

Cases of Eco-Friendly Pigsty and Hog Feeding and Management Based on u-IT Information Systems¹

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Abstract This study introduces cases of individual feeding systems for sow and the sow sorters which are the subparts of an eco-friendly feeding and management system based on a u-IT program using the hog feeding and management information system. The purpose of this study is to conduct an analysis of economic feasibility on cases of the improvement of the system using the u-IT and to provide information on the positive effects of an introduction of an eco-friendly pigsty and hog feeding and management system to hog raisers and government officials. The literature review and background section examine the effects of the introduction of u-IT technology into the field of livestock raising, hog feeding and management information system, and the eco-friendly feeding and management system based on the u-IT. This paper will present the results of the analysis on the effects and the economic feasibility of the individual feeding system for sow and the sow sorter utilizing the u-IT technology and information systems. The results of this study will contribute to the sustainable devel-

opment of the hog raising industry by showing that the new feeding and management system utilizing the u-IT can not only increase the efficiency and productivity of farm management but also contribute to efficient, eco-friendly hog feeding and management.

Keywords Hog feeding and management computation, u-IT, eco-friendly pigsty, eco-friendly hog feeding and management

1 Introduction

Issues such as climate change and energy as well as development of technology have caused new changes in the environment and agriculture. The Korean hog raising industry is struggling due to an acceleration of foreign imports and increasing feed prices following an increase in international grain and oil prices. In addition, internally, the conversion of the raising method of sow and the improvement of the pigsty environment are required because of the difficulties in management such as the increase in facility management cost and the decrease in productivity caused by the vulnerability to disasters due to the use of old pigsties. Moreover, in early 2011, 3.32 million pigs, which account for about 30% of the total hog population in Korea, were buried because of an occurrence of FMD (foot-and-mouth disease). In order for the Korean hog raising to overcome the issues described above and develop the pork industry into a long-term sustainable industry, the Korean hog raising industry must expand the consumption base of pork by developing consumer trust.

Following the settlement of UR agricultural negotiation in 1993, the foundation of the WTO regime in 1995, and the conclusion of Korea-Chile and Korea-U.S. FTAs, etc., the

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agricultural product market is moving towards the stage of a complete opening of the international market. As the opening of the agricultural product market expands, the amount of imports of agricultural and livestock products may exceed 40% of production, and exports are expected to expand. This leads to the progress of globalization of agriculture. Globalization means the intensification of competition not only in Korea but also between other countries, which makes the strengthening of competitiveness of Korean agriculture in the global market, emerge as the most important task.

The scale of production of the hog raising industry in Korea is about 5.6290 trillion won, which accounts for one-third of the entire livestock industry, but it was found that the number of hog farms have decreased by half from 11,300 farms in 2006 to 5,700 farms in 2011. The livestock industry is recognized as a hated industry by local communities because of the occurrence of FMD, etc. In addition, livestock industry regulations are strengthening due to the work of local governments. Hence, an eco-friendly stock raising base should be constructed by considering regional characteristics and the improvement of the environment of stock raising farms. In addition, the EU is strengthening livestock welfare regulations including the prohibition of sows raised in stalls by 2013. Various attempts and efforts are being made in order to adapt to these changes, and of these, the grafting of IT technology and agriculture is recognized as a method for the new era. In Korea, the application of agricultural IT technology has been conducted to demonstrate examples to some local governments, and as a result, successful commercialization cases are recently increasing.

In the field of hog raising, the feeding and management information system was developed in the late 1990s though it had been used earlier in other fields of agrifood. Recently, the u(ubiquitous)-IT technology began to be used as an example of IT fusion for technological innovation and enhancement of a competitive edge. 'Ubiquitous' means an environment where the users can access the network freely, without use of the main computer or network, regardless of where they are. That is, through the ubiquitous sensor network, the optimum swine raising environment including optimum temperature, humidity, concentration of CO₂ and oxygen in the pigsty can be obtained. The information systems and u-IT technology have commercialized in the field of agrifood and started to be used practically in the industry. Therefore, the related success cases of IT adoption needs to be recognized widely in the whole Korean hog raising industry. This goes together with the reflection on animal raising in the form of a

factory, animal welfare, the eco-friendly pigsty, and the hog feeding and management system using the u-IT technology which is expected to have positive effects on issues such as animal welfare.

