# Use of the M2M Service Platform in Agricultural ICT

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**Abstract**

Japanese agriculture is confronting an insufficiency of successors, making how to inherit cultivation know-how an important issue. One of the expected solutions to this issue is the application of ICT, which includes application to agricultural sites (farming fields, greenhouses and plant factories) and to agriculture management including planting decisions, work planning and result management. NEC is challenging both of these aspects by applying sensing technology to farming fields, supporting agriculture management and providing the achieved results as one of its M2M services. This paper introduces the contents of this service.

**Keywords**

agricultural ICT, field sensing and visualization, cultivation SNS, growth prediction, plastic greenhouse culture plant factory, environment sensing, agriculture management support system, GAP management

## 1. Introduction

Japanese agriculture is confronting problems such as an insufficiency of successors and a difficulty in accumulating cultivation know-how. The Ministry of Agriculture, Forestry and Fisheries of Japan is attempting to energize agriculture by promoting the application of ICT (IT) through the Project for the Generalization of IT Application in Rural Areas. In the severe circumstances surrounding agriculture and farming communities, this project attempts to energize regional agriculture by promoting agricultural production corporations and community farms that practice large-scale farming, shift work and a five-day work system so that novices can join the field of agriculture. About 1,100 agricultural production corporations have been organized by FY2009, tackling the production of unique and characteristic agricultural products by means of product branding, quality improvement and functionality improvement.

In this trend, NEC is challenging the application of ICT to agriculture and providing agricultural ICT services through the CONNEXIVE M2M service network.

In section 3, we will detail the application of IT to agricultural sites (farms, greenhouses, plant factories, etc.) and IT systems for supporting agriculture management such as the "agriculture management support system" and "GAP management system" as well as the "field sensing" system for supporting cultivation work with IT.

## 2. Summary of Efforts Made by NEC

In the Project for the Generalization of IT Application in Rural Areas (2009), the Ministry of Agriculture, Forestry and Fisheries emphasized the necessity of the "force to produce" and "force to sell" what consumers want or, in other words, the techniques supporting the management force. For this purpose, the ministry recommended the active use of IT (Information Technology), which specifically includes the following examples:

- To contribute to "labor saving," IT can be used to monitor and manage greenhouses, etc, with sensors and robots, which ensures stable crop production at a set quality level.
- To contribute to "convenience," IT can be used to give consultation and advice through mobile information terminals while checking the actual sorting results at the agricultural sites, which makes it possible to give optimum agricultural guidance.
- To contribute to "sales," IT can be used to identify the growth situations of farming fields and judge the optimum harvest timing for achieving high yields and quality, which consequently lead to an increase in sales.

As an application of ICT for "labor saving," we installed sensors in actual agricultural sites (farms, greenhouses, plant factories, etc.) to collect/record the environment data (measurements of temperature, humidity, sunshine hours, etc.) and succeeded in representing vegetable cultivation status in ob-

jective data. This result is expected to enable reproduction of cultivation environments based on collected environment data and documentation of the know-how of skilled farmers.

As applications of ICT for "convenience," we visualized the fertilizer usage situation with the "agriculture management support system" and gave guidance on agriculture management through support for the development of rules and management standards by agriculture coaching/promoting staff with the "GAP management system."

As an application of ICT for "sales," we installed sensors for detecting various types of cultivation environment data for farming fields such as temperature, humidity, sunshine hours and soil moisture content and collected/recorded farm data remotely through a network such as the Internet or a mobile network. By applying statistical analysis to the collected data and combining it with cultivation know-how, it is possible to identify the growth situation and harvest timing more accurately.

## 3. NEC's Efforts for Agricultural ICT

### 3.1 Management of Greenhouses and Plant Factories

**(1) Application of IT in agricultural sites**

The first step in the introduction of IT to an agricultural site is the installation of sensors to collect and record environment data. This means representing the status of vegetable cultivation in objective data, which has long been advanced based on intuition and experience.

If the reproduction of a cultivation environment is possible based on the collected data, it is possible to document the know-how of skilled farmers.

