

# Analysis of Recent ICT Convergence Technology Status in the Agrifood Area through the Case Review<sup>1)</sup>

Byungho Chung · Ikhoon Jang · Junghoon Moon

**Abstract** The purpose of this study is to explore the status of current ICT convergence technology in the agrifood area through reviewing articles. For this, we classified the ICT convergence technology into four categories including RFID technology, smart sensing technology, USN technology, and other ICT convergence cases and reviewed by extracting the cases related to the convergence technology that is recently conducted depending on each category from the Journal of Computers and Electronics in Agriculture between January 2012 and June 2014. Additionally, by combining the reviews of cases, we conducted the study in the direction of analyzing the recent ICT convergence technology status in the current agrifood area.

**Keywords** ICT convergence technology, RFID, Smart sensing, USN

## 1 Introduction

Michael Porter (2001) argued that the importance of proper utilization of ICT technology to be more competitive would be more emphasized over time. By supporting his theory, the technology convergence is tried in various ways by actively adopting the ICT technology in many areas including distribution, production, sales, etc. (Bhatnagar, 1999). The influence of ICT convergence technology developed in this way has not been limited to the development of individual area. It has changed the structure and information exchanging method of all markets as well as caused changes across most areas in society from the companies' strategy establishment and the method for establishing the relationships between producers and consumers to the distribution process (Zioupou et al., 2010).

The agrifood area cannot be free from this stream. However, there were difficulties in the agrifood area in the past when introducing new technologies, due to the reasons of persistence of traditional method, food safety, limited communication with consumers in both directions, etc. The introduction of ICT technology can make it easy to overcome obstacles. Actually, the ICT technology is actively adopted in various areas related to agrifood depending on each characteristic, and the new ICT convergence technology is also actively developed through this (Sturiale, 2011).

The purpose of this study is to introduce the current ICT convergence technology status. As mentioned above, the ICT technology introduction has been conducted in all areas related to agrifood in various forms. In this study, first, the ICT convergence technology related to the agrifood area was classified into four categories including RFID technology application, sensor technology application, USN technology application, and other advanced technology application. These four categories were classified according

---

D. B. Chung · I.H.Jang · J. Moon  
College of Agriculture and Life Sciences  
Seoul National University, South Korea

D. B. Chung  
e-mail: jncoboyss@gmail.com

I.H.Jang  
e-mail: igguniya@naver.com

J. Moon (✉)  
e-mail: moonj@snu.ac.kr

---

1) This research was supported by the MSIP(Ministry of Science, ICT and Future Planning), Korea, under the CITRC(Convergence Information Technology Research Center) support program (NIPA-2014-H0401-14-1008) supervised by the NIPA(National IT Industry Promotion Agency)

to the types of technology connected to ICT technology, and the current ICT convergence technology in the agrifood area is introduced by listing the current technologies in sequence according to each category. The references of this study are based on the Journal of Computers and Electronics in Agriculture, and we reviewed 17 articles corresponding to these four categories among articles published between January 2012 and June 2014.

## 2 Introduction of Current ICT Convergence Technology

### 2.1 RFID Technology

RFID is an abbreviation for Radio Frequency Identification and can be defined as the wireless communication technology that makes it possible for the computer to collect the information saved in a tag by recognizing the electronic tag that is a long distance away (Nath, 2006). The RFID technology can be categorized into Active RFID technology and Passive RFID technology depending on the type of chip used (Want, 2006). In the Active RFID technology, the RFID chip with the rechargeable and replaceable battery is used, and this technology is used to collect the tracking and mobile information of the target. On the other hand, in the Passive RFID technology, the subminiature RFID chip that does not need the battery is used, and this technology is appropriate for tracking the product history information.

### 2.2 Smart Sensing Technology

Smart sensing is the technology in which the user can extract and save the necessary information. While the existing sensor saves and transfers all the information collected to the linked device, the smart sensor is different because it extracts the necessary information among the various types of information and transfers it to the user after processing into the necessary form (Spencer, 2004).

### 2.3 USN Technology

USN (Ubiquitous Sensor Networks) is not a simple network but connecting herb of several service networks. When the USN service network is built, it is possible to control the work necessary for the user across the society at large including natural disaster monitoring, health management, housing automation, traffic control, etc. through wired/wireless network in the one place with one USN machine (Kim, 2008). It can be possible by installing several kinds of self-output style wireless sensors everywhere. The remote control is possible by collecting the various types of information through the sensor and transferring this through the network (Puccinelli, 2005).

## 3 Case of ICT Convergence Technology in the Agrifood Area

### 3.1 Case of ICT Convergence Technology Based on RFID Technology

#### 3.1.1 Action recognition technology for moving targets through RFID technology and the case of ICT convergence

##### 3.1.1.1 Analysis technology of feeding behavior of growing-finishing pigs (Brown-Brandl, 2013)

It is possible for a farmer to collect various types of information for effective livestock management by understanding the feeding behavior of livestock. The technology which is currently in the developing stage in the U.S. makes it possible to analyze this information by connecting the feeding behavior and the weight gain as well as health-related information and using the information about feeding behavior of growing-finishing pigs and weight information through the scale installed in the feeding system.