This study introduces cases of individual feeding systems for sows and the sow sorter, which are sub parts of the eco-friendly feeding and management system based on the u-IT using the hog feeding and management information system. The purpose of this study is to conduct an analysis of the economic feasibility of cases on the improvement of system using the u-IT and to provide the information on the positive effects of the introduction of an eco-friendly pigsty and the hog feeding and management system to the hog raisers and government officials. The parts of the literature review and backgrounds examine the effects of the introduction of IT technology into the field of stock raising, hog feeding and the management information system, and the eco-friendly feeding and management system based on the u-IT. This paper will then present the results of analysis on the effects and economic feasibility of the individual feeding system for sows and the sow sorter utilizing the u-IT technology and information systems. This study will contribute to the sustainable development of the hog raising industry by showing that the new feeding and management system utilizing the u-IT can not only increase the efficiency and productivity of farm management but can also improve eco-friendly hog feeding and management.

2 Literature Review and Backgrounds

2.1 Effects of the Introduction of IT Technology into the Field of Stock Raising

In the field of stock raising, as information on each individual is needed for the decision-making, feeding and management information system have been developed since the late 1990s, which is earlier than in other fields of agriculture. In addition, the fact that the field of stock raising was specialized and commercialized earlier than other fields of agriculture also accelerated the introduction of information systems (Minsu Lee et al., 2010). However, Verstegen et al. (1995) said that a high acceptance ratio does not show the objective effects of an agricultural information system. The objective information on the effects of an agricultural information system is a very important standard for the farmers who want to invest in an information system and enterprises and public research institutions that intend to provide an agricultural information

system. Hence, it is of great importance to objectively measure the effects of an information system when developing the agricultural information system (Minsu Lee et al., 2005). In the field of stock raising, while the feeding and management information system was developed earlier than in other fields of agriculture and has a variety of research periods and scope, in reality the related studies are very insufficient numerically. The studies that analyzed the effects of the introduction of IT technology into the field of hog raising are mostly about the changes in productivity or other outcomes after the introduction of the feeding and management information system.

In view of related studies, Verstegen et al. (1995a) examined the effects of the use of the information system by using panel data collected, which targets hog raising farms in the Netherlands. The study targeted 93 hog raising farms using the information system (the production management information system at an individual level) from 1983 through 1991, and then used the data on the management performance (Pig per Sow per Year, PSY) of each year of before, on, and after the year of introduction of the information system. As the analysis model, a linear mixed model was used. In view of the results of the study, the PSY of the farms increased by about 0.56 head by the use of the information system, and the return on investment (ROI) of the information system was about 220% through 348%.

Verstegen and Huirne (2001), using the survey data conducted in 1983 and 1992, verified the relationship between the management level of hog raising farms and the effects of the information system targeting the same 71 hog raising farms. As a result, it was found that the farms with a higher management level obtained more values from the information system. Tomaszewski et al. (1997) measured the effects of the information system (the production management information system at an individual level) by applying the linear mixed model, which targeted the hog raising farms and dairy farms in the Netherlands. As a result, it was found the hog raising farms had a ROI of 220% through 348% and that the dairy farms had a ROI of 52% through 205%. Minsu Lee et al. (2010) analyzed the effects of the use of the system by collecting the data targeting the farms using the Pigplan (a hog raising production and business management program), and found that the PSY and the sow's turnover ratio increased in the farms using the system. Kwangho Cho (2000) aimed to grasp the realities of the management of the farms producing pork for export in the South Jeolla Province and conducted the management diagnosis, such as the analysis of production cost of fed pigs, etc., by using the "hog raising management

diagnosis and economic feasibility analysis program (HOGAID)". Due to the information system's improved ability to highlight and diagnose certain issues, the introduction and use of the information systems for the Korean hog raising industry is encouraged.

