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Joint Research for 2021 KAPEX with Mongolia

Enhancing the Vegetable Value Chain and Policy Establishment Ability by Supplying Greenhouses in Mongolia

Korea Rural Economic Institute
Mongolian University of Life Sciences
Ministry of Food, Agriculture and Light Industry

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List of Abbreviations

DASC	Department of Agronomy and Soil Science
MGEA	Mongolian Greenhouse Entrepreneurs Association
MoFALI	Ministry of Food, Agriculture and Light Industry
MULS	Mongolian University of Life Sciences
NSO	National Statistics Office of Mongolia
SAE	School of Agroecology
SDGs	Sustainable Development Goals
SEB	School of Economy and Business
REPC	Research, Education and Production Center
KREI	Korea Rural Economic Institute

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1 Joint Research Outline

1.1. Joint Research Background and Purpose

Based on the historical period of development of greenhouse vegetable production in Mongolia, the researcher J. Chuluunbaatar (2005) classified it into several stages.

The first stage covers the period up to 1960, and in 1955, a single-sided glass greenhouse (Chinese model) with steam heating on the north side was built in Amgalan State Farm on a 2,000 ㎡ area. However, it has been phased out because of shortcomings, such as manual operation, small area of use, and the inability to observe microclimates automatically. Sh. Gungaadorj and P.F. Kononkov (1976) noted that at the end of 1960, the total area of glass greenhouses was only about 7,000 ㎡.

The second stage was the late 1960s and 1970s. During that time, special heated and unheated arc-shaped glass greenhouses were established to

cultivate early crops such as cabbages, onions, and radishes. By the end of 1972, the total area of the glass greenhouses reached 49,749 ㎡.

The third stage covered the period after 1972 when 70,000 ㎡ of Holland-style glass greenhouses were built with the help of Bulgaria and Russia to cultivate tomatoes and cucumbers throughout the year to supply fresh vegetables to the population.

In 1990, when our country transitioned to a free market economy, the previous state funding system changed, and large vegetable production companies were disbanded into many small, self-financing private companies.

In 1997, the Government of Mongolia implemented the "Green Revolution" program to provide small plastic greenhouses to households, small cooperatives, and communities for growing cucumbers, tomatoes, leafy vegetables, onions, and seedlings during the warm season.

In 2014, the Ministry of Industry and Agriculture provided a loan of MNT 22.1 billion to 25 enterprises and individuals in 8 provinces and to the capital city to build 10.7 hectares of greenhouses within the framework of the "Establishment of Winter Greenhouses" project financed by the "Chinggis" bond.

In our country, finding success in cultivating vegetables in the open field is difficult because of the four seasons and harsh climate. Therefore, there is a need to develop winter and summer greenhouse productions protected from adverse natural conditions that create favorable environments for plants to grow. Presently, greenhouse enterprises, cooperatives, and communities do not fully produce the greenhouse vegetables needed by the population, so imported greenhouse vegetables are used dominantly during winter and spring.

An in-depth review of the research aimed at increasing the greenhouse vegetable value chain of Mongolia has not yet been conducted. Therefore, the main activities of our joint project, such as identifying the current state and challenges of greenhouse vegetable production and conducting field surveys to gather data and information, would have significant impacts on the further development of greenhouse vegetable production in Mongolia.

1.1.1. Purpose

The Ministry of Agriculture, Food and Rural Affairs (MAFRA) of the Republic of Korea had a series of discussions with the Ministry of Food, Agriculture and Light Industry (MoFALI) of Mongolia from January to March 2021 about implementing a Korean Agricultural Policy Experiences for Food Security (KAPEX) Project. As a result of the discussion, MAFRA's and MoFALI's respective officers signed official documents on June 25, 2021.

The Korean Rural Economic Institute (KREI) and the Mongolian University of Life Sciences (MULS), on behalf of MAFRA and MoFALI, respectively, implemented this joint KAPEX Project from July 16, 2021, to January 31, 2022.

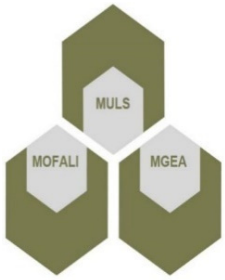
The title of the KAPEX Joint Research is "Enhancing Vegetable Value Chain by Supplying Greenhouses in Mongolia," and the main objectives of the Joint Research are the following:

- Comprehensively collect information and implement a depth analysis of the issues on the vegetable value chain related to greenhouses in Mongolia

- Provide policy recommendations to improve the vegetable value chain and increase the rate of self-sufficiency through the reduced importation of vegetables from other countries
- Build the capacity of officers and researchers related to vegetables from other countries
- Formulate policy measures, a strategic framework, and an action plan to address identified bottlenecks for future programs
- Contribute to drawing up a Project Document to discover a potential ODA project supported by MAFRA of the Republic of Korea in 2024.

The Mongolian project research team consists of 20 members from three main organizations.

- Three members from MoFALI. Their organization facilitates securing all necessary approvals and concerns and settling all legal matters concerning the implementation of the project.



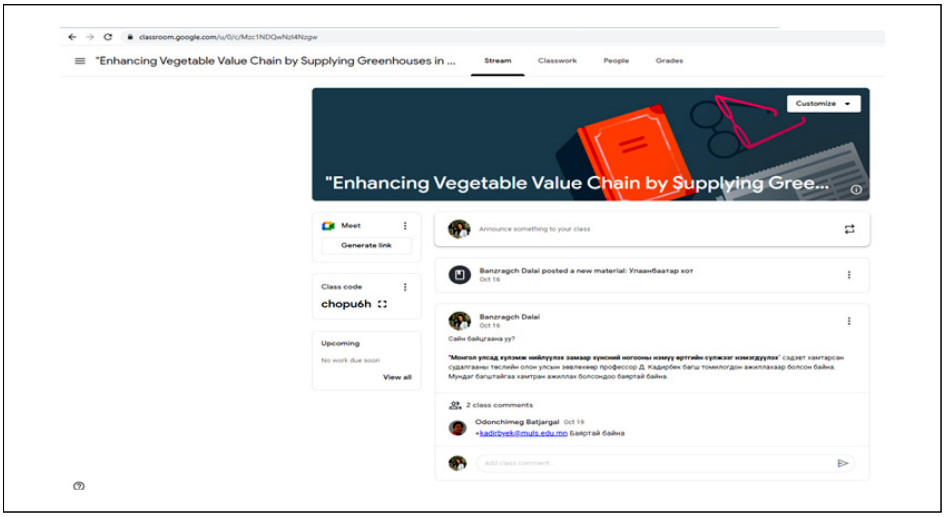
- Twelve members from MULS. Their tasks include identifying the most critical factors of the vegetable value chain in Mongolia by implementing an extensive survey and studying and deriving issues and problems.
- Five members from the Mongolian Greenhouse Entrepreneurs Association (MGEA). The MGEA team members are responsible for data collection from business entities and farmers through the association and cooperation with the MULS research team to organize field surveys.

Research team members

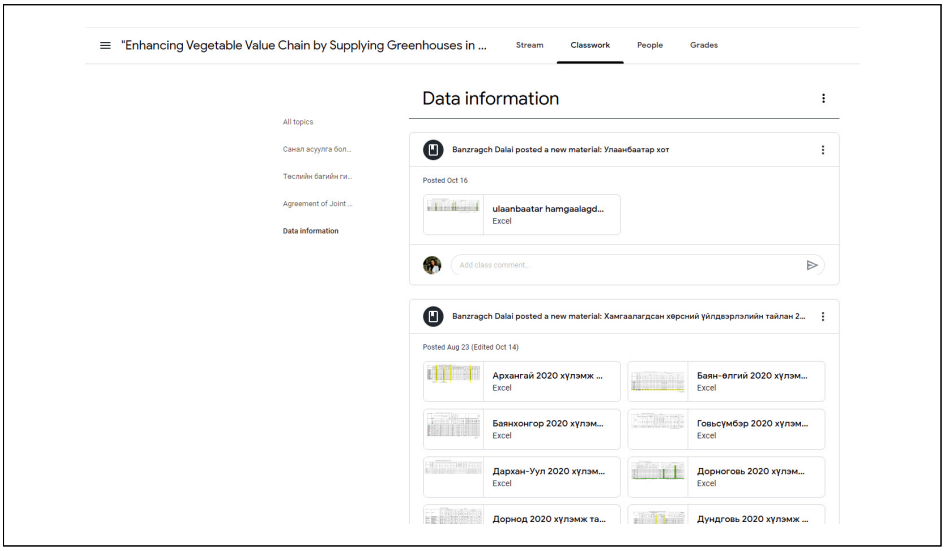
MULS	MOFALI	MGEA
1. P.Tsolmon /***Team leader***/ *Ph.D, Associate professor, SAE.*	1. V.Unenbat *Head of the Agricultural Policy Implementation Coordination Department.*	1. Ya.Oyunchimeg *Leader of MGEA. Tumen suikh LLC*
2. D.Banzragch /***Coordinator***/ *Ph.D, Senior lecturer, SAE.*	2. J.Tumurkhuyag *Senior Officer of the Agricultural Policy Implementation Coordination Department.*	2. T.Bayarkhuu *Agronomist, Atryn Shim LLC*
3. A.Buyanbaatar *Ph.D, Associate professor, Dean of SAE.*	3. D.Esun-erdene *Head of depertment, Depertment of the Soil, plant protection and seed varieties, Agricultural Policy Implementation Coordination Department.*	3. G.Narantsetseg *Agronomist, Amtat Nogoo LLC*
4. D.Khandsuren *Ph.D, Associate professor, SAE.*		4. D.Gerelmaa *Agronomist, Chandman Jims LLC*
5. B.Odonchimeg *Ph.D, Associate professor, SEB.*		5. Ts.Tumurtogoo *Agronomist, Mongolian Women Farmers Association*
6. T.Nasanjargal *Ph.D, Senior lecturer, SAE.*		
7. Sh.Dorjpagma *Ph.D, Senior lecturer, SAE.*		
8. N.Dambadarjaa *Ph.D, Senior lecturer, SAE.*		
9. P.Munguntsetseg *M.Sc, Lecturer, SEB.*		
10. E.Bayarjargal *M.Sc, Lecturer, SAE.*		
11. Ch.Javkhlanbayar *M.Sc, Assistance of DASC, SAE.*		
12. B.Turtulga *M.Sc, Researcher of "Nart" REPC, SAE.*		

1.2. Joint Research Results

A Google classroom entitled "Enhancing Vegetable Value Chain and Policy Establishment Ability by Supplying Greenhouses in Mongolia" was created for the MULS research team members.



This classroom was used to distribute announcements to research members, share relevant project documents, create a database, including relevant materials, reports, and information related to the project topic, and organize online meetings using Google Meet. All information about the joint research project is sent through email to research members.

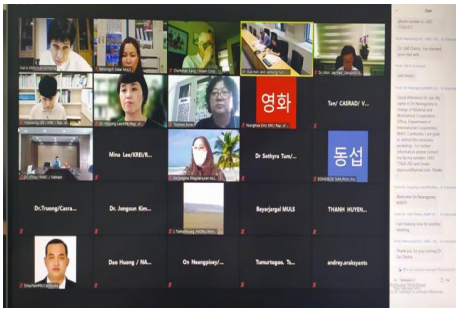


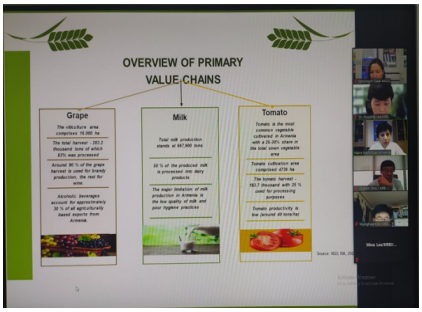
In addition, several face-to-face and online meetings and seminars were organized during the research team survey. Depending on the situation, the research subgroups held their own meetings.

- August 19, 2021. MULS research team meeting organized using Google Meet.
- August 24, 2021. MGEA and MULS research team meeting. Team leader, P. Tsolmon, introduced the main research activities related to the project topic and discussed the Mongolian partners and their duties on the joint research project. In addition, the coordinator, D. Banzragch, presented the current status of greenhouse vegetable production in Mongolia and discussed the action plan for the research team.

〈Figure 1〉 MGEA and MULS research team meeting at school of Agroecology, MULS.

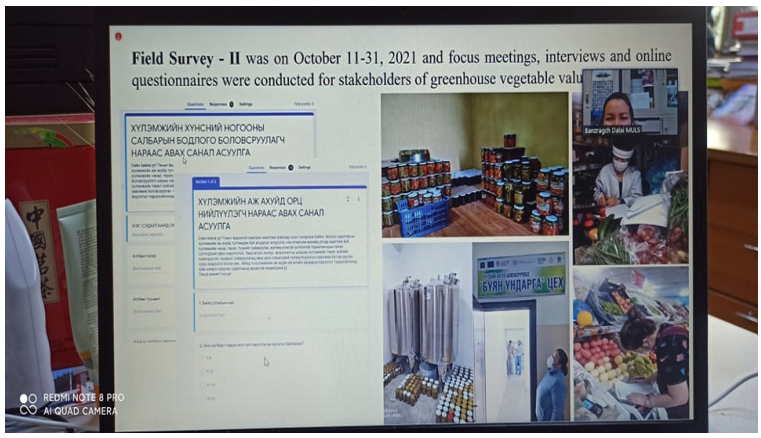
〈**Figure 2**〉 Joint Research Kickoff Workshop.





- August 30, 2021. A Joint Research Kickoff workshop was organized over a Zoom Meeting titled “To present KAPEX plans of Joint Research Team: consultation for the direction of joint research.” The participants were the research team of KREI, the joint research team of the partner country.
- September 2, 2021. MGEA and MULS research team meeting. Team activities for Field Surveys I and II were discussed, locations of the survey sites were selected, and the research team members were grouped. Questionnaires for stakeholders of the value chain were developed and discussed.
- December 9, 2021. The Joint Research Team presented their research results based on the interim report, and Korean and Mongolian experts gave some comments and suggestions according to their reviews of the report.

〈**Figure 3**〉 KAPEX Interim Workshop for Mongolia.

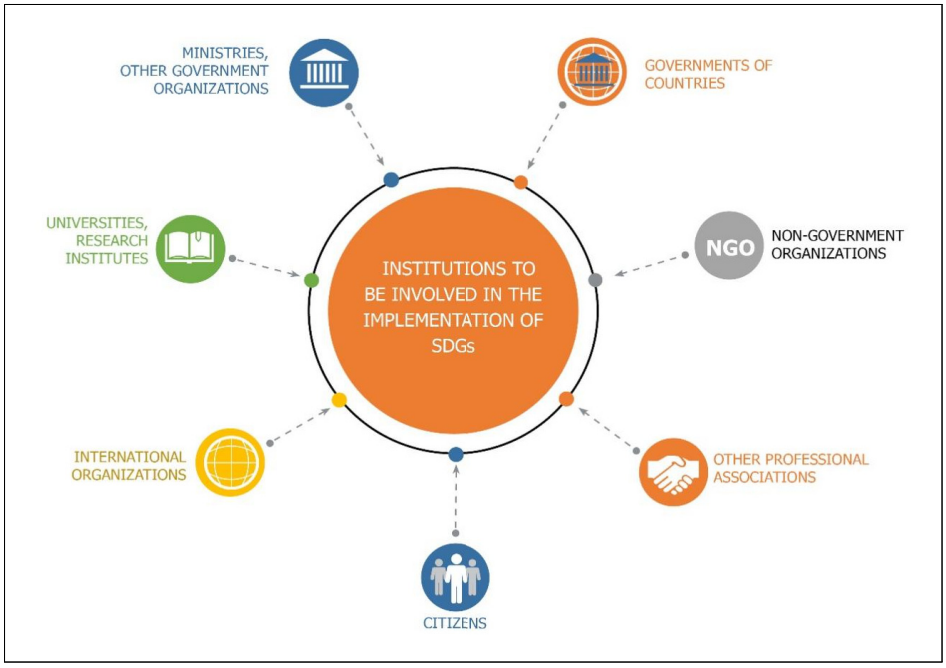


2 Domestic Policies and Agricultural Status Analysis

2.1. Consistency with Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development was first launched in 2012 at the United Nations (UN) Conference on Sustainable Development in Rio de Janeiro. The sustainable development goals (SDGs) are a continuation of the Millennium Development Goals, which expire in 2015. In 2015, the 70th session of the UN General Assembly approved 17 SDGs and 169 objectives, and on January 1, 2016, the SDGs were officially launched worldwide. The 2030 Sustainable Development Goals is a global long-term policy document based on three pillars: society, economy, and the environment.

Governments, ministries, other government agencies, universities, research institutions, local organizations, nongovernmental organizations, other relevant organizations, and citizens will be involved in implementing the SDGs.



■ The SDGs in Mongolia

The SDGs are a global call to action to end poverty, protect the earth's environment and climate, and ensure that people everywhere can enjoy peace and prosperity. These are the goals the UN is working toward in Mongolia:

■ Activities undertaken to be implemented by Mongolia with respect to SDGs

❍ The law on Development Policy and Planning of Mongolia was adopted in November 2015 to define the planning steps and principles; implement, monitor, and assess Mongolia's development documents, the rights and obligations of stakeholders; and establish the integrated systems of development policy and planning.

❍ The Mongolia Sustainable Development Vision-2030 was approved by the Parliament of Mongolia in February 2016. There are 17 goals and 169 targets of the Global SDGs aligned with 4 priorities and 44 targets of the Mongolia Sustainable Development Vision-2030, which are the following:

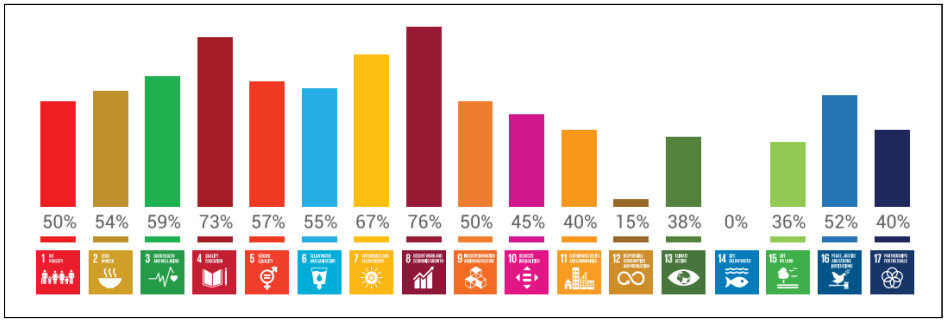
- According to a decree by the Prime Minister, nine Task Forces entrusted with determining national SDG indicators, methods, and data sources were set up under the supervision of the National Committee.
- The Subcommittee on the Sustainable Development Goals was set up under the standing Committee on Social Policy, Education, Culture, and Science of the Parliament. It is chaired by Ms. A. Undraa, a member of the parliament.
- In Mongolia, three assessments of the SDG indicators' availability were conducted. The first assessment was conducted in 2015, while the second and third assessment was made in 2017 and October 2017, respectively.

Among the 244 globally recommended SDG indicators, 233 apply to Mongolia, while 11 are irrelevant to the country. By the end of 2018, 50.6% of the indicators (118 indicators) were available in Mongolia. Official statistics from the National Statistics Office, administrative statistics of

ministries, other government organizations, and nonconventional data (big data) are data sources for SDGs.

According to the SDG data readiness assessment in Figure 9, existing data sources are insufficient for the following: (i) 62%–76% data insufficiency for health (SDG-3), education (SDG-4), gender (SDG-5), energy (SDG-7), economy and employment (SDG-8)-related SDGs; (ii) 45%–55% data insufficiency is found for poverty (SDG-1), food supply and nutrition (SDG-2), water (SDG-6), infrastructure and innovation (SDG-9), inequality (SDG-10), and governance (SDG-16); (iii) data is insufficient for urban development (SDG-11), accountable production and consumption (SDG-12), climate change (SDG-13), ecosystem (SDG-15), and partnerships (SDG-17). There is a need to increase national statistical capacity to estimate the remaining 115 indicators and introduce other sources of data in a systematic way, including qualitative evidence and big data, to scrutinize and validate credibility appropriately.

〈Figure 4〉 Readiness Assessment of SDG indicators.



Sources: Government of Mongolia 2019. Mongolia Voluntary National Review Report 2019: Implementation of the Sustainable Development Goals. Ulaanbaatar; www.1212.mn

2.2. National Development Strategies and Policies

Mongolia is one of the first countries to adopt the SDGs with the Mongolia Sustainable Development Vision-2030, a policy document with a clear set of targets aligned with the SDGs' main pillars on social, economic, and environmental priorities as a result of meaningful support and successful cooperation with the UN.

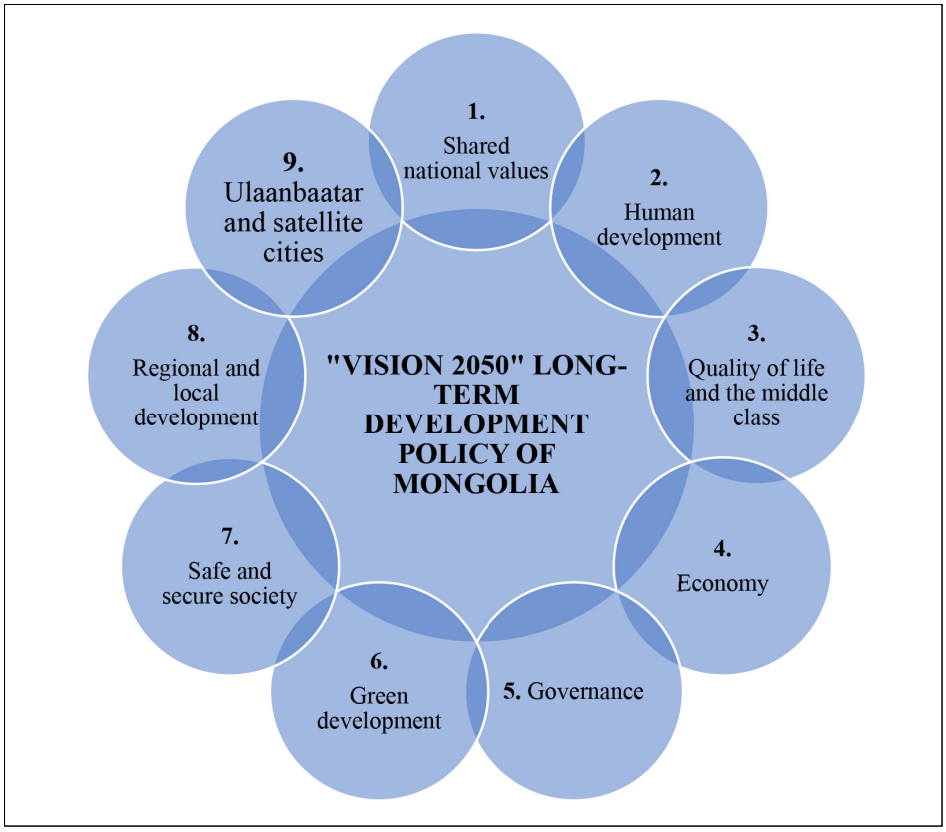
Mongolia carried this vision further in a new long-term national development policy document called Vision-2050, adopted in 2020. It aims to transform the country into a leading regional power by 2050 by fighting poverty, creating a greener economy, improving the education system and gender equality for enhanced job access, redefining Mongolian social strategy in a more citizen-oriented way, and offsetting the negative trends caused by the COVID-19 pandemic. Vision-2050 was approved by the Mongolian Parliament on May 13, 2020.

Vision-2050 aims to harness Mongolia's human capital by building on the momentum accrued through a system-wide reform and moving closer toward a system that ensures education quality and relevance at all levels with shared responsibility, sustainable governance, and management. Mongolian policymakers realized that in the aftermath of the COVID-19 pandemic, the vulnerability of the middle class, the driving force of society, is creating inequality and undermining the core values of democracy.

Therefore, the government has considered the necessity to develop a

long-term development policy document summarizing the past 30 years and envisions the next 30 years. Mongolia's long-term development policy has 9 fundamental goals and 50 objectives, which will be carried out in three periods: 2020-2030, 2031-2040, and 2041-2050.

Vision-2050 of Mongolia



2. Human Development – Safe Living Conditions

Favorable living environment

Target 2.5. Create a wealthy, healthy, safe, and comfortable living environment for the people ensuring food security.

Implementation phases and the general direction of the activities:

Stages	Objectives	Activities
Stage I (2020–2030)	Create a healthy and safe living environment	• Strengthen the system of registration, quality management, control, and verification at all levels of the food network. • Support the production of innovation–based goods and provide safe and nutritious food.
Stage II (2031–2040)	Create a comfortable living environment	• Improve the hygiene, safety standards, and requirements for food supply and distribution, and create reliable and sustainable food productions to cultivate healthy food consumption, including organic, fortified, and regulated food.
Stage III (2041–2050)	Create an environment that satisfies living needs	• Lead the development path of the food processing industry by improving the eco–food export conditions for the Mongolian brand.

Activities to implement within the target

Strengthen food control systems at all stages of the food chain, such as the registration, quality management, inspection, and certification processes

2.5.16. Set up the food safety control system by establishing tracking systems for potato and vegetable production processes, including reserved seed potatoes and vegetable seeds, soil conservation, soil processing, cultivation, irrigation, harvesting, storage, transportation, sales, and retail trade.

2.5.19. Introduce hazard analysis and critical point control principles, food safety management systems, food chain (from primary production to the consumer) control systems, and standards in the food processing industry.

Improve the availability of safe and nutritious food for all

2.5.20. Implement national food policies aimed at stabilizing food supply and availability, ensuring food safety at all stages of the food chain, and improving the national food standards following the international and regional standards.

2.5.21. Promote the innovative manufacturing of organic and nutrient-enriched products, regulatory services, and product variety.

2.5.23. Strengthen social protection measures to protect the poor and vulnerable groups in food-insecure households.

8. Regional Development (Capital City of Ulaanbaatar)

Sustainable Agriculture

Target 8.3. Develop agriculture as a leading economic sector that is environmentally friendly, adaptable to climate change, risk-bearing, responsive to social development trends, needs, and requirements, responsible, highly productive, and sustainable.

Implementation phases and the general direction of activities:

Stages	Objectives	Activities
Stage I (2020–2030)	Intensify the resource utilization and commercialization of agricultural production and transform the sector from quantity to productivity and quality.	• Adhere to the principles of a green economy in agricultural production, strengthen the capacity to adapt to climate changes and risks, and develop smart systems based on insurance, registration, and information. • Improve the utilization of total crop rotation fields, ensure the main cultivated crops fully meet domestic demands, and increase the production of other functional crops. • Develop specialized markets, supply chains, and value chains for agricultural raw materials and

Stages	Objectives	Activities
		products and boost their economic potential and effectiveness. • Provide the population with sustainable food supplies from agricultural production and supply the processing industry with high-quality raw materials.
Stage II (2031-2040)	Fully utilize agricultural resources and compete for sustainable production, efficiency, and productivity.	• Develop agricultural production with a science-based sustainable development orientation, build capacity to apply knowledge, introduce advanced technologies and innovations, and strengthen cooperation • Establish quality assessments for agricultural products and strengthen the exchange trading system. • Develop intensive agriculture and farming and build an ITP.
Stage III (2041-2050)	Develop "Smart" agriculture.	• Support and develop science-based green production, business, and agricultural tourism. • Renew the research and development system of the agricultural sector and expand production. • Increase exports through the production of high-capacity, organic, and branded products and create new sources of income for the economy.

National Food Vegetable Program

There is a need to increase the area for vegetable crops, develop the production of protected soils, strengthen vegetable seed production, irrigation, and production storage, and support domestic vegetable production. The "National Vegetable Program," implemented with our project, aims to sustainably develop vegetable production throughout the year and meet domestic demands by supporting household farmers, specialized vegetable enterprises, and cooperatives. The following objectives will be implemented within the framework of the program's objectives.

2.2.1. Support the cultivation of protected soils, increase the variety of crops, increase the yield per unit area, provide fresh vegetables in the winter and spring, and reduce dependence on imports.

2.2.2. Increase vegetable production by introducing advanced techniques and technologies and encourage private investments to increase the volume of irrigated crops, storage and cellar capacities, direct trade networks, and specialized markets.

2.2.3. Assist vegetable seed production and test localized crops and vegetables.

2.2.4. Build human resource capacity by improving the knowledge and skills of vegetable producers, conducting training and retraining, and providing information to qualified farmers.

Government of Mongolia Action Plan for 2020-2024

3.3. Develop the production and sales networks of agricultural products, fully satisfying the domestic demand for key food products and substituting import-oriented products.

3.3.1.5. Establish greenhouses that operate in all seasons to increase domestic production and reduce imports.

3.3.1.9. Introduce Good Agricultural Practices (GAPs) in agricultural production.

3.3.3 Fully meet the demand for main food products through domestic production.

3.3.3.6. Stabilize the supply of vegetables.

3.3.11. Provide incentives to herders and farmers who increase agricultural production and supply their products to national industries.

3.3.11.1. Establish storage and sales complexes for potatoes, vegetables, fruits, meat, and agricultural products in Ulaanbaatar and its regions.

National strategies aim to improve the agricultural production and nutritional status of Mongolians through various schemes. The proposed project aims to provide technical and financial assistance to smart greenhouses and expand the value chain. With this goal in mind, Mongolia gives its people the right to food security and a high level of agricultural development.

2.3. Policies and Strategies in the Agricultural Sector

The agriculture sector developed relatively late in Mongolia. However, the Government of Mongolia has implemented several programs and projects to develop greenhouse vegetable production, such as the vegetable industrial complex and Devshil state farm in Ulaanbaatar city, the Orkhon-Shariin Gol state farm in Darkhan province, and the Ulaan Tolgoi state farm in the Erdenet province. Moreover, other state farms in Batsumber, Bornuur, Jargalant, Baruunkharaa, and Zuunkharaa started to provide greenhouse vegetables to the markets of large cities and local areas.

M. Danzan, P.F. Kononkov, and V.N. Gubkin (1981) noted that the

establishment of greenhouse vegetable farming began in 1955 with the construction of a one-sided brick wall, steam-heated, 2,000 ㎡ glass greenhouse at the Amgalan State Farm.

Subsequently, this type of glass greenhouse was built based on the Khujirt, Shargaljuut, and Tsenkher hot springs. Unfortunately, no such greenhouses were built again because the entire production process was done manually, and productivity was low.

The period until 1960 is considered the first development stage of greenhouse vegetable production in Mongolia.

In the late 1960s and early 1970s, numerous steam-heated and unheated arched greenhouses were built in Bornuur, Orkhon Shariin Gol, and Batsumber Dairy and Vegetable Farms to cultivate cold-tolerant vegetables, such as early cabbages, green onions, and radishes. The total area of the greenhouses reached 49,700 ㎡. This period is considered the second development stage of greenhouse production.

Since 1972, with the technical and financial assistance of the People's Republic of China and the Soviet Union, Dutch-style glass greenhouses with an area of 60,000 ㎡ at Devshil Farm, 15,000 ㎡ at Ulaan Tolgoi Farm, and 10,000 ㎡ at Zuunkharaa Farm were built and provided fresh vegetables throughout the year. This period is considered the third stage of greenhouse development.

In 1990, social relations in Mongolia completely changed from a centrally planned economy to a free-market economy, and greenhouses of state farms were privatized. For example, a six-hectare greenhouse in Devshil State Farm was separated into two three-hectare parts and started operations as two Limited Liability Companies (LLCs).

Since the mid-1990s, private companies and business entities have imported plastic greenhouses from China and South Korea to cultivate various vegetables. It has played an important role in the greenhouse vegetable supplies of Mongolia. The hulls of these greenhouses were made of aluminum and other metal alloys, so they were durable and easy to transport and assemble. This period is considered the fourth stage of greenhouse development.

In 2009, the government began offering Korean greenhouses with discounts, the next development stage of greenhouse production. In 2013, with the approval of the Government Resolution on the "Establishment of Winter Greenhouses," loans were provided to farmers and entities, and Chinese-style winter and Dutch-style glass greenhouses were established on an 8.4-hectare area. Furthermore, Dutch-style glass greenhouses were newly built, and farmers started to cultivate vegetables in hydroponic conditions.

As of 2019, only 40% of Mongolia's vegetable needs were supplied by domestic production, of which less than 6% was greenhouse production, and 5,803.0 tons of vegetables were harvested from 95.9 hectares of greenhouses (27.4 hectares in winter greenhouses and 68.5 hectares in summer greenhouses). Among these, 139 farmers and business entities were engaged in 27.4 hectares of winter greenhouses and harvested 1,636 tons of vegetables. Concurrently, 5,086 tons of bell peppers, 9,342 tons of green vegetables, 550 tons of tomatoes, and 483 tons of cucumbers were imported.

2.4. Agricultural Political Environment, Laws, and Institutions

The Government of Mongolia supported the vegetable sector between 1997 and 2012 through the Green Revolution National Program. With the inception of the National Vegetable Program in 2017, support to the sector resumed and is scheduled to run until 2022. The program aims to support a sustainable supply of domestically produced vegetables throughout the year by promoting initiatives for small-scale household farms and smallholder farmers. In 2008, the government approved the Atar-3 Campaign National Program under the National Development Action Plan for 2008–2012. The campaign's major targets were directed to cultivate abandoned crop fields, improve access to and availability of quality vegetable seeds, and transfer advanced technology for vegetable production. The campaign was considered by agriculturalists as a rescue action for the recovery of the crop farming sector, which has been declining since the 1990s because of the dismantling and privatization of large-scale state vegetable farms.

Some legal acts, government policies, and decisions listed below have stimulated the development of greenhouse vegetable production in Mongolia.

- In 2013, according to Government Resolution No. 141, a decision was made to provide an investment loan of USD 17.4 million for the "Winter Greenhouse Establishment" project, and a loan of MNT 25.8 billion was provided to 30 companies to build 8.4 hectares of winter greenhouses.