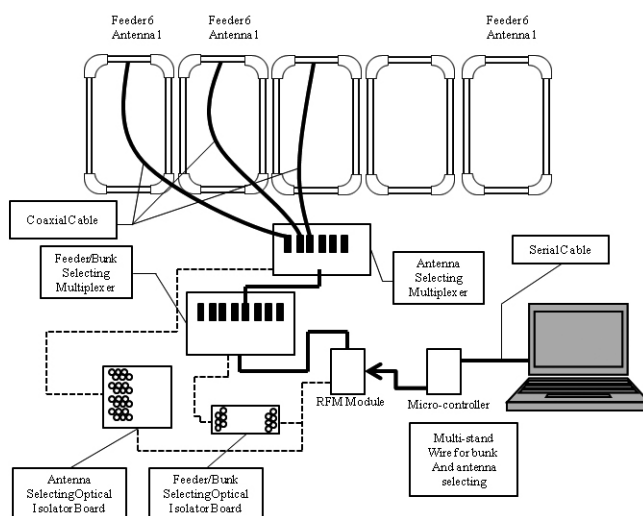


Fig. 1 Feeding behavior analysis system diagram (p. 247, Brown-Brandl, 2013)

<Figure 1> is the simple diagram showing the feeding behavior analysis system. Here, by using RFID technology and several multiplexes, feeding time and weight gaining of pigs are recorded. <Figure 1> shows the necessary system to analyze feeding behavior of livestock in one stable; if the maximum of eight multiplexes are installed here, information about more objects can be obtained. It is possible to identify the pigs with disease as well as pigs with a genetic difference in the group by analyzing the feeding behaviors of livestock collected by this way.

3.1.1.2 A wearable module for recording worker position in orchards (Ampatzidis, 2011)

The wearable module for recording worker position in orchards integrates RFID technology, wireless sensor network, RFID tag, bar code reader, and pedometer technologies and the device that can transfer the information about the wearer position in the real time. It makes it possible both to measure the working hours and the position information of orchard workers in the environment where the GPS reception is difficult and to improve the effectiveness of harvesting labor by effectively distributing the labor.

The position record wearable module device consists of the pedometer and the small barcode reader and performs the function of transferring the position information of the orchard worker in real time.

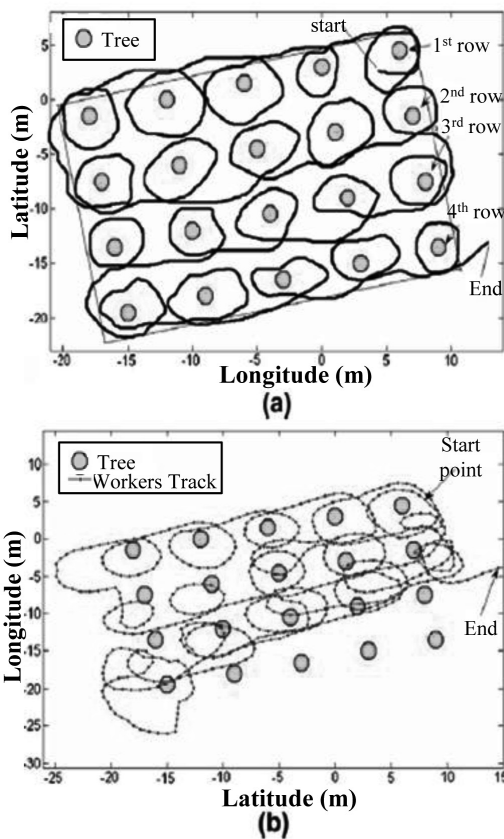


Fig. 2 Actual moving route of the wearer with the position recording wearable module device (a) and route measured by the device (b) (p. 227, Ampatzidis, 2011).

<Figure 2> shows the actual moving route of a device wearer (a) and the route measured through the wearable module (b). When comparing these two routes, there is a significant result as the technology can supplement the difficulty in collecting the GPS information due to the various environmental interruptions since there are only insignificant error of 2~3%.

3.1.2 Supply chain efficiency

3.1.2.1 Performance analysis of history tracking system of flour mill (Qian, 2012)

The history tracking system of flour mills is being improved and is becoming more efficient. When applying this system for one year, the hours for history tracking are reduced by 113%, and the 8% of accuracy increase effect is shown. The improvement of history tracking system efficiency is continued to 32.5% in the aspect of benefit improving effect.

This analyzing technology integrates the RFID technology and 2D barcode technology/QR code technology. The distribution information of products can be automatically collected by installing the subminiature RFID chip in a flour storing container; the history information can be easily shared through the QR code attached on an individual wrapper. Through this, it is possible to reduce the expense and the time required in the distribution process.

3.1.2.2 Food safety retention through Supply-chain Pedigree Interactive Dynamic Explore (SPIDER) (Wang, 2013)

The SPIDER is the platform that allows food consumers and quarantine authorities to share the quarantine information in each supplying step by tracking the source in the previous supplying step. This platform uses the RFID technology and the EPC Global Network and supports the increase of consumers' interest in the implementation of a food safety management certificate system including HACCP, etc.

