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# Utilizing Agricultural Data with the Prosumer Concept

Se-Yun Tak, Neung-Hoe Kim

*Undergraduate, School of Software, Kunsan National University, Korea*
*tpdbs1004@kunsan.ac.kr*
*Professor, School of Software, Kunsan National University, Korea*
*nunghoi@kunsan.ac.kr*

***Abstract***

*With increasing applications of technologies developed in the Fourth Industrial Revolution, data have come to replace important knowledge and experience in the agricultural field. Although data-based smart agriculture is growing at an average annual rate of 8.57%, research on ways to utilize data produced alongside is remains insufficient. Because such data may considerably help stakeholders involved in agricultural activities, we deployed the prosumer concept to revitalize agricultural data. We systematically structured and defined three relevant entities: the prosumer, which produces and consumes agricultural data; the database, which systematically processes and integrates agricultural data; and the consumer, which utilizes agricultural data in various ways. Our framework is designed to help stakeholders use agricultural data to improve the quality of crops, minimize the failure of agricultural activities, quickly adapt to new environments and methods of crop production, and find effective solutions to relevant issues.*

***Keywords:*** *Smart agriculture, Environmental data, Growth data, Prosumer*

## 1. Introduction

Smart agriculture entails the collection of weather, greenhouse environment, and biometric information using sensors to enable the remote automatic control of crop growth environments [1-4]. All data obtained throughout this process are transmitted to a cloud service to help agricultural workers make decisions. Thus, the core technologies of the Fourth Industrial Revolution have been applied to replace knowledge and experience – indispensable elements in the agricultural field – with data. With an average annual growth rate of 8.57%, data-based smart agriculture is expected to grow globally from $4,273.72 million in 2019 to $6,447.28 million in 2024 [1]. However, research on methods to utilize the increasing amount of data produced by smart agriculture remains insufficient. Because accumulated data serve as great assets that include knowledge and experience, their utilization is very important.

Data continuously produced during agricultural activities can be of great help to the many stakeholders involved in these activities. The concerned parties can continuously collect, analyze, and apply the data they produce to improve the quality of crops. Consequently, beginner farmers, as well as farmers trying new crops,

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Corresponding Author: nunghoi@kunsan.ac.kr
Tel: *** - **** - ****
Professor, School of Software, Kunsan National University, Korea

can receive help in the form of data produced by other farms, and thus quickly adapt to new circumstances. Furthermore, agricultural data can be analyzed to explore new environments and methods for crop production, as well as find solutions to relevant issues. Because the data produced by agricultural activities can be used in various ways, an appropriate framework must be developed.

Therefore, we formulated a plan to revitalize agricultural data using the concept of a prosumer. The prosumer, a portmanteau of 'producer' and 'consumer,' is a consumer who goes beyond passive consumption by directly participating in the production process [5]. Specifically, the farmers of data produced through agricultural activities can deploy said data for their own agricultural activities, generating new data that can be used by other farmers. By defining these activities, we can revitalize the use of agricultural data.

## 2. Proposed Method

We formulated a method for utilizing agricultural data based on the concept of a prosumer. This plan encompasses three entities: the prosumer, which produces and consumes agricultural data; the database, which systematically processes and integrates agricultural data; and the consumer, which utilizes agricultural data in various ways. Figure 1 illustrates the overall structure of this framework.