- In 2015, the Parliament of Mongolia approved Resolution 104 of the State Policy on Food and Agriculture. Article 3.1.13 of this resolution indicates that "developing winter and summer greenhouses and cellars increase vegetable cultivation and provide the urban population with fresh vegetables."
- Article 19.5.5 of the Law on Agriculture, approved by the Parliament of Mongolia on January 29, 2016, provides support for "establishing a storage and sales system for potatoes, vegetables, fruits, and berries, and establishing winter greenhouses."
- Domestically grown vegetables are exempt from value-added tax (VAT) and the 50% corporate income tax because of their agricultural production. The Government of Mongolia's Resolution No. 185 of 2016 increased the import tax on main greenhouse crops, such as tomatoes and cucumbers, from 5% to 20% to protect domestic production.
- In 2018, Government Resolution No. 324 was approved, creating the basic conditions for developing winter greenhouses and vegetable production increase throughout the year. According to the government's decision, winter greenhouses will be provided with up to 0.768 kWh per square meter of 100% discounted electricity, consumed from 10:00 p.m. to 6:00 a.m. from November 1 to April 1 each year.
- In 2017–2018, 880 complexes of plastic greenhouses with an area of 7.4 hectares were supplied from the state budget and provided to more than 300 farmers and business entities with 4-year, interest-free loans and a 30% down payment.

- In 2019, The government provided 28 greenhouses measuring 3,360 ㎡ for vegetable production and seed nurseries.
- The "Vision-2050" long-term development policy of Mongolia was approved by the Mongolian parliament on May 13, 2020.

In recent years, the Government of Mongolia has been paying close attention to developing winter and summer greenhouses and creating certain conditions for legal and economic support. However, large-scale greenhouse projects and programs have not yet been implemented because of the difficult economic situation.

The development of greenhouse production was reflected in the Vision-2050 long-term development policy of Mongolia, Mongolia Investment Program for 2021-2025, Government Action Plan for 2020-2024, and Ulaanbaatar City Development Master Plan 2030, respectively.

Laws and Regulations
• Law on Seeds and Plant Varieties of Agricultural Crops, 1999 • Law on Plant Protection, 2007 • Law on Soil Protection and Prevention of Desertification, 2012 • Law on Agriculture, 2016
Government Resolution
• State Policy on Food and Agriculture, Resolution No. 104 – Parliament of Mongolia, 2015. • "Vision-2050" long-term development policy and National Investment Program • Government Action Plan for 2020-2024
National Program
• "Vegetables" National Program, 2017-2022 • Atar-4 Sustainable Agriculture Development Campaign, 2020-2025

2.5. Lessons Learned from Past Related Projects

The Government of Mongolia supported vegetable production through the Green Revolution National Program from 1997 to 2012. In 2008, the Government of Mongolia approved the Atar-3 Campaign National Program for 2008–2012 according to the Comprehensive National Development Plan. This program aims to improve food security in the context of improving the legal and economic environment for agricultural production and increasing the production of domestically grown vegetables.

According to agricultural experts, the campaign revived the agricultural sector, which has been in decline since the 1990s because of the liquidation and privatization of large, state-owned vegetable farms.

The Atar-3 campaign was part of a national development plan developed by several governments and ran until 2020. The national program supported the establishment of agricultural park access centers in each soum and increased the capacity of local vegetable production. In addition, a direct greenhouse investment of MNT 2.5 million was allocated to each soum. This national program improved domestic production and reduced imports. However, it has not fully met the overall needs of the high-nutrient vegetable market.

Government Resolution No. 278 of 2017 approved the implementation of the National Vegetable Program in 2018–2022. The program's main goal is to develop vegetable production and sustainably meet domestic demands throughout the year by supporting household growers, specialized vegetable entities, and cooperatives. The framework for

supporting the cultivation of greenhouse vegetables to increase crop variety and yield per unit area, provide the population with fresh vegetables in winter and spring, and reduce dependence on imports includes the following:

1. Provide soft loan support to establish winter greenhouses and provide the urban population with fresh vegetables throughout the year.

In 2019, a winter greenhouse with a total area of 18,800 ㎡ or 1.8 hectares was established with an investment of MNT 736.4 million from the Small and Medium Enterprise Development Fund and MNT 2,663.6 million from the private sector and international organizations.

In particular, a 1,000 ㎡ hydroponic greenhouse was built in Zuunmod soum in the Tuv Province with an investment of MNT 550 million from the Gangwon province of South Korea; the Business International Market LLC built a 2,000 ㎡ glass greenhouse with its own funds in Bayanchandmani soum; the Eco Urkhan LLC spent MNT 600 million for a 7,200 ㎡ glass greenhouse in Bornuur soum; and the Green-yard LLC built a 1,000 ㎡ greenhouse in the Khan-uul district of Ulaanbaatar, In addition, Mr. Chinzorig built a 600 ㎡ greenhouse in the Sukhbaatar district, the Zagasan Nud-Zagastai LLC built a 600 ㎡ greenhouse in the Zavkhan Province, Khuvt Khariin Nuruu LLC constructed 250 ㎡ greenhouses, and Mr. Baujan renovated 500 ㎡ greenhouses in the Bayan-Ulgii Province and 600 ㎡ greenhouses in the Dornogovi Province and the Jargaltkhaan soum of the Khentii Province for MNT 35 million, with an investment of MNT 96 million from South Korea. D. Osorjamaa of the Kherlen soum built 240 ㎡ and 600

㎡ winter greenhouses in the Gurvantes soum of Umnugovi Province with a mining investment, and all are increasing greenhouse vegetable yields by 540 tons. Moreover, Government Resolution No. 324 of 2018 approved the reduction of electricity for winter greenhouses, and MNT 2 billion was approved in the 2020 budget. A survey of 137 companies was submitted to the Ministry of Energy to reduce electricity bills for greenhouse production.

2. Provide preferential support for the construction of plastic summer greenhouses in rural areas and increase the variety of crops.

In 2019, 38 complexes of 4,560 ㎡ vegetable greenhouses, with an area of 120 ㎡, were supplied with MNT 147 million from the state budget.

Plastic greenhouses were built in an area measuring 19,830 ㎡ with the investment of MNT 960 million from the portfolios of Parliament members, the local budget, citizens, and international organizations.

In particular, there are 3,320 ㎡ of summer greenhouses in Ulaanbaatar city, 3,232 ㎡ in Bulgan Province within the "Shine Hodoo" project; 192 ㎡ in the Ulgii soum of Bayan-Ulgii Province; 600 ㎡ with a local budget of MNT 160 million in the Bayankhongor Province; 920 ㎡ in the Sagsai soum with MNT 24.5 million in the Adra project; 620 ㎡ in the Khentii Province with World Vision International funding, 7,660 ㎡ in the Ömnögovi Province with MNT 300 million in funding from the Gobi Oyu Development Support Fund; 384 ㎡ with MNT 14.8 million from farmers; 400 ㎡ and 2,200 ㎡ greenhouses from the Shargaljuut hot-spa with MNT 10 million at the expense of business entities and individuals; 216 ㎡ in the Govisumber

Province, 3,120 ㎡ in the Khovd Province, and 286 ㎡ of plastic summer greenhouses built in the Khuvsgul Province, respectively.

3. Support the cultivation of mushrooms, vegetables, and strawberries in greenhouses, introduce advanced technologies for growing vegetables in a hydroponics setting, and increase unit yields.

Nationwide, greenhouse farmers from the provinces of Bayankhongor, Dornogovi, Khentii, Tuv, Umnugovi, Arkhangai, and Uvs, and the Songinokhairkhan district of the capital city, planted strawberries, mushrooms, and grapes on 97 hectares of greenhouses. Its 1,800 ㎡ greenhouse introduced advanced hydroponic technology, and unit yields increased by 5% in 2019 compared to the 2018 baseline.

4. Study the experiences of greenhouse farmers, introduce methods and technologies for vegetable cultivation in a hydroponics setting, and organize training for localities.

The Community Vegetable Farming for Livelihood Improvement project is a pilot initiative aiming to improve the livelihood of smallholders involved in the vegetable production in selected soums in four Mongolian provinces: Bornuur in Tuv, Orkhon in Darkhan-Uul, Ulaangom in Uvs, and Yeruu in Selenge. A total of 1,048 households in 39 groups, 53.5% or 561 members of which are women, and 55 households are headed by vulnerable households. A total of 757 kg of vegetable seeds, including carrots, cabbages, onions, and long onions, were distributed to farmer

groups in four soums. Small groups cultivated a total of 234.8 hectares of vegetables with project-funded seeds and harvested 2,553.7 tons of vegetables. In the Orkhon aimag, five young people received MNT 25 million for two greenhouses, MNT 10 million MNT for fertilizers, MNT 10 million for an artichoke cultivation and cellar farms, and MNT 45 million in loan support.

2.6. Stakeholder Analysis

The MULS research team organized field surveys with the MGEA to identify the challenges stakeholders face in the greenhouse vegetable value chain in Mongolia, assess their current situation, and collect the data, information, and evidence needed for further analysis of the greenhouse vegetable value chain.

The stakeholders of the greenhouse vegetable value chain are identified as follows, and the primary and secondary sources of information were used to identify stakeholders.

The primary source of information was identified through interviews with the following experts. These include:

- The leader and members of the Mongolian Greenhouse Entrepreneurs Association
- The Professor of School of Agroecology and School of Economics and Business, MULS

- Specialists from MoFALI
- Farmers and business entities around Ulaanbaatar city

Secondary sources include:

- Statistical information about Mongolia
- Mongolian customs information
- Research reports on vegetables, 2018-2020

Stakeholders of the greenhouse vegetable value chain

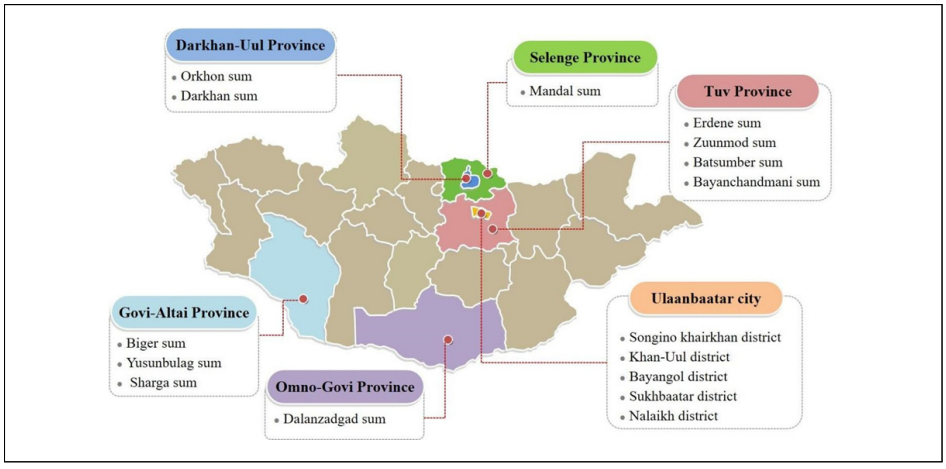
- Producers (smallholder greenhouse farmers, cooperatives, large and medium scale producers)
- Policymakers (public administration and professional organizations such as the Agricultural policy implementation coordination department of MoFALI, Food and Agriculture departments of provinces and the capital city, etc.)
- Input suppliers of raw materials and resources required for production (seeds, seedlings, fertilizers, pesticides, agricultural tools, equipment, greenhouses, etc.)
- Sellers (wholesalers, supermarkets, food markets, shops, retailers, etc.)
- Vegetable processors (households, entities, cooperatives and companies that process and pickle vegetables, etc.)
- Consumers (local and urban restaurants, hotels, mining companies, citizens, etc.)

Indirect stakeholders involved in the greenhouse vegetable value chain

- Public administration and professional organizations such as the Specialized Inspection Department
- Individuals, business entities, and organizations providing financial services (banks, nonbank financial institutions, savings and credit co-operatives)
- Nongovernmental and international organizations implementing projects and programs

2.6.1. Producer

A group and individual focus meeting, interviews, and questionnaires were conducted with large and medium-scale greenhouse vegetable producers, smallholder farmers, and cooperatives in six districts of Ulaanbaatar city and rural areas, such as the Selenge, Darkhan-Uul, Umnugovi, Govi-Altai, and Tuv provinces, respectively.



General information of the survey participants:

A total of 39 greenhouse vegetable producers were involved in the field survey. Of the total producers involved, 43.2% are companies and enterprises, 5.4% are cooperatives, and 51.4% are smallholder farmers.

〈Figure 5〉 Focus meetings and questionnaires with producers during the field survey. The first picture is a Chinese-style solar greenhouse in Khan-Uul district of Ulaanbaatar. The second picture is a Chinese-style solar greenhouse in Darkhan-Uul Province.

〈Table 1〉 General information of survey participants

	Indicators	Percentage of survey participants
Gender	Male	57.9%
	Female	42.1%
Age	18-25	2.6%
	26-35	5.3%
	36-45	21.1%
	46-55	34.2%
	56-64	28.9%
	Above 65	-
Years of work in this field	1-5 years	5.6%
	6-10 years	16.7%
	11-15 years	17%
	16-20 years	22%
	More than 21 years	39%
Business type	Companies or entrepreneurs	43.2%
	Cooperatives	5.4%
	Smallholder farmers	51.4%

Sources: Team analysis using field survey data

〈Figure 6〉 Greenhouse types in Mongolia. The first picture is a winter glass greenhouse (Tumen-suikh LLC); second picture is a blanket greenhouse; third picture is a Chinese-style solar greenhouse (Senjit-Oyu LLC); fourth picture is a double-layer greenhouse.

In terms of age, 2.6% were aged 18-25, 5.3% were aged 26-35, 21.1% were aged 36-45, 34.2% were aged 46-55, and 28.9% were aged 56-64. The majority of participants, or 39% of the total greenhouse vegetable producers, had more than 21 years of experience in the field. Furthermore, smallholder farmers and private companies were mostly involved in the greenhouse producers survey.

Current situation of greenhouse vegetable producers:

The following research results were obtained from the challenges faced by greenhouse vegetable producers and enterprises in their production

and cultivation stages, quality and availability of equipment, seeds, pesticides and fertilizers, etc.

〈Table 2〉 Statistics of survey participants

	Indicators	Percentage of survey participants
Land	Ownership	100%
	Rent	–
Size of the greenhouse area	360 ㎡	26.3%
	361–500 ㎡	7.9%
	501–1,000 ㎡	18.4%
	1,000 м2	47.4%
Types of vegetables	Cucumber	89.5%
	Tomato	73.7%
	Green leaves	34.2%
	Bell pepper	34.2%
	Others	36.8%
Types of greenhouses	Glass winter greenhouse	25.6%
	Chinese-style solar greenhouse	23.1%
	Double-layer plastic greenhouse	17.9%
	Plastic greenhouse	25.6%
Received a greenhouse from MoFALI and international organizations with soft loans and assistance	Yes	35%
	No	65%
Reasons for not taking a soft loan	Not requested	58%
	Requested but not supported	35%
	Lack of collateral	3.8%
	Other reasons	4%

Sources: Team analysis using field survey data

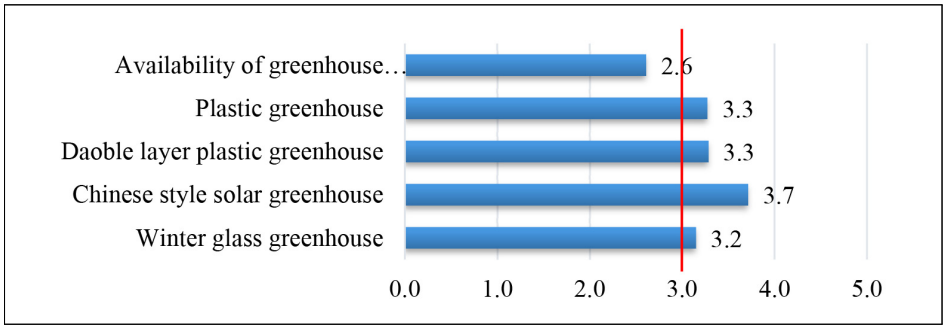
Among the total producers surveyed, 100% are producers on their own land. Considering the size of the greenhouses, 26.3% of the total participants have up to 360 ㎡ of greenhouses, 7.9% have 361–500 ㎡, 18.4% have 501–1,000 ㎡, and 47.4% have more than 1,000 ㎡ engaged in

production. Of all the participants, 89.5% cultivate cucumbers, 73.7% grow tomatoes, 34.2% grow peppers, 34.2% grow leafy vegetables, and 36.8% cultivate other vegetables. This shows that producers are very interested in cultivating cucumbers and tomatoes in greenhouses. The survey also shows that the participants were balanced based on the type of greenhouse, wherein out of all the participants, 25.6% are glass winter greenhouse operators, 23.1% operate Chinese-style solar greenhouses, 17.9% use double-layer plastic greenhouses, and 25.6% are plastic greenhouse operators (Table 2).

A total of 65% of the surveyed business entities did not receive any loans or technical and financial assistance from government and international organizations, 58% of which answered that they did not apply, while 35% said they applied but did not accept. However, during the focus meeting, greenhouse vegetable producers mentioned that they would like to apply for soft loans or assistance, but the lack of collateral did not meet the requirements of bank loans.

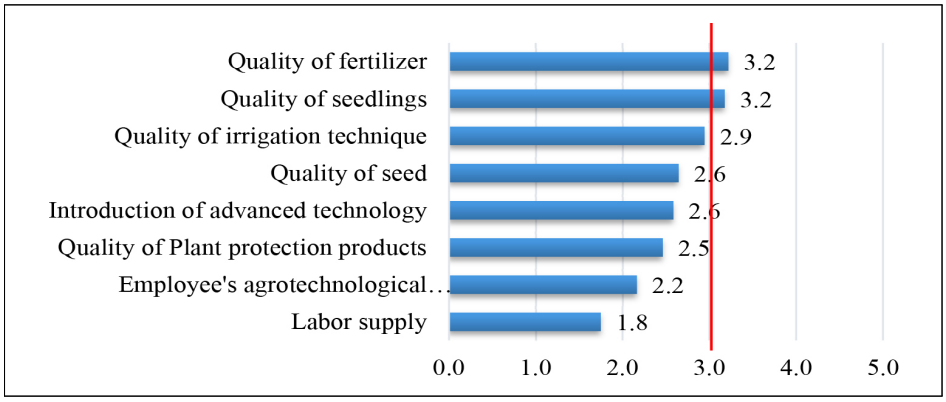
To assess the quality of greenhouses used by producers, the results of the survey were as follows:

〈Figure 7〉 Quality evaluation of greenhouses used in production.



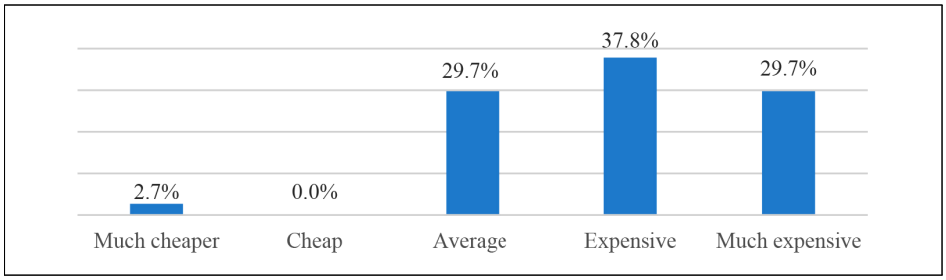
The survey results show that the availability of greenhouse materials in Mongolia is insufficient mainly because greenhouses are exempted from import tax. However, greenhouse materials and parts are not exempted from import tax. The quality of the greenhouses used in production is above average, ranging from 3.2 to 3.7 (Figure 7).

〈Figure 8〉 Quality evaluation of raw materials and inputs in production.



The main raw materials and inputs were evaluated as follows: fertilizer and seedling quality (3.2) with a medium rating, irrigation equipment (2.9) rated as medium, and seed quality and plant protection product quality (2.6) as below average. Furthermore, it was concluded that the employee's agrotechnological knowledge, skills, and labor supply had an insufficient, lower rate. The government should provide policy support to the workforce in the greenhouse production sector, focus on developing employees' knowledge and skills, and cooperate with educational institutions (Figure 8).

〈Figure 9〉 Price evaluation of raw materials and inputs in production.

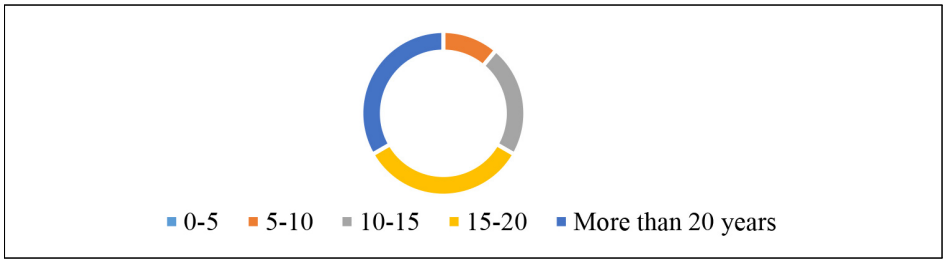


Producers mentioned that 29.7% are of average cost, 37.8% are expensive, and 29.7% are more expensive, based on prices. It indicated that the price of the main inputs has a significant impact on the producer's profitability and future operations (Figure 9).

2.6.2. Policymakers

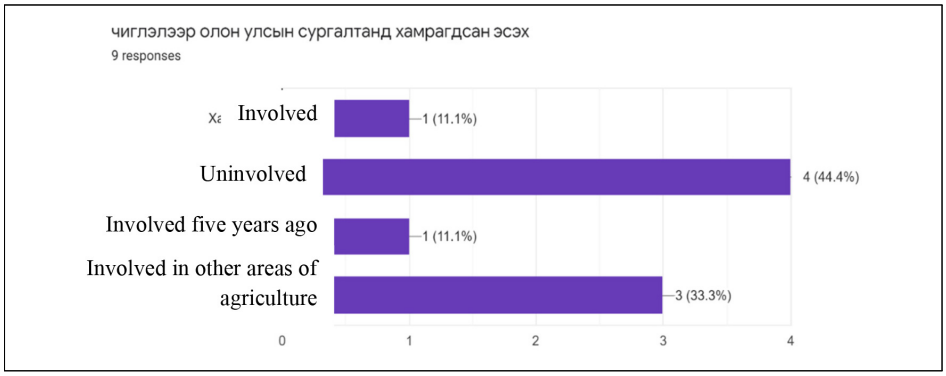
The research team conducted a focus meeting and an interview with policymakers using a questionnaire developed for officers, specialists, and agronomists of the Food and Agriculture department of the rural area and capital city, the Governor's Office of rural area and capital city, and nongovernmental organizations.

〈Figure 10〉 Work experience of policymakers in the agricultural sector, by years

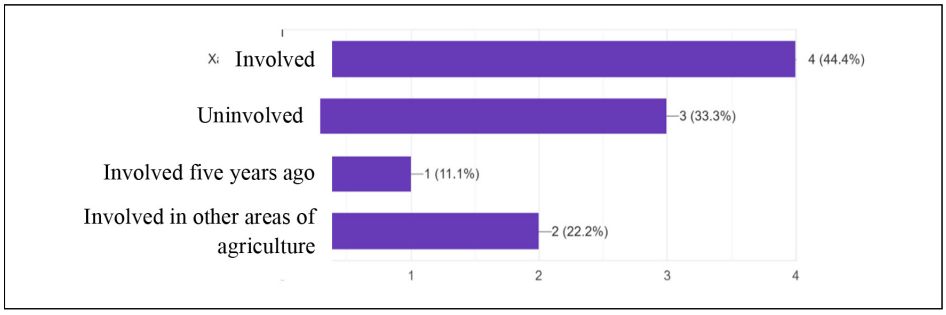


Considering the work experience of the participating policymakers, 1 person worked for 5–10 years, 2 people for 10–15 years, 3 people for 15–20 years, and 3 people for more than 20 years in the agricultural sector.

Have you participated in international trainings on “Enhancing the Vegetable Value Chain” in the last five years?



Have you participated in local trainings on “Enhancing the Vegetable Value Chain” in the last five years?



Policymakers assessed the most common challenges of the greenhouse vegetable value chain, which are as follows:

- *Government policies and decisions*
- *Local development policy*

- *Budget and financing*
- *International projects and programs*
- *International loans and aid*
- *Business entities and community participation and efforts*

2.6.3. Input Suppliers

In Mongolia, the main input suppliers of greenhouse vegetable production are located in Ulaanbaatar city and mainly supply vegetable seeds, fertilizers, plant protection products, agricultural machinery, and equipment. A total of 16 input suppliers were involved, including 9 companies, 2 cooperatives, and the remaining 5 individuals.

According to the questionnaire, vegetable seeds and plant protection products are mainly imported from China, Korea, Russia, and other countries, while fertilizers are mainly imported from China and Russia and produced in Mongolia.

General information of the survey participants:

〈Table 3〉 General information of survey participants

	Indicators	Percentage of survey participants
Years of work in this field	1–5 years	5.6%
	6–10 years	16.7%
	11–15 years	17%
	16–20 years	22%
	More than 21 years	39%

	Indicators	Percentage of survey participants
Business type	Companies or entrepreneurs	43.2%
	Cooperatives or partnerships	5.4%
	Individuals	51.4%

Sources: Team analysis using field survey data

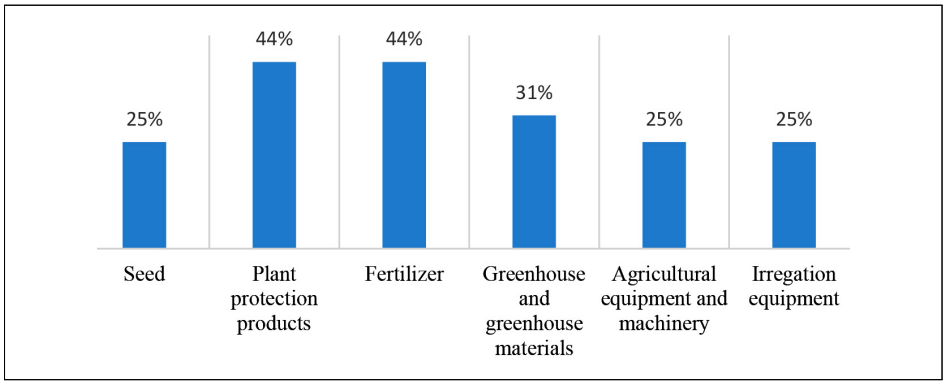
Among the surveyed suppliers, 16.7% worked for 10 years, 17% for 11–15 years, 22% for 16–20 years, and 39% worked for more than 21 years. It indicated that almost 80% of the total surveyed participants have more than 10 years of fieldwork experience (Table 3).

Regarding the business type, 56% are companies or entrepreneurs, 13% are cooperatives or partnerships, and 31% are individuals. It is observed that companies and individuals mainly supply inputs and raw materials for greenhouse vegetable production.

Current situation of input suppliers:

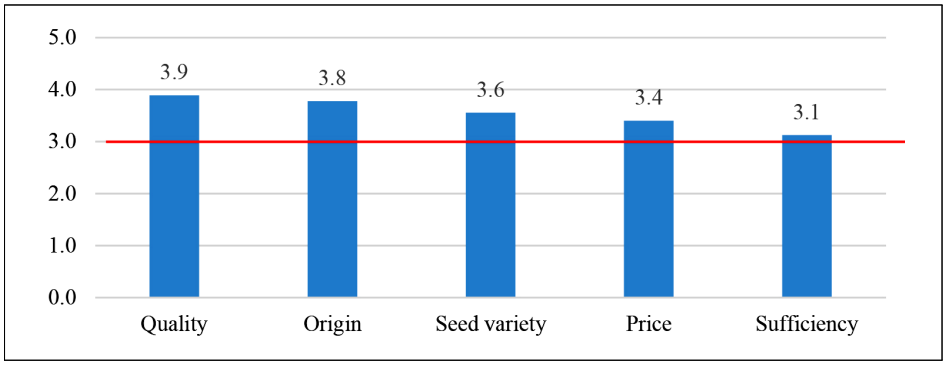
The focus meeting and questionnaire defined the following to clarify the types of inputs, raw materials, and supplier countries.

〈Figure 11〉 Percentage of suppliers of various inputs and raw materials.



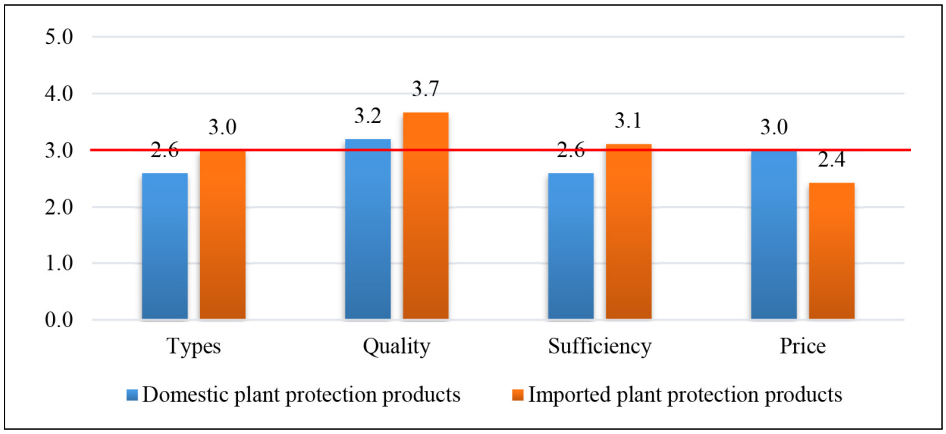
Suppliers of various inputs and raw materials in production accounted for 44% of fertilizer supplies and plant protection products. In addition, 25% accounted for seeds, 25% for agricultural equipment, 25% for irrigation equipment, and 17% for other ingredients (Figure 12). The survey showed that suppliers import seeds from other countries, such as China, Korea, Russia, and Holland, because of the lack of greenhouse seed production in Mongolia. Moreover, plant protection products are mainly imported from China, Russia, and Korea, while fertilizers are mainly obtained from China and Russia. Mongolian-made fertilizers are also widely used in production. Suppliers import greenhouse and greenhouse materials, irrigation and agricultural equipment and machinery mostly from China, Korea, and Russia.

〈Figure 12〉 Evaluation of seeds by input suppliers.



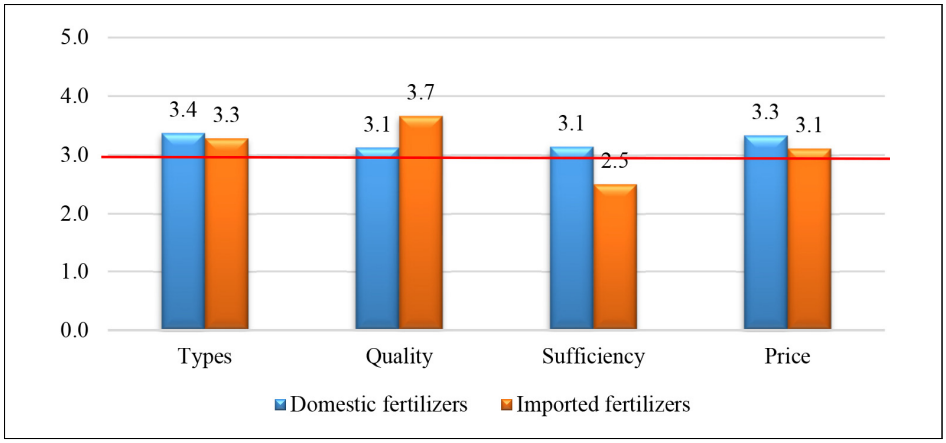
Input suppliers rated their seeds using a 5-point grade system. Seed quality and origin are adequate at 3.9 and 3.8 points, respectively. In addition, seed varieties and prices are rated good, with scores of 3.6 and 3.4, and seed sufficiency is average, with a score of 3.1 (Figure 12).

〈Figure 13〉 Evaluation of plant protection products by input suppliers.



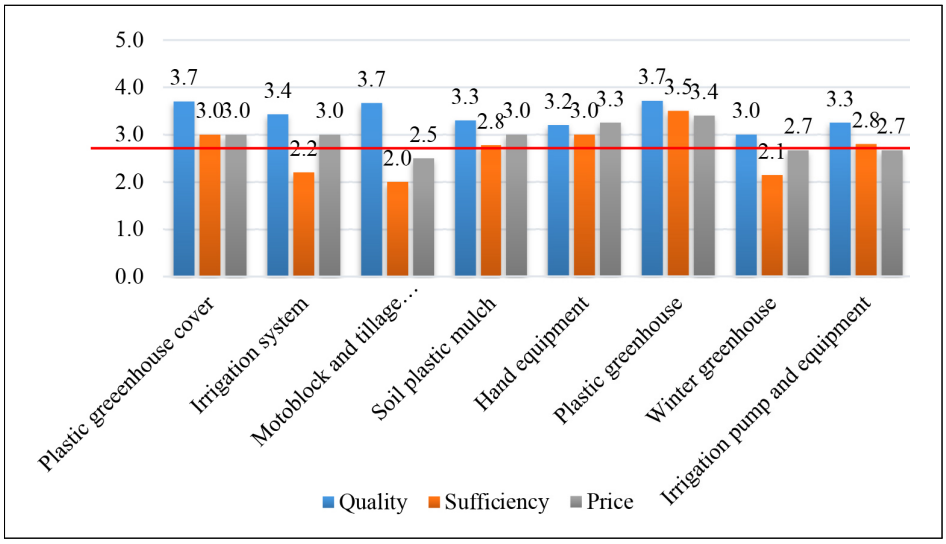
Prices for domestic plant protection products used in greenhouse production are higher than imported products. However, the types, quality, and market supply of domestic products are lower than imported ones. Generally, imported and domestic plant protection products were rated average and below-average based on types and supply on the market (Figure 13).

〈Figure 14〉 Evaluation of fertilizers by input suppliers.



The types of imported and domestic fertilizers have almost similar rates, with 3.4 and 3.3 points, while the quality of imported fertilizers is rated as 3.7, 0.6 points higher than domestic fertilizers. However, domestic fertilizers are dominant in the market. The prices of imported and domestic fertilizers are almost identical at 3.3 and 3.1 points, respectively. Generally, imported and domestic fertilizers were rated average and slightly higher than average, based on the types, quality, sufficiency, and price on the market (Figure 14).

〈Figure 15〉 Evaluation of various inputs and raw materials in production by input suppliers.



