International Journal of Agriculture Innovations and Research
Volume 6, Issue 4, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy):
Received: 21/12/2017 | Accepted on: 27/12/2017 | Published: 05/01/2018

An Effect of ICT Technology Adoption on Small-Sized Horticulture Farms in Korea

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Abstract **– The development of Information and Communications Technology (ICT) has an impact on various industries including agriculture. The Ministry of Agriculture, Food and Rural Affairs in Korea promoted the 'Horticulture ICT convergence project' for distributing technologies such as smart phone remote control, and an automatic control system in a single shell vinyl house. The smart farm is a small distributed single-span greenhouse and is different from other remote control management models that use a multivariable controller for glass and plastic greenhouses. We compare the performances of tomato, cucumber and strawberry. We investigate twenty-eight farms in Se-Jong city that cultivate tomato, strawberry and cucumber. The research method is a field interview survey. We implemented a t-test for analyzing the performance on the introduction of each items' smart farm. For strawberry farms, increasing rate of output, income and time saving have significant differences ($p<0.05$). However, for tomato farms, decreasing rate of income per year has significant differences ($p<0.05$). The coincidence of satisfaction and performance can facilitate performance evaluation only through a Likert-type measurement. To guide activation of ICT convergence technology, we have to promote management achievement in productivity and income improvement and management efficiency in time savings to farmers.**

Keywords **– Information and Communications Technology, Smart Farm, Horticulture.**

I. Introduction

Highlight a section that you want to designate with a the development of Information and Communications Technology (ICT) has an impact on various industries including agriculture. Agricultural ICT convergence technology pursues a creative value to improve productivity, efficiency and quality as compared to primary agriculture. After 2010, South Korea (hereafter, Korea) has been promoting this type of business model development project for the diffusion of information technology (IT) fusion technology. In agriculture, the most developed sector is facility horticulture. In the early 1990s, as the Dutch greenhouse was supplied into the country, the introduction of ICT convergence technology expanded to the vinyl greenhouse [1]. The Ministry of Agriculture, Food and Rural Affairs in Korea promoted the 'Horticulture ICT convergence project' for distributing technologies such as smart phone remote control, and an automatic control system in a single shell vinyl house. By introducing "smart farm" services in domestic agricultural IT fusion technology, we can control the crop production environment with remote monitoring and auto-sensing linkage for horticulture and fruit trees. The smart farm is a small distributed single-span greenhouse and is different from other remote control management models that use a multivariable controller for glass and plastic greenhouses. The distributed smart farm only has remote environmental monitoring, open area level of a side window and, closed-circuit television (CCTV) monitoring. The introduction of ICT fusion technology in Korea currently has a low modernization level as compared to the scale of facility horticulture. There are few introduced farms and low participation rates. Therefore, for aggressive ICT diffusion by farmers, it is necessary to verify the impact through an introduction of technology. We compare the performances of tomato, cucumber and strawberry. The farming and market price effect can be different according to items. Thus, we measure a relatively accurate performance controlling effect by item.

II. Concept of the Agricultural ICT Convergence Technology

ICT convergence technology of an agricultural area is a technology that pursues improvement of productivity and quality from an existing primary industry for agriculture. In Korea, there is an ICT convergence technology research and development (R&D) demonstration project applicable to agriculture. In the governments of Japan and the EU, R&D and investment is actively under way. Recently, governments have pursued an effort to modernize ICT convergence technology. However, the problem of introduction is that they do not focus on the need for the farming industry, but on the propulsion for IT technology. Project participants consist of a public officer and engineer, and thus cannot conform to the farmer's needs and desires. Greenhouse facilities are also not standardized by region and item. Technically, there is a shortage of corporation and workers to invest in ICT technology. Governments also proceed in a project with general IT companies [2]. Therefore, to properly apply ICT technology in horticulture, we need to develop an effective program for fulfilling the needs of farmers and inducing positive participation.

III. Performance Evaluation for Introduction of ICT Convergence Technology

Performance evaluation methodology of agriculture in Korea can be classified as a farm unit income study and agricultural corporation performance evaluation. For example, in income study per unit of farms, the Rural

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Table 1. Descriptive statistics of farm's quantitative performance

	Total			Tomato			Cucumber			Strawberry		
	Year 2014	Year 2015	increasing rate	Year 2014	Year 2015	increasing rate	Year 2014	Year 2015	increasing rate	Year 2014	Year 2015	increasing rate
Farms	28			7			13			8		
Green house Area (pyong)	1,055	1,020	-3.32	1,114	1,114	0	1,096	973	-11	938	1,013	8
Output (kg)	18,895	19,564	3.54	38,963	29,649	2	21,816	21,827	0	5,338	7,063	32
Gross income	51,847	52,229	0.74	106,742	84,812	-21	25,122	25,939	3	47,244	66,441	41

Table 2. Descriptive statistics of farm's survey

	Total	Tomato	Cucumber	Strawberry
Age	3.07	3.43	2.77	3.25
Farming year	16.39	25.00	9.54	20.00
Smart farm area	918	1057	973	706
Rate of smart farm	63.93%	56.76%	65.60%	67.50%
Adoption satisfaction	4.36	4.57	4.15	4.50
Self-esteem	4.07	4.71	3.85	3.88
Productivity satisfaction	3.54	3.43	3.23	4.13
Cost saving satisfaction	3.14	3.00	2.92	3.63
Labor saving satisfaction	3.50	2.86	3.54	4.00
Spare time satisfaction	4.00	3.86	3.69	4.63

Development Administration (RDA) evaluated characterization of farming areas [3]. They used a simple increasing rate when compared before and after income and productivity projects. Second, examples of performance evaluation for agricultural corporations are the 'garden brand promotion project' and the 'upland-crop promotion project' [4] [5]. There are quite a few studies on the effect of farmhouse education [6]. Research related to ICT adoption is also rare. This is the first study to identify the effects by ICT application of a small scale single-span greenhouse (i.e., 90% in Korea). This is very suggestive for small farming, but not for commercialized farming.