2.2 Hog Feeding and Management information system

The field of hog raising was specialized and commercialized earlier than other fields of agriculture, and the feeding and management information system was actively introduced. In the United States, the University of Minnesota developed a program called PigCHAMP in the early 1980s and for the first time the world of hog raising took notice. In Korea, Purina Korea first developed a program called Doncom in 1989. In 1995, Seoul National University and Ezfarm Co., Ltd. developed a program called PigPlan, which, currently, is the most widely used program. The PigPlan for general farms supports the feeding and management of farms and disease control through the management of breeding herds, growing pigs and the prevention of epidemics. In addition, the PigPlan program analyzes and compares the general state of management of individual farms by using breeding results of farms, feed transaction information and shipment information through connections with other businesses including feed companies and slaughter houses to support management improvement of the pertinent farms. The PigPlan for pig breeding farms manages performance-tested pigs and provides the functions of management of sales and parceling-out of breeding pigs, gathering sales, management of boar semen, and the business management for general state of management of farms. The PigPlan also provides services supported by the program for general farms, which is now a Web-based information system available on the Internet is provided. PigPlan provides optimized functions through long-term upgrades of the system and program. According to 'the Written Investigation on the Realities of Management of Nationwide Specialized Hog Raising Farms (2011)', which is presentation data from the Korea Pork Producers Association, it was found that about 42.2% of Korean hog raising farms use the feeding and management information system. This result of constant spread and expansion is thanks to the demonstration of the effects of use of the feeding and management information system.

2.3 Eco-Friendly Feeding and Management System Based on the u-IT

Today the IT is evolving into the ubiquitous Information

Technology (u-IT) centering on users, and it is also being applied to the hog raising industry. The current, automatic green house and pigsty management technology is devel-

oping into unmanned precision agriculture based on the u-IT. [Table 1] shows the shape of utilization of the u-IT in the field of agriculture and its expected effects.

Table 1 Shape of the Utilization of the u-IT in the Field of Agriculture and its Expected Effects

Field of Utilization	Shape of Utilization	Expected Effects
Agricultural Production	<ul style="list-style-type: none"> - Automatic greenhouse, pigsty management system - Livestock feeding standard management - Soil verification and agricultural technology - Farmland management through field server 	<ul style="list-style-type: none"> - Reduction of labor and production cost - Realization of precision technological agriculture
Distribution of Agricultural Products	<ul style="list-style-type: none"> - E-commerce of agricultural products - Traceability system of agricultural products - Intelligent, real-time logistics information system 	<ul style="list-style-type: none"> - Reduction of transaction costs and improvement of the distribution structure - Differentiated distribution of agricultural products - Quality management of agricultural products and settlement of disputes
Education, Medical Treatment, Welfare Services	<ul style="list-style-type: none"> - Remote education, medical treatment, and culture system - Home management system for the elderly and the disabled - Disaster control system 	<ul style="list-style-type: none"> - Improvement of quality of public services in rural areas - Enhancement of the quality of life of rural residents - Prevention of disasters

Source : Yunsik Shin et al., 2007, Rural Informatization Model in the Ubiquitous Era, National IT Industry Promotion Agency

In view of the cases of the application of u-IT in the field of hog raising, in 2008, the South Gyeongsang Province introduced the u-pork uniform pig growth management system utilizing the 'u-IT' to Kaya Inte Co., Ltd., which is a subsidiary company of PKPORK, for the first time in Korea. The u-IT let the state of growth of each individual, including the amount of intake of feed by pigs and measurement of weight, be easily distinguished by utilizing the RFID. Furthermore, u-IT made the weight management by growth stage and the automatic sorting management at the best age for shipment possible through the automatic pig weight sorter. In addition, the Universal Sensor Network (USN) and CCTV were utilized together to form the optimum environment by monitoring and controlling the growth and development environment of the pigsty and the pigsty model. This u-IT method has helped establish an environment management standard indicator proper for a windowless pigsty. The Jeju Special Self-Governing Province developed the hog raising system where the growth and development monitoring for prevention of disease of pigs based on the RFID/USN technology and the feeding and management based on the HACCP are possible through the business of the construction of a u-IT convergence hog raising FCG integrated system in 2008. This system was developed to automate the HACCP