In addition, the collation of environment data and vegetable growth status is expected to offer knowledge of the optimum cultivation conditions for each vegetable breed. We believe that the data can contribute to agriculture management in the future when it is applied to predicting vegetable growth ( **Fig. 1** ).

**(2) Environment sensors in greenhouses and plant factories**

Sensors used in environment data measurements are subject to restrictions caused by the measurement target sites. For instance, with hydroponic culture, it is necessary to measure the environment data of the water that is the culture medium and it is also indispensable to provide resistance against rust, etc. The main sensing items of various

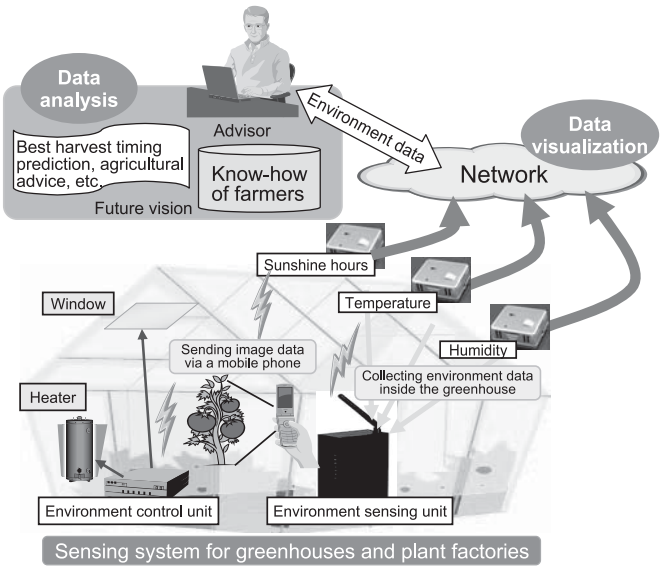


Fig. 1 Image of NEC's Agricultural ICT.

measurement target environments are as listed below:

- **Sensing of indoor (greenhouses, plant factories, etc.) and outdoor environments:**

Temperature, humidity, sunshine amount, $CO_2$ concentration, wind speed, etc.

- **Sensing of soil environments:**

Underground temperature, soil moisture, etc.

- **Sensing of underwater environments:**

Water temperature, electrical conductivity, pH (degree of acidity or alkalinity), etc.

**(3) Control of greenhouses and plant factories**

Environment data can be used in controlling the equipment in greenhouses and plant factories. The control targets are agricultural facilities such as windows, heaters, curtains, supplemental lights and fans. When many facilities are present, there are countless methods and combinations for executing a single control operation such as "lower the room temperature". This is because, in addition to the presence of multiple methods such as opening windows, closing curtains to screen sunshine and activating fans for forced ventilation, it is also necessary to select the method according to the circumstances of each moment, for example selecting a method other than opening the windows if the outdoor weather is a hard rain.

With vegetables, cultivation conditions vary between crops, and differences in the outdoor environment of each cultivation site affect the selection of environment control meth-

ods. With agricultural IT based on M2M, we aim to reproduce the optimum environment for each cultivated vegetable and contribute to the improvement of yields and quality and the reduction of labor and costs.

### 3.2 Agriculture Management Support System

**(1) Support for agriculture management**

NEC provides an “agriculture management system” and “GAP management system” to support agriculture management with IT.

The actions necessary for agricultural production include the planting decision, work planning, preparation of required materials and recording of daily work results (fertilization, pest and disease control, harvesting, etc.).

We support the planning and recording of information indispensable for agriculture management. In addition, we support optimum farm management for ensuring safety and security as well as agricultural work compliant with GAP (Good Agricultural Practices) to enable optimum management ( **Fig. 2** ).