A comparative assessment of the quality, availability, and price of various inputs and raw materials in greenhouse production shows that the quality of the greenhouse plastic cover is 3.7, and the sufficiency and price are graded at 3.0. The quality of the irrigation system is 3.4, the sufficiency is 2.2 or below average, and the price is average. For the motoblock and

tillage equipment, the quality is rated 3.7 or average, the sufficiency is 2.0 or insufficient, and the price is 2.5 (Figure 15).

The soil plastic mulch is available in white and black and is rated 3.3 in terms of quality, 2.8 for sufficiency, and 3 or average for the price. The quality of the hand equipment and tools is rated 3.2, the sufficiency is rated 3.0 or average, and the price is rated 3.3, which is reasonable.

The government provides 20 x 6 m plastic greenhouses at a discounted price in Mongolia. The quality of the plastic greenhouse was rated 3.7, 0.7 points above average, 3.5 for sufficiency, and 3.4 points for price, which are also above average. The quality of the winter greenhouse package is 3.0, its sufficiency is 2.1 or insufficient, and the price is high, with a rating of 2.7. The quality of other irrigation pumps and equipment is 3.3, or above average, their sufficiency is 2.8 or insufficient, and the price is 2.7 or expensive.

The survey results showed that the quality of various inputs and raw materials used in greenhouse production is relatively good but has low sufficiency and high market prices. There are no customs tax deductions on greenhouse materials and equipment except greenhouse and irrigation systems. Therefore, the Mongolian government needs to reconsider its import and tax policy.

The following issues and problems of input suppliers were identified based on the focus meeting and questionnaire:

What are the difficulties in supplying input?

- Transportation through customs is expensive and time-consuming.
- There are no customs tax deductions on raw materials and products except greenhouse and irrigation systems.

- Consumer knowledge and ability to use new technology and products
- Transportation and storage

What raw materials and products are in high demand in the market?

- Plant protection products and fertilizers
- Agricultural tools, equipment, greenhouses, and irrigation systems
- Vegetable seeds

What government policies (registration, inspection, tax, discount, promotion, etc.) support your business?

- Tax policies on imported raw materials and equipment are important for expanding domestic vegetable production.
- Greenhouse and irrigation systems were tax-exempt. However, government policies should provide detailed research and tax incentives for greenhouse production.

What government policies caused difficulties in your business expansion?

- Border customs clearance is time-consuming.
- Registration and introduction of new products to the market require many steps and costs.
- High taxes
- Customs tax deductions on importing greenhouse-repairing materials
- Lack of policy on seeds

2.6.4. Vegetable Processors

〈Table 4〉 General information of survey participants

	Indicators	Percentage of survey participants
Business type	Companies or entrepreneurs	64.3%
	Cooperatives or partnerships	21.6%
	Individuals	14.1%
Number of employees	Up to 10 employees	41%
	11–20 employees	32%
	21–50 employees	15%
	More than 50 employees	12%
Product type	Pickled vegetables	92%
	Pickled fruits	65%
	Juices and drinks	10%

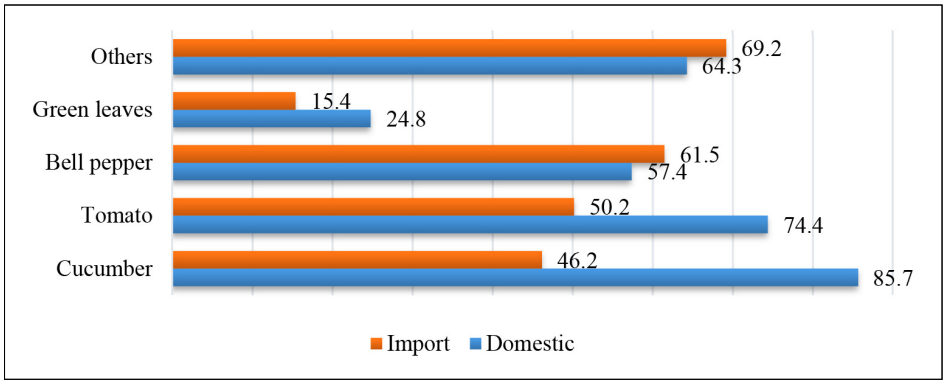
Sources: Team analysis using field survey data

According to the survey, 64.3% of business entities are companies, 21.6% are cooperatives, partnerships, and groups, and 14.1% are individuals. There are 41% with a minimum of 10 employees, 32% with 11–20 employees, 15% with 21–50 employees, and 12% with more than 50 employees. Moreover, 92% of the total participants manufacture pickled vegetables, 65% for pickled fruits, and 10% for juice and drinks (Table 4).

Generally, the total number of employees depends on the capacity of the processing. Around 4 to 20 people work as full-time employees, and 10 to 60 people work depending on the availability of seasonal raw materials. Product types are few, with generally 3 to 9 types such as canned cucumber, tomato and paprika, lecho and tomato paste, etc.

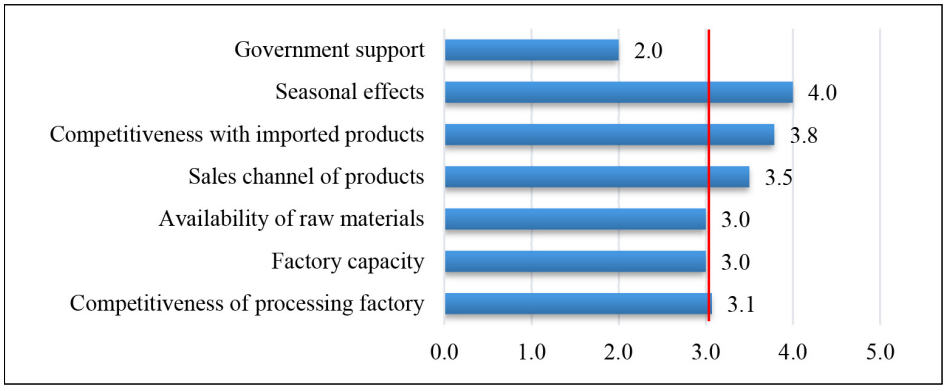
According to the survey for vegetable processors, 85.7% of the total participants use domestic cucumbers, 74.4% use domestic tomatoes, 46.2% use imported cucumbers, and 50.2% use imported tomatoes as their raw materials (Figure 16).

〈Figure 16〉 Types of vegetables used by processors.



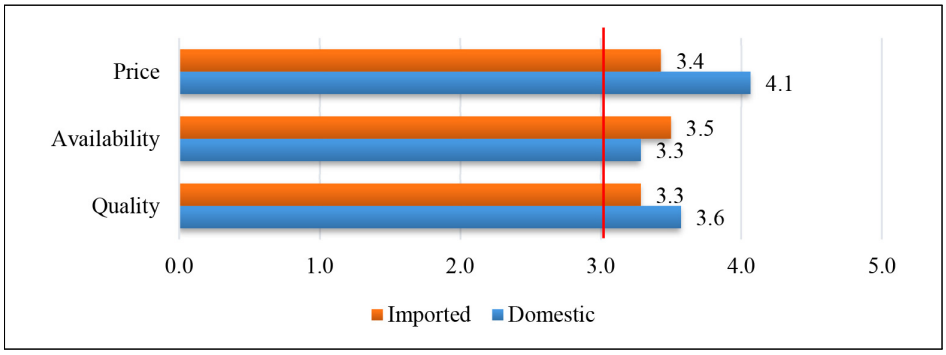
Out of all the respondents, 61.5% use imported sweet peppers, and 57.4% use domestic sweet peppers. Leafy vegetables are used less in the processing factory, with 24.8% processing domestic leafy vegetables and 15.4% using imported green leaves. Moreover, vegetable processors produce pickled products using many imported (69.2%) and domestic (64.3%) vegetables (Figure 16).

〈Figure 17〉 Evaluation of factors influencing processors.



\According to the evaluation of factors influencing processors, government support is rated the lowest at 2.0 points, while the seasonal impact is the highest at 4.0 points. Moreover, competitiveness with imported products is 3.8 points, the product sales channel is 3.5 points, availability of industrial raw materials is rated 3.0, factory capacity is 3.0 points or average, and the competitiveness of processing factory is rated average at 3.1 points (Figure 17).

〈Figure 18〉 Evaluation of domestic and imported vegetables by processors.



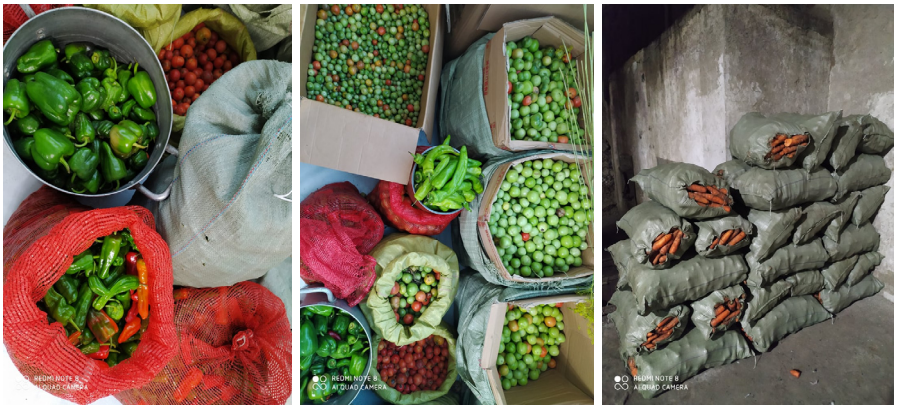
According to the survey, vegetable processors estimate that imported vegetables are cheaper and more available in the market. In terms of quality, domestic vegetables are of higher quality than imported vegetables but have higher prices and less availability (Figure 18).

Currently, the domestic vegetable processing sector consists of five main processing factories such as the “Gazar shim,” “Bagro,” “Vidan,” “Shimt gazar,” and “Vitafit” companies. Therefore, the number of factories, capacity, and development of vegetable processing in Mongolia are weak.

〈Figure 19〉 Products of Tsogt-Anu LLC, Orkhon sum, Darkhan-Uul province.

On the one hand, imported pickled vegetables are abundant in the market. On the other hand, vegetable producers could not supply raw materials to vegetable processors throughout the year, negatively impacting the development of the vegetable processing industry.

〈Figure 20〉 Raw materials of a vegetable processing factory (Tsogt-Anu LLC, Orkhon sum, Darkhan-Uul province).



Small factories and communities cultivate vegetables in their fields and greenhouses and process them seasonally. The production process is done manually according to traditional technology. Meanwhile, the products have high market demand and sell fast because of low production capacity and good taste. Small producers sell products to groceries and food markets because they do not require quality assurance or other official documents, and sellers pay on time.

Although the price of the products is stable in the market, the packaging material is directly dependent on the import price. Therefore, the price of the packaging material increases yearly, and the profits of small factories and communities decrease.

Large and medium-scale companies usually process domestic vegetables during the summer and imported vegetables during other seasons. Furthermore, some only use imported greenhouse vegetables because domestic greenhouse production is seasonal and scarce, and imported vegetables are priced low.

2.6.5. Sellers

The survey was conducted with sellers and distributors of hypermarkets, supermarkets, food markets, vegetable shops, and open markets in Ulaanbaatar.

〈Table 5〉 General statistics of the survey

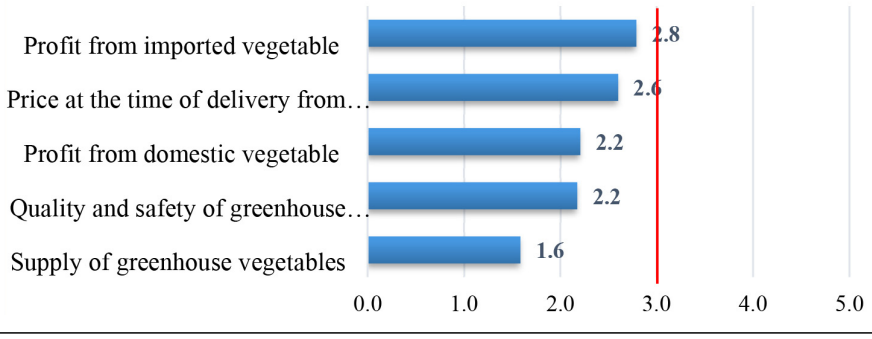
	Indicators	Percentage of survey participants
Business type	Supermarkets	1%
	Chain stores	12%
	Food markets	54%
	Open markets	12%
	Shops	5%
	Food stores	14%
Whether there is a contract with greenhouse vegetable producers	Contracted	47.4%
	No contract	52.6%
Types of vegetables for sale	Cucumbers	93%
	Tomatoes	94.7%
	Bell peppers	84.2%
	Green leaves	86%
	Other	80.7%

Sources: Team analysis using field survey data

According to the survey for sellers, 47.4% of the respondents have contracts with producers (farmers), and 52.6% do not. Cucumbers (93%) and tomatoes (97.7%) are the main products in the market (Table 5).

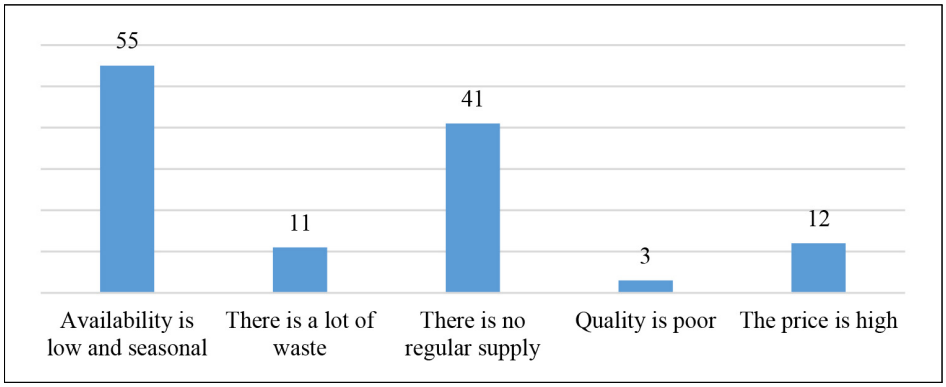
Food markets and shop sellers pay high rents, and there are no cooling systems for fresh vegetables, resulting in fewer profits. Hypermarkets, supermarkets, and chain stores have relatively stable profits because they have cooling systems for fresh vegetables and can return perished vegetables to producers, which are deducted from the total payment.

〈Figure 21〉 Evaluation of the factors that affect sellers



According to the survey results, the profit from imported greenhouse vegetables (2.8 points) is higher than from domestic greenhouse vegetables (2.2 points). Moreover, sellers rated the quality and standard of greenhouse vegetables low (2.2 points), while the supply of greenhouse vegetables was rated 1.6 points or very low (Figure 21).

〈Figure 22〉 Issues and problems with selling domestic greenhouse vegetables



Out of all the respondents, 55 participants or 94.8% said that the availability of domestic vegetables is low and seasonal, 19% or 11 participants commented that it is a lot of waste, 70.7% said there is no regular supply from farmers (producers), 5.2% thought that the quality is poor, and 20.7% said the price is high (Figure 22). During the research survey, sellers mentioned that the availability of domestic vegetables is limited in markets, and the highest supply is only between July and September. In winter, between December to February, domestic greenhouse vegetables are very scarce and expensive (Figure 22).


2.6.6. Consumers

〈Table 6〉 Current situation of consumers

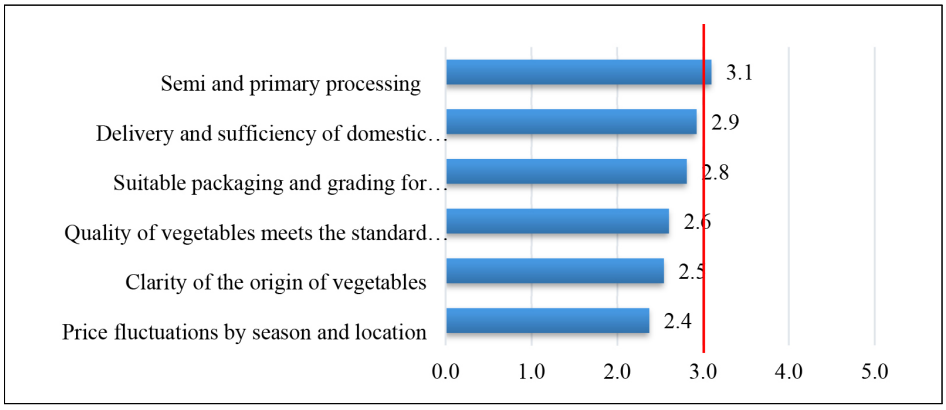
	Indicators	Percentage of survey participants
Where to buy greenhouse vegetables	Supermarket	20%
	Chain stores	50%
	Food markets	43%
	Open markets	7%
	Vegetable shops	23.8%
	Farmers	1%
Frequency of consumption	Daily	23.1%
	Every three days	26%
	Every seven days	32.7%
	Special days only	18.3%
If the prices of domestic greenhouse vegetables decrease and the supplies increase, will your greenhouse vegetable consumption increase?	Increased consumption	92.3%
	No increase in consumption	7.7%
If the sufficiency and price of domestic greenhouse vegetables are the same as imported vegetables, which one would you choose?	Domestic	97%
	Imported	2%
	Both	1%

Sources: Team analysis using field survey data

According to Table 6, 50% of the total participants purchase greenhouse vegetables from chain stores, 43% from food markets, 23.8% from vegetable shops, 20% from supermarkets, 7% from open markets, and 1% from farmers. It indicated that consumers have little opportunity to buy fresh vegetables directly from farmers.

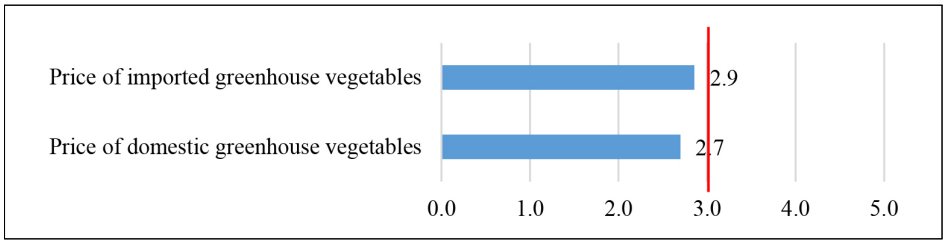
Furthermore, 97% of the total respondents said they would choose domestic greenhouse vegetables, and citizens are interested in using domestic vegetables in their food consumption. Regarding the frequency of greenhouse vegetable consumption, 32.7% of the participants answered that they eat them every seven days, 26% eat them every three days, 23.1% stated they eat them daily, and 18.3% said they eat them on holidays only. When asked whether to increase consumption, 92.3% answered that they would increase, showing a need to increase domestic greenhouse vegetable production in our country (Table 5).

〈Figure 23〉 Evaluation of issues of consumers about using domestic greenhouse vegetables



The consumer survey results indicated that semi and primary processing has 3.1 points or an average score. Delivery and sufficiency of domestic production have a score of 2.9, the packaging and grading of vegetables suitable for consumption have 2.8 points, and the quality of vegetables meets the standard requirement at 2.6 points. The last two indicators have the lowest rates, with scores of 2.5 for vegetable origins and 2.4 for price fluctuation by season and location (Figure 23).

〈Figure 24〉 Evaluation of greenhouse vegetable prices by consumers



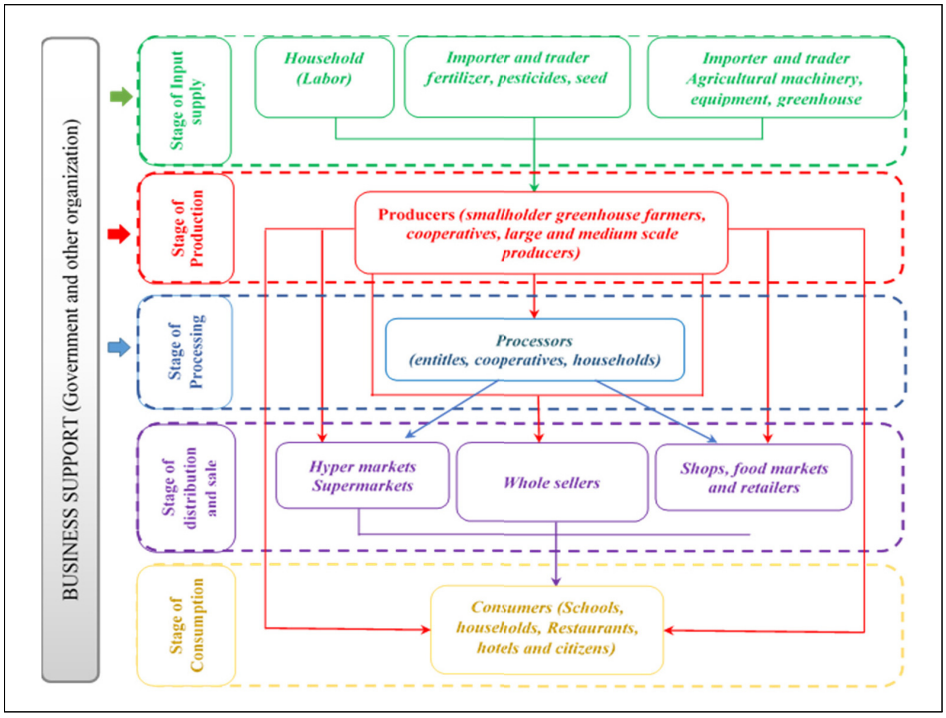
Consumers evaluated that the price of imported greenhouse vegetables is slightly lower than the price of domestic greenhouse vegetables (Figure 24).

2.7. Value Chain Analysis

The value chain map and key issues for each phase are illustrated below based on an overview of policy documents, focus meetings, interviews with representatives of business entities, cooperatives, individuals, professional organizations and associations, scientific publications, and other research

reports. The stakeholders in the value chain of greenhouse vegetables are divided into five groups (stages): suppliers, producers, distributors (wholesalers and retailers), vegetable processors, and consumers.

〈Figure 25〉 Stakeholders and the greenhouse vegetable value chain map



A list of issues at each stage of the greenhouse vegetable value chain was developed, and 30 issues were identified among the stakeholders based on the preliminary research survey conducted among greenhouse vegetable producers, sellers, consumers, etc. (Figure 25).

The following 30 issues were identified through focus meetings, questionnaires, and group and individual interviews to know the challenges for stakeholders at each stage of the value chain:

1. **Input supply and raw materials stage:** (Households, importers and traders of fertilizers, plant protection products and seeds, agricultural machinery, equipment, greenhouses and greenhouse materials, etc.)

   - Insufficient workforce training and employment

     There is a shortage of labor during cultivation and harvest, a deficiency of young professionals in the local area, low wage rates in the agricultural sector, and job fluctuations depending on the season. The insufficient labor supply during these times is because of the insufficient job placement service.

   - Lack of an integrated seed and seedling policy

     Farmers cannot always renew their seeds because of the high price of new, advanced varieties. Domestic seed plantation is not yet developed. In addition, farmers buy new seeds as cheaply as possible from the market, but they do not reach the quality requirements.

   - Insufficient integrated policy toward input supply

     The fact that individuals sell imported plant protection products and fertilizers of unknown origin on the market risks affecting the product's quality and safety.

   - Insufficient knowledge and information on the use of fertilizers and plant protection products

   - Price of inputs

     The main ingredients needed for crop production, such as pesticides, fertilizers, and machinery, depend on imports and transportation, and importation affects sales prices.

2. **Production stage (Cultivation):** Greenhouse vegetable producers (farmers) are key players in the value chain, and their activities range from purchasing the inputs needed for cultivation from other sources to producing, harvesting, and selling at the market. Therefore, the issues facing agricultural producers are considered in detail.

   - Lack of supply of smart greenhouses with advanced technology

     During the research survey, producers expressed that smart greenhouses with advanced technologies would play an important role in increasing productivity and developing greenhouse production further. In addition, the lack of funding limits the development of highly productive and smart greenhouses.

   - Ineffectiveness of electricity discounts for production

   - Infrastructure: Roads, communications, wells, sewage, and heating networks

   - Financial support

     Greenhouse cultivation is often done at the household level, making it harder to meet credit requirements. Some business credit lines have high-interest rates and short maturities.

   - Issues related to seed, fertilizer, and plant protection products

     Because of the lack of knowledge and information about food quality and safety issues related to pesticide and fertilizer regulation (GAP), farmers often misuse it. Educational programs should be provided to strengthen the abilities of agronomists and farmers and improve cooperation between MoFALI, MULS, farmers associations, and farmers.

   - Knowledge and skills of employees

Generally, vegetable cultivation and soil tillage are carried out with traditional technologies. There is a need to educate a labor force with theoretical and practical knowledge to work in a smart greenhouse with modern equipment.

- Sales channels for greenhouse vegetables

  The producers' profits go to wholesalers such as the Bars market because of the lack of distribution systems and wholesale markets for fresh vegetable products, resulting in fluctuating vegetable prices and negatively impacting producers.

- Labor force supply

  The shortage of labor force and lack of knowledge and skills of employees influence agrotechnical activities on crop yields and quality.

- Seasonal impact

  Producing greenhouse vegetables during the winter is difficult because of the harsh climate. Thus, introducing advanced electrical and heating systems into production is necessary.

3. Distribution and sale stage:

- Unstable supply from producers

  There is a demand for domestic greenhouse vegetables, but the unstable supply and seasonal products make it difficult for sellers. Selling prices are varied because of imports and an unstable supply of domestic production.

- Quality of vegetables

  Poor standard quality control for imported and domestic vegetables

leads to consumer loss.

- Impact of imported vegetables

  The quality of imported vegetables is lower than that of domestic products, but the lower prices cause pressure on vegetable farmers and consumer purchases.

- Wholesale and retail impact on prices

  The lack of direct market relations from producers to consumers allows wholesalers and retailers to control prices and sell to consumers at higher prices.

- Possibility of primary processing

  Most farmers do not have a storage and cooling system that meets standard requirements. Producers sell their products at the market as quickly as possible without primary processing.

4. Processing stage:

- Competitiveness with imported products

  Importing canned and pickled products and the unstable, seasonal supply of domestic raw materials and vegetables impact the vegetable processing industry negatively.

- High prices for industrial raw materials

  Processing factories buy raw materials (vegetables) from local producers, which cost more than imports because of the high prices of domestic greenhouse vegetables.

- Sales channel issues for end products

  Small processing plants have little opportunity to sell their products

to large chain stores because of the unstable supply and standard requirements.

- Unstable, seasonal supply of domestic vegetables

  Importing canned and pickled products and the unstable, seasonal supply of domestic raw materials and vegetables impact the vegetable processing industry negatively.

- Government support for processing factories

  Government support for vegetable processing and domestic products is weak.

5. Consumption stage:

- Unclear information about the quality and standards for vegetables

  Consumers make their choices based on their experience, as they do not have access to information on whether the quality of the vegetables meets the standards.

- Insufficient supply of domestic vegetables

  Greenhouse vegetables are abundant in the market during the growing season, but there is a lack of access to consumption during the other seasons. There is also an insufficient vegetable supply in the winter season.

- Price fluctuations

  There is a wide range of price fluctuations in vegetable prices depending on location and season.

- Insufficient packaging for consumption

  In markets and small shops, vegetables are usually sold without

packaging, and some packaged vegetables are unsuitable for consumption.

- Lack of knowledge on vegetable consumption

  Most consumers lack knowledge about healthy, fresh vegetable consumption and accurate knowledge about vegetable processing and cooking, affecting demand.

〈Table 7〉 Evaluation and ranks of challenges facing issues in each stage of the value chain by the analytic hierarchy process (AHP)

	Challenges facing issuesStages	
VChA-1 Input supply	Issue 1	Lack of an integrated seed and seedling policy
	Issue 2	Insufficient workforce training and employment
	Issue 3	Insufficient integrated policy toward input supply
	Issue 4	Insufficient knowledge and information about the use of fertilizers and plant protection
	Issue 5	Price of inputs
VChA-1 Production	Issue 1	Lack of supply of smart greenhouses with advanced technology
	Issue 2	Ineffective electricity discounts for production
	Issue 3	Infrastructure: Roads, communications, wells, sewage, and heating networks
	Issue 4	Financial support
	Issue 5	Issues related to seed, fertilizer, and plant protection products
	Issue 6	Knowledge and skills of employees
	Issue 7	Sales channels for greenhouse vegetables
	Issue 8	Labor force supply
	Issue 9	Seasonal impact
VChA-1 Sales	Issue 1	Unstable supply from producers
	Issue 2	Quality of vegetables
	Issue 3	Impact of imported vegetables
	Issue 4	Wholesale and retail impact on prices
	Issue 5	Possibility of primary processing
VChA-1 Processing	Issue 1	Competitiveness with imported products
	Issue 2	High prices for industrial raw materials

	Challenges facing issuesStages	
	Issue 3	Sales channel issues for end products
	Issue 4	Unstable, seasonal supply of domestic vegetables
	Issue 5	Government support for processing factories
VChA-1 Consumption	Issue 1	Unclear information about the quality and standards for vegetables
	Issue 2	Insufficient supply of domestic vegetables
	Issue 3	Price fluctuations
	Issue 4	Insufficient packaging for consumption
	Issue 5	Lack of knowledge on vegetable consumption

VChA-1-Value Chain Analysis, Sources: Team analysis using field survey data

The issues were analyzed using the analytic hierarchy process (AHP) based on questionnaires and interviews with stakeholders (Table 7).

The survey results were compared, and the results of each stage of the value chain were ranked and evaluated using AHP to determine which stages of the greenhouse value chain were the most complicated and which stages needed to be addressed in the first rank. If the coefficient is interpreted in percentages, it indicates the level of importance of the problem.

〈Table 8〉 Rankings of issues in the input supply stage

Issues	Rank coefficient
Insufficient integrated input supply policy	0.31
Lack of systematic seed and seedling policy	0.19
Insufficient knowledge and information about the use of fertilizers and plant protection	0.18
Insufficient workforce training and employment	0.16
Price of inputs	0.15

The most challenging issue at the input supply stage requires the government to develop an integrated input supply policy (0.31). The next

important challenge is the lack of knowledge about the integrated seed and seedings policy (0.19), followed by the use of fertilizers and plant protection products (pesticides). Workforce training and employment are ranked fourth, while ingredient prices are fifth on the list. These are the most challenging issues in the inputs stage of the value chain (Table 8).

〈Table 9〉 Rankings of issues in the production stage

Issues	Rank coefficient
Ineffective electricity discounts for production	0.31
Lack of supply of smart greenhouses with advanced technology	0.30
Issues of seed, fertilizer, and plant protection products	0.16
Sales channel for greenhouse vegetables	0.15
Knowledge and skills of employees	0.11
Financial support	0.07
Infrastructure: Roads, communications, wells, sewage, and heating networks	0.06
Labor force supply	0.05
Seasonal impact	0.03

Regarding the most challenging issues at the production stage, the incentives for electricity are ranked first (0.31), showing that current incentives for electricity are ineffective for production. The second item is the lack of supply of smart greenhouses with advanced technology (0.30). This rank is consistent with the survey that farmers were more interested in using smart greenhouses to generate vegetables in all seasons of the year. In addition, other challenges for producers are the supply of seeds, fertilizers, and pesticides (0.16), vegetable sales channels (0.15), and agrotechnical knowledge and skills (0.11). Table 9 reflects the most challenging issues based on the rankings of financial support, infrastructure, labor force supply, and seasonal impact.

〈Table 10〉 Rankings of issues in the distribution and sale stage

Issues	Rank coefficient
Unstable supply from producers	0.33
Quality of vegetables	0.24
Possibility of primary processing	0.18
Impact of imported vegetables	0.16
Wholesale and retail impact on prices	0.09

Regarding the issues in the sales stage, an irregular supply of producers is ranked first (0.33), and it is seen as the most challenging issue for sellers. Vegetable quality (0.24) and primary processing (0.18) are next. These issues are followed by the impact of imported vegetables (0.16) and the wholesale impact on prices (0.09). Most notably, the policy and assistance of government and international organizations are needed to enhance the winter production for producers and maintain the sustainable supply of vegetables throughout the year (Table 10).

〈Table 11〉 Rankings of issues in the processing stage

Issues	Rank coefficient
High prices for industrial raw materials	0.36
Government support for processing factories	0.26
Sales channel issues for end products	0.20
Unstable, seasonal supply of domestic vegetables	0.14
Competitiveness with imported products	0.05

One of the most challenging issues in the processing stage is the high price of domestic greenhouse vegetables, followed by issues with government support and sales channels. The next most challenging issues are seasonal raw material shortages and competition for imported products. Processors mentioned that the limited domestic greenhouse production in winter affects the prices and supplies of raw materials (Table 11).

〈Table 12〉 Rankings of issues in the consumption stage

	Rank Coefficient Issues
Lack of knowledge on vegetable consumption	0.43
Insufficient supply of domestic vegetables	0.26
Price fluctuations	0.14
Insufficient packaging for consumption	0.13
Unclear information about the quality and standards for vegetables	0.04

During the consumption stage, the most challenging issue was the lack of knowledge on fresh vegetable consumption (0.43). Vegetable consumption varies among the consumers, and it may be related to domestic vegetable supplies and prices and traditional food culture. However, there is a growing trend of using fresh vegetables in their diets (Table 12).

The next prominent challenges for consumers are the insufficient supply of domestic vegetables (0.26), price fluctuations (0.14), vegetable packaging (0.13), and vegetable quality issues and standards (0.04).

〈Table 13〉 Based on the results of interviews and questionnaires with greenhouse producers, the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was performed as follows:

Strengths	Weaknesses	Opportunities	Threats
• High greenhouse vegetable demand • Individuals' and companies' interests in greenhouse vegetable production • Government policies that support greenhouse vegetable production.	• The quality of seeds and seedlings of greenhouse vegetables is not guaranteed • Insufficient labor supply and professional knowledge and skills • Heating and electricity costs are high for greenhouse vegetable production in winter	• Possible expansion of greenhouse production and introduction of advanced technologies with international organizations • Improving standard quality grades, criteria, and packaging methods of vegetable products to increase	• Extreme climate • Imported, cheap greenhouse vegetables • Raw materials and inputs highly dependent on imports

Strengths	Weaknesses	Opportunities	Threats
	• Lack of government investment and funding for constructing smart greenhouse complexes • Poorly developed post-harvest management and low-temperature storage system • Poorly developed distribution system for fresh greenhouse vegetable products	the sales network • Producing education programs to strengthen the abilities of agronomists, farmers and cooperating with education institutes, such as the MULS and MoFALI	

■ Operation costs analysis by greenhouse type

The following cost analysis was based on the team survey results and showed the operation costs of greenhouses. The cost analysis covered different types of winter greenhouses with an area of 500-4,900 ㎡ and more than 5,000 ㎡.