work by using the USN; it was to enable the self-diagnosis at the production stage. Jangsu-gun was selected for the business of the 'construction of an eco-friendly hog feeding and management system utilizing the u-IT' supervised by the Ministry for Food, Agriculture, Forestry and Fisheries in 2010 in conjunction with Farmsco. This was done to develop an eco-friendly hog feeding and management model based on the USN for the efficiency of farm management and an increase in productivity utilizing the u-IT and information systems. This system is obtaining the effects of the increase in the shipping heads, reduction of feed cost and cost of prevention of epidemics, etc. by using the functions of feed bin, drinking water management, and maternity barn management using the u-IT. The shape of the utilization of the eco-friendly feeding and management system utilizing the u-IT by function in the field of hog raising is summarized as in [Table 2].

Table 2 Functions of the Eco-Friendly Feeding and Management System Utilizing the u-IT

Field of Utilization	Shape of Utilization	Expected Effects
Pigsty Environment Management Based on the USN	An automatic control of the USN temperature, humidity, and CO2 sensor is possible by using the controllers and communication devices based on the USN, and the real-time monitoring is possible through the Internet and smart phones.	Rapid countermeasure at the time of an unusual symptom and the enhancement of productivity through an analysis of the measured data and patterns of pig behavior
Feeding and Management Based on the u-IT	It becomes possible to automatically control the feeding and management facilities such as the feed bin and drinking water management, the individual feeding system for farrowing sow, group feeding system, market pig sorter, etc., and to diagnose the state in real time.	The accuracy of feeding and management becomes increased by pigsty, and the unusual symptoms can be identified in real time. Hence, the reduction of production cost and the reduction of productivity can be achieved at the same time.
Hog Production and Business Management	It grasps the realities of management through the information systems by collecting information on the environment of the pigsty and feeding and management in real time, and helps conveniently manage the production results of farms, the HACCP reports, etc.	It can be utilized as an important base for the decision-making needed for the operation of farms and the farm improvement activities such as the reduction of management cost, etc. become possible.

3 Cases of Analysis of the Effects and Economic Feasibility of the Eco-Friendly Feeding and Management Based on the u-IT

For the analysis of the actual effects and economic feasibility of the cases of construction of the eco-friendly feeding and management system using the u-IT technology, this study conducted an analysis on the basis of the data drawn from the results of the operation of two actual application cases of the pilot projects in which the agricultural IT consulting companies operating the feeding and management information system participated. The cases of individual feeding system for sow were examined in the business of 'the construction of the eco-friendly hog feeding and management system utilizing the u-IT' conducted in Jangsu-gun, and the market pig sorter was examined on the basis of the cases of the introduction and operation of the equipment in the farms using the feeding and man-

agement information system.

3.1 Individual Feeding System for Sow

The control of the proper amount of feed intake for sows in the maternity barn influences the enhancement of productivity and reduction of feed cost, and needs to be managed. The efficiency can be increased if the amount of feed is controlled by using the electronic feeding system, but there are difficulties in constant monitoring and analysis of data of the amount of feed intake if it is not interlocked with the information systems. When using the individual feeding system for sow utilizing the u-IT, the feed that is needlessly eaten or the feed left to be abandoned can be reduced by letting out the proper amount of feed for the sow only when the sows want to eat. The concept of this individual feeding system for sow is as in the below <Fig. 1>.