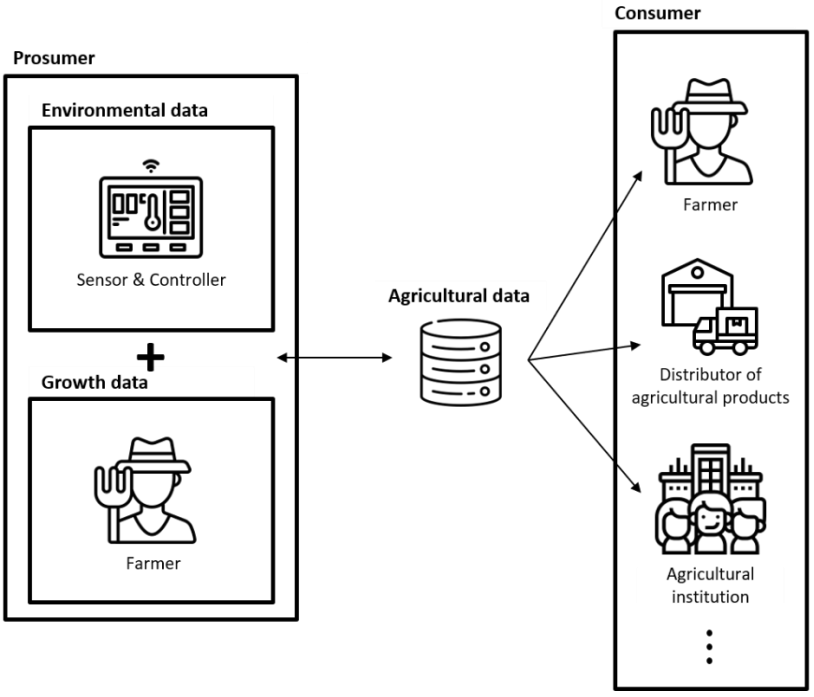


**Figure 1. Overall structure**

### 2.1 Prosumer Sector

The prosumer is represented by farmers who simultaneously produce and consume data while performing agricultural activities. Agricultural data generally comprise environmental and growth data. Environmental data are collected using sensors and control systems. By monitoring and controlling the growth environment inside and outside the greenhouse, an optimal environment can be created for growing crops and collecting data. Farmers directly measure and collect specific growth data, examples of which are listed in Table 1. The environmental and growth data produced in this manner can be used as a reference to continuously improve the quality of crops.

**Table 1. Examples of agricultural data**

| Item Code | Item Code Name |
|---|---|
| MD | Measurement Date |
| TI | Internal Temperature |
| HI | Internal Humidity |
| CI | $CO_2$ |
| SR | Solar Radiation |
| RP | Rainfall |

| Item | Item Name |
|---|---|
| measDate | Measurement Date |
| growLength | Growth Length |
| flowerTop | Flower Height |
| stemDiameter | Stem Diameter |
| leavesLength | Leaf Length |
| leavesWidth | Leaf Width |

### 2.2 Database Sector

The database is the sector where agricultural data collected by the prosumer are processed, integrated, and stored. To ensure data quality, any outliers and missing values are identified and corrected. Data associated with the same measurement date are integrated for storage, and the database is managed according to crop and regional classifications. Data stored in this manner can be provided to stakeholders for various uses. An example of such a database is presented in Table 2.

**Table 2. Examples of database**

| Item | Item Name | Type |
|---|---|---|
| measDate | Measurement Date | String(20) |
| inTemp | Internal Temperature | String(30) |
| inHum | Internal Humidity | String(30) |
| cardio | $CO_2$ | String(30) |
| solarRad | Solar Radiation | String(30) |
| rain | Rainfall | String(30) |
| growLength | Growth Length | Double(10) |
| flowerTop | Flower Height | Double(10) |
| stemDiameter | Stem Diameter | Double(10) |
| leavesLength | Leaf Length | Double(10) |
| leavesWidth | Leaf Width | Double(10) |

### 2.3 Consumer Sector

In the consumer sector, activities are conducted to provide stakeholders with agricultural data stored in the database sector. As described previously, these data are first systematically processed and integrated to benefit stakeholders. To ensure user-friendliness, the database is categorized by crop and region. Examples of agricultural data provided in the database are listed in Table 3.

**Table 3. Examples of agricultural data provided to stakeholders in the database**

| Measurement Date | Internal Temperature | Internal Humidity | $CO_2$ | Solar Radiation | Rainfall |
|---|---|---|---|---|---|
| 14 weeks | 15.94 | 65.37 | 617.8 | 80.63 | Y |
| 15 weeks | 12.0 | 58.63 | 450.4 | 123.1 | N |
| 16 weeks | 19.76 | 69.26 | 460.3 | 108.1 | N |
| 17 weeks | 64.17 | 64.17 | 507.7 | 115.4 | N |

| Measurement Date | Growth Length | Flower Height | Stem Diameter | Leaf Length | Leaf Width |
|---|---|---|---|---|---|
| 14 weeks | 132.0 | 0.0 | 4.0 | 237.0 | 162.0 |
| 15 weeks | 227.0 | 4.0 | 6.0 | 347.0 | 182.0 |
| 16 weeks | 191.0 | 93.0 | 9.0 | 436.0 | 238.0 |
| 17 weeks | 339.0 | 201.0 | 11.0 | 457.0 | 179.0 |

The representative stakeholders are farmers. Agricultural data, including environmental and growth data, can be crucial in a wide range of farming activities. Therefore, this database can greatly assist farmers engaged in agricultural activities, especially those seeking to try new crops or regions.

## 3. Conclusion

In this study, we deployed the prosumer concept to formulate a method to revitalize the use of data produced in smart agriculture. Because these data represent a considerable asset that includes knowledge and experience, their utilization is very important. Therefore, we systematically defined and organized three entities corresponding to the prosumer, database, and consumer sectors, respectively. We expect our framework to greatly assist stakeholders involved in agricultural activities, thereby revitalizing applications of agricultural data. Future research plans should include implementations of the measures defined in this study in an actual system for use by stakeholders.

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