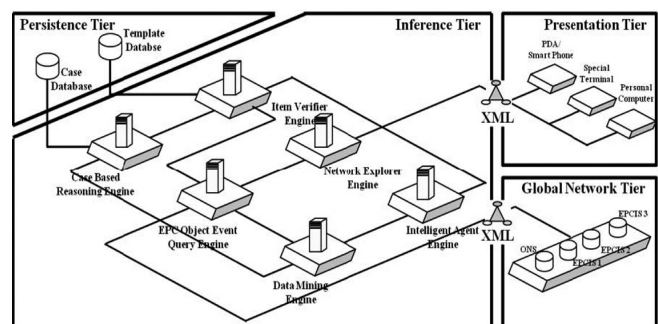


Fig. 3 SPIDER platform diagram (p. 16, Wang, 2013)

<Figure 3> is the diagram to easily understand the structure and operating method of the SPIDER platform. It is classified into four types including Presentation Tier, Inference Tier, Persistence Tier, and Global Network Tier. Unique functions are performed for food safety retention and the continued quarantine in each step. In addition, the system is continuously upgraded by using a CBR (Case-based Reasoning) Engine. The function of a CBR Engine is

divided into two types including role analyzing and saving new cases and providing the proper solutions by finding the similar case after comparing the already saved case. Through this, it is possible to manage the more effective SPIDER platform.

3.1.2.3 Building the virtual space based on Web 2.0 to save the information related to plant pathology (Luvisi, 2012)

This technology uses the RFID technology and Web 2.0, which is the technology to build the virtual space on the Internet. First, the various types of plant pathology information are collected by attaching the RFID chip on the plant leaf. Then, the collected information through RFID chip on the virtual space made through Web 2.0 is saved and updated by using the RFID application. Through this, it is possible for farmer, researcher, and several related institutions to effectively share the information about plant pathology.

3.2 Case of ICT Convergence Based on Smart Sensing Technology

3.2.1 Laser sensing technology

3.2.1.1 Weed vegetation sensing technology in cornfields (Andujar, 2013)

In a weed vegetation sensing technology of a cornfield, the remote sensing technology (LiDAR) was used. LiDAR (Light Detection and Ranging) is the type of Passive Remote Sensing obtaining the necessary information without directly contacting the object by using the same principle as that of radar. In other words, by emitting laser to the target to obtain the information, the necessary information can be obtained through sensing the time difference of electromagnetic waves reflected from the target and the energy change. This weed vegetation sensing technology is a system that distinguishes the weed in space between the lines of cornfield by the height difference between plants using the remote sensing technology based on the feature of height difference between corn and weed.

As shown by the test environment in <Figure 4>, the sensing data of a cornfield is collected by attaching the non-touch sensor such as LiDAR on the front side of an agricultural vehicle; the weed is distinguished by analyzing this data using the algorithms to identify the height difference between crops. In the test step, 77.7% of identifying rate function was shown.

3.2.1.2 Development and evaluation of petal thickness measuring device based on the Dual Laser Triangulation Method (Lee, 2013)

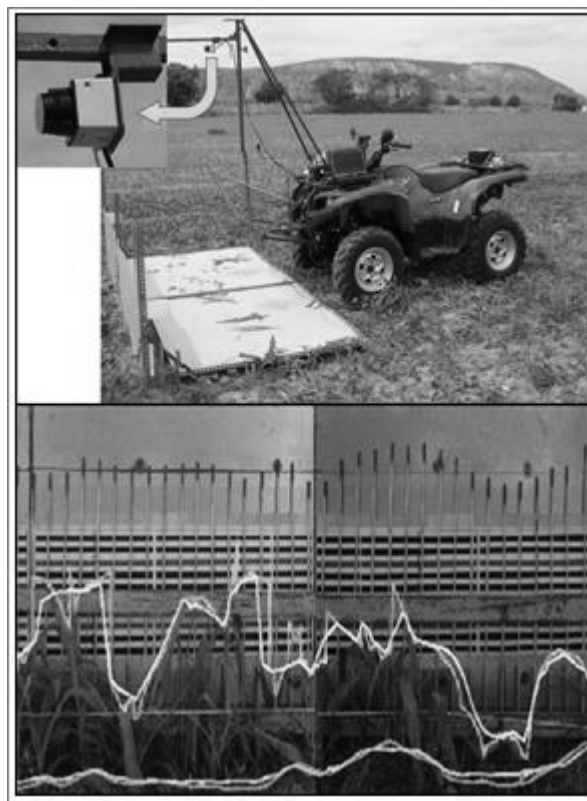


Fig. 4 LiDAR attached to a vehicle / comparison between the data collected by the algorithms identifying the height of crop and the height of actual crop (p. 13, Andujar, 2013)

While the growth and health condition could be measured through the leaf or thickness of leaf, it was difficult previously to actually measure it due to the irregular curvature and soft feature of the petal. This study was the trial to overcome this problem. For this, the non-touch petal thickness measuring device was developed using the Dual Laser Triangulation Method that was based on the Scheimpflug effect.

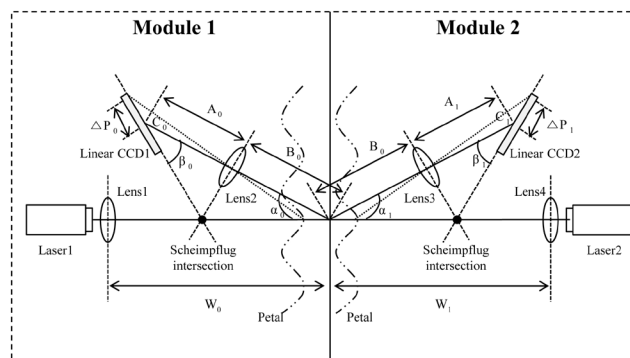


Fig. 5 Principle of thickness measurement (p. 86, Lee, 2013)

<Figure 5> simply shows the principle of non-touch petal thickness measuring devices. First, after measuring the multiple positions of petal surface through the Dual Laser Triangulation Method, the curved surface of multiple positions of petal surface is fitted using the tertiary cubic

spline method. When the data collected by this way is substituted according to the general curvature equation, the petal thickness can be measured.