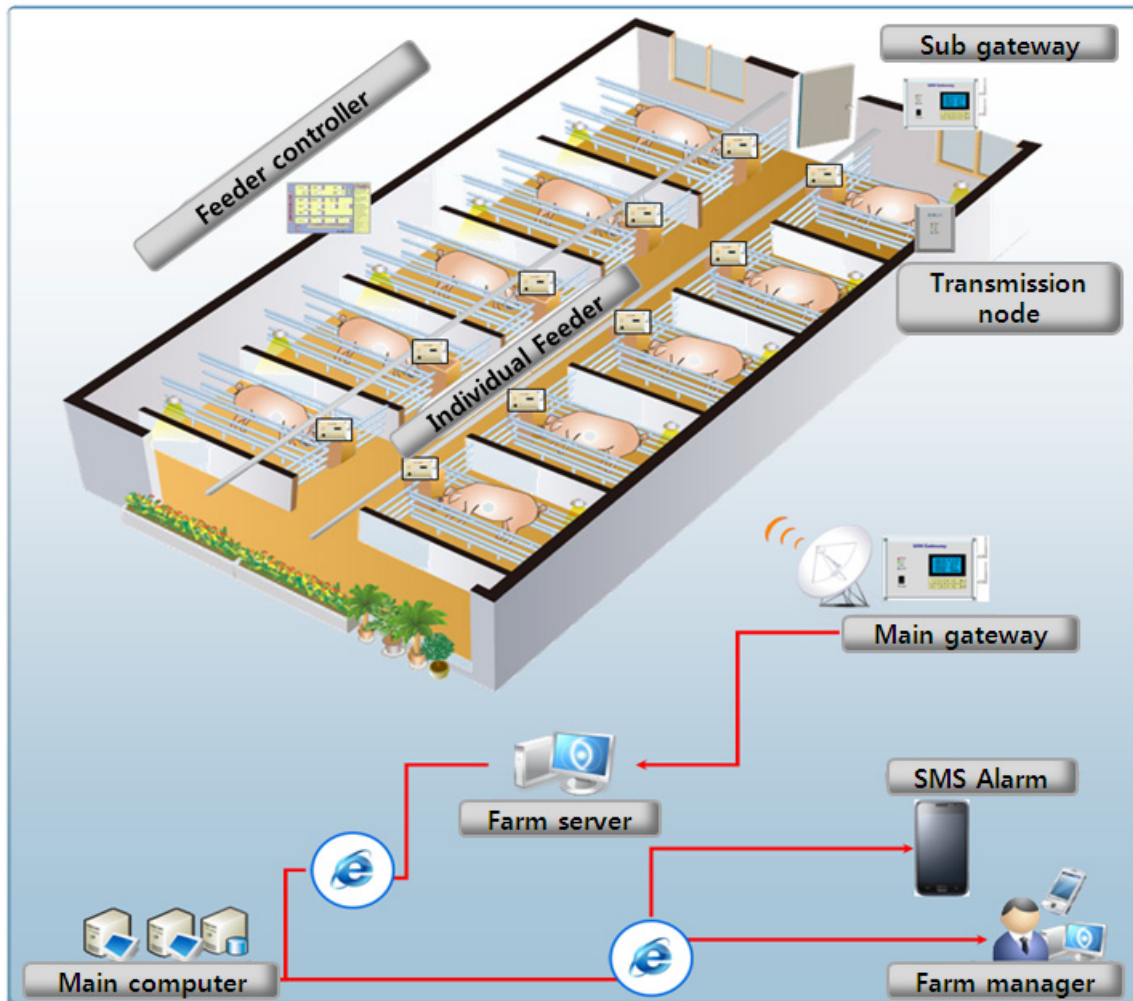


Fig. 1 Concept of Individual Feeding System for Sow

The use of the individual feeding system for sow has qualitative effects including: the prevention of waste of feed by reducing the loss of feed, the prevention of the danger of an attack of diarrhea of sows because of the change of the quality of the feed left in the feed bin in the hot pigsty environment, etc. In addition, it has the benefit to induce the optimum sucked feed amount proper for the growth and development of piglets by controlling the amount of feed inputted by the time of suckling after

farrow.