Up to 500-4,900 ㎡ greenhouses: According to the team survey, wages account for 40%-50%, seed costs account for 8%-20%, and operating costs account for 30%-40% of the total expense of Chinese-style solar greenhouse enterprises measuring up to 4,900 ㎡. The majority of these greenhouses do not function during the coldest period in Mongolia. Therefore, sowing begins in February to March, incurring heating costs until May. The Chinese-style solar greenhouse coating has a high heat loss ratio, which increases the heating cost excessively and is unable to cultivate in November, December, and January.

In addition, double-layer plastic greenhouses measuring up to 2,160 ㎡

and working during the winter (four seasons of the year) were selected for the cost analysis. This type of greenhouse is more expensive than those operated by companies that do not work in the winter and has a negative profit margin. The wage accounts for 50% because the labor employment has no seasonal effect, and the heating and electricity is 30% of the total expense.

Greenhouses with an area above 5,000 ㎡: These winter greenhouses work continuously for four seasons. The cost of the raw materials accounts for 10%–20% of the total expense, while the wage accounts for 20%–40%. In addition, the operating cost accounts for 50%–60%, and heating and electricity cost account for 40%–45%. Even though heating and electricity costs are higher, the firms are profitable depending on the significantly higher yield of the large 5,000 ㎡ area.

Cost types:

1. **Fertilizer cost:** High-quality seeds and fertilizers are priced higher, increasing yields. On average, the cost of the seeds and fertilizers accounts for 8%–20 % of the total expense.
2. **Wage cost:** Wage cost accounts for 17%–60% of total expenses. The share of wage cost in the total expenditures tends to decrease as the size of the greenhouse increases because the sales management and technical staff salaries are fixed regardless of the greenhouses' sizes, so the small-area greenhouses' wage costs in the total expenditures are high. In contrast, the share of wage costs in the total expense is low in greenhouses measuring 5,000 ㎡. Therefore, as the size of the greenhouse increases, the share of wage costs in total expenditures,

or unit costs, decreases. The analysis of the relation is illustrated in the following table.

〈Table 14〉 Relation of wage cost and greenhouse area

Greenhouse area (㎡)	2,160	600	726	5,040	10,000	3,000
Wage (thousand MNT)	40,500.0	16,300.0	7,600.0	142,100.0	261,400.0	61,200.0
Share of wage in total expense	42%	62%	40%	41%	17%	18%
Relation between greenhouse area and wage						0.99
Relation of wage share, greenhouse area, and total expense						-0.67

Sources: Team analysis using field survey data

The analysis shows that the greenhouse area and the salary are related [the level of correlation is high (0.99)), while the relation between the greenhouse area and the total cost is inversely related (-0.67).

3. **Operation cost:** The heating cost accounts for 80%–90% of the total expense in greenhouses smaller than 4,900 ㎡, and they can only be profitable if heating costs are paid from March to May. On the contrary, the yield is reduced because of the high heat loss of plastic film solar greenhouses, which do not provide the necessary heat to the plants in the cold season. The heating cost for glass greenhouses accounts for 45%–50% of the total expense, and they provide the necessary heat to the plants resulting norm.

〈Table 15〉 Relation of heating, energy, and greenhouse area

	2,160Greenhouse area (㎡)	600	726	5,040	10,000	3,000
Energy and heating costs (thousand MNT)	26,412.0	1,735.0	331.0	154,800.0	750,000.0	211,533.0

Share of the total expense	27%	7%	2%	45%	39%	62%
Relation between greenhouse area and energy cost						0.95
Relation of heating and electricity share in total expense, and the greenhouse area						0.52

Sources: Team analysis using field survey data

The analysis shows that an increase in greenhouse size increases the cost of energy and that the correlation is high (0.95), while the correlation between the greenhouse area and the total cost is inversely proportional (-0.67).

In addition to these estimates, the cost difference by greenhouse type is calculated per unit of output. The percentages are shown in the table below.

〈Table 16〉 Differences in costs and types of greenhouses

	Greenhouse types		Chinese-style solar greenhouse	Chinese-style solar greenhouse	Glass greenhouse	Glass winter greenhouse	Glass winter greenhouse (hydroponics)
1	Seasons in use		4	3	3	4	4
2	Heating system		Combination of a low-pressure furnace and electric heating	Low-pressure furnace	Central heating	Steam boiler	Steam boiler
3	Raw materials cost	Per unit, (kg/MNT)	395	69	1,074	424	822
		Percent	8%	2%	20%	9.3%	21.7%
4	Labor cost	Per unit, (kg/MNT)	2,190	2,432	2,174	1,880	653
		Percent	42%	62%	40.5%	41.2%	17.3%
5	Electricity cost	Per unit, (kg/MNT)	630	1,470	28	19	675
		Percent	12%	4%	0.5%	4.2%	17.8%
6	Heating cost	Per unit, (kg/MNT)	798	112	66	1,857	1,200
		Percent	15%	3%	1.2%	40.7%	31.7%

	Greenhouse types	Chinese-style solar greenhouse	Chinese-style solar greenhouse	Glass greenhouse	Glass winter greenhouse	Glass winter greenhouse (hydroponics)
7	Per unit costs, (kg/MNT)	5,177	3,910	2,263	4,567	3,780
8	Cost per tomato (kg/MNT)	–	3,910	2,263	4,567	–
9	Cost per cucumber (kg/MNT)	5,711	–	–	–	3,780

Sources: Team analysis using field survey data

As mentioned above, the unit cost of raw materials varies depending on the quality of the seeds used for cultivation. High-quality seeds are expensive and increase unit costs (Table 16).

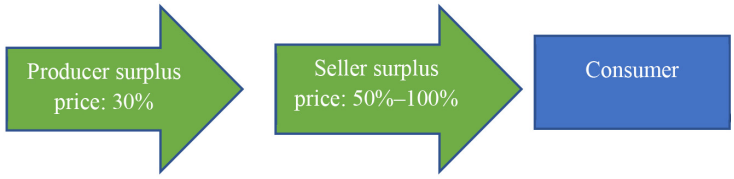
When heating a greenhouse with a steam boiler, the cost of heating per kilogram of vegetables is high (40.7%), while the cost of electricity is low (4.2%). As a result, the operating cost is higher in four-season winter greenhouses, increasing the cost of production. The unit cost of greenhouse vegetables varies based on the area's size, the quality of the seeds used, the type of heating, and the amount of harvest. Conversely, wage costs are less dependent on production quantity, indicating that the increase in production quantity decreases the costs of products per kilogram.

Research shows that the farmers' profit margins also fluctuate, as sale prices vary depending on who and where they sell their vegetables. If farmers sell directly to wholesalers, the profit margin is 0%–30%, and if they sell directly to end-users through their brand stores and grocery stores, the added value is 50%–100%. The profit margin is calculated on the cost, and its equation is shown below.

〈Table 17〉 The profit margin of a 1 kg yield

Greenhouse area	Greenhouse types	Seasons in use	Cucumber kg/MNT			Tomato kg/MNT		
			Cost	Sales price	Profit margin	Cost	Sales price	Profit margin
Up to 4,900 ㎡	Chinese-style solar greenhouse	3	-	-	-	3,910	5,000	27%
	Chinese-style solar greenhouse	4	5,177	4,700	-9%	2,263	3,900	-7%
Above 5,000 ㎡	Glass greenhouse	4	3,787	6,850	80%	4,567	6,000	31%
3,000 ㎡	Glass greenhouse (hydroponic)	4	4,287	8,844	106%	-	-	-

Sources: Team analysis using field survey data



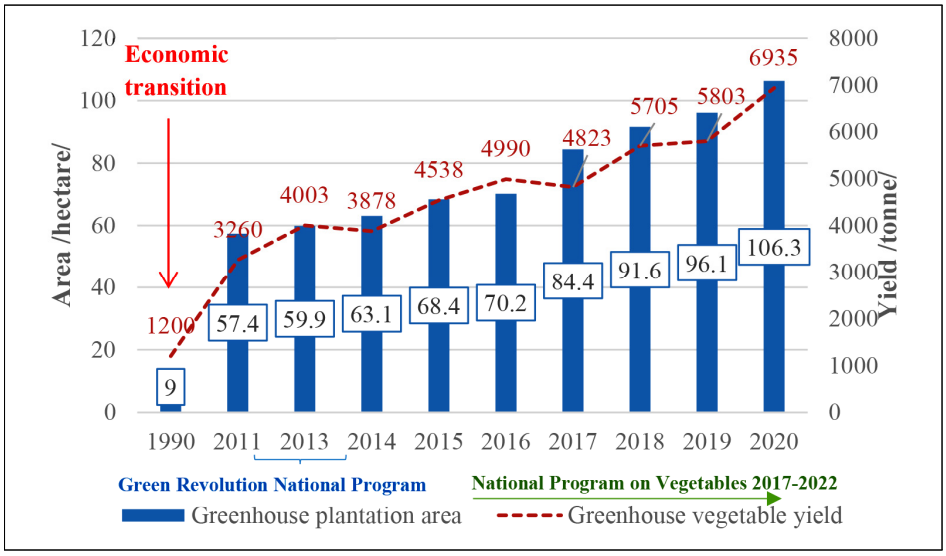
The prices of greenhouse vegetable producers increased by 30%-50%, and the prices of wholesalers and retailers increased by 50%-100%, respectively.

2.8. General Status and Prospect in Agriculture and Food Industry

In 1990, social relations in Mongolia changed completely from a centrally planned economy to a free-market economy, and state farms of greenhouses were privatized. The government implemented the "Green Revolution" national program in two phases from 1997 to 2012 to increase household income, reduce unemployment and poverty, and improve the food supply.

The Government of Mongolia approved the Atar-3 Campaign National Program under the National Development Action Plan for 2008-2012. This campaign was considered a rescue action for the crop farming sector's recovery, which has declined since the 1990s.

〈Figure 26〉 Greenhouse vegetable production in Mongolia from 1990 to 2020



As of 2020, an average of over 6,935 tons of greenhouse vegetables are grown on 106.3 hectares of greenhouse in Mongolia annually. Greenhouse vegetable production was about 6% of the total domestic vegetable production. The statistics on greenhouse vegetable production and consumption are shown in the following table.

〈Table 18〉 Statistics on greenhouse vegetable production and consumption

Indicators	Unit	2016	2017	2018	2019	2020
Area of greenhouse	ha	70.2	84.6	91.6	96.1	106.3
Total yield of greenhouses	tons	5.0	4.8	5.7	5.8	6.9
Vegetable production per ha	centner	710.83	673.25	622.8	603.9	649.0
Import volumes of greenhouse vegetables	Thousand/ tons	7.6	9	13.9	15.5	18.9
Import values of greenhouse vegetables	Thousand/ dollar	1,765.6	2,072.5	3,764.5	3,477.5	4,411.6
Needs of greenhouse vegetables for the population	Thousand/ tons	60.4	61.7	63.1	64.4	65.7
Self-sufficiency rate of domestic greenhouse vegetable production	percent	8.26	7.81	9.05	9.01	13.4
Sufficiency rate of greenhouse vegetables, including imports	percent	20.85	22.39	31.09	33.08	39.24

Source: NSO, www.1212.mn, MoFALI's official web page

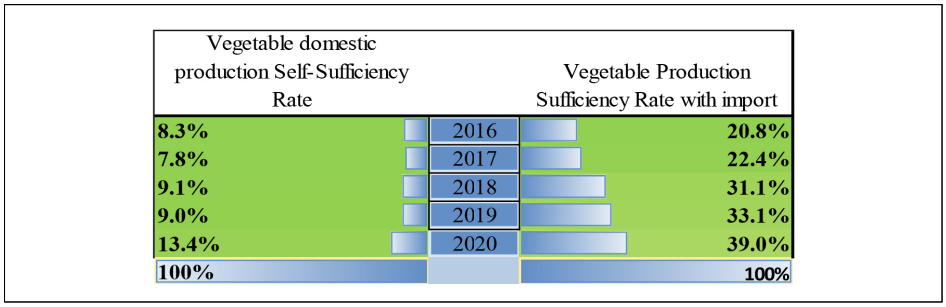
Table 18 shows that greenhouse production increased by 31% from 2016 to 2020, greenhouse vegetable yields were at 28%, and productivity per hectare decreased from 2016 until 2019 and increased in 2020. Moreover, 18,900 tons of greenhouse vegetables worth an average of USD 4,411.6 were imported.

Vegetables were cultivated on 106.3 hectares of greenhouses, yielding 649 centners per hectare, and a total yield of 6,935 tons of vegetables was produced in 2020. The government provided land to support greenhouse

production, but productivity declined because of funding, experience, and other factors.

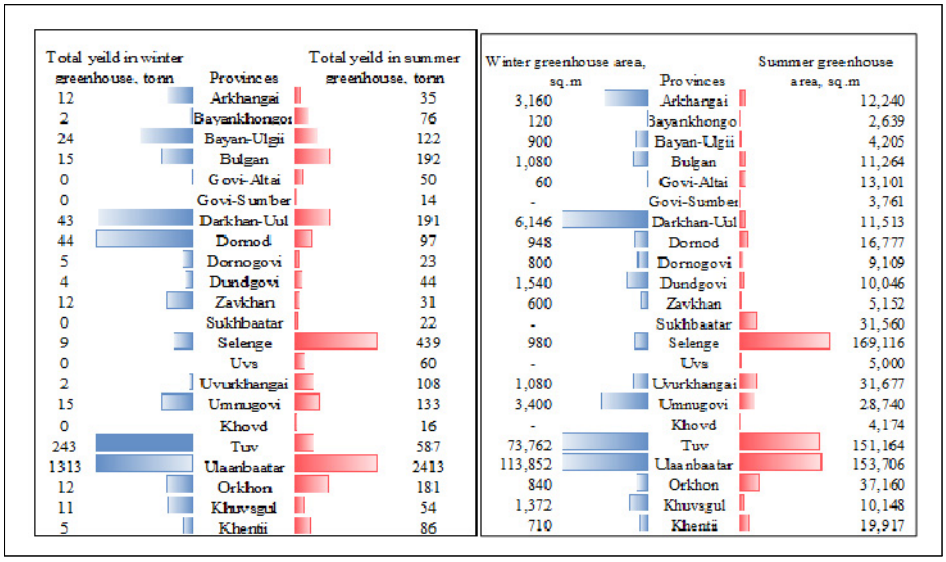
One strategy for reducing the dependency on imported vegetable produce is to increase the self-sufficiency rate of domestic production. The domestic production of potatoes satisfies the total demand by 100%, and other vegetables satisfy the total demand with about a 70% self-sufficiency rate because of several successful targeted projects implemented since 2000. It is estimated that, in 2020, domestic vegetable production met 13.4% of the demand, and it has increased by 6% since 2019 (Table 18).

〈Figure 27〉 Self-sufficiency rate of domestic greenhouse vegetable production



The National Official statistics indicated that the greenhouse vegetable production self-sufficiency rate in Mongolia improved between 2016 and 2020. Cabbages, carrots, onions, turnips, tomatoes, cucumbers, peppers, and leafy vegetables are considered the main sources of vegetables for Mongolians. It is estimated that about 30% of vegetable demand is provided, including imported vegetables, but the greenhouse vegetable consumption rate is lower than the demand. Therefore, it needs to support greenhouse vegetable production and producers.

There are several types of greenhouses in Mongolia, such as Chinese-style solar greenhouses and double-layer greenhouses with blankets for winter production. For summer production, polycarbonate and plastic greenhouses are generally used. The following figure shows the cultivation area and vegetable yields of winter and summer greenhouses by provinces of Mongolia (including Ulaanbaatar) in 2020.



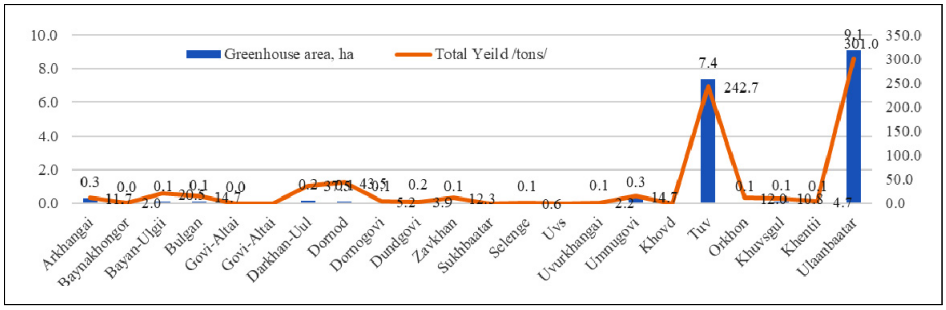
〈Table 19〉 Harvested greenhouse vegetables by greenhouse types, tons

Greenhouse type	2016		2017		2018		2019		2020	
	Provinces	Urban	Provinces	Urban	Provinces	Urban	Provinces	Urban	Provinces	Urban
Winter Class greenhouse	193.7	1,541	334.4	1,521	412.1	1,211	346	1,291	457	1,313
Plastic greenhouse	2,282	1,122	1,774	1,195	3,216	868.9	3,284	882.4	2,560	901.5
Blanket greenhouse	1,499.9	1,143	701	1,143	1,580.1	170.4	946.3	170.4	509	

Source: Data from MoFALI

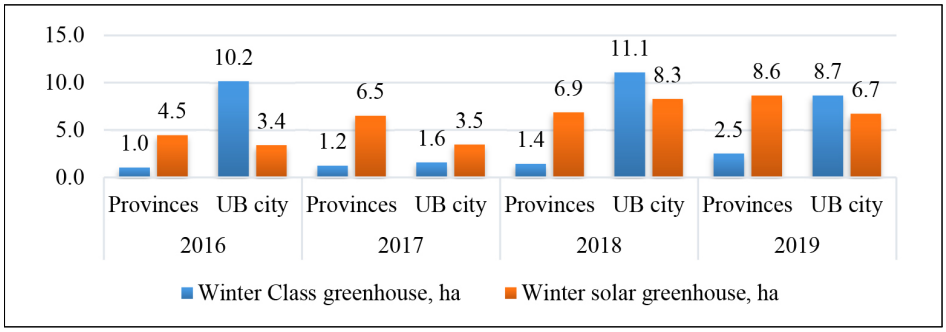
Winter greenhouse: Farmers mentioned that the harsh Mongolian climate significantly affects sustainable vegetable production in the winter (December to February). It causes the Mongolian population to consume inadequate amounts of greenhouse vegetables, such as tomatoes, cucumbers, and vitamin-rich leafy vegetables. Furthermore, a large part of the consumption of greenhouse vegetables is made up of imported vegetables. The following graph shows the winter greenhouse cultivation area and yield in each province and Ulaanbaatar city in 2020. Most winter greenhouses are concentrated in Ulaanbaatar city and the Tuv province.

〈Figure 28〉 Vegetable yield and area of winter greenhouses by provinces



Source: MoFALI data

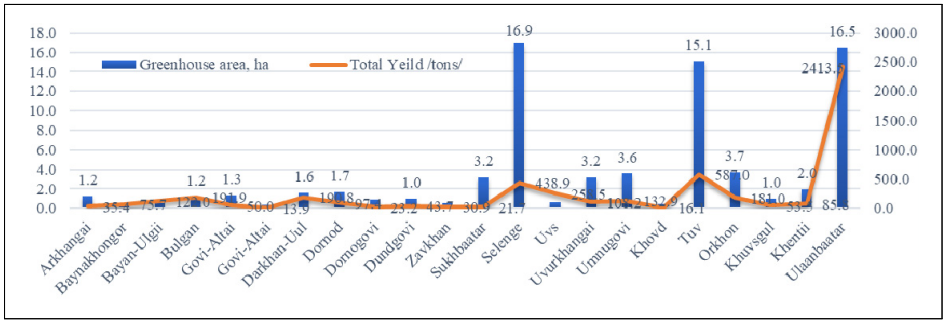
〈Figure 29〉 Types of winter greenhouses by provinces and Ulaanbaatar city



Source: MoFALI data

Summer greenhouse: The next graph shows the plastic greenhouse area and total yield by provinces and Ulaanbaatar city in 2020.

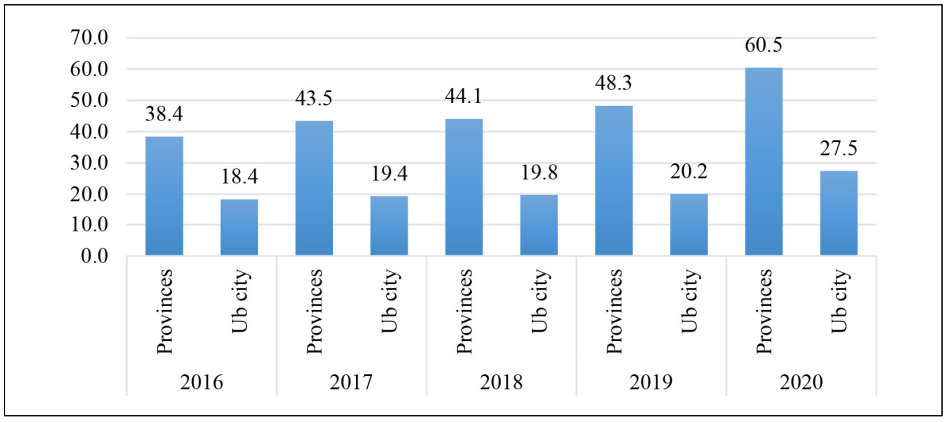
〈Figure 30〉 Types of winter greenhouses by provinces and Ulaanbaatar city



Source: MOFALI data

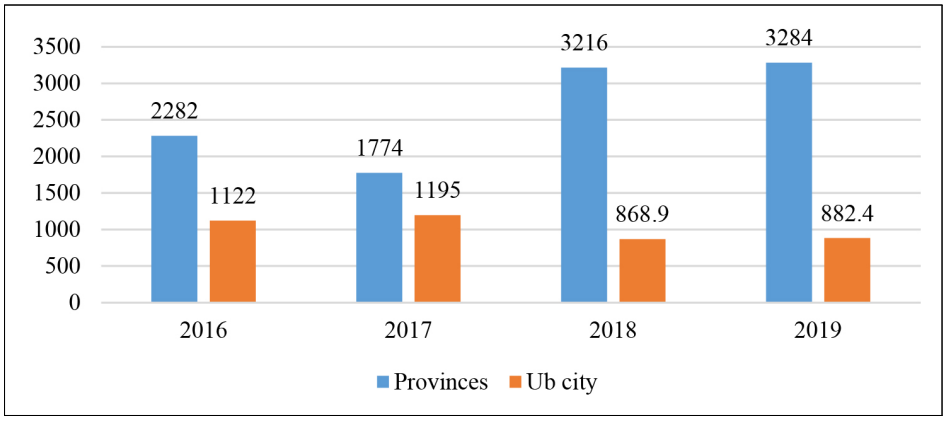
As seen in the above graph, the cultivation of plastic greenhouses dominates and is distributed in all provinces of Mongolia. Plastic summer greenhouses are cheaper than winter greenhouses, which may affect the development of plastic greenhouse production.

〈Figure 31〉 Area of plastic greenhouses by hectares (ha)



Source: MoFALI data

〈Figure 32〉 The yield of plastic greenhouses by tons for provinces and Ulaanbaatar City

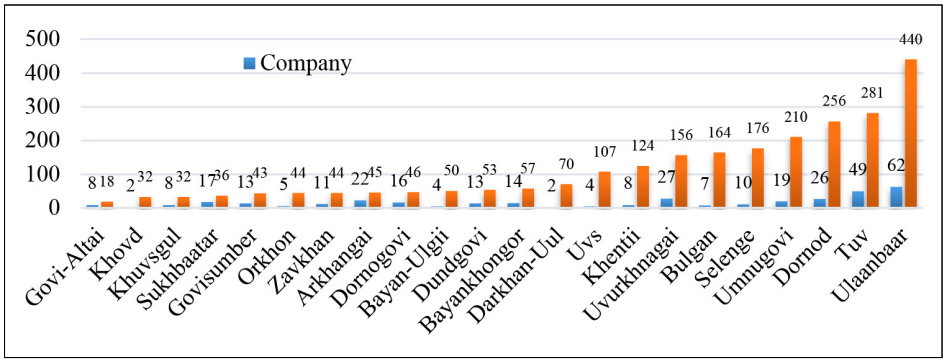


The first graph shows that the total area of plastic greenhouses increased from 2016 to 2019. Furthermore, the yield of plastic greenhouses increased in rural areas, but the urban yield somehow decreased because of the COVID-19 pandemic.

Greenhouse farming:

The greenhouse producers or plantations can be divided into two main groups: households and business entities. Business entities are mostly engaged in vegetable production in large and medium-scale areas, while household cultivation areas and greenhouse sizes are relatively small. As of 2020, 2,650 households and more than 350 business entities and cooperatives are engaged in greenhouse production.

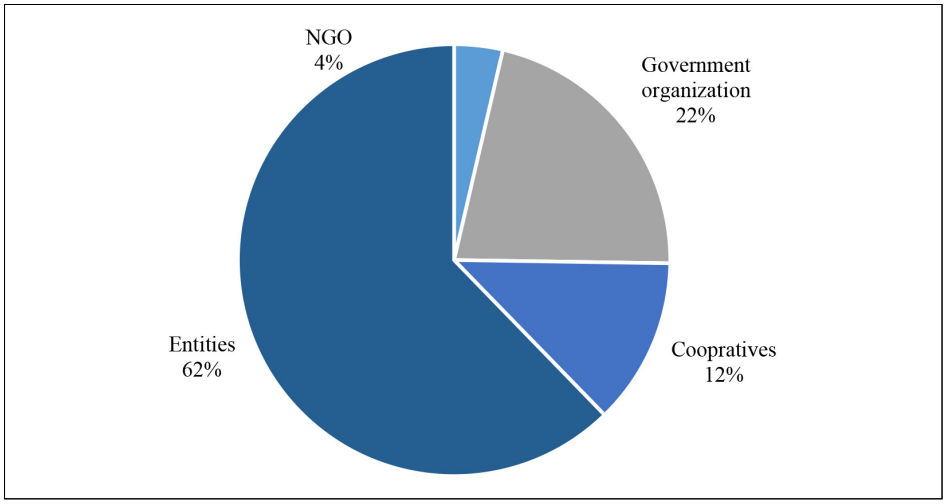
〈Figure 33〉 Number of households and business entities engaged in agriculture



Source: NSO, www.1212.mn

According to the data, vegetable production is concentrated in Ulaanbaatar and the Tuv province. The following figure illustrates the types of producer entities in greenhouse vegetable production.

〈Figure 34〉 Types of producer entities in the greenhouse vegetable value chain



Except for household producers, government agencies, nongovernmental organizations, and cooperatives are engaged in greenhouse cultivation.

Education and training programs, such as crop technology and good agricultural practices, can be directed at greenhouse vegetable producers.

〈Table 20〉 Producer entities in Ulaanbaatar

Area, ㎡	Winter		Plastic greenhouse
	Glass	Solar	
360	0%	25%	87%
361-500	10%	4%	1%
501-1,000	10%	25%	5%
1,001	80%	46%	7%

〈Table 21〉 Producer entities in the Provinces

Area, ㎡	Winter		Plastic greenhouse
	Glass	Solar	
360	56%	49%	78%
361-500	4%	4%	1%
501-1,000	12%	10%	2%
1,001	28%	12%	2%

3 Policies and Experience of Korea

3.1. Policies and Supporting Systems in Agricultural Sector

▣ Introduction

Since establishing diplomatic ties with Mongolia in 1990, Korea has been demonstrating the development of mutually cooperative relations in various fields over the past 30 years. Mongolia is a key hub for Eurasian logistics that connects Asia and Europe in a short distance. Accordingly, it has a common interest in "Northeast Asia Peace and Cooperation" and "Eurasia Initiative" and is also a partner country for mutually beneficial economic cooperation that can contribute to the expansion of the Korean market through transboundary and minilateral cooperation. In particular, the agricultural sector, which is emphasized as a strategic element in the

"New Northern Policy," is emerging as an axis of opportunity to improve Mongolia's poor environments such as infrastructure and technology shortages and climate change that disrupt the development of Mongolia's agricultural sector through the transmission of Korea's excellent agricultural technologies, as well as to export Korea's agricultural technologies. Agricultural development projects have been discussed with Mongolia since the early 2000s. In 2009, with the support of the Korean government, the "Agricultural Development Master Plan" was established and contributed to the development of Mongolia's agricultural and livestock industries (Ministry of Foreign Affairs, 2016). As such, Mongolia has maintained a complementary relationship with Korea based on trust and is expected to expand and develop into a continuous cooperative relationship based on the robust growth between the two countries.

3.1.1. Foreign Policy

■ New Northern Policy

Starting with the "Protocol on Diplomatic Relations" in 1990, Korea and Mongolia adopted the Korea-Mongolia joint statements through their summit visits such as "21st Century Mutual Complementary Cooperative Relationship" in 1999, "Friendly Cooperation Partnership" in 2006, and "Comprehensive Partnership" in 2011 and have continued to develop close cooperation. In addition, in September 2017, the "New Northern Policy" was announced at the "3rd Eastern Economic Forum," focusing on expanding economic cooperation with northern countries.

The New Northern Policy is a continental policy aimed at creating a future growth engine for the Korean economy and realizing mutual economic cooperation with the goal of establishing a foundation for the unification of the two Koreas based on peace and prosperity on the Korean Peninsula by enhancing the cooperation and linkage in various fields, such as transportation, logistics, and energy, with 14 Eurasian countries including Mongolia, three Chinese provinces, Russia, Uzbekistan, and Ukraine. This policy has a vision, "Northern Economic Community of Peace and Prosperity," and four main goals as a strategy such as ① building a foundation for peace in Northeast Asia by activating minilateral cooperation, ② sharing strategic profits by building an integrated network, ③ creating new growth engines by advancing industrial cooperation, and ④ promoting mutual understanding by expanding human and cultural exchanges. In addition, the detailed promotion tasks of this policy include ① K-epidemic prevention and health care, ② culture and education exchange, ③ agricultural and fishery trade, ④ finance, commerce, and innovation platform, ⑤ digital and green cooperation, ⑥ industrial infrastructure cooperation, ⑦ establishment of an integrated network, and ⑧ customized cooperation by region, and a total of 70 short- and long-term tasks were established in these 8 areas. Short-term tasks in the "agricultural and fishery trade" of the detailed promotion tasks include expanding exports of smart farms, developing and distributing excellent varieties, and ODA for agriculture and fisheries, and its long-term tasks include expanding exports of agricultural equipment and cooperation of customized agricultural technology.

In the New Northern Policy, differentiated strategies were established by

region through the division of the Eurasian economic sphere, which include strengthening cooperation in resource development and infrastructure fields with great growth potential with Mongolia belonging to the central sphere, expanding cooperation to manufacturing, agriculture, and information and communication fields where Korea has strengths, and strengthening private support and government cooperation through intergovernmental councils. In particular, a linkage plan for cooperation with the "Mongolia-China-Russia Economic Corridor" was prepared through the New Northern Policy based on the record that Mongolia reached an agreement with China and Russia in 2016 to promote the "Mongolia-China-Russia Economic Corridor Program" that includes a total of 32 projects such as transportation, infrastructure, logistics, agriculture, and energy.

■ Bilateral discussion between Korea and Mongolia

In 2020, the "Korea-Mongolia Friendship Year" was designated to commemorate the 30th anniversary of the establishment of diplomatic relations between Korea and Mongolia. With 2020 as the first year of the new northern cooperation, the Mongolian government is continuing cooperative relations with Korea, Mongolia, China, Russia, and other new northern countries. In September 2021, the Korea-Mongolia summit was held, and the relationship between the two countries was upgraded to a "strategic partnership" through the discussion on cooperation promotion ways related to the relation between the two countries and regional and international situations. The summit was promoted for the mutual

realization of Korea's "New Northern Policy" and Mongolia's "Vision 2050'" development policy.

In this summit, the two countries agreed to deepen and expand cooperation in five areas, including ① politics and security, ② economy, trade, and investment, ③ education, science and technology, environment, and health, ④ culture, tourism, and human exchange, and ⑤ international and regional cooperation. In the area of economy, trade and investment, the two countries also agreed on establishing a complementary economic cooperation relationship that utilizes Mongolia's abundant resources and Korea's advanced technologies with comparative advantage. In particular, Mongolia highly appreciated the fact that Korea's ODA support has played an important role in Mongolia's national development, expecting that paid and free development assistance projects related to eco-friendly renewable energy, green energy, smart city, and climate change are carried out, and active investment for the projects are made. In addition, Mongolia proposed to explore the possibility of mutual cooperation in exchanging information on animal and plant products and preparing sanitary and quarantine standards for exporting its agricultural products to Korea, including nurturing experts in the field of agricultural technology.

Through this summit, Mongolia expressed its willingness to continue to support Korea's New Northern Policy, thus strengthening the basis that can substantiate the New Northern diplomacy. Further, a framework for cooperation between the two countries was laid for the realization of "Vision 2050," Mongolia's national development policy.

■ The 3rd Basic Plan for International Development Cooperation (2021-2025)

The International Development Cooperation Committee of Korea enacted the Framework Act on International Development Cooperation to secure the legal stability of ODA policies and promote policy coherence and aid effectiveness. To implement this Act, it announces every year the "Basic Plan for International Development Cooperation" established every five years and the "Comprehensive Implementation Plan for International Development Cooperation" that specifies implementation plans for each paid-and-unpaid sector. In the "3rd Basic Plan for International Development Cooperation (2021-2025)," newly established in 2021, a vision of "realization of global values and win-win national interests through cooperation and solidarity" was set, and to achieve it, it was decided to promote 4 main strategic goals and 12 key tasks.

