
# A Context Changing With Precision Agriculture In Japan

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**Abstract.** A new context is emerging under introducing of precision agriculture, impacted by top-down ICT policies and bottom-up collaborative activities. Food chain is changing by a holistic technology policy of integration in the fields of breeding, farm production, processing, transportation, and market in consumers. A new ICT strategy was issued by the government for precision agriculture to enhance the interoperability and portability of data/information sets collected from the field. The administration focused on standardization of data/information protocol, common terminology to share the information and knowledge. Intellectual properties produced by collaboration of growers and industry, such patents and know-hows, are also issues to be handled. On the basis of a platform of agricultural information some value-chains should be produced. Agro-medical food is also an emerging program for value-added produce with a high function of encouraging the quality of lifestyle. The agricultural sector must be changed into suppliers of fairly controlled products to the medical sector, which requires controlled protocols of production with traceable management. The medical sector confirms the evidence of effectiveness against disease prevention and wellness in medical science. The nutrition and dietetics sector provides personalized diets using agro-medical foods. The business sector commercializes agro-medical foods and diets. The engineering sector provides bio-sensing and control technology to manage the system and communicate beyond disciplines.

***Keywords.*** *ICT, Portability, Interoperability, Food chain, Agro-medical food*

## Introduction

Smart society 5.0 is a phrase of the 5th 5-year basic program for science and technology innovation in Japan (CSTI 2016). It involves 11 subprograms and two of them are rooted in the agricultural sector: a smart food chain system and a smart agricultural production system. The agricultural issues in Japan are all critical today, such as losing expert skills and knowledge, less new coming young farmers, frequent damages by natural disasters, and market pressures of consumers' motivations. In the other point of view Japanese industry and economy has experienced a long-term depression and a new break-through business has been expected. The agriculture is focused as a new frontier of industry innovation, and that is why advanced technologies are expected to be applied into agricultural fields. The SCTI program is pushing the innovation in agriculture and related business fields. People call the new projects by phrases, such as "smart agriculture", "AI (agro-informatics or artificial) agriculture", "ICT agriculture", and "intelligence-oriented farm management". Goals of the projects tend to be shown by different terminology, such as "cost-effective and market-in farm management", "restoring/rehabilitation from disasters", "agro-medical foods for health and life", "water conservation agriculture", and "GAPs for farm assurance/food security". The food chain changes with precision agriculture.

ICT strategy of agriculture was issued by the government to enhance the interoperability and portability of data/information collected from the field (SHIT 2014). The strategy of agro-medical foods was also reorganized in 2016. The agro-medical approach promises to expand the fields of precision agriculture, and that is why its briefing is introduced (Shibusawa 2015, 2016).

The objective of the paper is to introduce current trends in precision agriculture focusing on the science and technology program, the strategy on ICT agriculture and agro-medical food.

## ICT-ORIENTED PROGRAM IN AGRICULTURE

### Smart Society 5.0 Service Platform

The Council of Science and Technology Innovation, Cabinet Office, Japan have issued the 5th basic program for science and technology on January 19, 2016, and the innovative technology targeted was introduced as Smart Society 5.0 Service Platform as shown in Fig. 1. This is a holistic view of technology systems expected in the next generation. It has 11 sub-systems or core programs, including two programs in the agricultural field: a smart food chain system and a smart production system. This is the first time that agricultural sectors are nominated in the national basic program for science and technology.