**(2) Agriculture management support system**

Every agricultural product has cultivation guidelines defined for it, which farmers cultivate each product by following. Cultivation guidelines prescribe rules related to cultivation timing and the use of agricultural chemicals and fertilizers. For example, on the subject of “agricultural chemicals,” the guidelines prescribe the types of usable chemicals, the number of chemical usages, the timings, the amounts, etc. and that the farmers should record and manage the chemical usage situation during their work. As such management work is required for every product and every process, it is very troublesome and laborious for farmers. To deal with this, we are planning to introduce “LifeTouch,” an information terminal that accepts data input by direct touch of the screen.

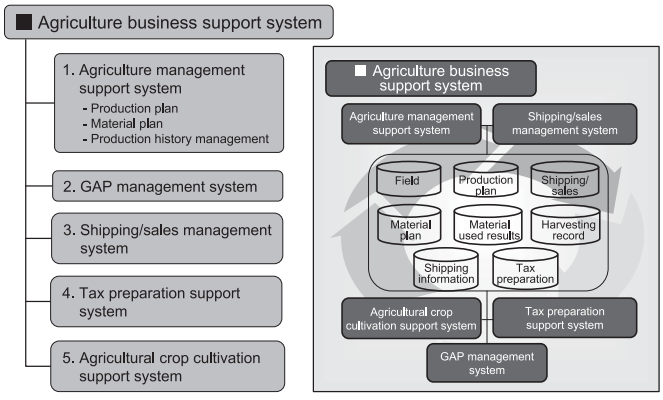


Fig. 2 Summary of the agriculture management support system.

**(3) GAP management system**

GAP define rules of action and standards of management covering a very wide range of areas such as the management of farms, use/storage of fertilizers and chemicals, harvesting/sorting/shipping and worker safety.

It is possible to implement a mechanism for improving the work of farmers by monitoring and verifying that farm management regulations are planned and designed effectively in compliance with GAP. The GAP management system supports the development of rules and management standards by agriculture coaching/promoting staffs. Based on the results of the standard compliance audition, it also supports the practice of the PDCA cycle for promoting correction and improvement. We are also planning the application of the “LifeTouch” information terminal to this system.

**(4) The future of the agriculture management support system**

The data input to the agriculture management system can also be used as crop production information. When combined with the environment data measured by field sensors, etc., the data can also be analyzed as production technology information. In the future, it will be possible to create mechanisms such as an agricultural crop cultivation support engine and an agricultural crop cultivation support database. This will replace the domain of knowledge that is presently regarded as the skills of practical and experienced farmers with scientific, objective data, which makes it possible for subsequent generations to inherit these skills. We believe that the application of IT from the viewpoint of agriculture management support will also contribute to the advancement of Japanese agriculture in the future.

### 3.3 Field Sensing Solution

**(1) Summary of field sensing**

We are challenging “field sensing,” aiming to support cultivation work with IT.

Field sensing refers to remote collection/recording of farming field data through a network such as the Internet or a mobile network by installing sensors to detect various types of cultivation environment data such as temperature, humidity, sunshine and soil moisture in farming fields including rice fields, fruit gardens, greenhouses and plant factories.

By applying statistical analysis to the collected data and combining it with agricultural cultivation know-how, it is possible to identify growth situations and harvest timing more accurately.
We will improve product quality and production efficiency by means of accurate identification of crop sugar/acid levels, cultivation work history covering water feeding and fertilizing and field environment data such as accumulated temperature, accumulated sunshine and moisture content.
We adopt an M2M technology for the system that performs collection and statistical analysis of the data. This will help us to provide versatile and flexible services quickly.

**(2) Field sensing technology**

Although the general targets of cultivation environment sensing are temperature, humidity, sunshine, soil moisture, soil EC and $CO_2$ concentration, the collected information is complicated and extended depending on the crops being cultivated and their cultivation methods. Information collection methods are greatly variable depending on the scale of cultivation and the situation of the farm, for example whether the information to be collected is local or wide-area information. Collection of local information is possible by installing sensors in the required positions, while that of wide-area information may be facilitated by field data measurements from satellite images. Furthermore, apart from sensing the cultivation environment, field sensing in the wider meaning of the term can also include monitoring cultivation equipment status, identifying the operating status of motors, etc. and identifying fuel usage to reduce production costs through energy saving.
NEC has been providing a solution using the Field Server of elab experience Inc. since 2009. The Field Server is used for local measurements, with sensors installed in the farming field.
This solution uses temperature, humidity and sunshine sensors as standard and can select soil moisture, soil EC and leaf surface moisture sensors optionally. It also incorporates a web camera for acquiring still images of farming fields at the same times as the periodic acquisition of sensing data and enables monitoring the images remotely in real time, which contributes to making the system very suitable for the remote monitoring of farming fields.

