CURRENT STATUS OF PROTECTED HORTICULTURE IN KOREA

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ABSTRACT

The greenhouse area in Korea is 54,945ha, which is the third largest after China and Spain. The greenhouse area per capita in Korea, 10m², is the largest in the world. The greenhouse area has rapidly expanded due to the governmental policy support for the supply of greenhouse in 1990s. At that time, standard model for greenhouse was developed and introduced to farmhouses, and it has resulted in significant changes in the type of greenhouse and internal facilities. Facing annually recurring damage to greenhouses from typhoon and heavy snowfall, Korean government has been developing and announcing strong greenhouse models against disasters since 2007. As the proportion of heating cost among operating cost of greenhouse is 27% in Korea, which is relatively high, a lot of research are actively being carried out in the field of improvement of thermal insulation as well as use of natural energy for reducing heating cost. Recently, agricultural sector in Korea is experiencing worsening management due to the rising labor costs and material costs and having trouble to secure specialized workforce. In order to overcome many difficulties, many research projects on development of Korean smart farm equipped with information and communication technologies are going on.

INTRODUCTION

Protected horticulture makes it possible to produce vegetables and fruits in winter season, therefore playing a role to provide food in a stable manner throughout the year. As national income increased, demand for fresh vegetables, flowers and fruits increased, and protected horticulture meets the food demand of the people by producing high quality, clean agricultural products annually. Since Korea has a small area of cultivated land and lacks labor force, it has to move away from land and labor-oriented agriculture and shift to capital and technology-intensive agriculture. Protected horticulture is one of capital and technology-intensive agriculture. To be considered as an industry, it must meet two important factors: value-adding and competitiveness. Starting with wood-framed greenhouses in the 1950s, Korea's protected horticulture now has advanced to high-tech greenhouses and plant factories. This paper is to introduce the history and current status of protected horticulture, structure of greenhouse, energy saving technologies, environment control system, and smart farm in Korea.

Current status of protected horticulture

The greenhouse area in Korea is 54,945 ha in 2015 (Figure 1), and the greenhouse area per farmhouse is 0.4 ha, which is small. Almost all greenhouses (99%) are plastic greenhouses with 88% of single-span and 11% of multi-span greenhouse. The glasshouse area is only 400 ha, with a score of 0.7%. The heated greenhouse area is 17,800 ha in 2015, with 73% of greenhouses using air heater. The hydroponic cultivation area is 3,295 ha (2015), accounting for 6% of the total greenhouse area, and nearly half of the area is for strawberry and paprika cultivation.
History of Protected Horticulture

The protected horticulture in Korea began in the 1950s when six polyvinyl chloride film greenhouses with a size of 300m² were constructed for vegetable cultivation. Wood and bamboo were mainly used as frame materials and PVC film was used as covering material. In the 1970s, pipes and polyethylene films were produced in large quantities as POSCO petrochemical complexes in Ulsan were established, therefore plastic greenhouses made of pipes and polyethylene films started to spread, which are now widely available. They were mainly utilized for cultivation by heat conservation until the 1980s. In the 1990s, the greenhouse area increased sharply with the active support of government for greenhouse supply. It was an important period to establish a basis for stable vegetable production throughout the year. Large-scale multi-span plastic greenhouses were spread, and automation equipment, labor saving devices and heating devices began to be introduced. In the 2000s, the scale became bigger, the multi-variable controllers and the hydroponic cultivation area were increased (Figure 2). In the 2010s, research is being conducted to precisely control greenhouse environments, nutrients, and moisture using information and communication technologies (ICT).
Figure 2: History of protected horticulture in Korea.