In addition, this plan aims to expand Korea's total ODA size to more than double compared to that of 2019 (KRW 3.2 trillion) by 2030 and flexibly adjust the paid-and-unpaid support ratio to 40:60, investing more than 70% of bilateral ODA projects targeting key partner countries. The main directions are 1) strengthening support to respond to infectious diseases such as COVID-19, promoting human-centered development cooperation such as humanitarian aid and ending hunger; 2) promoting the tasks in connection with Korea's external policies such as building various infrastructures for common prosperity in response to climate change and for the economic and social development of recipient countries; 3) support for strengthening the scientific technology and public administration innovation capabilities of recipient countries, utilizing innovative

technologies of startups and social enterprises, and expanding participation of private funds; 4) strengthening partnerships with international organizations and donor countries by establishing a national cooperation system with public (government / local government / public institution)-private (civil society / company)-research (academia / research institute) institutes; and 5) strengthening the basis for implementation such as nurturing professional human resources and strengthening performance management, and ensuring accountability and transparency to enhance the efficiency of international development cooperation (Related Ministries Joint 2021b: 7). Among the 12 key tasks, the following tasks were selected as key promotion tasks: improving agricultural productivity and contributing to food security, nutritional status improvement, and income increase through comprehensive rural development and smart farm projects tailored to recipient countries; expanding irrigation facilities; distributing agricultural machinery and transferring technologies; supporting for agricultural production-processing-distribution-sales; and planning and disseminating of business utilizing appropriate technology. Along with this, the task also aims to promote an ODA project that integrates Korea's ICT technologies into agriculture, health, education, quarantine, and transportation fields, which are in high demand in recipient countries considering the global non-face-to-face economic and cultural spread (Related Ministries Joint 2021b: 11,15).

■ Country Partnership Strategy

Country Partnership Strategy (CPS) is the highest paid-and-unpaid ODA support strategy by country and was established in 2010 with Korea joining the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD). In this strategy, comprehensively considering Korea's development assistance strategies and the development tasks of key partner countries, the scale of support for each country, 3-to-4 key cooperation areas, and action plans are specified. Korea's CPS for Mongolia was first established in 2012, and in 2016, the second CPS was established through the outcome evaluation of the first CPS and was newly revised in 2020.

The key cooperation areas in the first CPS (2012–2015) were set with the goal of concentrating at least 70% of the total support budget into ① ICT / public administration, ② urban development, and ③ agricultural development. With the goal of strengthening food security and increasing farm household income through the improvement of agricultural productivity in Mongolia, ① suburban agricultural development and ② livestock program support were set as detailed implementation plans. Accordingly, for the development of suburban agriculture in Mongolia, the Korean government supported an ODA project to transfer vegetable and fruit greenhouse cultivation technologies, support experimental cultivation and pilot farm operation in the suburbs of Ulaanbaatar, and improve the distribution network of agricultural products, including fresh vegetables and fruits produced through suburban agriculture, and established a system for this. In addition, projects, including joint research in connection with agricultural technology-related universities as well as

the modernization of food processing processes and sanitation management to advance the agricultural processing field, were carried out to nurture human resources and support the government's policy establishment and the enhancement of management capability. Support projects related to the livestock industry include the improvement of distribution-related laws and systems for the safe and efficient distribution of livestock products and establishment of a livestock system suitable for environmental conservation, and other support projects for system development and installation were carried out, such as livestock products processing and sanitation management system and the establishment of distribution facility management system (Related Ministries Joint 2012: 43, 60-65).

Unlike the first CPS, the key cooperation areas of the second CPS include ① education, ② water management and health and sanitation, ③ public administration, and ④ transportation. However, the area of "agricultural development" was excluded. In the CPS revised in 2016, the area of "climate environment" was newly included, and areas that cope with the common issues of the international community and to the development needs of Mongolia were selected, such as discovery and support of environmental projects in connection with multilateral organizations (Related Ministries Joint 2020b:10).

3.1.2. ODA Support Status

■ Comprehensive Implementation Plan for International Development Cooperation (2021)

The International Development Cooperation Committee of Korea announces the "Comprehensive Implementation Plan for International Development Cooperation" every year by adjusting and reviewing paid-and-unpaid implementation plans for each field. The "Comprehensive Implementation Plan for International Development Cooperation" is a comprehensive plan to suggest directions and strategies in advance for the paid-and-unpaid projects of Korea for international development cooperation, plan and discover projects corresponding to the national strategy, and enhance the efficiency of the projects, rather than a development cooperation strategy limited to Mongolia. In the "2022 Comprehensive Implementation Plan for International Development Cooperation" announced in July 2021, 4 major strategic goals and 12 key tasks were prepared with the vision of realizing global values and win-win national interests through cooperation and solidarity (Related Ministries Joint 2021a).

〈Table 22〉 Direction and Plan for International Development Cooperation in 2022

	Overcoming COVID-19 Crisis Strategic tasks	Leading climate change response	Diversifying development, cooperation, and innovation	Advancing partnership
Key tasks	① Establishing health and medical response system	① Customized support for green transition	① ODA support for Digital New Deal	① Consolidating public-private cooperation including civil society

	Overcoming COVID-19 Crisis Strategic tasks	Leading climate change response	Diversifying development, cooperation, and innovation	Advancing partnership
	② Strengthening the realization of humanitarianism	② Leading Green New Deal global cooperation	② Program innovation and financial diversification	② Advancing bilateral and multilateral development cooperation
	③ Promoting economic resilience	③ Green New Deal for win-win development	③ Enhancing ODA effectiveness and accountability	③ Creating development cooperation ecosystem

Among the 12 key tasks, for "enhancing the realization of humanitarianism," improvement of agricultural productivity through the expansion of partner countries' ICT smart farm projects and the support for comprehensive rural programs, improvement of crop quality and agricultural profits, and support for responding to climate change through the creation of an eco-friendly agricultural foundation were set as detailed promotion tasks. In particular, to "promote economic resilience," the government bond market advancement plan to revitalize the Mongolian economy will be promoted (Related Ministries Joint 2021a). In the tasks promoted in the "Comprehensive Implementation Plan for International Development Cooperation," enhancing consistency with Korea's foreign policy and supporting strong sectors of partner countries based on their needs are set as promotion strategies for international development cooperation in 2022.

■ Mongolia support status

The amount of ODA support to Mongolia has been steadily increasing,

and for the past five years (2013–2017), the international community has provided an average of USD 456.91 million per year to the country based on the total amount of expenditure. The largest donor country is Japan, which has provided USD 1.091 billion (47%), equivalent to about half of the total international community aid over the past five years. The top five donors and institutions, including the Asian Development Bank (9.1%), the World Bank (8.2%), Korea (7.0%), and the United States (5.8%), account for about 77% of the total ODA to Mongolia. Korea is the fourth largest donor country, which has provided about USD 163 million (annual average of USD 32.52 million) to Mongolia over the past five years (Related Ministries Joint 2020b: 35-37). Looking at the status of Korea's support for Mongolia's agricultural sector, unlike the first CPS, in the second CPS established in 2016, the area of agricultural development was excluded as a key cooperation area. However, the ratio of support by the agricultural sector to the total amount of Korea's ODA to Mongolia increased from 4.7% in 2016 to 14.5% in 2017, and among them, the area of agricultural development account for a high proportion consistently at 0.8% in 2016 and 4.3% in 2017, respectively.

〈Table 23〉 Korea's support status for Mongolia in agricultural, forestry, and fisheries areas

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total amount of ODA	43.6	34.4	36.3	30.9	32.2	26.3	43.5	24.7	74.9	57.2
Agriculture, forestry, and fisheries	3.8	2.6	4.8	3.8	7.1	3.8	3.7	3.0	3.3	3.5
Agriculture and forestry	0.8	0.9	2.6	2.3	5.0	2.1	1.7	1.1	1.3	1.4
Forestry	3.1	1.7	1.5	1.4	2.1	1.7	2.0	2.0	2.0	2.1

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Share of agriculture, forestry, and fisheries in total ODA(%)	8.7	7.6	13.2	12.3	22.0	14.4	8.5	12.1	4.4	6.1

Note: Based on the OECD DAC's ODA gross disbursement and constant price
Source: Reorganized by the author based on the website of ReOECD.
Unit: Million dollars (USD)

Along with this, the ODA project promoted in Mongolia was carried out according to the CPS implementation plan, comprehensively reflecting Mongolia's development needs and Korea's areas with comparative advantage (refer to Table).

〈Table 24〉 Details of Mongolia's agriculture-related ODA projects (1993-2020)

Project type	Contents (period/support scale)
Projects	Refrigeration Warehouse Construction in Mongolia (1993-1998/USD 34.29 ten thousand)
	Support Project for the Food and Agricultural Inspection Institute in Mongolia (1995-1997/USD 32.61 ten thousand)
	Project for Promoting Mongolia's Livestock Sanitation Quarantine Ability (2004-2005/USD 41.69 ten thousand)
	Establishment of the Livestock Viral Disease Diagnosis Center in Mongolia (2007-2009/USD 132.1 ten thousand)
	Support for the Installation of Vegetable Growing Greenhouses in Mongolia (Ulaanbaatar and Darhanul) (2008-2010/USD 94.19 ten thousand)
	Development of Mongolia's Livestock Safety Management System (2008-2010/USD 104.11 ten thousand)
	Project for Afforestation and Water Resource Development in Bayannur region, Mongolia (2009-2011/USD 164.05 ten thousand)
	Project for the Development of Pilot Farms in Khalkhgol, Mongolia (2011-2014/USD 415.55 ten thousand)
	Support Project for Mongolia's Green Growth Policy (2011-2012/USD 128.11 ten thousand)
	Support Project for Improving Mongolia's Eco-Friendly Agricultural Productivity (2013-2015/USD 171.72 ten thousand)
	Project for Enhancing Mongolia's Agri-Food Safety Management Capacity (2013-2015/USD 106.46 ten thousand)

Project type	Contents (period/support scale)
	Korea Program on International Agriculture (KOPIA) for Mongolia (2019–2023/KRW 46.95 hundred million)
	Project for Mongolia's Greenbelt Afforestation (2017–2021/KRW 100.75 hundred million)
	Creation of a Forest of Hope in Mongolia (2018–2022/KRW 25 hundred million)
	Project for Enhancing Veterinary Treatment Capacity in Ulaanbaatar, Mongolia (2019–2023/KRW 46 hundred million)
Development consulting	Establishment of an agricultural development master plan in Khalkhgol, Mongolia (2008–2010/USD 206.1 ten thousand)

Source: Related Ministries Joint (2020a), Reorganized by the author based on the website of ODA Korea

3.1.3. Support Strategies of ODA-related Organizations for Mongolia

■ Korea Trade-Investment Promotion Agency (KOTRA)'s Strategy to enter Mongolia

KOTRA is an organization that supports Korean companies' export support and foreign investment attraction, which presents the entry strategy of each country in terms of overseas market exploitation and international development cooperation support. Unlike the systematic policies and strategies of the government, this agency provides research and analysis of the business environment for trade and investment expansion and establishes promising areas for investment and entry strategies according to changes in domestic and foreign circumstances every year.

The "national entry strategy into Mongolia" established in 2021 was presented by dividing it into major issues, entry strategies by industry, and entry strategies through Korea-Mongolia economic cooperation. In the

entry strategy through Korea-Mongolia economic cooperation, ① consumer goods and distribution, ② industrial diversification, and ③ human exchange were selected as detailed entry areas. For industrial diversification, the promotion of manufacturing and agriculture areas was presented as a top priority task (KOTRA Ulaanbaatar Trade Center 2021: 40-45).

The Mongolian government is establishing a policy for self-sufficiency in vegetable consumption and expansion of exports and aims to more than double the yield of grains, vegetables, and potatoes. The Ministry of Agriculture in Mongolia is promoting a policy to reduce dependence on imports by raising the tariff rate on imported vegetables to 25% under the domestic vegetable support policy. According to these local conditions and demand, KOTRA suggested equipment exports for the cultivation and storage of related items as a promising field. In addition, the agency selected fresh fruits such as strawberries, pears, and apples as promising items for export to suggest a strategy of supplying the related items by discovering large local distribution chain vendors. The fruits produced in Mongolia are strawberries, apples, and watermelons, and their yields are less than 1% of domestic consumption, depending on imports. Strawberries have been cultivated in plastic greenhouses for about five years, but the yield of strawberries is significantly low. Strawberries have been cultivated in greenhouses since about five years ago, but the yield of strawberries is also remarkably low. In Mongolia, strawberries from Korea and China are distributed, and in 2019, only Korean strawberries were imported, thus showing that Mongolian consumers have a high preference for Korean strawberries (KOTRA Ulaanbaatar Trade Center 2021: 40-45). Strategies

for entering Mongolia in the smart farm area include exports of subsidiary materials for smart farm manufacturing, such as exports of the related equipment and the latest equipment and machines. To solve problems such as a continuous decrease in arable area and precipitation, deterioration of soil quality, and reduction of the labor force, Mongolia includes the mechanization and technology introduction of the agricultural sector in its policy. In addition, Mongolia relies on imports for subsidiary materials for greenhouses and the rebar, films, covers, and systems (such as temperature and light controllers) for plastic greenhouses, so it was analyzed that it would be possible for Korea's latest equipment, machinery, and greenhouse-related equipment to advance into Mongolia (Min-Jung Kim 2020: 145). Mongolia has severe climatic conditions such as long winter, and there is a high demand for technologies that can preserve agricultural products harvested in greenhouses for a long period, so it will be easy for Korean technologies with comparative advantage in post-harvest management technology and the related companies to advance into Mongolia

■ Korea Overseas Agro-Resources-Development Association (KOAA)'s guide to entering Mongolia

KOAA was established in accordance with Article 29 of the "Overseas Agriculture and Forest Resources Development and Cooperation Act" with the approval of the Minister of Agriculture, Food and Rural Affairs (MAFRA) of Korea. This association prepares Korea's private companies for overseas expansion with information and business consulting on the

agricultural environment, investment system, foreign investment law, infrastructure, and distribution network of the target country for overseas expansion to help the companies enter overseas markets. In addition, this association presents manuals for overseas agricultural development projects by country and guides for overseas expansion.

KOAA predicted that as fields for Korean companies to advance into Mongolia, ① post-harvest treatment facilities, ② transmission of advanced agricultural technology through connection with ODA project, and ③ breed improvement project were promising. According to the analysis of agricultural conditions in Mongolia, the biggest threat factors hindering agricultural development were extreme daily and annual temperature differences, low rainfall, and short crop growth period. Accordingly, KOAA empathized that the direction of applying Korea's general farming methods to Mongolia should be avoided and that it is necessary to increase grain production and foster flower agriculture so that unfavorable natural conditions such as climate can be overcome. As a promising area for agricultural investment, it is considered an eco-friendly medicinal plant. Mongolia's natural conditions are unfavorable for grain production while having suitable conditions for the cultivation of medicinal plants. Therefore, this association analyzed that it is necessary to develop the related agricultural policies so that the unfavorable natural conditions of Mongolia can be overcome by cultivating medicinal plants and special crops, and the agricultural development base can be established as a market for medicinal and health supplements (MAFRA 2013; KOAA 2015).

▣ Summary

For the foreign policy and agricultural support strategy of Korea for Mongolia, its strategies and detailed implementation plans were established based on the Korean government's "New Northern Policy," the Mongolian government's "Vision 2050" development strategy, the systematic realization of agricultural policies, and the demand of both countries. Investment and development cooperation is being promoted to enhance the consistency of the policies promoted by the two governments, and the two countries have continued to cooperate in pursuing mutual interests and strategic values.

The direction of Korea's trade and entry into Mongolia is to promote development cooperation projects in connection with the ODA project to compete with China, Japan, and the United States, which are Mongolia's major investment countries, and Korea has designated Mongolia as a key partner country and is increasing the scale and proportion of the ODA project to the country. In the agricultural sector, the business cooperation in human and material exchanges, where Mongolia's demand and Korea's comparative advantage match, such as agricultural and livestock development, food processing, response to infectious diseases of livestock, greenhouse and post-harvest management technology, and agricultural equipment is analyzed to be promising. In particular, through the export of the "Korean Smart Farm Package," which takes into account the import substitution strategy of fruits and vegetables, including the national policy and development strategy of Mongolia, the development and application of technologies to increase productivity in Mongolia's facility horticultural industry can be accelerated, which can contribute to reducing agriculture

and livestock operation costs and loss of agricultural products. At the same time, considering ways to vitalize the export of fresh Korean fruits, which are in high demand in Mongolia, and developing a market for the export of seeds, a high value-added industry, are necessary.

Korea and Mongolia maintain a politically friendly relationship and have built a relationship of mutual understanding and trust through summit meetings on the international stage. Based on this, the two countries have continued to expand cooperation in a diversity of fields such as politics, economy, and development cooperation and have greater cooperation potential than the achievements so far. In the future, it is expected that close exchanges will continue in new industrial areas such as the front-back industry of agriculture, eco-friendliness, and investment.

3.2. Lessons Learned from Past Projects, Policies and Systems

Environmental changes affecting agriculture are occurring continuously around the globe. These include a need to increase agricultural productivity due to population growth, global warming limiting the existing agricultural system, the aging rural society, the agricultural market opening, and the convergence of agricultural production technology with the Fourth Industrial Revolution. In light of such changes in the agricultural production environment, modern agriculture sets a strategy to increase domestic output and raise profitability by securing competitiveness

in the export market with cutting-edge technologies, such as information and communication technology (ICT), biotechnology (BT), and environmental technology (ET). In particular, advanced agricultural countries have entered the era of competition in information technology (IT)-based smart agriculture by converging cutting-edge technology with existing technology to increase productivity and cultivate high-quality crops in line with these changes. The convergence of the Fourth Industrial Revolution technology and agricultural technology is happening in all fields of agriculture, such as production, distribution, and consumption. As a result, the agricultural sector is developing into the sixth industrial stage through innovation in the primary, secondary, and tertiary industries.

3.2.1. Advanced Agricultural Countries' Smart Farming Strategies

A. Dutch Smart Farming

The competitiveness of the Netherlands, an advanced agricultural country, is attributed to the use of big data to determine the optimal environment for growing crops and IT automatically control the indoor environment and develop outstanding varieties for the export market. It is characterized by the collaboration of the government, universities, farmers, and private companies.

〈Table 25〉 Agricultural Exports by Country (Unit: USD million, %)

Country	United States	Netherlands	Germany	Brazil	France
Export	182,235	112,061	100,777	87,890	81,187
% to Global Export	10.3	6.3	5.7	5.0	4.6

Source: Agricultural Economic Report 2015 of the Netherlands, Statistics Korea

The difference between agriculture in the Netherlands and Korea lies in agricultural technology. Moreover, although the Netherlands has a smaller land area than Korea, the cultivated area per farm household is larger.

〈Table 26〉 Dutch Cultivated Area per Farm Household

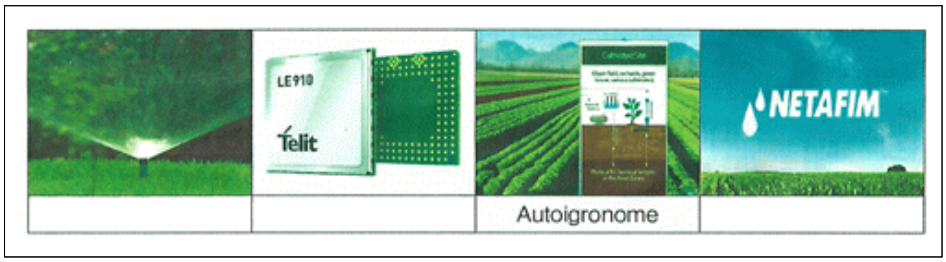
Particular	Land Area	Cultivated Area (a)	No. of Farm Households (b)	Cultivated Area per Farm Household (a/b)
Korea	99,720	1,596,100	1,120,776	1.4
Netherlands	41,543	1,893,000	65,507	28.0

The fact that the Netherlands has the world's second-highest competitiveness in agricultural export through agricultural technology development, despite its smaller land area than that of Korea, shows how important the future development of Korean agricultural technology is. The Netherlands' agricultural competitiveness, which has overcome its poor agricultural environment, is an exemplary case of successful cooperation between the government and industry-university-research, and the country has installed the export-oriented Seed Valley nationwide.

B. Israeli Smart Farm Competitiveness

Israel offers an example of securing competitiveness as a world-class advanced agricultural country through agricultural technology innovation that overcomes the poor agricultural environment in the desert region. The export destinations of Israeli agricultural products are the world's most agriculturally developed countries (Netherlands, United States, United Kingdom, Russia, and France). It differs from Korea's case, where Korea's agricultural importers are concentrated in Japan and Southeast Asia. Although the population is only one-fifth of Korea, the food production efficiency, determined by the total population/number of economically active people in agriculture, was about four times higher than that of Korea (2015 KREI).

〈Figure 35〉 Israeli Agricultural Technology Exporters



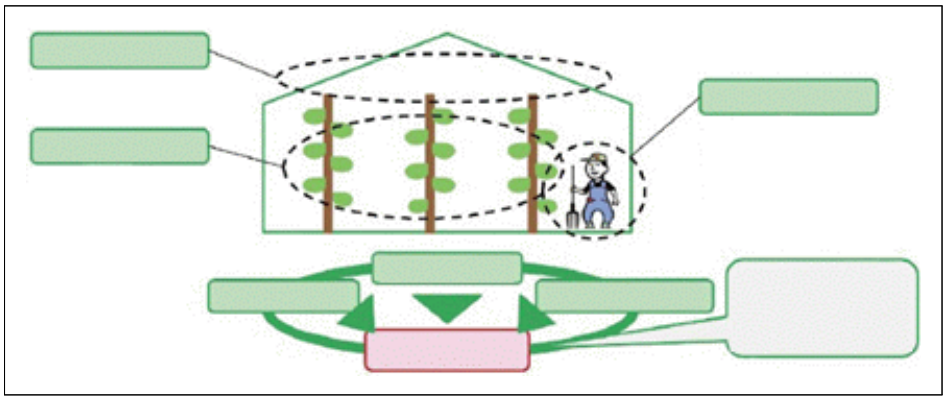
The Israeli government's research and development (R&D) investment support is one of the factors that allowed it to become a world-class agricultural leader. The Agriculture Research Organization (ARO), Israel's national agricultural research organization with a history of 90 years, performs 75% of national agricultural research and has 200 doctoral-level researchers and 340 engineering and technical personnel. In particular, it

secured competitiveness similarly to that of the Netherlands by the participation and cooperation of private companies in R&D in addition to the national research institutes' research outcomes.

C. Japan's Smart Farm

Japan's smart farm support policy imitates the Dutch development model. The Japanese smart farm market is expected to grow 3.6 times from JPY 6.614 billion in 2013 to JPY 30.849 billion by 2020. The Japanese government's smart farm support policy started in 2001 when high-speed Internet networks were installed at a world-class level nationwide under the "e-Japan" policy, a strategy for expanding the broadband Internet network. In 2004, ubiquitous technology became available in agriculture by converging ICT with industry, economy, and life under the "u-Japan" strategy. The "i-Japan 2015" strategy that began in 2011 made it possible to link agriculture with traditional culture and tourism.

〈Figure 36〉 Japanese Smartagri System Conceptual Diagram



Source: Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry

Japanese companies' entry into the agricultural sector is not just for the stable supply of agricultural products or exploiting new businesses, but it extends agriculture to various fields, such as retail, manufacturing, finance, transportation, and tourism. In particular, Japanese smart farm companies are venturing into the export market based on accumulated smart farm experiences.

D. United States' Smart Farm

Large enterprises in the traditional agriculture sector in the United States are actively entering the smart agriculture segment as they find it favorable because of its managerial convenience and agricultural productivity. Sixty percent of all farmers in the United States use smart data services for agricultural management. John Deere has aggressively acquired precision agricultural data technology companies from 2015 to 2017 to commercialize optimal seeding prescription services. Meanwhile, Monsanto acquired a big data company to make farming decisions through crop cultivation environment data analysis. Cargill is promoting a big data-based livestock feed service business, and DuPont provides a satellite image-based crop monitoring and decision-making support service. The United States' smart farm support policies are mainly driven by the US Department of Agriculture (USDA), and government support mainly focuses on technologies requiring long-term and costly support. Private equity funds, venture capital, Microsoft, Google, and some others are developing smart farm technology by investing in startups in the smart agriculture segment. The trend of smart farm technology development in

the United States will be that intelligent agricultural machines, robots, and drones are increasingly utilized in most agricultural tasks, and farm management and decision-making are made with AI-based big data analysis services. Therefore, the key to the United States' competitiveness in smart farm technology will be the extensive data collection and processing technology required for crop cultivation. The United States government's smart farm support policy is different from most agriculturally advanced countries: in the Netherlands, Israel, Japan, and Korea, agricultural competitiveness relies on the government-led support policy and the degree of private companies' cooperation, while the United States federal government focuses on investing in long-term and costly R&D projects so that startups with rapidly advancing core smart farm technology can conduct research and commercialization with investments from various routes. The United States' competitiveness in the export smart farm technology markets is also based on technology and large capital (comprising various forms of private equity and venture capital).

〈Table 27〉 The United States' Core Smart Farm Technology

Technology	Definition	Application
Internet of Things (IoT)	Technology that collects data in real time and shares it over the Internet using various sensors installed on devices	Collecting data on soil, crops, and environments using robots, drones, and sensors
Big Data	A platform composed of vast amounts of data created in the digital environment, the physical hardware storing data, and apps/software running the said hardware	Optical cultivation environment consulting through analysis and forecasting with the data collected on an IoT basis
Cloud	The availability of data anywhere and anytime through the Internet, which is stored on a central computer	Data storage, data processing for farm management, and facilitating communication

Technology	Definition	Application
Artificial Intelligence (AI)	Computer science and information technology that can mimic human intelligence (thinking, learning, and self-development, among others)	Provision of necessary information upon analyzing accumulated big data
Agricultural Robot	A machine that recognizes the external environment and judges the situation to provide intelligent services through autonomous operation	Divided into open-field agriculture, controlled agriculture, and livestock: Self-driving tractors, combines, and pest-control drones Sowing, weeding, and harvesting robots Milking robots and bio-robots
Agricultural Drone	An unmanned aerial vehicle controlled by radio waves	Aerial photo-taking for mapping, sowing, spraying, crop growth check, and pest detection
5G	Fifth-generation mobile communication technology • 20 times faster than 4G's transmission speed • 100 times higher processing capacity	Implementing virtual reality, autonomous driving, and IoT technologies New anticipated 5G-based service market

Source: United States, TechRepublic

E. Korea's Smart Farm Support Policy

1) Characteristics of K-Plant Smart Farm

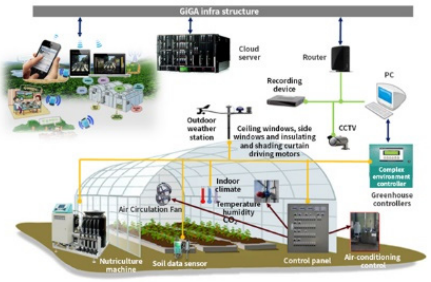
Korea's agriculture began in earnest in the 1950s when the development of domestic varieties for self-food-sufficiency began. In the 1970s, the White Revolution of Greenhouse allowed fresh vegetables to be produced all year round. In the 1980s, the demand for horticultural crops was diversified along with increased national income. As horticultural crops became a part of the major diet, the Korean government started the greenhouse standardization project. In the 1990s, under the influence of the Uruguay Round Agreement on Agriculture (URAA), the modernization project for controlled horticulture was promoted as a core support project

for that industry to prepare for opening the agricultural market. In the 2000s, as we enter the era of rapid information technology and the Fourth Industrial Revolution, smart farms are spreading throughout controlled horticulture.

〈 Korea's White Revolution of Greenhouse in the 1970s 〉

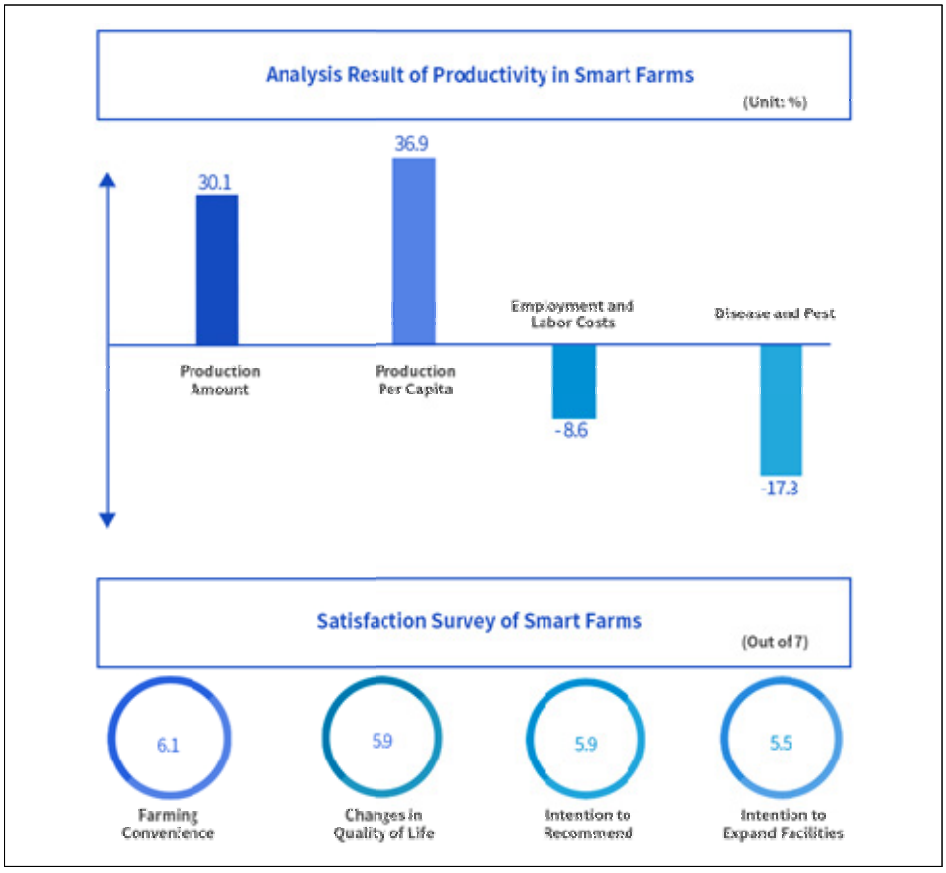
Source: Reporter Jae-sun Song, Rural Women's News, July 7, 2015

〈 Korea's Smart Farm 〉



Smart farms are equipped with sensors for each device to manage the crop cultivation environment, the core of controlled agriculture, enabling major environmental data to be built up as big data in the central processor. Advances in AI technology enable more efficient environmental control than human cultivation experts. As a result, productivity increased by 30%, quality improved by 40%, labor input reduced by 10%, and diseases and pests reduced by 17% compared to conventional controlled agriculture. A study showed that satisfaction with farm work, quality of life, the intention to recommend smart agriculture, and willingness to expand farm size were high. If Korea's smart farm technology is linked with the Kuwaiti government's controlled agriculture development policy, it will contribute to food security, safe food, and short-distance production while increasing the life satisfaction of high-income earners.

〈Figure 37〉 Increased Productivity in Smart Farms



Source: Ministry of Agriculture, Food and Rural Affairs, Korea

2) Korean Government's Smart Farm Policy

The Korean government established the first "Rural and Agricultural Informatization Plan" in 2002 to overcome the shortcomings of existing controlled agriculture and started installing PCs and Internet networks in rural areas to promote ICT-agricultural convergence projects in stages. Currently, it is building a system in which a specialized public agency provides feedback by managing data generated in the entire process of

production, management/distribution, sales, and consumption. In 2018, a Smart Farm Innovation Valley construction project was proposed, under which a national review committee reviews the project feasibility, export revitalization measures, past production results, and energy-saving plans and subsidizes up to 50% of the project cost with central and local government funds.

Through the said project, the Korean government aims to promote the stable supply of high-quality, safe food and homogeneous agricultural products by smartization and scaling production and distribution facilities. It also aims to establish a smart farm specialist fostering system to help young people settle in rural areas and create new jobs. In addition, it plans to enhance R&D cooperation between companies and research institutes, innovate technologies, invent new products, and create new markets. Notably, the project has the advantage of generating new jobs and narrowing the gap between urban and rural areas by relocating businesses and research centers to underdeveloped rural areas.

〈 Korea's Smart Farm Complex〉

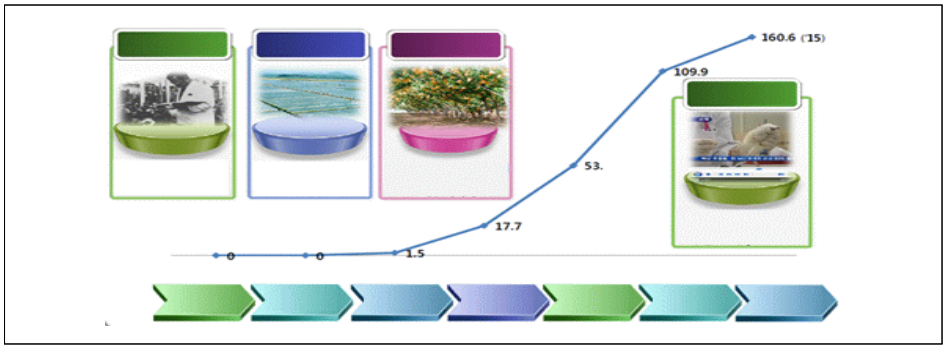
Source: Buyeo County Office, Korea

〈Bird's-Eye View of the Korean Government's Smart Farm Innovation Valley〉

3) Development of Horticulture in Korea

In Korea, controlled horticulture started with the self-sufficiency of vegetable seeds and the cultivation of domestic varieties in the 1950s. In 1968, vegetable production became self-sufficient, and the foundation for supplying four-season vegetables was laid with a project supporting the installation of horticultural greenhouses. In the 1980s, controlled horticulture was in full swing, and in the 1990s, high-quality, high-yield cultivation technology advanced. From 2008 to 2017, after signing the Korea-US Free Trade Agreement (FTA), the government supported the structural improvement and operational efficiency of horticultural facilities by expanding greenhouses, strengthening disaster tolerance, and introducing automation devices, such as side window openings, as part of the Korean greenhouse modernization project. In 2009, the government-supported new and renewable energy facilities, such as multilayer insulation curtains and geothermal cooling/heating equipment in horticultural facilities to increase productivity and build infrastructure for producing high-quality crops under the "Efficient Agricultural Energy Use Project."