### 3.2.2 Sound sensing technology

#### 3.2.2.1 Sound sensor system for qualitative analysis of asparagus (Fernandes et al., 2013)

As one of frequently consumed crops in Europe, the white asparagus is cultivated in around 20,000ha only in Germany. The more effective cultivation of white asparagus that is one of traditional intensive farming becomes possible through mechanization as in other farming. However, for the work to distinguish the hollow white asparagus in the last step of product harvest, the mechanization has not been performed. This technology is to automatically thin out the hollow white asparagus by using the sound sensing technology and laser scanning technology.

First, the vibration of asparagus is measured through the sound sensor system after regularly stimulating the asparagus; here, a faster and finer vibration pattern of asparagus can be shown in 3D form by connecting the laser stemming technology. By analyzing the vibration pattern recorded by this way, not only can the hollow white asparagus be distinguished but also the quality of asparagus is discovered.

#### 3.2.2.2 Automatic measuring method of the feed intake of broiler chickens by sound technology (Aydin, 2014)

The research to prove the correlation between various kinds of sound made by livestock and the behaviors of animals is conducted in various ways. In this study, the relation between picking sound and feed intake amount is researched by developing the algorithms to sense the broiler chickens' picking feed sound. When the sound technology is being used, its usefulness is evaluated by comparing the algorithm's result with the feed intake amount measured by size and video observation.

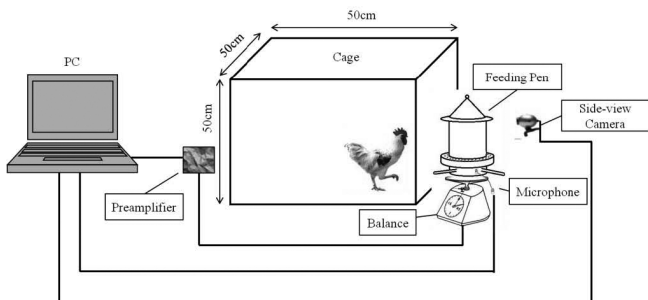


Fig. 6 Device installation to measure the sound of individual broiler chicken (p. 19, Aydin, 2014)

<Figure. 6> is the diagram of device design for the test.

The broiler chicken used in this test was fasted for four hours before the test. The feed intake amount during the test was recorded through the automatic measuring system, and the amount of feed loss was measured by collecting and weighing the loss manually to determine the whole feed intake amount which is necessary to verify the algorithm.

Consequently, 93% of picking sound was properly verified to be associated with intake by algorithms; as a result of linear regression test about feed intake amount and picking behavior, the significant result was obtained as 0.985 of decision R2. In other words, as a conclusion, the picking sound technology system in this study can be used as a tool to measure the feed intake amount.

### 3.2.3 Photosynthesis sensor technology

#### 3.2.3.1 Smart lighting system for plant growth and development (Olvera-Gonzalez, 2013)

The smart lighting system finding the optimized light amount for green plant growth and development and providing proper amount of light depending on each plant has been developed. This is the technology using the chlorophyll fluorescence monitoring system and temperature/humidity/CO2 sensing technology and performed by the steps shown in <Figure 7>.

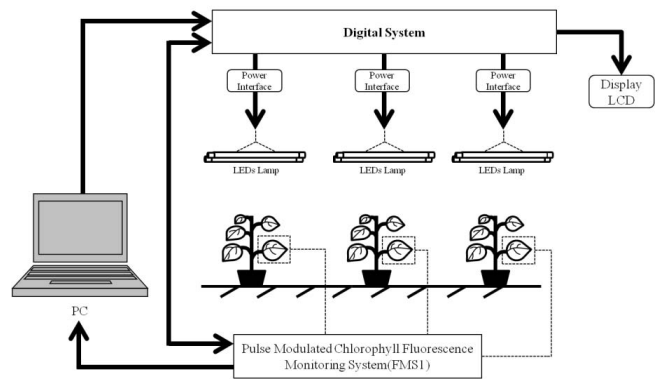


Fig. 7 Smart lighting system (p. 49, Olvera-Gonzalez, 2013)

As shown in <Figure 7>, the amount of light that each plant receives can be effectively controlled by installing a single LED lamp for each object. Additionally, it can be possible to find and provide the LED lamp frequency to optimize growth and development of a plant by attaching the chlorophyll fluorescence monitoring system and temperature/humidity/CO2 sensor on each plant.

### 3.2.4 Electrical conductivity sensor technology

#### 3.2.4.1 Millimeter scaled sensor array system to measure the electrical conductivity sensor array system in soil (Murata, 2014)

In the precise farming, the fertilizer amount should be controlled to make a balance between supplying and demanding amounts of a plant, and there is also a value in effective use of fertilizer. However, it is difficult to measure the amount of fertilizer absorbed through the root of a plant. The millimeter scaled electrical conductivity sensor array system is the system to more precisely measure the amount of fertilizer being absorbed by a plant.

