysis, Chi-Squared Testing, Stepwise Regression, and Principal Component Analysis (PCA), while anomaly detection was performed using Local Outlier Factor (LOF) and One-Class Support Vector Machine.

Results and Discussion

The developed platform enabled integration of heterogeneous agricultural datasets and automated generation of predictive models supporting both yield forecasting and production cost estimation. The hybrid modelling approach demonstrated the highest potential for combining information from satellite imagery and field-level observations, providing a comprehensive representation of crop development and production conditions. The anomaly detection framework improved data quality assessment and increased the reliability of predictive analytics.

Conclusions

The PRAGMATIC platform demonstrated the feasibility of combining Earth Observation data, agronomic information, and artificial intelligence techniques within a unified decision-support environment.

The developed solution supports medium and large agricultural enterprises in improving production planning, optimizing costs, and aligning crop production with market requirements. The platform contributes to the advancement of data-driven and sustainable agriculture through the practical application of AI and satellite technologies.

References

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