〈Figure 38〉 Development of Korean Horticultural Industry



Source: Rural Development Administration

The government devised the "Agricultural, Forestry, and Food Science and Technology Development Mid- to Long-Term Plan (2013-2022)" in 2013 to secure national competitiveness in smart farm technology, moving away from the hardware-oriented approach that focuses on the extension and remodeling of existing facilities to promote ICT-based smart agriculture. In 2018, the Smart Farm Innovation Valley was established to create a youth startup ecosystem and industrial infrastructure, develop professional human resources, and expand R&D projects. The Smart Farm Demonstration Complex is under development to innovate technology by demonstrating and verifying ICT equipment, new items, and smart greenhouse machines; analyzing and utilizing big data; and supporting exhibitions, experiences, and startups. The government is building infrastructure in the private-sector occupancy zone within the Innovation Valley while companies build their facilities, promoting the private-sector collaboration with government policies. As for the Netherlands, cooperation between the government and industry-university-research organizations has been successful, resulting in high technological competitiveness. On the other hand, Korea has been unsuccessful in fostering cooperation between the government and private companies. The Demonstration Complex within the Valley is expected to allow conquering such shortcomings. However, it is necessary to improve the investment environment in which Korean smart farm startups receive investment from competing countries such as the United States or other advanced countries instead of domestic investors, thereby disclosing technology abroad. The smart farm technology level in Korea is shown in the table below.

〈Table 28〉 Smart Farm Technology Level in Korea

Particular	First Generation	Second Generation	Third Generation
Time to Commercialize	Present	2030	2040
Targeted Effects	Improved convenience – "More convenient"	Improved productivity – "More with less input"	Better substantiality – "High productivity and high quality by anyone"
Key Functions	Remote facility control	Precise growth management	Full-cycle intelligent and automatic management
Core Information	Environmental information	Environmental and growth information	Environmental, growth, and production information
Core Technology	Communication technology	Communication technology, big data, artificial intelligence (AI)	Communication technology, robotics, big data, AI
Decision-Making/ Control	Human/Human	Human/Computer	Computer/Robot
Typical Example	Smartphone greenhouse control system	Data-based growth control software	Intelligent robotic factory

Source: Ministry of Agriculture, Food and Rural Affairs

Most of the Ministry of Agriculture, Food and Rural Affairs' (MAFRA's) smart farm-related budget tends to be biased toward upgrading the existing greenhouse to the smart farm technology level or building an experimental smart farm complex, such as Innovation Valley. Here, R&D investment in core technology to secure smart farm competitiveness, as seen in the case of the United States, is insufficient, and large-scale smart farm complexes with export competitiveness are absent. The Rural Development Administration (RDA)'s Korean-style smart farm model development, the Korean Institute of Science and Technology's (KIST's) Smart Farm Solution Convergence Research Platform project, and Multi-Ministerial Innovative Technology Development Product for Smart Farm Package should be successfully promoted to enhance Korea's smart

farm technology competitiveness in the export market. Innovation Valley in Goheung, Jeollanam-do, aims to develop a southern-style smart farm that can withstand climate changes. The plan should successfully demonstrate a low-end smart farm greenhouse to export to Southeast Asia. Japan has already developed and operated a smart farm operable in Siberia at the technology level of a greenhouse company. In contrast, Korea has installed a testbed currently being verified to recreate a desert-type greenhouse. The desert-type smart farm greenhouse export market can enhance our export competitiveness by applying new and renewable energy technology and water-saving technology as the market highly prefers IT technology, in which Korea excels. The Netherlands' glass smart farm greenhouse requires a high initial investment cost, while Korea's plastic smart farm greenhouse technology reduces the initial investment cost and offers price competitiveness.

〈Figure 39〉 Japan's Smart Farm for Siberia

Source: Hokkaido Greenhouse Company, Japan

Japan applied advanced smart farm technology when it built a smart farm for producing tomatoes all year round in the Yakutsk region, where the mid-winter temperature drops below -45°C. The farm uses Russia's abundant natural gas as an energy source and triple-layer insulation. On top of the triple insulation, the farm is built with 95% transparent materials. It successfully reduced the operating cost of a separate CO2 fertilization facility using locally available cheap natural gas as an energy source and utilizing CO2 generated as a byproduct in cultivation. In terms of cultivation technology, the farm considered consumers' concern over food safety and significantly lowered the nitrate content of the high-quality tomatoes from 300 mg/kg to 17–22 mg/kg. Around 30% of the total budget for this project was financed by the Far East Development Fund, while 70% was financed by Japanese companies' investments. With the successful smart farm business in the background, Russia is expanding the project into a smart farm city business with Japanese companies. Likewise, Korea is preparing for a bright future of smart farm agriculture by investing in the R&D of smart farm technology, standardizing smart farm technology, and promoting the Innovation Valley project. It also actively supports the Economic Development Cooperation Fund (EDCF) through the Export-Import Bank of Korea. Still, support for commercializing technologies is essential to attract investments in smart farm startups, as seen in the United States.

〈Figure 40〉 Desert-Type Dutch Smart Farm

Source: United Arab Emirates Baniyas Research Station

Advanced countries in smart agriculture, such as the Netherlands, United States, Japan, and the European Union states, develop and distribute various models suitable for local agricultural characteristics. Each country has different competitive factors. In the Netherlands, glass greenhouses are used to increase output and grow high-quality crops; the country utilizes a global distribution network, but the initial investment cost is high. As for the United States, it is approaching the export market based on large-scale capital investment and bold investment in smart farm technology startups.

The Dutch desert-type greenhouse is characterized by a water-saving nutrient solution system applied with advanced technology and aquaponics technology using wastewater. However, the excessive use of electricity and the high initial investment cost required for a glass greenhouse remain challenging. Desert countries are reducing public support for irrigation systems that run on fossil energy, cooling methods,

and excessive agricultural water use. They are demanding research on new energy sources, water-saving irrigation systems, and cooling methods to attain sustainable agriculture with eco-friendly resources as much as possible. Power generation technology using solar heat as an alternative energy source has been introduced, but other alternative energy sources are needed because of the high initial investment cost. The United Arab Emirates piloted the smart farm greenhouse project, recently invested in by Korea, and revealed many shortfalls because of insufficient preparation. Alternative energy sources were overlooked, the water-saving system was inefficient, and the cooling system consumed excessive electricity. The Korean government's smart farm research plan includes advanced smart farm greenhouse specifications for the export market.

〈Table 29〉 Korea's Smart Farm Supply Target

		Target 2017Category	Target 2022	Description
Controlled Horticulture	Advanced export type	600 ha	7,000 ha	Total controlled cultivation area (100%) of major export items that use cutting-edge greenhouses, such as paprika, tomatoes, and flowers
	Complex link type	2,400 ha		30% of the linked greenhouses (7,853 ha) that have advanced in scale and modernized for items, such as cucumber and strawberries
	Single and simple type	1,000 ha		10% of single-unit greenhouses (10,719 ha) in the main production area for melons and watermelons

Source: Ministry of Agriculture, Food and Rural Affairs

The advanced export-type greenhouse supported by the Korean government should be developed after conducting a preliminary investigation into the farming environment of the target export market and the requirements of the government and farmers, who are the real buyers. For example, a Japanese greenhouse company that entered Siberia, Russia, expanded its business after successfully demonstrating a pilot project because it possessed a greenhouse design technology to produce stable crops in the hot season. On the other hand, if a Korean company without a desert-type greenhouse design technology installs a pilot greenhouse under a public support project, it is highly likely to fail to meet the local government or farmers' needs, and the public subsidy will be wasted. Therefore, research that suits the characteristics of each target market must be conducted to successfully launch the advanced export-type greenhouse invested in by the Korean government. For example, a desert-type greenhouse structure can be developed in various forms, depending on the consumers' needs and the initial investment size. The United Nations' Food and Agriculture Organization's (FAO's) research on greenhouse technology for high-temperature desert areas suggests three types of greenhouse structures: (1) a net house with the lowest investment cost, (2) a plastic greenhouse, and (3) a glass greenhouse. The research presented the advantages and disadvantages of each type. In the case of the net house, it is proposed for an area with a favorable climate for cultivation, given that the investment cost is low, but the management of the cultivation environment is difficult. In the case of the plastic greenhouse, the investment cost is higher than the net house, but it can be selected for a place where long-term operation effect is desired because it is advantageous in managing the cultivation environment. In the case of

the glass greenhouse, it is not preferred in the local area because of the high initial investment cost, although it is advantageous for managing the growing environment.

4) Korea's Smart Farm Case

Since the introduction of smart farm technology in a mushroom farm, the inconvenience of checking and adjusting environmental data on the farm every time to manage the growing environment has disappeared. By controlling the environment with a smartphone regardless of the location, the farm expanded its business with increased productivity by 30%, reduced labor costs by 16%, and reduced working hours by 16%.

〈 A Smart Mushroom Farm in Korea〉

Source: Reporter H J Choi, Dong-A Daily, 2017

〈 A Smart Tomato Farm in Korea〉

Source: Reporter S H Bae, Newsis, 2018

〈Figure 41〉 Korea's Smart Tomato Farm in Kazakhstan

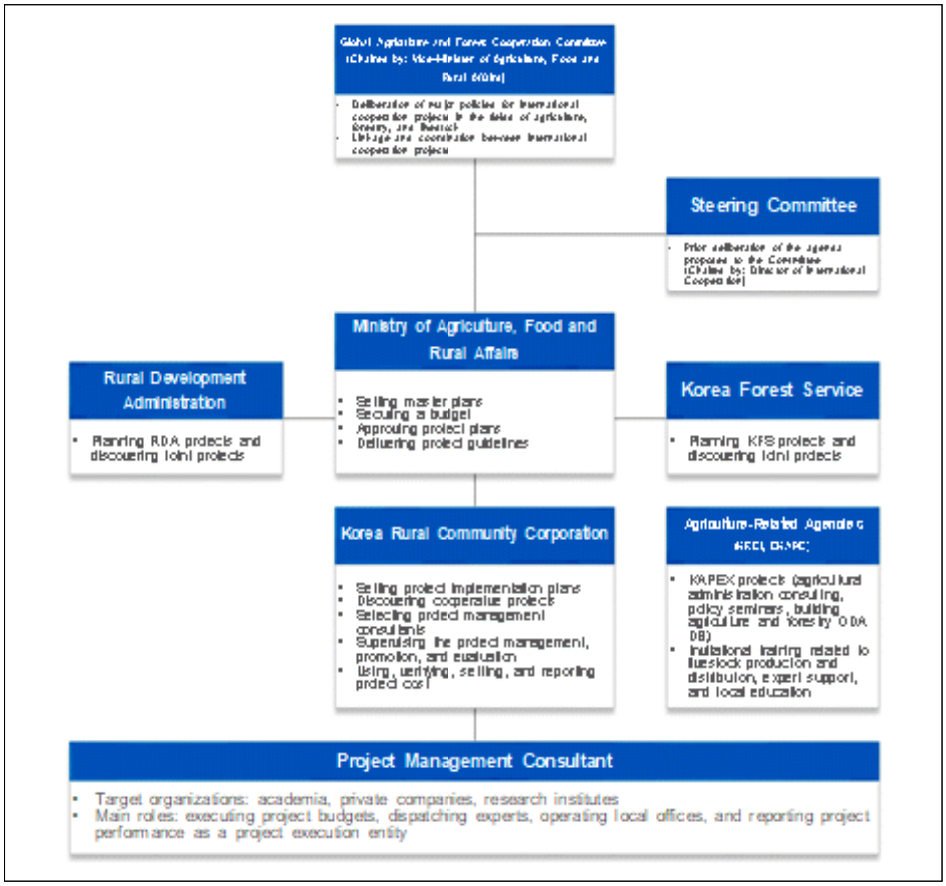
Source: Junza, Kazakhstan, Doojin Construction, 2017

Last year, Ham, a farmer, installed and operated an ICT-based complex environment control system in his 3,300 ㎡ greenhouses. He was interested in smart farms even before he returned to farming, so he considered ways to increase income and productivity by comparing and analyzing existing greenhouses and learned about ICT-based agricultural technology through smart farm education and professional consulting. With these efforts, he could control the growing environment in the greenhouse, improve work efficiency, and increase the annual output from 32 t to 50 t. Energy consumption is reduced by 35% and labor input by 50%, resulting in annual sales of KRW 120 million, fulfilling his dream of becoming a wealthy farmer.

3.2.2. Analysis of the Past Policies and Support Projects

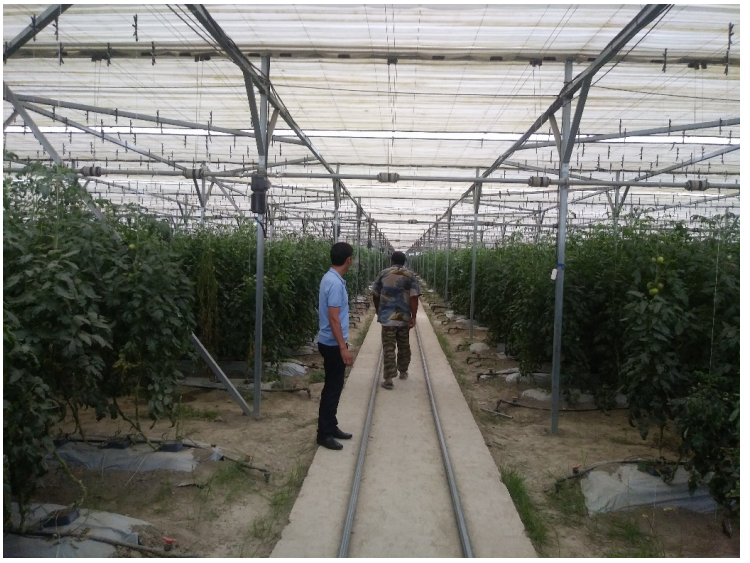
■ Official Development Assistance (ODA) Support for Smart Farms

The ODA project supported by the Korean government for the global export of smart farm agricultural technology is a good opportunity to receive smart farm technology free of charge for developing countries that have difficulties in promoting the smart farm greenhouse project requiring high initial investment costs. The ODA fund is collected from OECD DAC (Development Assistance Committee) member states, a group of advanced donor countries. As of January 2021, 30 countries (including Korea) are member states. The ODA project aims to achieve the United Nations' (UNs') 17 Sustainable Development Goals (SDGs) and 169 targets.



The International Agricultural Cooperation Project (ODA) aims to promote cooperation between Korea and recipient countries by transferring successful experiences in agriculture to developing countries for free. It plans 45 projects targeting 13 countries (8 Asian countries, 3 African countries, and 1 each of the Commonwealth of Independent States [CIS] and Latin American countries) and 4 international organizations (FAO, ADB, UNDP, WFP). In 2013, KOICA promoted a pilot greenhouse project worth about KRW 2.3 billion in Uzbekistan to transfer Korea's advanced smart farm technology.

〈**Figure 42**〉 Korean Greenhouse in Uzbekistan



Source: International Horticulture Institute

If the cooperation system between Korea's greenhouse companies and the government is inadequate, there is a risk that the original purpose of the ODA project (transfer of advanced agricultural technology) may not be attained. At the same time, it may give a bad impression to local farmers about Korean technology. If the local market is approached based on the lowest price, it may cause the shrinking of the export market because of bleeding competition among Korean greenhouse companies. Therefore, when promoting an ODA project, the criteria for selecting participating companies should be further subdivided so that companies with technological competitiveness can participate in the project. Smart farm technology that intends to enter the export market through ODA may need to meet the minimum standards set forth in the specification. However, the competition is likely fierce if a firm enters a free competitive export

market, as it must satisfy local buyers and present commercial feasibility to attract third parties' investment. Successful entry into export markets through ODA requires at least a smart farm technology level review.

〈Table 30〉 Smart Farm Technology for Overseas Expansion through ODA

No.	Item	Description
1	Whether major equipment can be localized	Promotion of domestic technology development and export
2	Yield prediction and cultivation environment management technology	Intelligent precision growth management
3	Technology for sensing biometric, soil, and environmental information	Intelligent precision growth management
4	Securing skilled labor force for cultivation	Support for crop cultivation and smart farm operation
5	Sales support solutions	The convergence of agriculture with the Fourth Industrial Revolution technology
6	Management support solutions	The convergence of agriculture with the Fourth Industrial Revolution technology
7	Agricultural robots	Third-generation smart farm technology
8	Cultivation education and training programs	Fostering local skilled labor

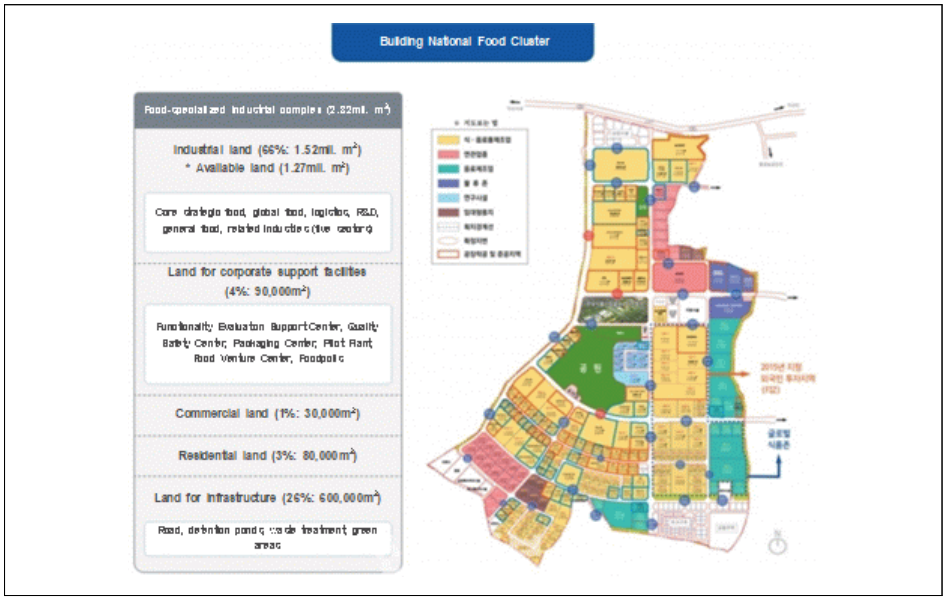
Source: International Horticulture Institute

The smart farm technology stage promoted by the Korean government should be the first step to expand the smart farm export market and increase the efficiency of project promotion when linking an ODA project with smart farm agricultural technology. Although past ODA smart farm technology projects focused on facility infrastructure, they will need to concentrate on the joint advancement of facility infrastructure and SW. If the advantages of the government-supported ODA project are not fully utilized, Korea's small greenhouse companies that have failed to secure competitiveness in overseas markets will find it challenging to compete with advanced agricultural countries.

■ The R&D and Export-Centered "Global Hub in the Northeast Asian Food Market"

Since 2008, the Korean government has been building national food clusters, starting with the one in Iksan, Jeollabuk-do, taking the example of the Dutch FoodValley. The government invested KRW 460 billion to make the cluster an R&D and export hub to lead innovation and growth in the national food industry. However, the performance has been unsatisfactory. In 2012, the government announced the "Comprehensive National Food Cluster Plan" aiming to attract 160 companies and research institutes into the clusters, generate annual sales of KRW 15 trillion for resident companies, achieve export of KRW 3 trillion, and create 22,000 jobs from 2020 and Source: Ministry of Agriculture, Food and Rural Affairs

〈Figure 43〉 National Food Cluster, Iksan, Jeollabuk-do



Source: Ministry of Agriculture, Food and Rural Affairs

As the R&D hub, the Dutch FoodValley is a major contributor to the export of agricultural products, which contrasts with Korea. FoodValley is a government-led R&D cluster of industry-university-research cooperation, forming an overseas market network based on global market development and technological innovation. FoodValley has been leading technological innovation and global networks since its establishment in Wageningen in 2004. The Netherlands is located in Northern Europe and has unfavorable climatic conditions for growing crops, resulting in poor tomato quality and low profitability. However, the country developed a cutting-edge greenhouse and applied hydroponics technology to overcome the adverse cultivation conditions, making it famous for its world's best productivity and quality. The government played a major role in achieving this outcome. The Dutch government brought together industry, public officials, and agricultural managers and induced technology development through collaboration to secure global competitiveness despite its harsh environment. The purpose of FoodValley is to secure export competitiveness in the agricultural sector based on the global export network built upon the knowledge-based collaboration system. This network runs on a membership basis, provides new business opportunities to investors by connecting global partners, and provides member companies with new knowledge, support systems, and partnership opportunities. This global network and partnerships provide worldwide member companies an ample opportunity for technological innovation based on technology and know-how unique to the Netherlands.

〈**Figure 44**〉 Dutch Agricultural R&D Hub "FoodValley"

Source: FoodValley

The competitive factors that can give the Netherlands an edge in the global agricultural market are (1) the maximized output based on glass greenhouses with advanced technologies, (2) high-quality production systems and investing in R&D through FoodValley, (3) industry-university-research cooperation clusters, (4) global networks, (5) distribution systems that can maintain freshness, (6) cooperative systems, (7) the high education level of farmers, and (8) world-class logistics infrastructure investments. Clusters such as "Agro Park" are built to reduce agricultural production costs, laying the groundwork for domestic and foreign farmers to make eco-friendly and low-cost products within the cluster well equipped with smart agricultural infrastructure. Iksan's national food cluster should be revitalized because, based on experience, agricultural production clusters such as the Dutch Agro Park can be promoted. The table below summarizes the supplements to activate the Iksan Food Cluster to provide R&D and sales solutions among the core values of securing export competitiveness of smart farm technology.

〈Table 31〉 Vitalization of National Food Clusters

No.	Task	Remarks
1	Reinforcement of collaboration functions between industries, public officials, and farmers	
2	Improvement of global networks	
3	Improvement of benefits to attract occupying companies	
4	Improvement of doctoral-level researchers and experts network	

Source: International Horticulture Institute

■ Smart Farm Innovation Valley and Dutch Agriport 7

In 2018, the Korean government considered the "smart farm" that combines the Fourth Industrial Revolution technology with agriculture as an effective alternative to attract talented youth, investment, and front and rear industries for agriculture. As a result, it selected the smart farm as a leading innovative growth project and announced a policy to create an integrated base. The policy targeted young farmers and front and rear industries. The Dutch Agriport 7 project forms an export-oriented cluster by aggregating smart farms and facilities. Korea also aims to foster a global market by nurturing a young labor force through the "Smart Farm Innovation Valley" and expanding and integrating technological innovation and developing front and rear industries through joint R&D investment with private companies.

The Dutch Agriport 7 is an agricultural cluster that combines agricultural and industrial complexes. A state-of-the-art glass greenhouse complex of 850 ha and a business complex of 100 ha are built here, and companies in various fields, such as agriculture, logistics, energy, and data centers, are located here. As a privately led paprika and tomato production complex, it

has a cold storage facility and logistics complex and is designed to significantly reduce production costs through its power generation facility using geothermal heat. Most of the paprika and tomatoes produced are exported to overseas markets. Smart farm greenhouse export complexes' design should reflect the connection with the logistics network that can quickly move fresh goods to a nearby airport or port to maintain their freshness. The crops produced in Agriport A7 are exported through nearby highways, airports, and ports. In other words, the competitiveness of a smart farm export complex requires (1) the production capacity and stable production of high-quality crops and (2) an efficient connection of distribution and logistics systems.

〈Figure 45〉 Dutch Agriport 7

Source: Agriport 7

Korea's Innovation Valley has potential as a specialized export cluster because it is comprised of a production complex, a distribution complex, an education complex, a residential complex, a demonstration complex,

agricultural and industrial complexes, and an energy complex. The advantage of Dutch FoodValley and Agriport 7 (an export-oriented glass greenhouse complex) is that cooperation between participating farmers and R&D organizations is well established. In the case of Innovation Valley, the cooperative system should be reexamined so that R&D, expansion, and dissemination projects are not centered on developers and suppliers only. Government-led projects can potentially undermine private firms' voluntary technology development efforts. While long-term investments in technology development in advanced agricultural countries are being made, many projects are carried out on an ad hoc basis in Korea. These shortfalls must also be addressed. In the case of the United States, the government bears long-term and high R&D expenses. Despite the Korean government's standardization efforts, the interchangeability of ICT parts (sensors, controllers, and communication devices) is low. As for equipment, including sensors, foreign companies dominate the domestic market, and the market share of foreign products is expected to increase gradually. Among the measures to enhance smart farm technology export competitiveness, eco-friendly energy utilization technology takes precedence over greenhouse design technology. In the case of Agriport 7, competitiveness was secured through geothermal energy. Oil-producing countries, including the United Arab Emirates, introduce smart farms to secure food security. However, the competitiveness of smart farm greenhouses that rely on existing fossil fuels will inevitably be inferior. The Korean pilot smart farm installed in the United Arab Emirates also lost competitiveness by applying a thermal storage system running on electricity. The energy utilization technology of the smart farm greenhouse

complex will become a new determinant of smart farm export competitiveness in the future.

〈Figure 46〉 Korea's Innovation Valley

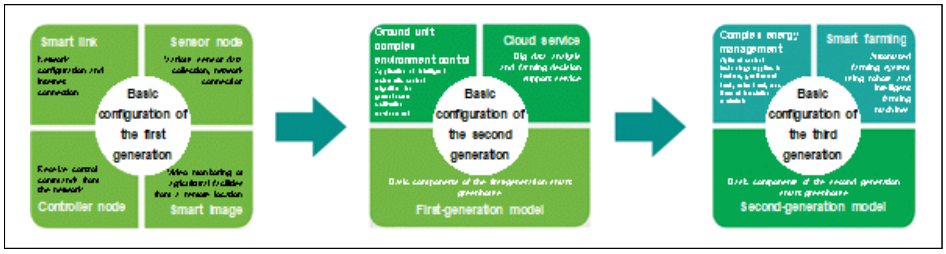
Source: Ministry of Agriculture, Food and Rural Affairs

■ Korean Advanced Export-Oriented Smart Farm Model

The Advanced Export-Oriented Smart Farm Greenhouse, planned by the Korean government, is a system that reduces labor and realizes integrated control using robotics and automation technology. On top of the technological foundation that improves the convenience of the first generation and the productivity of the second-generation products, the new Smart Farm Greenhouse minimizes the energy consumption for production. The competitiveness of the first-generation Korean greenhouse, which is mainly exported to Central Asia, lies in its excellent price-performance ratio. Importing countries are aware of the

disadvantage of the Dutch state-of-the-art glass greenhouses (requiring high initial investment costs), although they are highly productive and satisfactory for growing high-quality crops. They also recognize that low-end greenhouses are low in durability, functionality, and productivity. So far, Korean smart farms (plastic greenhouses) have been competitive in some export markets as an alternative to a high-end one as they are moderate in initial investment costs and performance. However, exporting countries such as China, Turkey, and Iran compete with Korea by narrowing the technology and price gaps. It is time for Korean smart farms to find new competitive factors in the export market.

〈Figure 47〉 Applied Technology at Each Development Stage of the Advanced Export-Oriented Smart Farm



Source: Rural Development Administration

■ Innovation Valley Southern Smart Farm Model

The Smart Farm Valley, which the MAFRA will create in the Goheung Bay reclaimed area of 29.5 ha (22 ha of core facilities and 7.5 ha of resident-participating complexes) in Jeollanam-do, consists of a youth startup incubation center (4.5 ha), a lease-type smart farm complex (6 ha), a resident participation-type complex (6 ha), and a technological

innovation complex (4.5 ha). It has a big difference in scale compared to Dutch Agriport 7 (1,000 ha of glass greenhouses and 40,000 ha of open-air production complexes) promoted earlier. Furthermore, Agriport 7 is private-led while the Innovation Valley is government-led. The pilot project with a budget of KRW 100 billion on about 30 ha aims to create a competitive private-led export complex like Agriport 7. The plan to design a "southern-style smart farm model" to produce tropical crops in preparation for global warming should be a case that can verify the feasibility of expanding the smart farm export market in Southeast Asia. The startup incubation center supporting youth education, employment, and startups, the lease-type smart farm complex where farmers can challenge smart farms, and the demonstration complex where companies and research institutes can test their new technologies should act as a forward operating base to expand the export market. Although the Innovation Valley is a government-led project, cooperation among farmers, prospective young farmers, researchers, private companies, distributors, logistics companies, and cultivation specialists relocated in the Innovation Valley is still vital. It is essential to review the requirements of Southeast Asian importing countries for the Smart Farm Innovation Valley to develop the local agricultural industry a step further and for the Jeonnam-style Smart Farm Innovation Valley to succeed as a global youth startup model.

〈Southeast Asian-Style Smart Farm〉

Source: Wageningen University, Netherlands

The southern-style smart farm model, experimentally promoted in the Innovation Valley in Goheung, Jeollanam-do, should be an opportunity to substitute import items and verify the appropriateness of the smart farm greenhouse model in the Southeast Asian greenhouse export market by successfully cultivating subtropical crops.

Greenhouses in Southeast Asia should be designed to control high temperature and humidity throughout the year, apply insect screens to prevent the intrusion of various pests, and have a structure to prepare for typhoons unique to the tropics. The Netherlands is already piloting greenhouses suitable for these climates. Even in the tropical regions of Southeast Asia, specialized research on greenhouse structures and covering materials is required to design a regional-specific greenhouse considering various climatic zones, including mountainous and coastal regions. In most Southeast Asian countries, the power supply is often unstable, so an energy-saving design should be applied. Green energy, also

called eco-friendly energy, uses pollution-free natural energy, such as solar, geothermal, wind, tidal, and wave power, unlike hard energy that pollutes the environment, such as oil, coal, and nuclear power. It is necessary to review the use of continuously available alternative energy sources, such as solar, geothermal, and hydropower. At the same time, prior consultation is necessary as new energy such as solar, hydro, wind, bio, tidal, and geothermal heat will require a higher initial investment.

An eco-friendly pest control system is critical when designing a southern-style smart farm greenhouse model. In a greenhouse in a humid area, ventilation windows are installed to manage the internal environment, and insect screens are placed. However, the insect screen attached to the ventilation window has the disadvantage of lowering the ventilation effect while offering pest control effects. As a countermeasure, other insect repellent devices may be considered together with the insect screens, or the ventilation window fitted with insect screens may be enlarged. In general, pests prefer an environment with high UV rays, so installing an insect screen that blocks UV rays inside the greenhouse would be good. Aluminum screens that reflect UV light are also known to help prevent pest infestation. Colored insect screens may be used to allure certain insects. Therefore, it is necessary to investigate pests thriving in the local area to select the right insect screen that does not impair ventilation.

〈Figure 48〉 Example of Insect Screen Installation for Greenhouses for Tropical Regions

Source: Rural Development Administration

Among the climatic conditions to consider when designing a southern-style smart farm greenhouse, a window opening and closing device will be required to control humidity. In particular, the efficient design of the skylight, which plays a major role in ventilation inside the greenhouse, may be a competitive factor for export-type greenhouses. Most tropical regions prefer well-ventilated greenhouse structures. Greenhouse skylight systems are designed to provide 100% ventilation while not damaging the greenhouse covering material. An insect screen is installed on the ventilation window to prevent the intrusion of pests, and a barrier is put up to prevent rain from entering the greenhouse even when the skylight is open. The integrated skylight opening/closing device opens and closes the skylight quickly, advantageous for uniform environmental management, such as lighting, temperature, and humidity. This system allows the efficient and cost-effective management of the cultivation environment by discharging the hot indoor air through the skylight, side windows, and front and rear windows without using an energy-consuming

forced ventilation system. The crops can be protected from harmful hot air by increasing the greenhouse height from 4 m to 8–9 m. The design of skylights, side windows, and front and rear windows needs to be reviewed according to the greenhouse type and local conditions.

Because the Smart Farm Innovation Valley project is government-led, it may proceed differently from other cases where private companies take the lead and secure competitiveness according to the market logic, as shown in the Dutch case. In other words, a collaboration between the stakeholders of the smart agriculture policy is crucial. Because private companies cannot afford to develop various technologies necessary for building the southern-style smart farm model, the goal set by the government, integrated governance at the government level, is necessary to facilitate cooperation between various actors, such as research institutes, greenhouse companies, and participating farmers. A plan should increase the localization rate of smart farm equipment necessary to develop the Korean smart farm export model. The government's equipment standardization project can only be carried out smoothly when equipment is localized. Another reason behind the localization is to secure cost leadership. Price competitiveness and technology matter most in the smart farm greenhouse export market. Currently, Dutch and Japanese smart farm greenhouses are the most highly-priced in the export market, followed by Turkish and Korean products, while China dominates the low-end market. Because of the export market's various characteristics, competitiveness in the smart farm is driven by technology and price, the availability of professional growers, and the supply of training programs and operational support systems.

〈Table 32〉 Supplements Proposed to Government-Led Support Policies

	SupplementsNo.	Description
1	Expansion of smart farms	Converting open-air farms, greenhouses, and cattle sheds to smart farms, plant factories, and vertical farms
2	Enhanced collaboration with ICT firms to expand and support smart farms	Contribution of KT and SKT to the smart farm expansion by installing smart farm training centers and subsidizing communication costs for participating farmers
3	Intensified support in distribution and export for smart farms	Shifting production innovation to distribution/export innovation by prioritizing support for agricultural products processing centers (APCs), cold storage, and export logistics
4	Smart farm industrial ecosystem	Reducing manufacturing and administration costs by developing Korean-style operation models and standardizing equipment
5	Smart farm plant industry	Expanding the contribution to the national exports and economy with plant exports potentially worth millions of dollars at a time

Source: International Horticulture Institute

■ Smart Farm Export Model Development and Private Investment Vitalization Plan

Along with securing a budget for the public support policy, it is necessary to create an environment where startups can receive private investments in their technology development. There is a case where the United Arab Emirates' representative sovereign wealth fund, Investment Corporation of Dubai (ICD), has invested about USD 200 million in Indigo Agriculture, a farm tech startup based in Boston, United States, since the end of 2017. Indigo Agriculture produces crops resistant to temperature and salinity by developing technology utilizing fungi and microorganisms to increase crop yields. With the demonstration complex within the Innovation Valley and by supplementing the government's system for industry-university-research cooperation, an environment that can attract investments, like

the Indigo Agriculture case, can be created. As an example of a joint venture, Emirates Catering, a subsidiary of the United Arab Emirate's largest airline, Emirates Airline, established the world's largest vertical farm (12,000 ㎡) near Al Maktoum International Airport in 2018 through a joint investment of USD 40 million with Crop-One, an agricultural firm based in California, United States. Given the size of small smart farm greenhouse companies, the system to support the investigation into different financial support systems, government support systems, and private investment funds in each country should be supplemented.