The results of the analysis of economic feasibility as the quantitative effects of the individual feeding system for sow are as in [Table 3]. The break-even point is calculated to be 2.8 years if one considers an average reduction in feeding costs of 12% against the initial installation cost of an individual feeding system for sows. The analysis conditions for <Table 3> are based on cases of raising 100 sows for three years as the standard.

Table 3 Analysis of the Economic Feasibility of the Individual Feeding System for Sow (3 Years of Raising of 100 Sows)

Loss Elements (A)	Profit Elements (B)
<ul style="list-style-type: none"> ○ Increased cost: - Individual feeding system: $400,000 \times 100 \text{ EA} = 40,000,000 \text{ won}$ - Supplementary installation cost: $2,500,000 \times 2 \text{ set} = 5,000,000 \text{ won}$ - Total (A): $45,000,000 \text{ won}$ 	<ul style="list-style-type: none"> ○ Increased profit - Reduction of the amount of loss of feed: 12% - Amount of reduction of feed: $6\text{kg} \times 365 \text{ days} \times 100 \text{ heads} \times 600 \text{ won} \times 12\% = 15,768,000 \text{ won}$ - Total (B): $15,768,000 \text{ won}$
<ul style="list-style-type: none"> ○ Estimated amount of profit (B-A) = $(15,768,000 \text{ won} \times 3 \text{ years}) - 45,000,000 \text{ won} = 2,304,000 \text{ won}$ 	

3.2 Market Pig Sorter

The market pig sorter is equipment that sorts pigs reaching the shipment standard through an automatic measurement of weight and is installed where the pigs pass by to drink water. The purpose of the market pig sorter is to determine if it is impossible to measure the weight of individual pigs with a scale. The realities of motion of the sorter are monitored in real time through communication devices and information systems. The sorter can also guide the light pigs and the heavy pigs to different rooms. RFID tags can be attached to each individual pig in order to make better use of the market pig sorter. This monitors the weight of individual pigs and checks the physical conditions of the pig and discovers unusual symptoms described earlier.

The use of the market pig sorter can have qualitative effects such as fasting at the time of shipment and before shipment of standard pork, the convenience of shipment

work, etc. The standard pork responds to the changing demand of standard of weight of shipment and supplements the errors of sorting with the naked eye (by season and by pedigree) to increase the rate of appearance of AB grade, which are the high levels, in the standard grade. The effects of fasting before shipment can lead to mooring at the shipment space for 0 through 24 hours, the reduction of feed, the decrease in stress during transport, and the increase in the carcass yield percentage. In addition, the market pig sorter can sort automatically by measuring the weight of all market pigs and can reduce the time for shipment work by guiding pigs to the shipment space; it can increase the convenience of the shipment work.

In view of the case of Farm B, it can be observed that after the introduction of the market pig sorter on May 1st, 2012, the frequency of appearance of the First class, which is the grade of quality of meat, steadily increased and the AB grade which is the standard grade, certainly increased.