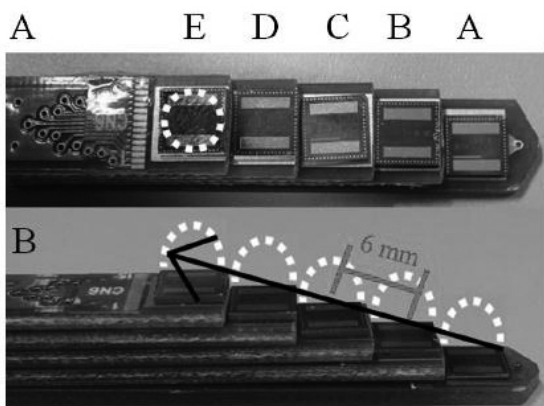


Fig. 8 Listing method of EC sensor (p.45, Murata, 2014)

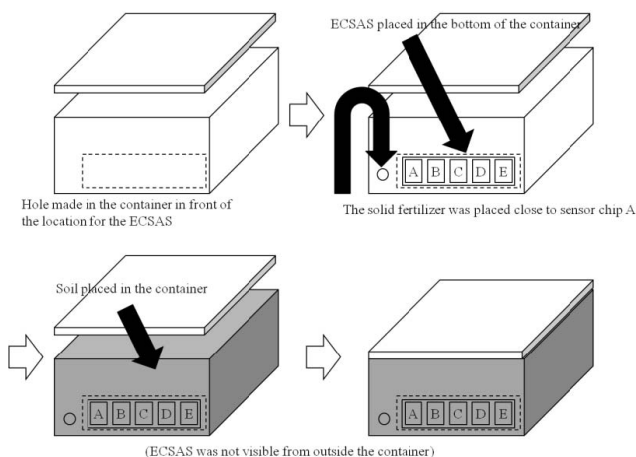


Fig. 9 EC sensor installing method (p. 47, Murata, 2014)

<Figure 8> shows the stacking of five electric conductivity sensor chips. These stacked electric conductivity sensor chips are installed on the bottom of the box as shown in <Figure 9> and covered by soil. The fertilizer amount absorbed through plant root is measured by putting the fertilizer beside the sensor chip and continuously measuring the diffusion of fertilizer in the millimeter unit.

3.3 Cases of USN Based ICT Convergence Case

3.3.1 Monitoring using USN

3.3.1.1 A monitoring system for intensive agriculture based on mesh networks and the android system (Montoya, 2013)

A big issue is the productivity improvement through the effective land use according to the change from the traditional agriculture to the intensive farmland-use agriculture. At the same time, various kinds of technology such as web application, mobile system, etc., helping the effective data collection in real time, have been developed. Additionally, as these types of technology are opened as open source, they greatly contribute to the convenience of users. The purpose of this study is to provide an overview of the development of the android applications based on Linux, Apache, MySQL, and PHP to collect and monitor various environmental variables that can influence the farming in the modern agriculture.

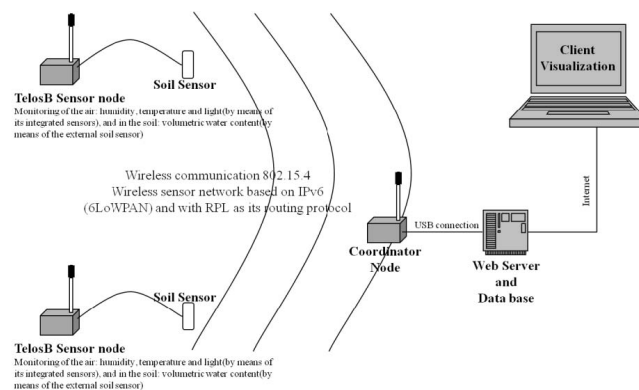


Fig. 10 Whole system diagram (p. 15, Montoya, 2013)

<Figure 10> shows the basic structure of an intensive agricultural monitoring system based on mesh network and android system. This system consists of a sensor measuring the environmental information, wireless sensor network sending the data, and server receiving, saving, and sending the data. First, various environmental variables are measured from the atmosphere and soil of the farmland through the sensor and transferred through the WSN network that is the sensor network. The transferred information is gathered at the coordinator node and sent to the user's computer. Here, the WSN uses 6LoWPAN technology composed of low power wireless network and IPv6 local network, and the server system uses Linux, Apache, and MySQL. Lastly, the data is saved at MySQL DB and provided in the form that users can understand through the mobile App.

3.3.1.2 A GPS/GSM based birth alarm system for grazing cow (Calcante, 2014)

When managing a livestock farm, it is essential to prevent the injury of mother cow and to reduce potentially harmful environmental factors by anticipating delivery time and taking a quick action. Since quick intervention is difficult, it is important to carefully manage the pregnant grazing cow. In this study, the GPS birth alarm system (GPS-CAL) was developed, and a patent for it was obtained

since its creativity and effectiveness was verified in European countries, including Italy.



Fig. 11 A: Plastic box with a transmitter-receiver, B: Small USB connector, C: Polyethylene cushion, D: GPS/GSM antenna, E: Transceiver installed on external genitals (p. 125, Calcante, 2014)

<Figure 11> shows the cow's collar with its GPS/GSM antenna and the transceiver installed on cow's external genitals. The transceiver sends SMS with information including the animal's birth date and time, its ID, and its geographical coordinate of postnatal location to the farmer by clearly identifying the time when the cow's delivery starts. Here, the accurate geographical coordinate can be obtained by the GPS/GSM antenna installed in the collar.

3.3.1.3 The early warning system for pest outbreaks using a wireless sensor network and the GSM network (Liao, 2012)

The core function of this technology is to immediately detect environmental changes in an orchard. The early alarm system is built to expect and prevent pests in advance. By this means, it is possible not only to prevent pests, but also to reduce the use of chemical pesticide, which can give harm to humans and the environment.

