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## Developing Digital Platform and Eco-system of Smart Services for Rice Cultivation

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### Abstract

Rice is not only the main food in Asia but also is one of the top five foods in the world. According to United Nations statistics, the current world population has exceeded 7 billion people, and the demand for rice has also increased year by year. The Food and Agriculture Organization (FAO) of the United Nations notes that world rice consumption increased by 1.1% to 503.9 million tons in 2017/18. By 2018/19, world rice utilization will increase by another 520 tons to reach 509.1 billion tons (FAO, 2018).

But growing demand for rice can meet in near future a number of issues with production and supply because many countries in the world are currently facing a number of new challenges including global climate changes, growing demand for soil carbon sequestration, etc. It requires that agriculture need to become more smart, flexible and adaptive - to provide high quality of products, better efficiency and productivity, and finally the competitiveness and sustainability of countries development.

In this paper we present first vision of international Taiwan-Russia project on the development digital platform and eco-system of smart services for rice cultivation.

The project is oriented on new coming era of Industry 5.0 which is associated with the next step from automation of physical processes, data integration and visualization (as it is currently considered in Industry 4.0) – to Artificial Intelligence (AI) for supporting cooperation of humans and robots in managing organizations (so called “Augmented Intelligence”).

More specifically the objective of the project will be the developing of new models, methods and tools for the digitalization of domain-specific knowledge and the automation of

coordinated decision making between smart services designed as a potentially autonomous cyber-physical systems with the use of ontologies and multi-agent technology.

There are now a number of digital platforms and services on the market which are already well-developed and used in practice, but they have a number of limitations. For example, some of them are closed for end-users and developers or dictate their rules to farmers. Some other not allow users to have access to all resources in one mobile phone. Third are focused on accounting and routine automation and not provide farmers with smart services supporting knowledge-based decision making in problem situations and every day operations, etc.

In the proposed project the new concept and prototype of open digital inter-cloud AI platform and eco-system of smart services for rice cultivation will be developed.

The functionality of the platform and eco-system will help farmers:

- select varieties for planting, depending on the type and composition of the soil;
- determine the patterns of good, normal and weak rice growth;
- analyze the state of the rice, discover problems, find a solution and adjust work plans;
- make recommendations on the use of fertilizers or pesticides for rice, etc.

To solve a problem we propose to develop inter-cloud platform which will provide and combine traditional and AI services with ability to discover problem situations, find possible solutions and make negotiations between services for taking coordinated decision - collecting required data from existing platforms by specified protocols and integrating knowledge on fields and crops, machines, agro-technologies, etc.

The first prototype of digital eco-system of smart services will be focused on forming knowledge base for farm management, collecting data from sensors, hyper-spectrum analysis of images of fields, forming crop rotation plans and scheduling humans and machines with economic estimates. The digital platform will be designed as an open system - and smart services developed in one country will have chance to enter eco-system for interest of concrete farmer working in any other country.

As a first services for rice cultivations we consider the following services:

1) Knowledge Base on rice growth and physiological prediction for assessing the state of soil and plants.

At present, different rice cultivation technologies significantly affect the quality and yield of rice as well as climate events, water shortage and other factors. Agriculture must be oriented to a scientific, intelligent, and value-based approach to effectively manage and reduce costs and labor expenditures. Collect the growth parameters of the plant cultivation process, establish a digital database, and then analyze the crop growth pattern by the agricultural big

data model to effectively predict the crop production capacity. In this development rice will be treated with silicon fertilizer, and the growth, physiology, disease and microclimate data of rice development will be collected, and a database of rice growth and climate will be established to provide a reference for subsequent growth pattern analysis.

## 2) Smart service based on spectroscopy for rapid analysis of soil.

With the development of refined agriculture, people know that in order to maintain the fertility of the soil and improve the soil structure, the soil must have large amount of organic matter. Therefore, the demand for soil and organic material in cultivated land is increasing, but the traditional physical and chemical analysis of soil is time-consuming and tedious. To solve this problem, the research hopes to develop a method for rapid analysis of soil. The study will divide a field in Guanshan, Taitung, into three sections and assigned one agricultural cultivation treatment with different fertilizers and probiotics to each section. Different spectra of soil samples from each treatment will be collected and compared for supporting decision making processes.

Expected results for the project:

- The concept of an open digital inter-cloud platform and eco-system of smart services for rice cultivation.
- The basic ontology and knowledge base on the most advanced techniques and tools of rice cultivation for generating recommendations to farmers.
- The distributed architecture of the platform and eco-system of smart services to provide openness, flexibility and efficiency, high performance, reliability and security.
- Models, methods and tools to support collective decision-making and negotiations between agents of smart services in digital eco-system.
- Prototypes of smart services of crop cultivation to the level of each field.
- The inter-cloud integration of smart services into a digital eco-system for rice cultivating and the study of its applicability on selected farms.

In future the number of such services could be extended involving governmental organizations, universities, commercial companies, start-ups, etc

The first prototype will be focused on the domain of rice production but the main part of the platform and eco-system will be also applicable for wheat production, tropical fruits, etc.

**Keywords:** *Precision agriculture, Digital platform, Eco-system of smart services, Multi-agent technology, Ontology, Knowledge base.*