〈Table 33〉 Measures to Raise Smart Farm Export Fund

No.	Fundraising Measures	Remarks
1	Bank loans in the importing country	Korea Trade-Investment Promotion Agency (KOTRA) research fees to be subsidized
2	Bilateral investment (1:1)	Contract-based financial support required
3	Public aid in the importing country	KOTRA research fees to be subsidized
4	Lending projects (Korea EXIM)	Investigations (EDCF and others) required
5	International organizations (IBRD)	Support of MFA required
6	Local ODA projects	Need to expand ODA projects

Source: International Horticulture Institute

Public support policies tend to be biased toward infrastructure investment geared to upgrade smart farm technology. The smart farm plant industry is the basis for creating high added value through the sixth agriculture industry, while the smart farm plant export can lead to the smart farm city construction industry beyond agriculture. Therefore, smart farm plant exporters need global brand management, and methods to selectively support such marketing technologies and costs should be reviewed. Public support is desirable because local market research is

often costly for a private firm to bear, and the benefits of research results are broad. In particular, MFA needs to provide the necessary support when inviting overseas buyers. Given the ripple effect of smart farm plant exports, forming a network between MFA, KOTRA, RDA, KRCC, private companies, and policy-making ministries is essential. In 2018, MFA dispatched a "Private-Public Joint Smart Farm Cooperation Delegation for Central and South America" to Ecuador and Uruguay in cooperation with MAFRA and KRCC. The delegation comprised public institutions (RDA and the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, and Forestry (IPET)) and five smart farm companies to expand the export market through the network of governments, research institutes, and private companies. Unfortunately, the mission ended as a one-off event. KOTRA, in cooperation with MAFRA, formed a smart farm overseas expansion committee to share countries' market conditions with member companies and support the production of overseas marketing materials. However, KOTRA's support projects must be expanded to include overseas bidding information and investment fund information. The Ministry of SMEs and Startups (MSS) selects promising small and medium exporters to support their joint venture opportunities through networking with global companies and provides information on financial support. In particular, the Financial Services Commission (FSC) is operating a "growth support fund" that each company can use in each growth stage. However, FSC needs to set a plan in cooperation with MAFRA to help private exporters utilize the fund, as the fund requires specialized knowledge to access.

〈Table 34〉 United Arab Emirates Smart Farm Plants' Export Fund Raised

Company	Facility Type	Investment Type	Remarks
Pure Harvest	Smart Farm	Multiple venture capital investments	About 1 ha advanced tomato greenhouses
Baniyas Aquaponics Farm	Smart Farm	Khalifa Fund and Abu Dhabi Jayed Agricultural Center investment, a form of public-private joint investment	The world's largest aquaponics farm (2,400 ㎡) producing 12 t of fish per year and 40 t of fresh vegetables per year
Al Dahra Baywa Greenhouse	Smart Farm	Private investment between Germany and local firms	Annual production of 300 t/ha in the area of 10 ha
Elite Agro Farm	Smart Farm	Private investment by a large enterprise	20 ha producing tomato, paprika, cucumber; tomato production of 300 t/ha
Themar Al Emarat	Smart Farm	Spanish private investment	5 ha, the solar-energy cooling technology applied
Al Zaabi's Farm	Smart Farm	Khalifa Fund	3.3 ha, producing tomato, paprika, cucumber, eggplant, and melon for government purchases; Spanish cultivation technology applied

Source: Korea Agro-Fisheries & Food Trade Corporation (aT)

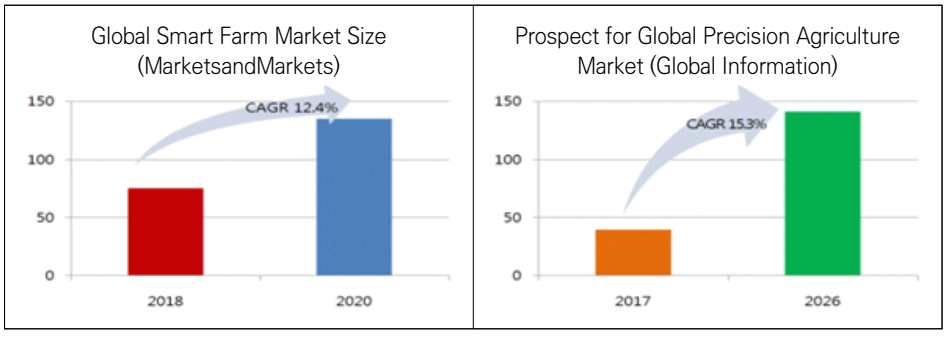
The government-led Smart Farm Innovation Valley serves as a primer for Korean smart farm plant exporters to advance globally. A smart farm production complex capable of high production, educational facilities, a research complex, distribution and logistics facilities, and agricultural and industrial complexes have been built to enhance Korean smart farm technology's export competitiveness. It is necessary to reexamine the roles of each organization so that information sharing between each department can be facilitated for government-academia-research-private sector cooperation.

3.2.3. Expansion Support Policy in Korea and Private Firms' Expansion Status

■ Smart Farm Export Market

The global smart farm market is expected to grow at a CAGR of 12.4% from USD 7.53 billion last year to USD 12.5 billion next year. However, because of the global population increase, there are fiercer changes in the aging rural society, abnormal temperatures due to global warming, the weaponization of food in many nations, and the convergence of agricultural technology with the Fourth Industrial Revolution, competition among advanced agricultural countries in the smart farm and precision agriculture markets.

〈Figure 49〉 Global Smart Farm Market



Source: Ministry of Agriculture, Food and Rural Affairs

The smart farm greenhouse export market is characterized as a plant-type market encompassing greenhouse facilities, equipment, data, and labor force. Therefore, high added value can be created; continuous income can be generated through equipment supply, maintenance, and

repair; related industries, such as seeds, fertilizers, and pesticides, can grow together; and related jobs, such as cultivation and operating, can be created when export is successful. At least 50 different parts are used to build a smart farm greenhouse, indicating that small and medium parts manufacturers can export their products too. However, until the government's active export support project, private greenhouse companies had to stand on their own feet to enter the overseas market. As of 2018, their total exports were a mere USD 100 million. There was no long-term plan to create a brand value (such as "K-Smart Farm") in overseas markets. The average greenhouse export contract amounted to KRW 500 million. Thus, various government support policies are in place to promote small Korean exporters in the large and still growing global smart farm plant market.

A. Pilot Greenhouse Project

The government has built a pilot greenhouse to promote the excellence of Korea's greenhouse technology and is using it as an export base. Smart Farm Foundation of Agri, Tech, Commercialization & Transfer (ODA FACT), Korea Agency of Education, Promotion & Information Service in Food, Agriculture, Forestry & Fisheries (EPIS), and KOTRA have jointly established a cooperative system to support the dispatch of labor forces, local education, and market research as a package for pilot greenhouses. The pilot greenhouse under the Smart Farm ODA project has been or will be installed in Uzbekistan, Kazakhstan, Vietnam, Myanmar, and the Philippines. A new smart farm will be built to demonstrate a raised-bed device for growing strawberries in Russia.

〈Figure 50〉 Four Hectare-Scale Pilot Tomato Greenhouse in Kazakhstan

Source: Doojin Co., Ltd.

Companies wishing to participate in the government-promoted pilot project must form a consortium comprising specialized companies in each field, such as greenhouse construction and design, equipment, materials, and operation. Then, the consortium must submit a proposal comprising a basic business plan and demo greenhouse construction and operation plan, among others. The successful consortium's expenses, including smart farm design and construction, ICT equipment installation, support for the dispatched personnel, local training, and greenhouse demonstration, are subsidized as a package for two years.

The pilot greenhouse project can benefit private companies with low export competitiveness in smart farm plants to enter the export market with government support. Nevertheless, some private companies with excellent technological competitiveness are advancing into overseas markets independently. Although most pilot projects are carried out under

official aid (ODA) programs, joint investment between a smart farm plant company and the hosting government is also made. Another way to promote a pilot project is through joint research on smart farms, as shown in the Middle East (United Arab Emirates and Qatar).

〈Figure 51〉 A Pilot Greenhouse in the United Arab Emirates

Source: Rural Development Administration

■ Export Fairs and Exhibitions

The International Agricultural Machinery Fair, an effective support policy to promote smart farm plant exports, is held in Korea and promising importing countries. Participating in overseas fairs can be burdensome for many small- and medium-sized enterprises because it is costly and requires professional human resources. The official aid (ODA) pilot greenhouse project in promising export markets has a couple of limitations. The target export market is limited and mostly conducted through competitive bidding, benefiting only a few successful bidders. The

government-supported project that can make up for the shortcomings of these pilot projects is the International Agricultural Machinery Fair. The cost of participating in the Fair overseas is subsidized by a maximum of KRW 30 million (the government bears 70% of the total cost while the participating company bears the rest) for each location, and participating companies are selected through documentary screening.

〈Figure 52〉 A Pilot Greenhouse in the United Arab Emirates International Agricultural Machinery Fair in Uzbekistan

Source: KOTRA

KIEMSTA (Korea International Exhibition of Machinery, Equipment, Science and Technology for Agriculture), a domestic exhibition hosted by

MAFRA, is an export marketing event that anyone can join by paying a small participation fee. The Exhibition hosts representatives of many counties (including Deputy Minister of Industry Morozov, Indonesian ambassador to Korea, Uzbekistan ambassador to Korea, Sudan ambassador to Korea, Zambia ambassador to Korea, Sri Lanka ambassador to Korea, Italian deputy ambassador to Korea, and Dutch deputy ambassador to Korea). Although it is not the best overseas marketing opportunity because no real overseas buyers participate, it can be an alternative for companies that cannot participate in overseas fairs.

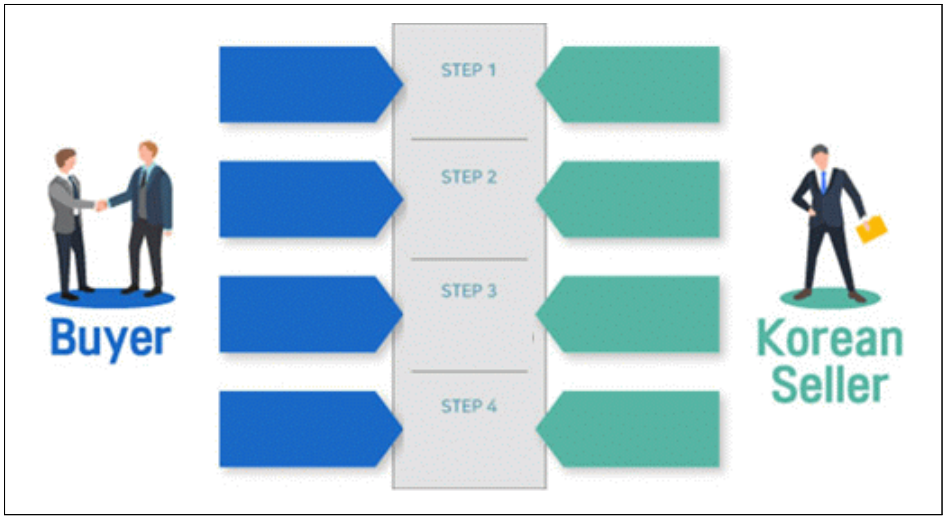
■ Smart Farm Trade Mission

The public-private joint smart farm cooperation delegation is promoted by relevant organizations, such as MFA, MAFRA, KRCC, RDA, IPET, KOTRA, and the embassy of the visited country. It aims to bolster the export of smart farm plants as a support project for the companies interested in expanding the export market. Because the "Smart Agriculture Cooperation Forum" and "Business Seminar and Consultation" events are held in the visited countries, the participating companies can have an opportunity to discover local partners through information exchange. Although it offers the advantage of concluding an export contract reliably and quickly, which would have been difficult for private companies to conclude alone, the number of participating companies is limited, and the mission is not regularly organized.

■ Online Export Marketing through buyKOREA

It is also effective to enter overseas markets using buyKOREA's online export marketing service, an e-marketplace provided by KOTRA. buyKOREA is the only B2B e-marketplace in Korea supporting all transaction processes, such as overseas promotion of export products, the introduction of buying offers (purchasing information), payment services (KOPS), and international EMS deliveries. It also supplies local market research services through KOTRA's overseas trade offices. While pilot projects and overseas exhibitions offer limited opportunities and are expensive to participate in, online export marketing has the advantage of being a cost-effective alternative for all exporters.

〈Figure 53〉 Online Export Marketing through KOTRA-Provided buyKOREA



Source: KOTRA

■ Trade Finance for Smart Farm Exporters

Export support policies supported by the Export-Import Bank of Korea (Korea EXIM) for Korean companies are broadly divided into grant (ODA), relending, and loan (EDCF) facilities. The ODA project support (grants) is restricted to developing countries, and its financial resources are limited.

Relending is a financial arrangement in which the Korea EXIM extends loans to overseas banks under a credit line arrangement to lend money to importers of Korean goods. For example, an Uzbek importer can borrow money from a local bank to pay for the product imported from Korea. Although Uzbek farmers can purchase Iranian, Turkish, or Chinese greenhouses, they can get a loan to purchase Korean greenhouses. Korean exporters are paid immediately without any credit risk. However, there are disadvantages in that only a few foreign banks deal with the Korea EXIM under a credit line: currently, the Korea EXIM offers a credit line of USD 7 billion with 28 banks in 12 countries.

The availability of EDCF loans must be checked with the Korea EXIM because the supported countries and projects are pre-categorized. Eligible projects include (1) a project to resolve global issues, such as climate change and food crises; (2) a project eligible to receive cooperative loans involving international organizations such as the Asian Development Bank (ADB); and (3) an aid-related project joined by small- and medium-sized enterprises (SMEs) in specialized fields.

■ Private Smart Farm Plant Companies' Overseas Expansion

Prior to the government's pilot greenhouse project supporting smart farm plant exports, Norugiban, a private company, signed an agreement with the National University of Agriculture in Kazakhstan for controlled horticulture. The company entered the export market through an arrangement of repairing and operating a 4 ha-large tomato greenhouse in Sarkent. However, the effect of market expansion was insignificant. A new pilot greenhouse will be built on a scale of 1 ha in Almaty by a consortium (K2 Agro Farm Consortium) composed of companies specializing in various fields, such as smart farm construction and design, equipment, and systems. Programs such as cultivation, operation, and education must be successful so that the pilot greenhouse project can result in an export expansion opportunity.

〈Figure 54〉 Signing Ceremony for a Pilot Greenhouse Project in Kazakhstan

Source: Ministry of Agriculture, Food and Rural Affairs

■ Pilot Greenhouse Project in Uzbekistan

Because Korea built a pilot greenhouse under an ODA project in 2014, about 10 Korean smart farm plant companies have entered the Uzbek market. Uzbekistan is a favorable market for exporters, as it is a beneficiary state of the Korea EXIM's relending facility. The exporting countries to Uzbekistan's smart farm market are Russia, China, and Korea, competing on technology, price, and education.

〈Figure 55〉 Three Hectare-Scale Tomato Greenhouse in Uzbekistan (Doojin Co., Ltd.)

Source: International Horticulture Institute

■ Desert-Type Pilot Greenhouse Project in the United Arab Emirates (Green Plus)

The United Arab Emirates is geographically a base market connecting Asia, Europe, and Africa. With the world's second-largest Dubai Airport and the ninth-largest Dubai Port, it has the advantage of growing into a logistics base for controlled horticultural exports. Furthermore, the population in their 20s and 30s, which leads consumption, accounts for

more than 50% of the total population, and the productive population aged 15-64 accounts for 85%, showing excellent market potential in production and consumption. The Internet or mobile environment, essential for the spread of smart farms, is also stable. The United Arab Emirates, an oil-producing country, promotes export through joint research with the Korean government. When designing a pilot greenhouse in a desert area, it is vital to apply an energy source that does not use existing fossil fuels and a water-saving nutrient solution system to consider the reality of water scarcity. A desert-type insect screen different from those in Korea should be applied, and sufficient anticorrosive treatment should be applied to the bottom of the foundation, considering its high salt content.

〈Figure 56〉 Desert-Type Pilot Greenhouse Project in the United Arab Emirates (Green Plus)

Source: Rural Development Administration

3.3. Lessons Learned from Korean Agricultural Experiences

▣ Introduction

Nowadays, Korea is actively implementing international development and cooperation projects for developing countries. Developing countries are making efforts to have continuous development by accepting financial and technical support either at a cost or for free from advanced countries to escape absolute poverty. They request the support of Korea, in particular, because it can hand down its experiences as the only country that has progressed from being a developing to a developed country. Korea received financial aid amounting to USD 12 billion from 1945 (i.e., uponindependence from Japan and when Korea was a country with absolute poverty) to 1995, and through continuous and rapid economic growth, it became a member of the Organization for Economic Co-operation and Development (OECD) in 1996. Since 2000, Korea has actively engaged in Official Development Assistance (ODA) projects as a donor of the OECD Development Assistance Committee (DAC). However, most of these ODA projects are implemented by the Korea International Cooperation Agency (KOICA) of the Ministry of Foreign Affairs (MOFA).

In the 2000s, local governments began to promote exchange and cooperation in several areas as local governments gained their autonomies, and such international exchange and cooperation occurred in the form of human economy and commerce, cultural exchanges, and so on. Furthermore, some local governments are actively participating in

international development and cooperation projects.

In addition, since Sustainable Development Goals (SDGs), which replaced Millennium Development Goals (MDGs), were chosen as the new development agenda at the United Nations (UN) Summit in 2015, the number of ODA projects of local governments has been increasing rapidly (Hye Yeong Jang, 2016).

For about 25 years since 1994, Gangwon-do has been engaging in international exchange activities with local governments of nearby countries such as Primorsky Krai of Russia, Jilin Province of China, and Tottori-ken of Japan, as well as Tuv Aimag of Mongolia through the "Northeast Asia local government growth meeting." Based on such experiences in exchange and cooperation, Gangwon-do built and operated "Gangwon-do Agricultural Town" in Tuv Aimag to hand down Korea's advanced greenhouse cultivation technology to Mongolia, which had traditions of nomad culture and is not familiar with standard agriculture.

As a result, the Mongolian government's prime minister, other ministers, congressmen, journalists, agricultural public officials, and local farmers visited the town and saw the possibility of developing Mongolian agricultural technology. They also commended the level of Korean agricultural technology and recognized it as a successful model.

3.3.1. Mongolian “Gangwon-do Agricultural Town” Building and Operation

■ Mongolian Agricultural Status and Background of Exchange and Cooperation with Tuv Aimag

Traditionally, livestock industry centered on nomadic livestock farming was the key economic industry in Mongolia, and because of nomad culture, wherein people moved around to find pastures, Mongolians usually ate meat and consumed very little amounts of fresh vegetables. After Mongolia's independence from China in 1921, major cereal crops such as wheat, potatoes, and others were locally produced through the Soviet Union’s influence and support. However, after the Soviet Union collapsed in 1989, Mongolia accepted the market economy system in 1990, and its economy collapsed rapidly such that the local production of food became impossible. Thus, since then, Mongolia has relied on import and assistance from other countries (MOFA, 2016).

Project Content	Project Plan	Outcomes
Mongolian “Gangwon-do Agricultural Town” building and operation	On land of 5-10 ha, building greenhouses and others, dispatching experts for six months, handing down cultivation technology	Three sites in 13.5 ha, greenhouses in 0.6 ha, extending the period because of excellent outcomes (2004-2019)
Inviting and training Mongolian agricultural experts	From April to September every year (for 6 months), a total of 32 (2 agricultural public officials, 30 farmers)	Training six agricultural public officials for three years, reducing the size of the project because of the inability to issue visas for farmers
Building “Mongolian nomad culture experience center” in Gangwon-do	On land with high altitude in Gangwon-do, building Mongolia’s traditional culture experience center (Ger lodging, riding a horse, and so on)	Given foot-and-mouth disease (FMD) prevalence in Mongolia, project cancelation because of the prohibition of importing horses

Source: Jae Hee Won, 2016

A major cause of the Mongolians' low average life expectancy is thought to be their meat-centered diet, so the government is looking into vegetables to improve the people's diet. However, Mongolia has a very cold and long winter, as well as a continental climate such that the frost-free season is less than 100 days. Thus, the self-sufficiency rate of vegetable production is very low. In addition, a short history of standard agriculture and lack of cultivation technology served as obstacles, such that it became essential to receive support, including the introduction of technology from other countries, to improve national vegetable productivity

Mongolia in 1990. However, for agricultural projects, some of the standard agricultural components were included, with a focus on the livestock industry, which is a basis of Mongolian agriculture. Since 1999, Gangwon-do has promoted the international development and cooperation of standard agriculture with Tuv Aimag, a large local government that has an exchange and cooperation relationship with Gangwon-do

After establishing a basic plan regarding agricultural technology exchange with Tuv Aimag in 2000, small greenhouses (2,150 ㎡ in 12 buildings) were constructed for testing cultivation in the 10 districts of Tuv Aimag starting 2001. However, because of the low level of cultivation technology, the result was poor, and the dispatch of cultivation area building experts had to be prioritized. To solve the problem, on November 6, 2003, Gangwon-do and the Mongolia Ministry of Food Agriculture and Light Industry (MOFALI) made an "Agricultural technology exchange agreement," thereby beginning an official agricultural technology exchange project (Jae Hee Won, 2016).

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■ Mongolian Agricultural Exchange Project Overview and Promotion Process

The Mongolian agricultural technology exchange project ran for three years, from 2004 to 2006, and the decision on whether to continue the project was to be reviewed after analyzing outcomes. Based on these, three project plans were made as follows (Table 35).

〈Table 35〉 Early Exchange Project Plan (2004-2006) and Its Outcomes

Classification	Total	Step 1 (3 years)				Step 2 (4 years)					Step 3 (5 years)					Step 4 (4 years)				
		Sub total	2004	2005	2006	Sub total	2007	2008	2009	2010	Sub total	2011	2012	2013	2014	2015	Sub total	2016	2017	2018	2019
Total	**1,192**	**368**	113	123	132	**175**	47	30	29	69	**265**	88	50	40	46	41	**402**	40	60	46	256
Transfer of foreign funds	**857**	**265**	85	85	95	**110**	20	20	15	55	**202**	78	40	30	30	24	**280**	24	38	24	194
Overseas travel expenses	**198**	**58**	18	20	20	**40**	10	10	10	10	**50**	10	10	10	10	11	**42**	6	12	12	12
Foreign guest invitation expenses	**107**	**45**	10	18	17	**25**	17	·	4	4	**12**	·	·	·	6	6	**50**	10	10	10	20
Administration fees	**30**																**30**				30

Among the initially planned three projects, only "Gangwon-do Agricultural Town" building and operation was progressed in Mongolia, and the other two projects, of which preliminary reviews were lacking, were either reduced or canceled

Among those three projects, the "Gangwon-do Agricultural Town" building and operation project led by the Gangwon-do Agricultural Research and Extension Services (GWARES) was extended to 2019 to improve the project results based on three-year outcomes. Regarding the invitation and training of Mongolian agricultural experts, only agricultural public officials were invited and not general farmers. The details and outcomes each project are as follows.

■ Mongolian Gangwon-do Agricultural Town Building and Operation Outcomes

First, let's look at the early process of building "Gangwon-do Agricultural Town," which is regarded as a successful model of Gangwon-do's Mongolia agricultural technology exchange projects. From 2004 to 2006 (i.e., for three years), facilities and equipment were supported for two sites in Tuv Aimag to build "Gangwon-do Agricultural Town," and experts were dispatched to review its adaptability through the test cultivation of fruits and vegetables in facilities as well as outdoor leaves and root crops. Also, Mongolian permanent managers were trained on cultivation technology.

However, because crop cultivation circumstances differ every year because of severe climate change, the establishment of a cultivation technology system befitting Mongolia proved to be difficult. Furthermore, Gangwon-do judged that three years were not enough for Mongolian farmers, who only had knowledge on basic cultivation technology, to reach the level of independent farming of fruits and vegetables in facilities. In addition, Tuv Aimag requested the extension of this project so that it became a long-term project consisting of 4 steps with the addition of 1 site from 2004 to 2019 or for 16 years (Jae Hee Won, 2016).

Until 2019, the total budget of Gangwon-do Agricultural Town Building and Operation including the training by invitation was KRW 1.192 billion (Table 26). Its expenses covered facilities and equipment, such as three sites in a total land area of 13.5 ha in Tuv Aimag, greenhouses in 0.6 ha, small agricultural machines, tube wells, fences, and so on (Table 36).

〈Table 36〉 Budget per Year (Gangwon-do Budget: KRW 1.192 billion)

Classification	Total	Step 1 (3 years)				Step 2 (4 years)					Step 3 (5 years)					Step 4 (4 years)				
		Sub total	2004	2005	2006	Sub total	2007	2008	2009	2010	Sub total	2011	2012	2013	2014	2015	Sub total	2016	2017	2018	2019
Total	1,192	368	113	123	132	175	47	30	29	69	265	88	50	40	46	41	402	40	60	46	256
Transfer of foreign funds	857	265	85	85	95	110	20	20	15	55	202	78	40	30	30	24	280	24	38	24	194
Overseas travel expenses	198	58	18	20	20	40	10	10	10	10	50	10	10	10	10	11	42	6	12	12	12
Foreign guest invitation expenses	107	45	10	18	17	25	17	·	4	4	12	·	·	·	6	6	50	10	10	10	20
Administration fees	30																30				30

Because all of the project funds were supported by Gangwon-do, the support of facilities and equipment was minimized, and consumable agricultural materials and travel expenses for operating the project were distributed appropriately to maximize the limited budget.

Moreover, to achieve the ultimate goal of Gangwon-do Agricultural Town Building and Operation (i.e., Mongolian farmers' independent farming), about 3,800 Mongolian farmers were trained on-site.

〈Table 37〉 Gangwon-do Agricultural Town Building Details (Three Sites in 13.5 ha)

Classification (Year)	Location (District)	Cultivation Facility	Additional Facilities	Major Equipment		Others
				Agricultural Machines	Watering Source	
Sum	Three sites	13.5 ha	Six facilities with three types	31 machines with 14 types	Three watering sources with two types	Six devices with five types
Town 1 (2005-2006)	Zuun Mod	Land of 5.5 ha, greenhouses in 3,300 ㎡ (10 buildings)	Offices, storage, temporary compose ground	Total of 13 machines with 13 types (cultivator, machine for farming, cutter, sprayer, seeding machine, and so on)	One tube well and one watering source (2 ha)	Wood fence (2 ha), iron fence (3.5 ha), coal heater

Classification (Year)	Location (District)	Cultivation Facility	Additional Facilities	Major Equipment		Others
				Agricultural Machines	Watering Source	
Town 2 (2004)	Borno	Land of 3.0 ha, greenhouses in 1,650 ㎡ (five buildings)	Offices, storage	Total of 12 machines with 12 types (cultivator, machine for farming, cutter, sprayer, seeding machine, and so on)	One tube well and one watering source (1 ha)	Wood fence (1.5 ha), brown coal boiler
Town 3 (2011)	Bayang Chandman	Land of 5.0 ha, greenhouses in 990 ㎡ (five buildings)	Storage	Total of six machines with six types (cultivator, machine for farming, cutter, sprayer, seeding machine, and so on)	One tube well	Diesel heater

Source: GWARES, 2019

Regarding GWARES's dispatch of vegetable experts, the periods were six months for the first dispatch year (i.e., 2004) and less than one month for the second year onward. As cultivation technology became stable, the dispatch periods were reduced such that from 2011, only four to five trips with about a seven-day period per trip had been made for the project.

Upon review of the adaptable crops and their specific types in Mongolia, a total of 20 crops with 50 types, including fruits and vegetables in facilities and outdoor leaves and root crops, were cultivated for testing for 3 years, and 13 crops with 20 types were chosen based on high adaptability and the locals' preferences (GWARES, 2007). Through a review on adaptability, high-quality production technology was secured, and high-yield crops such as watermelon were feasible as the best Mongolian products. In particular, strawberries were produced and supplied through Gangwon-do

Agricultural Town for the first time in Mongolia. MOFALI linked this to one of the national policy projects, and the Mongolian president highly commended the permanent managers of the agricultural town in 2012 for its outcomes (Jae Hee Won, 2016).

〈Table 38〉 Local Adaptability Test Results for Crops in Mongolia (2004-2006)

	2004 (1st year)Year	2005 (2nd year)	2006 (3rd year)
No. of crops and types reviewed	17 crops with 40 types	20 crops with 50 types	13 crops with 20 types
14 crops selected	• Fruits and vegetables grown in facilities (seven crops): Tomato, cucumber, red pepper, watermelon, oriental melon, pumpkin, strawberry (2010) • Outdoor leaves and root crops (seven crops): Potato, cabbage, radish, Korean cabbage, carrot, onion, green onion		

Source: GWARES, 2007

During the project, various vegetables produced in Gangwon-do Agricultural Town received the grand prize multiple times in the annual agricultural fairs held by MOFALI. Gangwon-do Agricultural Town's permanent managers received the most number of honorable awards, making the Mongolian government acknowledge their contributions to cultivation technology.

In Agricultural Town 1, using internal funds, sunlight greenhouses, which are common in Jilin Province of China, were established. This led to the introduction of tomato and cucumber cultivation in winter as well as strawberry cultivation through hydroponics. As the conditions of the cultivation facilities and production technology improved through this project and the Mongolians' efforts, their production level reached about 70% of that of Korean farming in facilities, signifying high productivity.

Based on these outcomes, Gangwon-do Agricultural Town has been

recognized as a test bed for vegetable cultivation in Mongolia, and after the successful project, it has been linked to MOFALI's policy projects multiple times.

In addition, the success of this project was so widely known in Mongolia that KOICA (Hyeon Woo Lee & Jeong Ik Son, 2008), Japan International Cooperation Agency (JICA), Agence Française de Développement (AFD), and so on visited Gangwon-do Agricultural Town as a preliminary investigation for Mongolian agricultural ODA projects. This was also for an on-site inspection of a developing country's anti-poverty program of the Food and Agriculture Organization of the United Nations (FAO) Regional Office for Asia and the Pacific (Jae Hee Won, 2016).

Furthermore, Gangwon-do Agricultural Town cohosted annual kimchi-making seminars and local parties with Mongolia's Korean women's association using agricultural products made in Gangwon-do Agricultural Town, such as Korean cabbages, radishes, and so on. The Korean Embassy and Koreans in Mongolia participated in these events and expressed their gratitude for playing a part in improving Korea's reputation. Many Koreans in Mongolia also purchased Korean agricultural products from Gangwon-do. Because of that, most of the Koreans in Mongolia were introduced to Gangwon-do's products.

During the project, the Mongolian prime minister, the MOFALI minister, the Tuv Aimag governor, the Russian ambassador, and others visited Gangwon-do Agricultural Town, acknowledging the achievements of Korean agricultural technology and its contribution to Mongolian agriculture. During the Mongolian prime minister's visit, in particular, a state-run TV of Mongolia and Korea's Korean Broadcasting System (KBS),

Munhwa Broadcasting Corporation (MBC), Chosun Ilbo, and others did a major coverage of the event by visiting Gangwon-do Agricultural Town. This provided a benchmark for the other local governments of Korea, and the project was regarded as one of successful international development and cooperation projects (Jae Hee Won, 2016).

Also, the project became an opportunity for exporting Korean greenhouse agricultural materials and small agricultural machines. For instance, MOFALI tried to provide greenhouses using Chinese agricultural materials in the 2000s, but because of strong winds in 2010, many facilities were damaged. This led to MOFALI's agricultural machine department chief (Mr. Davaasuren Yesun-Erdene) to inquire about Korean agricultural materials and machines for cultivation in facilities. Thus, the Korean standard greenhouse design (which is resistant to disasters) and pictures of utilizing Korean small agricultural machines in Gangwon-do Agricultural Town were supplied, and Korean agricultural materials and machine companies were introduced. Through these, until 2012, Korean greenhouse agricultural materials for 16 ha and agricultural machines (100 multipurpose farming machines and 200 cultivators) could be exported to Mongolia. In addition, from 2016 to 2021, 1,692 seeds of flowers such as calla lilies that were produced in Gangwon-do were exported. It was believed that through such projects, it seemed necessary to find ways for mutual collaboration.

However, the biggest challenge was that Mongolian farmers were not able to produce vegetables independently in Mongolia because they lacked the relevant training required. Although there was an agricultural technology training center under MOFALI, the training conducted was

mainly on producing major crops, such as wheat, and there was no expert on the production of vegetables. Thus, in terms of the training system for Mongolian farmers, not only Tuv Aimag but also MOFALI was not able to establish it. Meanwhile, Gangwon-do Agricultural Town was the only on-site vegetable cultivation training place, and it was acknowledged by the Mongolian government for its potential.

Thus, to establish a training system on vegetables for Mongolian farmers, a memorandum of understanding (MOU) was made with the Mongolian State University of Agriculture (MSUA) from 2016 to 2019 (i.e., 4 years). The training programs composed of theory and practice were executed with a focus on the cultivation of vegetables and fruits, such as tomato, cucumber, and strawberry, in facilities. MOFALI also selected and called the public officials of 21 Mongolian Aimags and farmers for training and supported their travel expenses as well as administration and budget. Accordingly, a total of 730 Mongolia agricultural public officials and farmers participated in training, and those who have completed training have been exerting efforts to distribute the technology for cultivating vegetables in facilities. In addition, farmers have been earning income from fruit and vegetable cultivation by investing in facilities and contributing to the improvement of the independent supply of vegetables in Mongolia.