The smart food chain system should be composed of four main sub-systems of breeding industry, growers' organization of production, processing companies, transportation business and market needs of consumers. The basic program strongly affects the policy and plans of respective

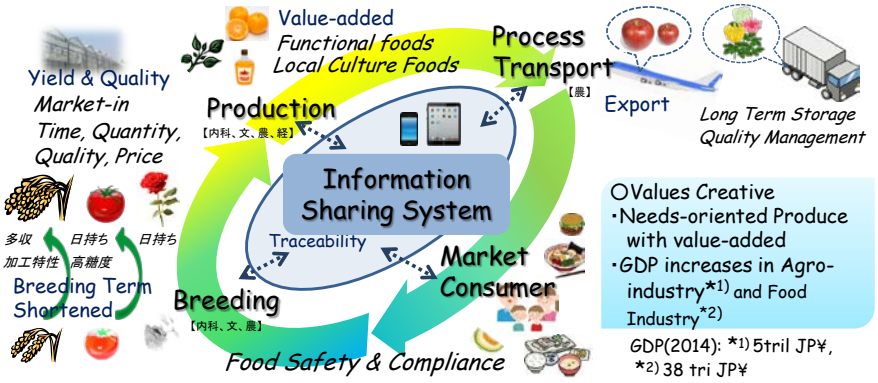



Figure 2. A vision of smart food chain (Local Resources Strategy Committee, Council for Science and Technology Innovation, 2015).

ministries as well as industry and academia.

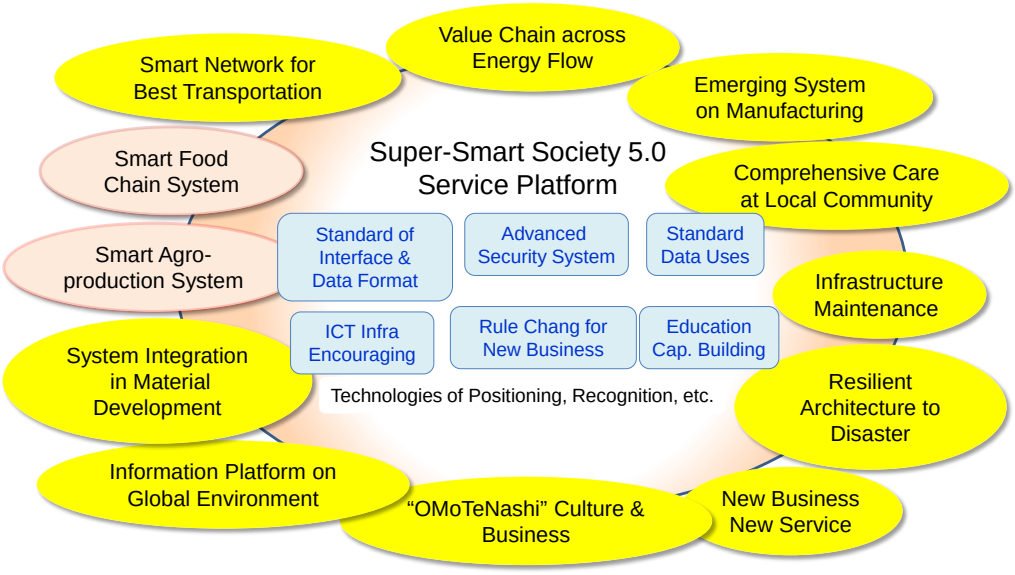



Figure 1. A vision of super-smart society 5.0 in the 5th Basic Program for Science and Technology.

## Strategy for Information Creation and Application

A new ICT strategy, as shown in Fig. 2, was issued by the government to enhance the competitiveness in agricultural activities, paragriculture industry and marketing activities of the industry, by accelerating the creation and application of agricultural information. Interoperability and portability are required for users to cost-effectively handle the data and information collected from the field. The strategy also focused on standardization of data/information protocol, commonly available terminology to share the information across the inter-industry and inter-ministry sectors. Intellectual properties are also managed for growers and companies. Consequently a local industry of agriculture will be changed into a global export industry.

Examples for the interoperability and portability are illustrated in Fig. 3. The interoperability implies here that the data or information accumulated can use in different application or operation systems which have a common protocol of handling them. Figure 4 shows examples of mutual utilization among other farmer's system data, other agricultural machinery products able to be replaced, mutual utilization among different system, and other control system products able to be replaced. For the portability, examples are: a new application system can use the previously used data continuously with the data files downloaded, and any application system can refer the data used in a previous system. The portability implies here that users can handle their own database in any application system.