IV. Data Collection

We investigate twenty-eight farms in Se-Jong city that cultivate tomato, strawberry and cucumber. These farms have instituted smart farm services since 2014. We use income and satisfaction results from twenty-eight farms. The research method is a field interview survey. When considering cropping season, we set the research time for strawberry in May 2015, and the research time for cucumber and tomato in September 2015. Each item's satisfaction is measured by a five-point Likert-type scale. The output for all farms increased 3.54% per year (i.e., tomato 2%; strawberry 32%).

V. Data Results

In the farm's satisfaction survey, farmers' age averaged in their fifties. The cucumber farmers are somewhat younger in their forties, and the tomato and strawberry farmers are in their fifties. A farming career in tomatoes last for 25 years, and a farming career in cucumbers last relatively short. The rate of each smart farm is about 64%, and adoption satisfaction is about 4.36. Spare time received the highest score when comparing satisfaction with productivity, cost saving, labor saving and spare time. Satisfaction of strawberry is relatively high.

We implemented a t-test for analyzing the performance on the introduction of each items' smart farm. For strawberry farms, increasing rate of output, income and time saving have significant differences ($p<0.05$). However, for tomato farms, decreasing rate of income per year has significant differences ($p<0.05$). As the price of tomatoes decreases, income also distinctly decreases. The scale of differences for strawberry, tomato and cucumber before and after ICT introduction gradually appear. In the case of strawberry, both effectiveness (i.e., output and income) and efficiency (i.e., working hours) could improve. Effectiveness can be changed by the external environment in the market and individual conditions of the farmers. However, efficiency could relatively obtain a regular effect

The satisfaction for adoption is mostly high with spare time, productivity and labor saving. However, cost saving has a low effect. The performance evaluation through a t-test also has significant differences in output, income and working hours. The coincidence of satisfaction and performance can facilitate performance evaluation only through a Likert-type measurement. It might be possible to obtain similar results from a t-test. As we rise over a '4'

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Table 3. Results of t-test between before and after introduction of ICT

Performance Factor	Crop	Year 2014 Mean (SD)	Year 2015 Mean (SD)	N	p-value
Ouput	Tomato	28,962 (8,016)	29,648 (7,119)	7	0.434
	Cucumber	21,816 (10,036)	21,827 (9,518)	13	0.498
	Strawberry	5,337 (2,091)	7,062 (1,568)	8	0.041*
Income	Tomato	91,059 (27,549)	68,885 (17,933)	7	0.049*
	Cucumber	9,855 (7,149)	10,834 (8,235)	13	0.374
	Strawberry	11,261 (15,776)	27,052 (16,109)	8	0.033*
Operating costs	Tomato	15,682 (3,838)	15,926 (4,780)	7	0.459
	Cucumber	15,266 (7,357)	15,104 (7,507)	13	0.477
	Strawberry	35,982 (18,661)	39,388 (19,830)	8	0.364
Working hours	Tomato	7.85 (1.67)	7.00 (2.14)	7	0.210
	Cucumber	8.46 (2.06)	7.65 (2.41)	13	0.184
	Strawberry	8.00 (0)	4.87 (0.83)	8	0.000***

In the scale of satisfaction, a simplified evaluation form using a Likert-type scale can appropriate valuation criteria as '4'.

VI. Conclusion

In this study, we compared differences before and after the introduction of each item's satisfaction in order to analyze the introduction of ICT convergence technology in horticulture. Productivity, cost saving and labor saving could affect enlarging an application of ICT convergence technology. However, it is important to satisfy the needs and desires of farmers at the same level as management performance. Demand volatility and external factors for these periods can affect ICT introduction and adoption. To guide activation of ICT convergence technology, we have to promote management achievement in productivity and income improvement and management efficiency in time savings to farmers. Farmers also need technical improvement. From the survey, farmers' feedback shows an increase in the use of CCTV, difficulties of using a smart phone and the improvement in electricity consumption. As a limitation, this study did not have enough survey samples. Therefore, it is difficult to generalize the research results. Through additional data collection and analysis, we look forward to contribute to the diffusion and settlement of ICT convergence technology.

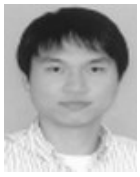
Acknowledgment

This research was supported by the MSIP (Ministry of Science, ICT and Future Planning), Korea, under the ITRC (Information Technology Research Center) support program (IITP-2017-2013-0-00877) supervised by the IITP (Institute for Information & communications Technology Promotion).

References

[1] J. Park, "Korea-Netherlands Agro-IT Convergence Workshop", National Assembly in South Korea, 2014.
[2] Center for Food, Agricultural & Rural Policy, "Present and Future on ICT convergence in horticulture" *Special issue: scientific technology and agricultural innovation*, vol. 52, winter, 2014.
[3] Rural Development Administration, "Local Agriculture Characterization Performance Analysis Report", 2013.
[4] aT Center, "The Garden brands Promotion Project Analysis Report", 2014.
[5] aT Center, "The Up-land brand Promotion Project Analysis Report", 2014.
[6] T. Greenhalgh and R. Peacock, "Effectiveness and efficiency of search methods in systematic reviews of complex evidence: audit of primary sources", *Information in practice*, Vol 331, 2005, pp. 1064-1065.

Authors' Profiles



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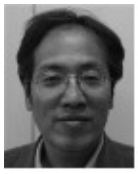

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