Greenhouse Structure

Around the year of 2000, typhoons and heavy snowfall caused severe damage to plastic greenhouse, so the government has announced new disaster-resistant greenhouse models as a countermeasure. The disaster-resistant greenhouse is the one which has strengthened structural safety by exceeding regional standards of the design wind speed and design snow depth that were determined by analysis of the weather data. The government provides subsidies for installation and recovery costs in case of damage only for disaster-resistant greenhouse. The Protected Horticulture Research Institute developed disaster-resistant multi-span and a single-span plastic greenhouses having strengthened design strength compared to prior ones, as well as the greenhouse suitable for growing paprika, strawberry, tomato, and pepper (Figure 3) and introduced them to farmhouses.

Figure 3: New models of greenhouse.
Energy Saving Technology

Oil, which is sensitive to international oil price fluctuations, accounts for 84% of the fuel used for heating. The area of heating greenhouses is steadily increasing from 15,600 ha in 2010 to 17,800 ha in 2015, and heating costs put a heavy burden on greenhouse management. To save heating costs, it is necessary to improve the thermal insulation of the greenhouse, improve the efficiency of heating devices, and use technology utilizing alternative energy. The area of greenhouse heating with renewable energy is increasing from 127 ha in 2012 to 373 ha in 2015. The Protected Horticulture Research Institute has developed a multi-layered insulation curtain (Figure 4), which has a five-ply material woven as a duvet for improved thermal insulation. Compared to non-woven fabric curtain, it reduces heating costs by 46%. A combination of multi-layered heating curtain and geothermal heating system could save 76% of heating cost compared to heating using oil.

![Figure 4: Multi-layered insulation curtain.](image)

Environment Control System

The control system of the greenhouse environment is mainly concerned with the temperature and the carbon dioxide gas concentration. It is a simple controller to individually control the operation of hot air heater, CO₂ generator, ventilation fan as well as opening/closing of roof window, side window, curtain using thermal sensor or timer. It can be installed individually or collectively using a control panel for centralized control, without consideration of interaction between each environmental factor such as temperature, humidity, and solar radiation. Various factors such as humidity, carbon dioxide gas concentration, and light intensity as well as temperature affect the growth of crops. Likewise, as ventilation for temperature control affects carbon dioxide gas concentration, humidity, etc. so precision control for multiple factors becomes difficult. A method of controlling two or more environmental elements in an optimal state by linking them is called a multi-variable controller. It is introduced in greenhouses where high value-added crops such as paprika and tomatoes are grown, and mainly manufactured in the Netherlands. Recently, several Korean manufacturers have also developed multi-variable controller and supplied them to farmers (Figure 5).
Smart Farm

Smart farm refers to a farm where ICT is applied to greenhouses, animal sheds, orchards, etc. to remotely and automatically manage the growth environment of crops and livestock properly. Currently, the government is striving to discover new growth engines in agriculture, and Smart Farm is attracting attention as a future industry that combines ICT. Utilization of ICT among leading farmhouses introducing Smart Farm has led to an increase in production and the gross profit. Production increased by 44.6% compared to the prior condition, and the gross profit increased by 40.5%. Smart Farm in Korea is yet in the early stage, so the government put a lot of efforts into the standardization of sensor and controller, development of Korean Smart Farm models, measurement of plant biometric information (Figure 6), and development of optimal growth management software utilizing growth prediction model for expansion of Smart Farms optimized for the Korean climate.

Figure 5: Computerized environment control system in Korea.

CONCLUSIONS

Protected horticulture industry in Korea has developed rapidly in recent three decades with government support and efforts of farmers. As production value of the protected horticulture is larger than that of the open-field culture, the protected horticulture industry is a quintessential industry which occupies a large proportion in industrial aspects and also provides fresh agricultural products in a stable manner throughout the year. Recently, Korean agriculture has faced difficulties both internally and externally. The profitability and competitiveness of agriculture is deteriorating due to the small scale of management, labor shortage, rising wages, and agricultural import liberalization. To cope with such changes in agricultural conditions, much effort have been made regarding modernization of structures of greenhouse, energy saving technology using growth and automation devices, as
well as natural energy, and development of Smart farm utilizing ICT.

REFERENCES