The government issued action plans for the strategy as guidelines on agro-informatics in March,

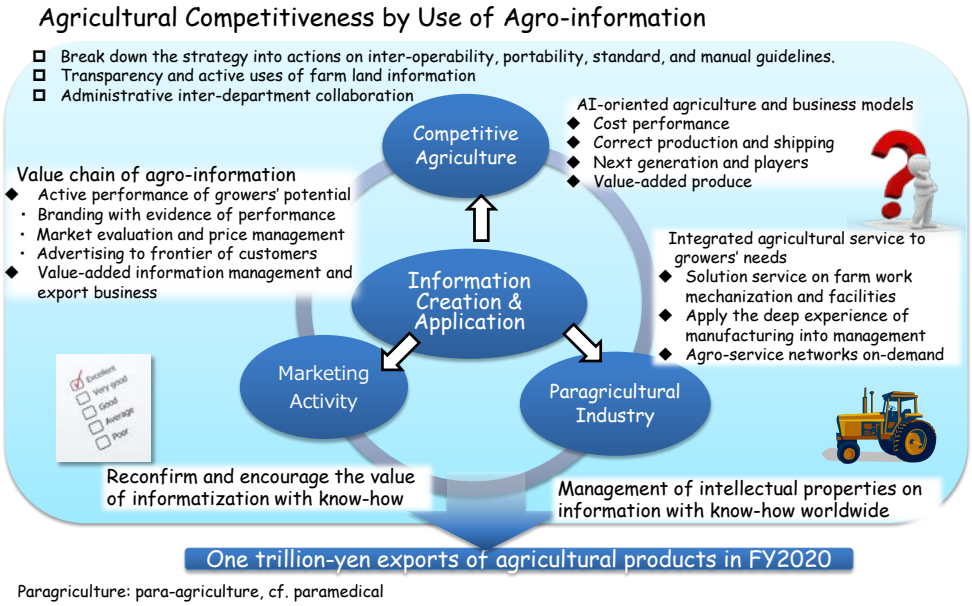
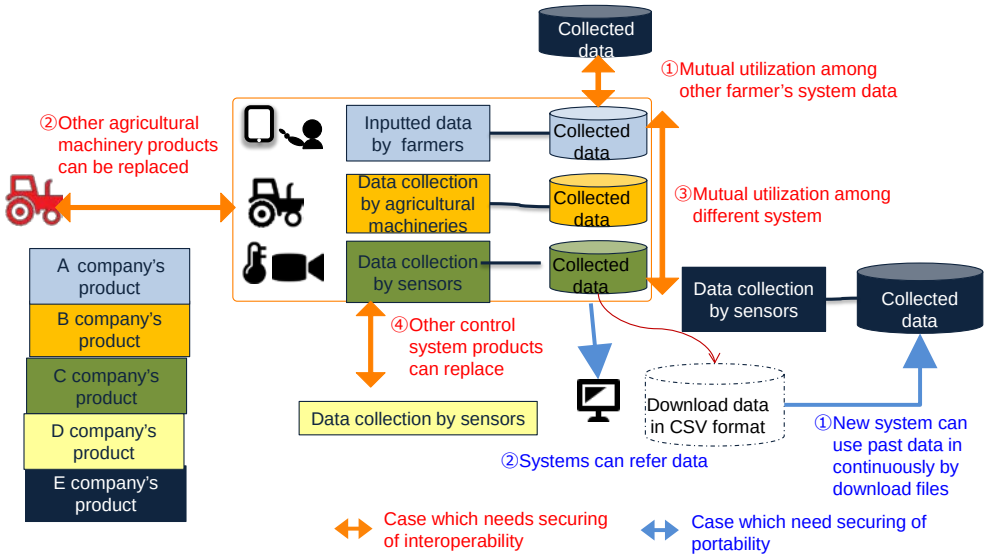