<Figure 12> shows the early warning system for pest outbreaks. Pest prevention technologies in past had difficulty immediately detecting rapid increases in the number of pests. However, with the early warning system for pest outbreaks using the wireless sensor network and

the GSM network, it is possible to effectively predict long-term changes as well as immediate changes. Additionally, if the number of pests increases or there is a sensor sending an abnormal signal, warning messages are automatically sent to the manager.

3.4 Other Cases of ICT Convergence

3.4.1 Web-based networking of herb gardens to exchange planting materials (Rao, 2014)

While the demand for medicinal plants and aromatic plants is greatly increasing, the network for collecting, storing, and exchanging the herb planting materials to support this demand has not been developed. To fulfill these requirements of consumers, the herb garden web-based network called HIG has been developed in India. As a web-based system, HIG provides information about herb gardens in India, helps the decision of consumers, and makes the exchange of planting materials easy.

This system has been designed by the module approaching method and has an additional module for nodal officers and general users. The nodal officer has an authority to update and delete the data related to each garden, and the user can obtain information about herb gardens and information to approach another herb garden that sells the necessary plant materials.

3.4.2 Exploration of customized farmland for each plant based on GIS technology (Mendas, 2012)

As urbanization proceeds, the area of farmland where cultivation is possible gradually decreases. Following this trend, the exploring suitable land for effective cultivation is becoming more important. The purpose of this study is to develop a program marking the optimal land for plant cultivation on the map by synthesizing environmental factors for effective cultivation of specific plants.

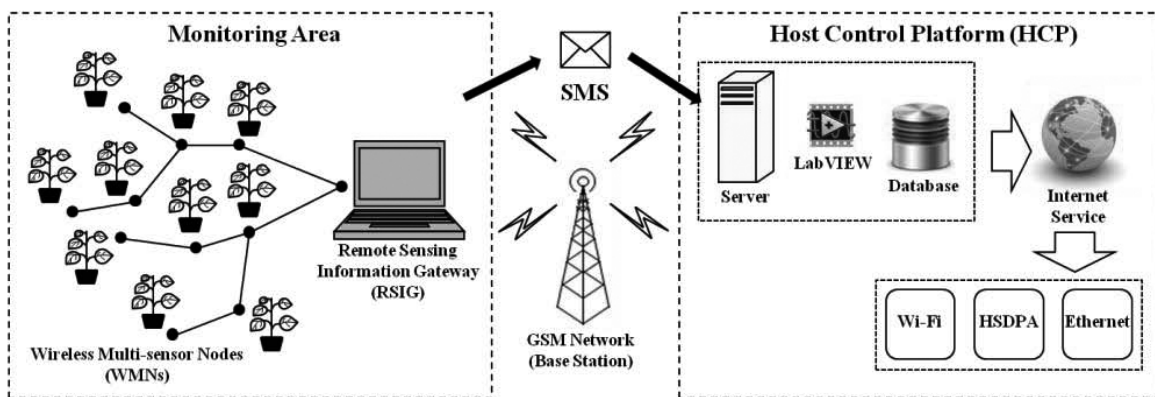


Fig. 12 The early warning system before a pest outbreak (p. 3, Liao, 2012)

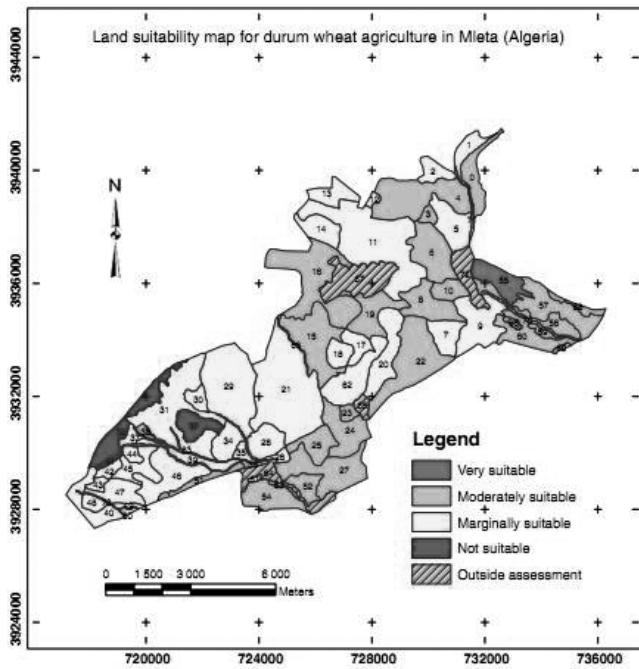


Fig. 13 Map of the result of exploring the optimal land for durum wheat cultivation in Mleta area, Algeria (p. 124, Mendas, 2012)

<Figure 13> shows the map of the result of exploring the optimal land for durum wheat in the Melta area of Algeria by using this study. For this, the GIS technology and the MCDA technology are applied. The GIS technology is the optimized technology to analyze the necessary geographical data to draw the map; the MCDA is used in this program since it is one of the techniques to help make a decision depending on various conditions and has a function

of space cohesion.

3.4.3 Automatic intra-row weeds knife control system by using the GPS technology (Perez-Ruiz, 2012)

In crop production in modern society, the effort to realize the technique of automatically removing intra-row weeds without chemicals has been continuously made. The purpose of this study is to find the way in which the weed knife can move between rows without giving any harm to the plant.