**(3) Applications of field sensing**

We provide a cultivation work support service based on a fusion of field sensing and agricultural know-how ( **Fig. 3** ). This service started in October 2011 in the framework of a cloud system performing visualization of field sensing data and providing cultivation SNS for users. Each user who records his or her cultivation work and crop status can receive advice on optimum cultivation for the user's circumstances from a cultivation advisor. Featuring a mechanism that enables users to monitor their fields and continue cultivation remotely, this system will be introduced initially in community gardens and expanded to professional farmers and private home gardens in the future.
In the areas damaged by tsunamis in the 2011 Tohoku Earthquake, salt damage is becoming an important barrier hindering the regeneration of agriculture. We are planning to contribute to the rehabilitation of these areas by measuring soil salt levels, etc. through field sensing.
In the future, field sensing is expected to evolve into a management solution capable of the automated control of temperature management equipment, greenhouse window opening/closing, water sprinkling and fertilizer distribution and the control of plant factories.

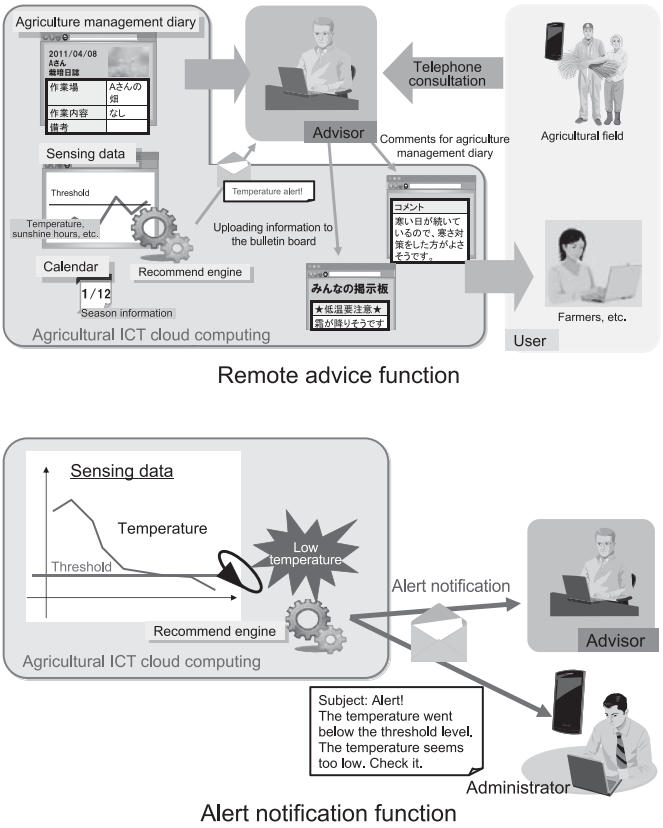


Fig. 3 Cultivation work support service using field sensing.

## 4. Conclusion

The application of ICT to agriculture is expected to be a means to energize Japanese agriculture and also as one of the solutions for such issues as the insufficiency of successors and the difficulty of inheriting know-how. Furthermore, identifying crop harvesting timing and predicting yields makes it possible to stabilize production, increase the incomes of farmers and promote the branding of production regions.

Providing agricultural ICT services as M2M services of cloud systems is expected to disseminate the application of ICT to agriculture. We will endeavor to develop agriculture and the application of ICT to agriculture by providing services that are easy to use and easily affordable for the persons and organizations engaged in agriculture.

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