Figure 3. Strategy for Creation and Application of Agricultural Information (The Strategic Headquarters for the Advanced Information and Telecommunications Network Society, Cabinet Secretariat, Japan. 2014.6.3)




2016. The Cabinet Secretariat has issued the roadmap on putting the strategy into practice, and also issued the guide for providers and users on business contract of ICT service in agriculture. The Ministry of Agriculture, Forestry and Fishery has issues the guidelines for practical terminology on name of crops, on name of farm works, the guidelines for intellectual properties in ICT application to agriculture. The Ministry of Internal Affairs and Communications has issued the guidelines for terminology on environmental information used in agriculture, and the guidelines for interface of data exchange on agricultural information.

These guidelines inevitably affect the farming system, as shown in Fig. 5. The farming system is

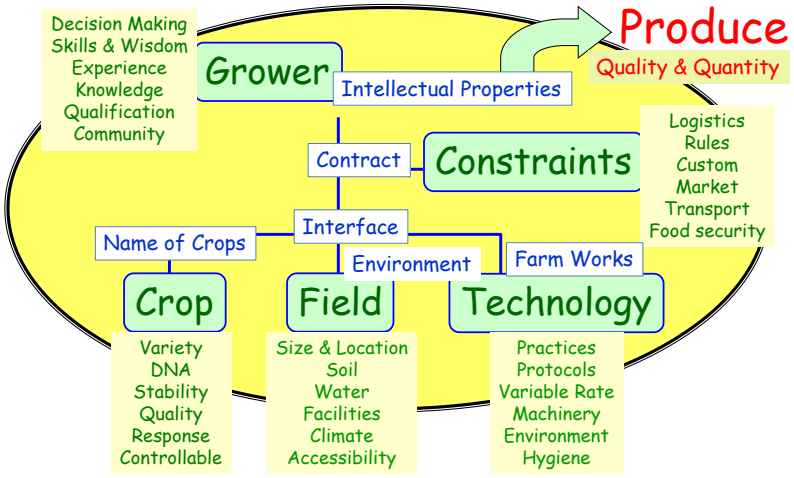



Figure 5. Five factors of farming system and ICT standards

composed of five factors: crops, fields, technology, regional constraints, and growers' motivation (Shibusawa 2015). When the guidelines are practiced, the five factors are respectively standardized in part at the same time. Precision agriculture creates information-oriented fields and information-added products, and the information created is standardized by the guidelines. It makes easy communication among growers and stakeholders, and then the context for community-based precision agriculture is constructed.

## AGRO-MEDICAL FOODS

Agro-medical foods are defined as agricultural products with a high content of functional materials with evidence of effects on health and wellness produced by precision agriculture, and they are promoted by the agro-medical initiative (Shibusawa 2012, 2015, 2016). The agro-medical initiative is a research group of medical, agricultural, and engineering scientists, aiming at the cure of lifestyle-related disease by having agricultural products with a high content of functional materials.

Figure 6 shows a research cycle of agro-medical foods. The agricultural sector supplies fairly controlled products to the medical sector, which requires controlled protocols of production with traceable management. The medical sector confirms the evidence of effectiveness against disease prevention and wellness in medical science. The nutrition and dietetics sector provides personalized diets using agro-medical foods. The business sector commercializes the agro-medical foods and diets. The engineering sector provides bio-sensing and control technology to manage the system and communicate beyond disciplines.