To explore the position of plants and the moving route of a weed knife, the RTK-GPS technology is used. First, the moving route of a weed knife can be controlled after converting the plant seedbed preparing process data and the plant transplanting process data into the RTK-GPS and saving them. As a result of this test, when this automatic intra-row weed knife control system was operated in an actual tomato farm in California, the result showed that it was successful in removing weeds without giving any harm to 682 tomatoes.

4 Conclusion

<Table 1> shows the list of various types of ICT convergence technology in the agrifood area newly developed in the last two years and reviewed in this study. There are four categories classified into RFID technology, smart sensing technology, USN technology and other technology depending on the technology. While there are different features depending on each technology, all of these have been developed based on the expectation of the

Table 1 ICT convergence technology in the agrifood area

| ICT convergence technology in the agrifood area   |   |   |  |
|---|---|---|--|
| RFID technology   | Smart sensing technology  | USN technology  | Others   |
| <p><b>1. Moving behavior recognizing technology</b></p> <ul style="list-style-type: none"> <li>- Analyzing technology for growing-finishing pig's feeding behavior</li> <li>- Wearable module to record the position of workers in an orchard</li> </ul> <p><b>2. Supply chain effectiveness</b></p> <ul style="list-style-type: none"> <li>- Analysis of the performance of a flour mill history tracking system</li> <li>- Securing food safety by using SPIDER</li> <li>- Making the Web 2.0 based virtual space to save information related to plant pathology</li> </ul> | <p><b>1. Laser sensor technology</b></p> <ul style="list-style-type: none"> <li>- Weed sensing technology in cornfield</li> <li>- Development and evaluation of a petal thickness measuring device based on the dual laser triangulation method</li> </ul> <p><b>2. Sound sensor technology</b></p> <ul style="list-style-type: none"> <li>- Sound sensor system for testing the quality of asparagus</li> <li>- Automatic measuring method for broiler chickens' feed intake amount</li> </ul> <p><b>3. Photosynthesis sensor technology</b></p> <ul style="list-style-type: none"> <li>- Smart lighting system for growth and development of plants</li> </ul> <p><b>4. Electrical conductivity sensor technology</b></p> <ul style="list-style-type: none"> <li>- Millimeter scaled sensor array system to measure the electric power supply from the amount of electrical conductivity</li> </ul> | <p><b>1. Monitoring by using USN</b></p> <ul style="list-style-type: none"> <li>- Monitoring system for intensive agriculture based on mesh networks and the android system</li> <li>- GPS/GSM based birth alarm system for grazing cows</li> <li>- Early warning system for pest outbreaks by using the wireless sensor network and the GMS network</li> </ul> | <p><b>1. Web-based networking of herb garden to exchange the plant materials</b></p> <p><b>2. Exploration of the customized farmland depending on each plant based on the GIS technology</b></p> <p><b>3. Automatic intra-row weed knife control system using the GPS technology</b></p> |



improvement of effectiveness in the corresponding areas such as production, distribution, consumption, etc. through convergence with ICT technology. In RFID technology, smart sensing technology, and USN technology categories, the effect of improved effectiveness can be expected in the production and distribution processes; in the case of other technologies, the improvement of effectiveness can be expected in the production and consumption processes. In addition, considering the fact that major technologies are still on the demonstrating step, it can be thought that this area has potential to create new added value through more active investment.

In this study, by reviewing 17 technologies related to the agrifood area among ICT convergence technologies developed during the last two years, the stream of current ICT convergence technology could be understood. However, this study has a limitation, because all the technologies introduced in this study were developed in different countries, and optimized in the characteristics and agricultural environment of each area in which they were developed. Therefore, if these were introduced without considering the domestic situation, it would be difficult to expect the same level of the improved effectiveness. With this reason, it is necessary to conduct additional research to introduce these technologies that are appropriate for a domestic situation.