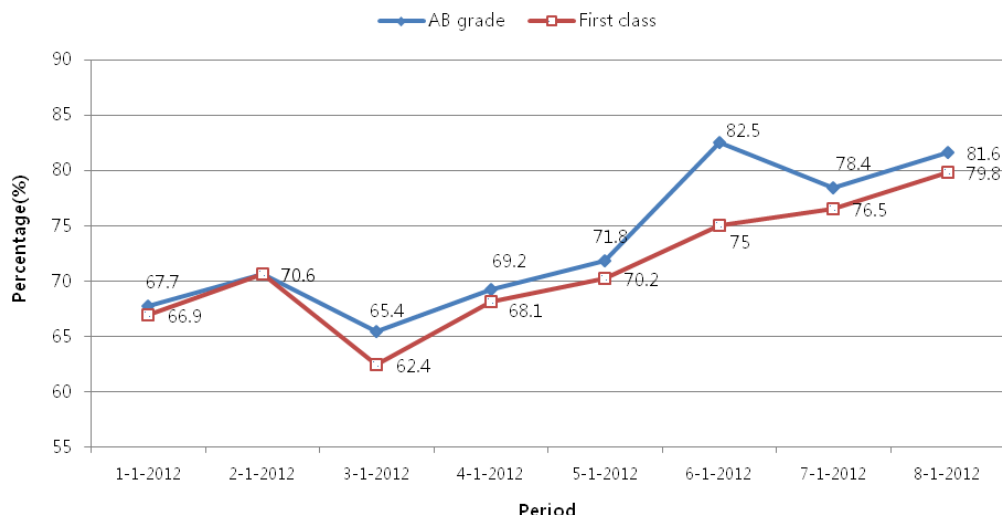


Fig. 2 Effects of the Improvement of Shipment Grade after Sorting of Market Pigs (Date of Introduction: May 2012)

The results of the analysis of the difference per head following an increase of pay rate of 1% with a per pig at 4,000 won and a weight of shipment of 110 kg as the standard, and the analysis of excess profits by assumption

of shipping heads per year at 1,800 heads for the analysis of economic feasibility because of the introduction of this sorter are as in [Table 4]. The break-even point is calculated to be 1.9 years.

Table 4 Analysis of Economic Feasibility of Market Pig Sorter (Stock Raising of 1,800 Market Pigs for 2 Years)

Loss Elements (A)	Profit Elements (B)
<ul style="list-style-type: none"> ○ Increased cost: - Sorter: 1 unit×15,000,000 won - Total (A): 15,000,000 won 	<ul style="list-style-type: none"> ○ Increased profit - Increase in the pay rate of live weight from 70% to 71% - Standard: Pig price of 4000 won/Kg, 110Kg - Reduced amount per shipping head: $(4,000 \times 110 \times 0.71) - (4,000 \times 110 \times 0.70) = 4,400$ won - Excess profits at the time of shipment of 1,8000 heads per year = $1,800 \times 4,400$ - Total (B): 7,920,000 won
<ul style="list-style-type: none"> ○ Estimated amount of profit (B-A) = $(7,920,000 \text{ won} \times 2 \text{ years}) - 15,000,000 \text{ won} = 840,000 \text{ won}$ 	

4 Conclusion and Consideration

Eco-friendly hog feeding and management programs utilizing u-IT technology have passed the pilot project stage and are now in the commercialization stage. An analysis of technical issues and economic effects was conducted in some cases; however it has not been proven that it deserves investment in the long-term viewpoint despite the initial cost. This study examined the cases of construction of the u-IT eco-friendly hog feeding and management system using the feeding and management information system. The study conducted an analysis of this system's economic feasibility by examining the effects drawn at the farms where the system was actually introduced. As a result of analysis, the introduction of the individual feeding system for sows can expect a profit of 15,768,000 won per year with an operation of 100 sows as the standard. The break-even point was determined to be 2.8 years. The introduction of the market pig sorter can expect profits of 7,920,000 won per year with the shipping of 1,800 heads as the standard, and the break-even point examined to be 1.9 years.

In this connection, the introduction of eco-friendly feeding and management systems using the u-IT can achieve profits in the long-term despite the burden of investment cost in the short term, and can expect additional effects including the improvement of the pigsty environment, the strengthening of the immunity level in pigs, and the reduction of labor cost. Hence, farmers need to consider the introduction of this latest system. Government must also support businesses by examining the effects, compatibility, and economic feasibility of a variety of eco-friendly feeding and management technologies using u-IT technology in order to improve the Korean hog raising industry. Currently, this industry still presents a high risk of hog disease due to group raising and fails to satisfy the quality standard demanded by advanced nations.

Recently, the uncertainty of the pork market is increasing along with the rising interest of consumers in the eco-friendly agrifood market and with the possibility of animal welfare regulations working as a trade barrier.

Therefore, it is time for the hog raising industry to introduce new technologies and new systems, escaping the existing mass-production systems in the form of factories to make a leap forward. The meeting of the u-IT technology and the hog raising industry is expected to serve as an important bridge for the development of the Korean hog raising industry.

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