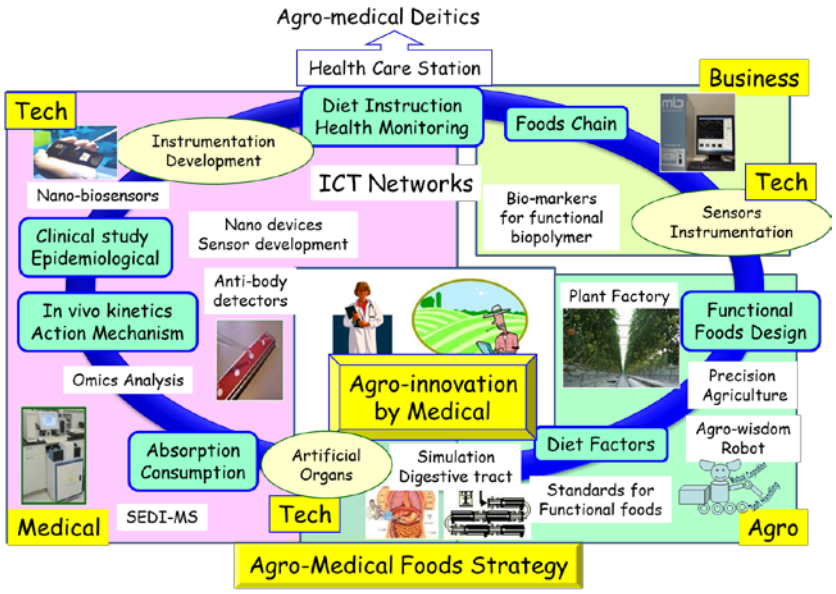



Figure 6. Research cycle of supply chain for agro-medical foods.

Table 1. A frame of standardizing research the produce of agro-medical foods.

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| Crop | Syndromes under Medical Examination<br>Cohort Animals<br>Intervention Cell-culture | Method of Analysis<br>Foods base<br>Bio-specimen base | Crop Variety & Management<br>Breeding Process/Cooking<br>Cultivation |
|---|---|---|---|
| Onion | Metabolic Syndrome<br>Dry mouse/eyes, Cognitive impatient | Quercetin | Quercetin rich crop |
| Green Tee | Immunopotentiative, Antiallergic | Strictinin,<br>Epigallocatechin | Strictinin rich crop<br>Epigallocatechin rich crop |
| Orange | Metabolic Syndrome<br>Fatty liver/ Diabetes | Not yet | Beta-cryptoxanthin rich crop |
| Soybean | Metabolic Syndrome, Osteoporosis<br>Dry mouse/eyes, Macular degeneration | Isoflavone | Isoflavone rich crop |
| Apple | Metabolic Syndrome, Diabetic<br>Arteriosclerosis, Osteoporosis | Procyanidin | Procyanidin rich crop |
| Spinach | Macular degeneration, Dry eyes, | Lutein | Not yet |
| Tomato<br>Egg plant | Metabolic Syndrome, Diabetic | Not yet | Osmotin rich crop |

Agro-medical foods requires a standard scheme of production in the categories of operation, work chain, and farming system (Fig. 5). The operation standard involves specification of mechanization and guidelines. The work chain requires protocol of process jobs from soil preparation to shipping. The farming system is composed of the five factors of crop, field, technology, constraints, and motivation, and each factor has a sub-structure of farming elements such as crop variety and tillage machine. At least three production categories need clear description when they are put into practice in the shape of precision agriculture.

Table 1 shows a framework or roadmap of how to produce agro-medical foods. There are three control points and nine check items. The first control point is the target syndrome and medical examination with the four check items of cell culture, animals, intervention, and cohort. The second control point is the target material and analysis method with the two check items of food body base and bio-specimen base. The third control point is crop variety and management with the three check items of breeding, cultivation, and processing/cooking. The test crops were onion, green tea, orange, soybean, spinach, tomato, and eggplant in 2011. Many more crops and functional materials will be examined in a couple of years.

## Conclusion or Summary

The strategy for creation and application of agricultural information has launched, including standardization of terminology on five factors of farming system. This event encourages the uses of ICT in agriculture as well as the introduction of precision agriculture. The information standards enhance the communication across the stakeholders in food chains, followed by producing new business. Agro-medical foods is one of the new business scheme to provide functional healthy foods with collaboration with agricultural sector and medical sector. The medical sector confirms the evidence of effectiveness against disease prevention and wellness in medical science. The agricultural sector provides design-in products requested from the medical sectors by using precision agriculture management.

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