## References

- Y.G. Ampatzidis, S.G. Vougioukas, and M.D. Whiting, "a Wearable Module for Recording Worker Position in Orchards", *Computers and Electronics in Agriculture*, Vol. 78, p. 222-230, 2011
- D. Andujar, A. Escola, J. R. Rosell-Polo, C. Fernandez-Quintanilla, and J. Dorado, "Potential of a Terrestrial LiDAR-based System to Characterise Weed Vegetation in Maize Crops", *Computers and Electronics in Agriculture*, Vol. 92, p. 11-15, 2013
- A. Aydin, C. Bahr, S. Viazzi, V. Exadaktylos, J. Buyse, and D. Berkman, "a Novel Method to Automatically Measure the Feed Intake of Broiler Chickens by Sound Technology", *Computers and Electronics in Agriculture*, Vol. 101, p. 17-23, 2014
- S. Bhatnagar, "Information Technology and Development: Foundation and Key Issues", *Information and Communication Technology in Development*, Sage Publications, p. 1-13, 2000
- T.M. Brown-Brndl, G.A. Rohrer, and R.A. Eigenberg, "Analysis of Feeding Behavior of Group Housed Growing-finishing Pigs", *Computers and Electronics in Agriculture*, Vol. 96, p. 246-252, 2013
- A. Calcante, F. M. Tangorra, G. Marchesi, and M. Lazzari, "a GPS/GSM Based Birth Alarm System for Grazing Cows", *Computers and Electronics in Agriculture*, Vol. 100, p. 123-130, 2014
- C. Goumopoulos, B. O'Flynn, and A. Kameas, "Automated Zone-Specific Irrigation with Wireless Sensor/Actuator Network and Adaptable Decision Support", *Computers and Electronics in Agriculture*, Vol. 105, p. 20-33, 2014
- M. A. Fernandes, S. G. Matos, E. Peres, C. R. Cunha, J. A. Lopez, P.J.S.G. Ferreira, M.J.C.S. Reis, and Raul Morais, "A Framework for Wireless Sensor Networks Management for Precision Viticulture and Agriculture Based on IEEE 1451 Standard", *Computers and Electronics in Agriculture*, Vol. 95, p. 19-30, 2013
- E. E. Kim, "USN standard and Technology", 2008 10th International Conference on Advanced Communication Technology. Vol. 2, 2008
- K. Lee, J. Yang, and H. H. Yu, "Development and Evaluation of a Petal Thickness Measuring Device Based on the Dual Laser Triangulation Method", *Computers and Electronics in Agriculture*, Vol. 99, p. 85-92, 2013
- M. Liao, C. Chuang, T. Lin, C. Chen, X. Zheng, P. Chen, K. Liao, and J. Jiang, "Development of an Autonomous Early Warning System for *Bactrocera dorsalis*(Hendel) Outbreaks in Remote Fruit Orchards", *Computers and Electronics in Agriculture*, Vol.84, p. 1-12, 2012
- A. Luvisi, A. Panattoni, and E. Triolo, "Electronic Identification-based Web 2.0 Application for Plant Pathology Purposes", *Computers and Electronics in Agriculture*, Vol. 84, p. 7-15, 2012
- A. Mendas, and A. Delali, "Integration of MultiCriteria Decision Analysis in GIS to Develop Land Suitability for Agriculture: Application to Durum Wheat Cultivation in the Region of Mleta in Algeria", *Computers and Electronics in Agriculture*, Vol. 83, p. 117-126, 2012
- F. G. Montoya, J. Gomez, A. Cama, A. Zapata-Sierra, F. Martinez, J. L. D. L. Cruz, and F. Manzano-Agugliaro, "a Monitoring System for Intensive Agriculture Based on Mesh Networks and the Android System", *Computers and Electronics in Agriculture*, Vol. 99, p. 14-20, 2013
- H. Murata, M. Futagawa, T. Kumazaki, M. Saigusa, M. Ishida, and K. Sawada, "Millimeter Scale Sensor Array System for Measuring the Electrical Conductivity Distribution in Soil", *Computers and Electronics in Agriculture*, Vol. 102, p. 43-50, 2014
- B. Nath, Franklin Reynolds, and Roy Want, "RFID

- technology and applications", *IEEE Pervasive Computing* Vol. 5.1, P. 22-24, 2006
- L. M. Ni, Y. Liu, Y. C. Lau, and A. P. Patil, "Landmarc: Indoor Location Sensing Using Active RFID", *Kluwer Academic Publishers, Wireless Network* 10, p. 701-710, 2004
- E. Olvera-Gonzalez, D. Alaniz-Lumbreras, R. Ivanov-Tsonchev, J. Villa-Hernandez, C. Olvera-Olvera, E. Gonzalez-Ramirez, M. Araiza-Esquivel, V. Torres-Arguelles, and V. Castano, "Intelligent Lighting System for Plant Growth and Development", *Computers and Electronics in Agriculture*, Vol. 92, p. 48-53, 2013
- M. Perez-Ruiz, D.C. Slaughter, C.J. Gliever, and S.K. Upadhyaya, "Automatic GPS-based Intra-row Weed Knife Control System for Transplanted Row Crops", *Computers and Electronics in Agriculture*, Vol. 80, p. 41-49, 2012
- M. E. Porter, "Strategy and the Internet", *Harvard Business Reviews*, Vol. 79.3, p. 62-79, 2001
- N. S. Rao, K. A. Geetha, and S. Maiti, "Web-based Networking of Herbal Gardens for Exchange of Planting Material", *Computers and Electronics in Agriculture*, Vol. 103, p. 26-32, 2014
- B.F. Spencer Jr, M. E. Ruiz-Sandoval, and N. Kurata, "Smart sensing technology: opportunities and challenges", *Structural Control and Health Monitoring*, Vol. 11.4, p. 349-368, 2004
- L. Sturiale, and A. Scuderi, "Information and Communication Technology (ICT) and adjustment of the Marketing Strategy in the Agri-food System in Italy", *Proceedings of the International Conference on Information and Communication Technologies in Agriculture, Food and Environment*, Vol. 8-11, p. 77-87, 2011
- J. Qian, X. Yang, X. Wu, L. Zhao, B. Fan, and B. Xing, "a Traceability System Incorporating 2D Barcode and RFID Technology for Wheat Flour Mills", *Computers and Electronics in Agriculture*, Vol. 89, p. 76-85, 2012
- L. Wang, J.S.L. Ting, W.H. Ip, "Design of Supply-chain Pedigree Interactive Dynamic Explore (SPIDER) for Food Safety and Implementation of Hazard Analysis and Critical Control Points (HACCPs)", *Computers and Electronics in Agriculture*, Vol. 90, p. 14-23, 2013
- R. Want, "An introduction to RFID technology." *Pervasive Computing, IEEE*, Vol. 5.1, p. 25-33, 2006
- S. Zioupou et al., "Adopting New Information Technologies in Supply Chain Management in the Greek Food Industry", *6th HSSS Conference, Mytilene*, 2010