In September 2017, an international symposium with the topic "Korea and Mongolia agricultural exchange project status and development plan" was held in Ulaanbaatar in Mongolia, where the previous operational outcomes and development plan of the vegetable cultivation in facilities in Mongolia were discussed. In 2019 (i.e., the last year of the project), a

Gangwon-do Agricultural Town operation report was published in Korean and Mongolian and presented in Mongolia. About 100 people attended this session, including the Mongolian Tuv Aimag governor, the MOFALI vice-minister, the Korean ambassador to Mongolia, and the president of the Korean society in Mongolia, and they commended the outcomes (GWARES, 2019).

Moreover, in the opening ceremony of the "2018 PyeongChang Winter Olympics," the Tuv Aimag governor notified that he would build the Agro-Park in Zuun Mod soum (soum is the equivalent of a district or "gun" in Korea) under the jurisdiction of the Tuv Aimag's office and requested technology and facility support. The governor of Tuv Aimag was planning to intensely promote agriculture, as a Mongolian new international airport (5 km away from the project site) was built. Through discussions between Gangwon-do and Tuv Aimag, in 2018, Tuv Aimag prepared the land and infrastructure, including civil engineering works, electricity, and tube wells, in the center of Zuun Mod soum (next to the sports complex) using its own budget. In 2019, for the first time in Mongolia, Gangwon-do additionally supported a hydroponics cultivation facility with a size of 1,000 ㎡ for green vegetables. However, the selected project managers were ignorant of cultivation technology. Then, Gangwon-do Agricultural Town operation was terminated because the cultivation technology support was really difficult, and the conditions of producing crops were unfavorable. Cultivation failures were repeated until 2020, and in the early 2021, Tuv Aimag handed down management authority to the permanent managers of Agricultural Town 1. Consequently, cultivation, harvest, and sales are all stable this year. For difficulties arising from operational cultivation

technology, as well as facility and environment management, communication with GWARES using SNS and others has been done to solve any issue. Handing down the technology of cultivation in facilities requires much time based on a recipient country's cultivation conditions, human resources, infrastructure, and so on. In the end, when a providing country transfers technology to a recipient country, the technology level and experiences of the recipient country prove to be beneficial to having a successful project, and Tuv Aimag acknowledged the project as such.

■ Inviting and Training Mongolian Tuv Aimag Agricultural Public Officials and Farmers

In the early period of the project, from 2004 to 2007, a total of eight agricultural public officials (two officials per year) for four years were invited for six-month vegetable cultivation technology training by GWARES as well as visits of nearby complexes of cultivation in facilities. It was a standard agricultural technology with excellent outcomes. However, Tuv Aimag delayed the selection of public officials for training, the submission of documents required for visa issuance held up the training period, and long-term training results were less than expected yearly because of the trainees' lack of language abilities in a foreign language (Jae Hee Won, 2016).

Because all of the project funds were supported by Gangwon-do, the support of facilities and equipment was minimized, and consumable agricultural materials and travel expenses for operating the project were distributed appropriately to maximize the limited budget.

Moreover, to achieve the ultimate goal of Gangwon-do Agricultural Town Building and Operation (i.e., Mongolian farmers' independent farming), about 3,800 Mongolian farmers were trained on-site.

〈Table 39〉 Status of Inviting and Training Mongolia Agricultural Public Officials

Year	Training Period	No. of Trainees	Participants	Training Details
2004-2007	Long-term training (6 months)	8	Agricultural public officials	Vegetable cultivation technology, on-site visit, and so on
2009-2019	Short-term training (2-4 weeks)	40	Public officials, farmers, graduate students, and so on	Same as above

Source: Gangwon-do office, 2004-2019

Thus, the long-term training was stopped, and since 2009, it was improved with a short-term training of two to three weeks; not only agricultural public officials but also farmers who cultivated or wanted to cultivate vegetables were included as trainees. Moreover, for smoother communication, it was requested that among the trainees, at least one trainee had to be able to speak in English or Korean. Initially, for the long-term training, the entire training costs were covered by Gangwon-do. For the short-term training, airfares were paid by trainees, so only trainees enthusiastic about acquiring vegetable cultivation technology participated, improving the training results.

Gangwon-do is located at a high altitude, and its cool summer weather makes it Korea's main location for vegetable production during summer. As the weather characteristics of Gangwon-do are very similar to those of Mongolia, the training program by invitation, in which trainees could apply appropriate vegetable cultivation technology on-site in Mongolia,

was operated as well as Gangwon-do Agricultural Town.

Through such training process, Tuv Aimag's agricultural public officials and farmers realized the importance of the technology of cultivating vegetables in facilities and Korea's advanced agricultural level. As a result, some of the public officials who completed the training built facilities such as greenhouses at their discretion in Mongolia and educated local farmers on cultivating vegetables. Also, they participated as assistants in the practical vegetable cultivation technology training in Gangwon-do Agricultural Town, thereby improving the training results (Jae Hee Won, 2016).

3.3.2. Implications of "mongolian Ag ri cultural technology Exchange Project"

■ **Success Factors of Agricultural Technology Exchange Project**

The reason that "Mongolian Gangwon-do Agricultural Town Building and Operation" of Gangwon-do, the local government's first project, was successful is that it promoted an essential project for Mongolia and performed detailed tasks tailored to local conditions. The major success factors are summarized as follows.

- First, by fostering close relationships between the local governments of both countries in 1999, works regarding exchange and cooperation were prioritized, and preliminary investigation was performed during the planning of an agricultural exchange project. A few vege-

table crops were cultivated in advance for testing for three years, and after that, ODA project plans were made to reflect the local conditions. Thus, an international development and cooperation project with a high possibility of success could be promoted.

- Second, through long-term cooperation between both local governments, project stability was secured. As the project's purpose was to increase self-sufficiency in terms of vegetable products by improving the agricultural technology level of a recipient country, it was supposed to take a long time to train specialized human resources. However, the current outcomes are possible because diplomatic relationships between the recipient and providing countries did not matter, and short-term outcomes were less important. Gangwon-do consistently upheld the policy by providing long-term support until the agricultural technology level of Mongolia attained self-sufficiency.
- Third, sufficient human networks of the recipient country were secured. To promote successful ODA projects, experts and helpers from the recipient country were needed, and many Mongolians staying in Korea because of studies, work, and other reasons understood the project's purpose and cooperated so that the projection's promotion was relatively smooth. In addition, there were only two GWARES employees responsible for the project for 16 years; each worked under the project for over 12 years, and so sufficient human networks were established.
- Fourth and last, a project related to vegetable farming at a high altitude was chosen because of Gangwon-do's potential. ODA projects of

local governments have less resources compared to the central government, so this project was judged to be an appropriate international development and cooperation project, wherein good outcomes could be obtained with small project costs (Jae Hee Won, 2016).

Report was requested by the international agricultural development and cooperation project team), the "Mongolian Gangwon-do Agricultural Town Building and Operation Project" was evaluated with a focus on financial and economic analyses based on five evaluation criteria of the OECD Development Assistance Committee (DAC). The results show that ① adequacy was equivalent to that of the Green Revolution (2003-), which is Mongolia's national program; ② efficiency was good, as permanent managers and agricultural public officials were well trained; ③ effectiveness was evident, as profits increased and reinvestment was made because of improved productivity since 2008; ④ through technology training, public influences were made, such as by establishing a training center for farmers in Gangwon-do Agricultural Town as a Mongolian NGO used Swiss ODA funds; and ⑤ continuity was excellent because of reinvestment and technology training based on project profits (So Hee Park and Jong Seob Kim, 2018).

Furthermore, in an article called "Effective Policy Making Process in Local Government's International Development and Cooperation Project" (Ji In Kim, 2020), in the project composition step (i.e., policy formation step), aid knowledge was lacking, and a project was selected based on intuition, experiences, insight, work knowledge, and so on. However, in the policy execution step, local adaptability based on a multitude of

experiences regarding high-altitude vegetables, technology cooperation, partnership, efficient communication structure, and securing continuity through a long-term project was made. Thus, in the policy evaluation step, the project was deemed to have led vegetable production in Mongolia and helped improve the relationship between both countries.

■ Implications and Future Improvement Plan

Despite success factors and excellent evaluation from an institution specialized in international development and cooperation, there were some problems with the Gangwon-do Mongolia Gangwon-do Agricultural Town Project. Upon reviewing those, suggestions for future international development and cooperation projects are described as follows.

First, even in the project planning step, it is important to acquire accurate information about the recipient country and prevent mistakes by having sufficient discussions in advance. Decision-making in most local governments' international exchange projects is usually done through a top-down approach. The farmland in this project is a state-owned land rented by individuals for 60 years, so the persons who required training were farmers and not agricultural public officials. Thus, ownership of the project was foreseen in the middle of the project execution. It was through an interpretation and translation communication error that Tuv Aimag understood this undertaking to be a support project for farmers. Furthermore, the Customs Law of Mongolia does not allow free customs for ODA projects between local governments, so it was difficult to clear customs every year. Therefore, sufficient preliminary review, including

that of local conditions such as the legal and institutional strategies of a recipient country, must be performed when promoting ODA projects (Jae Hee Won, 2016).

Second, to improve the outcomes of projects, a standard model of an international development and cooperation project such as Gangwon-do Agricultural Town must be developed. The Gangwon-do Agricultural Town project started by training a few Mongolian farmers toward becoming personnel that specialized in cultivation in facilities. However, to have the same goal of "improving self-sufficiency in terms of vegetables," an important component of vegetable-related policies in Mongolia, it was crucial to train a greater number of Mongolian farmers. Thus, by cooperating with MOFALI and MSUA, on-site training programs for farmers were operated, drawing the Mongolian government's attention. The project has been completed, but to train farmers in the future, consistent efforts from the Mongolian government are required. Furthermore, a standard project model utilizing cases such as Gangwon-do Agricultural Town needs to be created, and a recipient country's government, coupled with financial institutions, needs to support distributing such models financially (So Hee Park & Jong Seob Kim, 2018). As of 2020, the Mongolian agriculture and livestock industry fund is loaned at a low long-term interest for farmers to have Korean-style greenhouses (Hong Jin Kim, etc., 2020). In addition, as there is no agricultural wholesale market in Mongolia, selling fresh agricultural products is difficult. Thus, improving distribution and sales by introducing a public wholesale market, installing a low-temperature storage facility, and other tasks must be included in Mongolian government's national as well as international development and cooperation projects.

Third, to grow together with Mongolia based on a cooperative relationship between both countries, more active economic exchange and cooperation programs are necessary. Mongolia has set and pursued a sustainable agricultural and livestock industry goal from 2021 to 2030. Moreover, through the "Mongolian long-term development policy vision 2050 (hereinafter "Vision 2050")," regional development goals were set. If ODA support such as the Gangwon-do Agricultural Town project systemically becomes a part of agriculture-related support systems, industrial cooperation between two countries will commence naturally, creating a virtuous cycle. In particular, in "Vision 2050" of the Mongolian government, one of the goals is to develop a smart agricultural and livestock industry in relation to the Fourth Industrial Revolution, and it poses a potential avenue for Korea to support smart farms and advance related industries (Hong Jin Kim, etc., 2020). Because Mongolia lacks a manufacturing industry, most of the agricultural materials needed for farming were supplied through import. Through this project, Korean agricultural materials, such as small agricultural machines and greenhouse materials, were recognized for their great quality, increasing the exposure of Korean agricultural materials to Mongolia to some extent. Thus, when promoting ODA projects, the plan should consider how to improve Korea's image by advertising relevant industries (Jae Hee Won, 2016).

▣ Conclusion

So far, through the "Mongolian Gangwon-do Agricultural Town Building and Operation Project," which was promoted to expand future

collaboration through the support of the technology of vegetable cultivation in facilities in Mongolia, a developing country near Korea has been improved.

Gangwon-do performed the first international development and cooperation project of agriculture as a Korean local government, and it was very meaningful because its advanced agricultural technology became known both locally and internationally. It has been devising a new plan for continuous development following the basic strategy that Mongolian agricultural development and mutual benefits are to be promoted. However, to secure an exit strategy by considering Mongolia's independent continuous operation, the project period was extended repeatedly so that it became a 16-year long-term project. Therefore, there is a limitation on the analysis of the project outcomes.

Regarding international development and cooperation, agriculture is essential for developing countries to flourish continuously. Likewise, it is vital for the continuous expansion of Korean ODA projects. To expand the ODA budget to the level recommended by OECD DAC, not only the Korean government but also the local governments and private organizations play a crucial role.

Under such circumstances, Korean local governments are expected to actively participate in or independently promote various international development and cooperation projects. Thus, I expect that the "Mongolian Gangwon-do Agricultural Town Building and Operation Project" promoted by GWARES will become a successful "standard model" of agricultural technology ODA projects for local governments

〈 Reference Photos 〉

〈Figure 57〉 Gangwon-do Agricultural Town Construction.

Source: GWARES, 2019

〈Figure 58〉 Outdoor vegetables.

〈Figure 59〉 Training Technology in Mongolia.

〈Figure 60〉 Training in Korea by Invitation.

〈Figure 61〉 Training Mongolian Agricultural Public Officials on the Technology of Cultivating Vegetables in Facilities (Both Theory and Practice).

〈Figure 62〉 Installation of Korean-Style Smart Farm Test Beds (KIST Branch in Gangneung).

〈Figure 63〉 Gangwon-do Agricultural Town 1: Since 2006, Funded by Mongolia.

〈Figure 64〉 In Gangwon-do Agricultural Town 1, Installation of a Training Center by NGO for Farmers.

〈Figure 65〉 Korea and Mongolia International Symposium (Ulaanbaatar in September 2017).

〈Figure 66〉 Main Visitors: (Left) Northeast Asia Local Government Growth Meeting, (Middle) Mongolian Prime Minister, (Right) Russian Ambassador to Mongolia

3.4. General Status and Supporting Systems for Korean Private Companies to Advance to Partner Country

■ Agricultural Environment

- Mongolia has a typical continental climate, the period with the lowest temperature (i.e., below zero) is between early and late September, and temperature becomes above zero between early May and early June. The number of frost-free days during which cultivation of crops is possible is between 92 and 128.
- The amount of rainfall was 290 mm (as of 2019) in Selenge Aimag (an agricultural region), and it rains intensively between June and September.
- The land area is 156.41 million ha, which is larger than the Korean

Peninsula by 7.4 times. Out of the total cultivating area (114.736 million ha), the agricultural land area comprises 1.20 million ha (i.e., less than 1%), and 80% of it is pasture, while 10% of it is forest.

■ Main Crops/Fruits and Vegetables Supply Status

- Mongolia is traditionally a nomadic country, and the agricultural and livestock industry comprises about 13% of the total GDP.

- The number of livestock farms is about 170,000, and their production amount is about 86.1% of the Mongolian agricultural production amount.

- The domestic meat consumption amount is 318,800 tons, and the export amount was about 70,000 tons, accounting for 28.5% of the total export (USD 1.60 million in 2018), coming only next to cashmere. In addition, every year, about 4–5 million animals are slaughtered for export.

- As of 2020, the number of livestock was 71 million, and as 96% of feed depended on pasture, productivity was low. Moreover, on 23% of the pasture, the number of animals that were grazing was 3–4 times greater than capacity limitation.

- It is expected that the number of livestock will increase by 6.7%–10% annually until 2025, so a policy for increasing the settlement-type livestock industry to 20% is being promoted. It is also expected that the feed market will grow by 40%, and the use of mixed feed will comprise about 10%.

- The amount of harvesting agricultural products largely depends on the amount of rainfall, and in 2018, it increased by 73% compared to the previous year, so it was the largest amount in six years. However, in 2019, it was reduced by about 5% compared to 2018.

- A total of 424,100 tons of crops, including wheat, 192,100 tons of potatoes, and 98,900 tons of vegetables were harvested, and as of 2019, among the total sowing area (526,000 ha), land for crops comprised 70.2%, and those for potatoes, vegetables, and feed grains comprised 2.8%, 1.5%, and 8.3%, respectively.

- In 2018, 90.9% of the crop sowing area and 80.6% of the feed grain sowing area belonged to farming companies. On the other hand, individual farmers worked on 77.5% of the area devoted to growing potatoes, 76.1% of that for vegetables, and 19.4% of that for feed grains. That is, in Mongolia, farming companies cultivate crops and feed grains, while individuals mostly cultivate potatoes and vegetables.

- As of 2017, 2,700 tons of fruits were harvested from 6,200 ha, thereby supplying 11% of the domestic demand.

- As of 2017, 5,140 tons of vegetables were harvested from 75.9 ha (in winter: 19.1 ha, and in summer: 56.8 ha) through greenhouse cultivation.

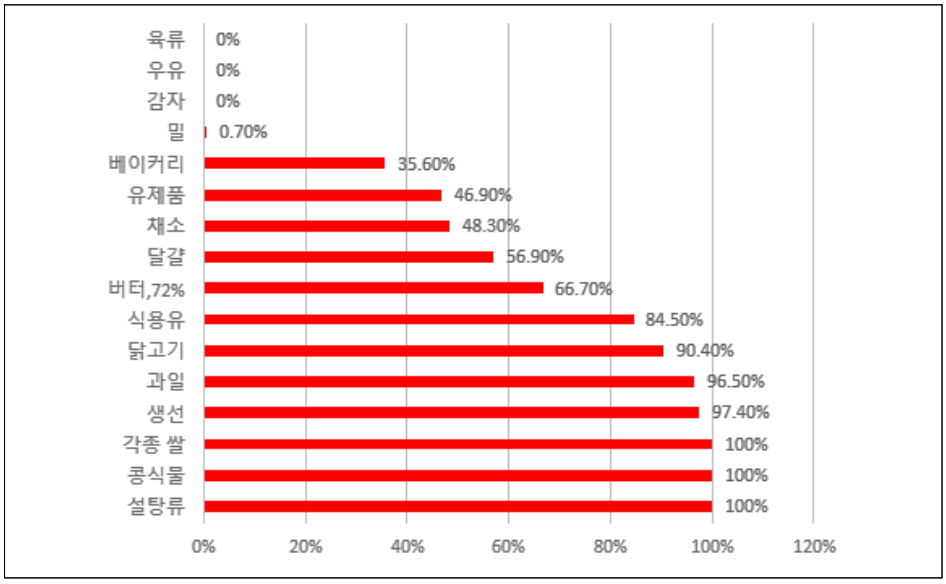
- Foods other than meat, milk, and potatoes rely on imports, and since 2020, the custom of importing vegetables has been increased to 30% to encourage domestic vegetable cultivation.

- As the manufacturing infrastructure was weak in Mongolia, in 2018, the export of vegetable products amounted to USD 22.01 million, but

the import was six times greater (i.e., USD 130 million).

- Because of low storage technology, some crops (e.g., potatoes) are being imported continually, although domestic production can supply 100% of the total demand. Similarly, as greenhouse cultivation has been increasing recently, the domestic supply of strawberries, cucumbers, and tomatoes is increasing.
- Although the main diets of Mongolia, such as wheat, potatoes, meats, dairy products, etc., can be supplied domestically, the supply of vegetables, fruits, and high-quality dairy products mostly rely on imports.

〈Import share of main foods〉



■ Opportunities and Obstacles of Korean Companies Advancing into the Mongolian Market

- The Mongolian government is trying to introduce mechanization and innovative technology to solve problems such as reduction of farmland, soil deterioration, and shortage of workforce.

- Because wheat, potatoes, onions, etc. are cultivated on a large scale by farming companies, most of the processes, such as sowing, pest control, harvesting, etc., are mechanized, and large agricultural machines are commonly used.

- Because of the large amount of solar radiation, dry air, lack of soil infiltration by water, and high runoff, introducing technologies in irrigation, such as mulching, drip-watering, etc., are necessary.

- Although active efforts need to be exerted to meet the demand for the latest machines, such as irrigation equipment, etc., there is a disadvantage because the downstream industry foundation is weak.

- Vegetables, such as cucumbers, watermelons, strawberries, tomatoes, carrots, etc., are cultivated in greenhouses and supplied by small-sized independent farmers. As of 2017, the mechanization level of vegetable cultivation was 38%, as 96.5% of farmers performed manual irrigation, whereas automated irrigation was done only by 3.5% of farmers.

- The cultivation of vegetables in facilities is usually done in unheated greenhouses and in suburban areas, with leafy vegetables, in particular, being cultivated in northern winter greenhouses through heat-

ing with coal-burning boilers. Because these areas are located at high latitudes (north latitude 41.35–52.08) with short sunshine hours, the cultivation of vegetables or fruits during winter is very rare.

- Because of various national programs promoted by the Mongolian government, it is expected that the demand for Korean products will increase for their own manufacturing.

〈Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis of Korean Companies Advancing into the Mongolian Market〉

Classification	Positives	Negatives
Regional Characteristics	〈Strength〉 • Better recognition of "Made in Korea" than that of Chinese products • Cheap workforce, lots of Mongolian workforce who can speak Korean well • Products whose prices are competitive with European products can be advanced into the market more smoothly	〈Weakness〉 • Small market only for 3.23 million people • Weakened price competitiveness caused by high transportation costs as compared to Chinese products • Limitation of the export market because it is an inland country • Lack of specialized human resources • Weakened price competitiveness because of the strong KRW
External Environment Change	〈Opportunity〉 • 113 million ha of pasture area and 1.2 million ha of farmland • Total of 66 million livestock • Near to the huge markets of China and Russia • Improvement of sales condition after local manufacturing and production	〈Threat〉 • Corruption in the entire society • Sensitive to international variables because of a high reliance on 3Cs (China, copper, and coal) • Reduced purchasing power because of the weakened Mongolian currency • Soil deterioration in 60% of the farmland area

- As Mongolia has a weak manufacturing infrastructure, it relies on importing everything, including simple subsidiary materials.

- Cultivation in facilities is increasing gradually; thus, the demand for winter greenhouse pipes, cover (usually polycarbonate), plastic, irri-

gation, thermostats, and light control apparatus is high.

- Because of a long winter, the demand for technology as well as facility and equipment that can be used to store agricultural products obtained from greenhouses in the long term is high.

• As suburban agriculture is expected to develop, the demand for smart farm-related materials and materials for solar power generation for heating is expected to increase.

• The mechanization level of vegetable cultivation, production, and harvest processes was about 40% as of 2018, and to increase it to 60%, in 2020, the "Two-Step Vegetable Program (2019–2022)" was promoted using MNT 229.3 billion (about USD 90 million).

• Mongolia is producing an annual average of 2,500 tons of fruits but is importing about 18,000–22,000 tons of fruits per year.

- A total of 92% of the fruits harvested in Mongolia is seaberries, while 8% of them consists of watermelons, small-sized apples, and wild berries, all of which are only 1.5% of domestic fruit demand.

- The currently promoted "Fruit Program (2018–2022)" diversifies the types of fruits, and as the demand for seeds and raising seedlings for diversification is high, the import of materials for raising seedlings and seeds is expected to increase.

〈Promising Exhibitions Participated in by Korean Companies〉

Item	Details
Name of Exhibition	Mongolian International Agriculture and Food Fair
Period/Location	Every year / Khui 7 Khudag / September 6–8, 2019
Exhibition Item	All items related to the agricultural and livestock industry
Participation Size	100 companies / 10,000 persons
Website	www.agroexpo.mn
Note(s)	Host Institution: Expo Mongolia LLC Person-in-Charge: Ms. Chuluundari Email: info@expomongolia.mn Contact no.: (+976) 8909-0820

〈 Reference 1 〉

Relevant Institutions for Cultivation in Facilities

Name of Institution	(English) Ministry of Food, Agriculture and Light Industry (MoFALI) (Korean) 몽골 식품·농업·경공업부
Department in Charge	NAEC National Agricultural Extension Center
Home Page	www.naec.mn
Main Phone Number	Tel.: (+976) 7011-8087
	Email: info@naec.mn
	Address: 60-1 Damba Street, 6th Khoroo, Chingeltei District, Ulaanbaatar, Mongolia
Note(s)	• Mongolian MoFALI is in charge of making and implementing policies for the food industry that is directly related to the health of the people, traditional agricultural and livestock industry, and light industry, wherein various raw materials for leather and hairs obtained from livestock industry are processed. • It was established through Decree No. 286 of the Mongolian government to build an innovative technology introduction center for the agricultural industry in 1996. Furthermore, it was supported to achieve stable development and introduce innovative technologies in the agricultural industry.

Name of Institution	(English) National Association of Mongolian Agricultural Cooperatives (Korean) 농업 협동조합들의 협회
Home Page	www.namac.coop
Main Phone Number	Tel.: (+976)11-458899, 453824
	Email: info@namac.coop
	Address: NAMAC building, 1st Khoroo, Bayanzurkh District, Ulaanbaatar, Mongolia
Note(s)	• To protect the rights of agricultural workers and develop the agricultural industry

〈 Reference 2 〉

Main Agricultural Companies

Name of Company	GATSUURT LLC	**Home Page**	www.gatsuurt.mn
Import Items	Agricultural machines, fertilizers		
Company Overview	• Established in 1992 (no. of employees: 1,100) • Operates branches in the agricultural and livestock industry, mining industry, food manufacturing industry, real estate and construction industry, tourism industry, etc. • Overseas cooperative companies: John Deere, Grimme, Valley, Morris, Valmont, Westeel, Castrol, Hardi, Interlim, Gooweol Engineering, Dong Yang Engineering • Cultivates vegetables, such as wheat, potatoes, carrots, cabbages, ginger, etc., in a 20,000 ha farmland		
Main Importing Country	Korea, Russia, France, United Kingdom, United States, etc.		
Contact Information	• Phone number: (+976) 7000-3357 • Email: assist@gatsuurt.mn • Address: Gatsuurt own Building, 20th Khoroo, Bayangol District, Ulaanbaatar, Mongolia		

Name of Company	AGROMACHTECH LLC	Home Page	www.agromachtech.mn
Import Items	Agricultural machines		
Company Overview	• Established in 2008 (no. of employees: 30) • Imports and distributes agricultural machines and provides customer services • Overseas cooperative companies: Rostselmash, Altay Shina, Klever, Kirov Tractor, Altrak Agro, YTO International, etc.		
Main Importing Country	Russia, Ukraine, Belarus, China, etc.		
Contact Information	• Phone number: (+976) 70375059 • Email: agromachtech.mgl@gmail.com • Address: Agromachtech own Building, Khunsnii Combinat Street, Darkhan City, Mongolia		

Name of Company	Agro-Alfa	Home Page	https://www.facebook.com/Agro-Alfa-LLC-169527046529289/
Import Items	Agricultural pesticides, fertilizers		
Company Overview	Established in 2011 Imports agricultural pesticides and fertilizers		
Main Importing Country	Korea, China, Russia, Netherlands		
Contact Information	9911-4556 agroalfa576@gmail.com 1st and 2nd floors, Urguu-68 Building, Peace Avenue, 10th District, Bayangol District, Ulaanbaatar City, Mongolia		

Name of Company	Nogoon harsh	Home Page	https://www.facebook.com/NOGOONKHARSH/
Import Items	Landscaping materials, seedlings, solar heat / Chinese-type greenhouse, irrigation systems		
Company Overview	Established in 1996 Provides landscaping, seedlings, solar heat greenhouses, and customer services		
Main Importing country	China		
Contact Information	9191-9969, 9191-4026 greencastle_mgl@yahoo.com Nalaikh District, Ulaanbaatar City, Mongolia		

Name of Company	Microciti Irrigation	Home Page	http://www.usal.mn/
Import Items	Irrigation systems		
Company Overview	Established in 2013 Provides irrigation systems and customer services		
Main Importing Country	Israel, China		
Contact Information	7010-0246, 9666-0246 info@microcoto.com A10, 1st floor, 2nd District, Bayanzurkh District, Ulaanbaatar City		

Name of Company	Soyolj	Home Page	http://www.soyolj.com/
Import Items	Agricultural materials, seeds, seedlings, irrigation systems		
Company Overview	Established in 1992 Provides agricultural materials, seeds, seedlings, and irrigation systems		
Main Importing Country	China, Russia, Germany, United States		
Contact Information	7777-5080, 8810-8255 soyolj@magicnet.mn 1st Khoroo, Sukhbaatar District, Ulaanbaatar City		

Name of Company	Munkh nogoon amidral	Home Page	https://ecobirj.weebly.com/
Importing Item	Irrigation system, solar heat greenhouses		
Company Overview	Established in 2005 Provides irrigation systems, solar heat greenhouses, and customer services		
Main Importing Country	China		
Contact Information	9961-4895, 9911-6763 www.ecobirj.mn Greenhouse Building, 28th School, Bayangol District, Ulaanbaatar City		

Name of Company	MK Supermarket	Home Page	http://www.mkyds.com
Importing Item	Korean food ingredients, fruits, fish		
Company Overview	Transportation company, grocery store managed by MK directly		
Main Importing Country	Korea		
Contact Information	976-9611-8809		

Agricultural Products-Related Korean Companies (Handling Korean Foods)

Name of Company	Monchaga	Home Page	
Import Items	Mongolian Chaga mushroom, pine nut, natural honey, health supplement foods		
Company Overview	Sells Mongolian health supplement foods to Korean tourists		
Main Importing Country	Korea		
Contact Information	976-8085-4353		

Name of Company	Peace Supermarket	Home Page	
Importing Item	Korean food ingredients, fruits, fish		
Company Overview	Sells products, such as Dongwon Tuna, Nongshim, Maeil Milk, Chungjungone, etc.		
Main Importing Country	Korea		
Contact Information	976-9192-3176		

〈 Reference 4 〉

Mongolian Agricultural Products-Related Trend (2021)

- As the number of Mongolian livestock has increased excessively, several issues, such as lack of pasture and water, have occurred, so a livestock tax was established (Mongolian Assembly; November 13, 2020).
- Korean and Mongolian startup ecosystem MOU (January 14, 2021)

  Korea: Korea Institute of Startup & Entrepreneurship Development (KISED; president Kim Gwang-hyeon) of Ministry of Small and Mid-Size Enterprises (SMEs) and Startups

Mongolia: MoFALI Young Entrepreneurs' Association (President Namuun Battulga)

Sharing information regarding the business environment and policy trends of both countries

Exchanging expertise and improving cooperation between the companies of both countries

Promoting a collaborative project on the development of the legal infrastructure of Mongolian SME startup policy

Establishing a "Startup Hub" in the new city hall in Ulaanbaatar

- Submission of a bill of free customs for agricultural machines/materials to the national assembly (Department of Agriculture; April 16)

  Free or reduced customs for tractor, combine harvester, irrigation equipment, fertilizer, agricultural pesticide, etc.

  Contributing to the continuous growth of agriculture, introduction of new technology, environment-friendly agriculture, etc.

  Agricultural product cultivation area (2020): 536,600 ha

  Wheat 364,000 ha, potatoes 18,600 ha, vegetables 9,600 ha, rapeseed 61,100 ha, feed grains 52,700 ha

  Increased production amount compared to the previous year for wheat 7,400 tons, potatoes 50,400 tons, vegetables 20,400 tons, and feed grains 52,100 tons.

  Agricultural equipment import amount (2008-2020)

Agricultural machine: MNT 1.47 trillion, fertilizer and pesticide: MNT 893.4 billion *All of them have been imported.

- Establishing Mongolian government's water resource management and utilization plan (Department of Environment and Tourism; April 30)

  Spending 35% of water-related income for water resource protection and recovery

  Among MNT 45.1 billion, MNT 9.2 billion was spent for water resources protection and recovery (2020)

  Mongolian annual average water resource in total: 6,084,000 ㎥ *Required amount: 5,000,000 ㎥

  Because of the recent global warming, it was reduced to 5,648,000 ㎥.

  180 lakes, 116 rivers, and 381 wells were dried up

  By 2030, the demand for water will increase by 2–3 times greater than it is now.

- Approving Mongolian government's 2022 development plan (National Assembly; June 17)

- Approving a development plan based on "The Law on Development Policy, Planning and Management)" established in May 2020.

  A total of six chapters: 23 goals with 263 implementations

  COVID-19 response, raising workforce, economic policy, e-policy,

green development, urban development, regional development, etc.

Budget: MNT 10 trillion, *Mongolian government MNT 8.7 trillion, local governments MNT 117 billion, foreign debt and aid MNT 2.2 trillion, private and public investment MNT 1.2 trillion, and others MNT 5.7 trillion

Economic growth rate 4.6%, inflation 5.8%, financial deficit 3.6% of GDP

Expanding occupational education and training with the goal of zero poverty rate in 2030 *Poverty rate in 2020: 26%–30%

- Mongolian national assembly reviewing "Plant seed and type law revision," etc. (July 6)

  Designating the nation's additional special preservation areas

  Three areas in the Arkhangai Province: Jargalant, Chuluut, and Undur-Ulaan soums

  Reviewing the plant seed and type law revision and seed industry development support law

  To respond to weather changes, such as drought, severe heat, severe cold, etc., activities were performed, including the following: analyzing the status and preparing innovative plans, such as for plant type development, research, trade improvement, oil resource utilization, food security, etc.

- Prohibiting self-slaughter for food safety (September 1)

Annual meat consumption amount per person: 170.8 kg *54 kg/month (winter), 13.5 kg/month (summer)

No. of meat contamination cases (2019): 33,200/106,100 cases tested *Contamination rate: 3.3%

- Expected problem during harvest because of the lack of workforce and frequent rain (Department of Agriculture) *Start of harvest: September 15

  Wheat 416,800 ha (26,700 ↑), potatoes 19,000 ha (1,600 ↑), vegetables 9,400 ha (877 ↑), feed grains 80,000 ha (51,200 ↑), oilseed crop 86,000 ha, fruit trees 4,700 ha

  Germination and harvest delayed because of low temperature during the sowing period

  Encouraging students, soldiers, and volunteers to participate in harvesting (MNT 50,000 per day)

- Sufficient supply of wheat, which is the main crop, because of the efforts of the government

  Loaning agricultural fund at a low-interest rate: MNT 326.0 billion, interest rate 3% with 50% of advance loan

  Importing MNT 18 billion of agricultural machine/equipment, supporting 12,500 tons of wheat seeds (seed renewal 30%), 485 tons of feed grain seeds, 43.3 tons of crop protecting agents, 890,200 liters of fuel

Promoting “Household Farming Movement” as a national vegetable program

Supporting 10 types of vegetable seeds with a total of 176.2 tons: Saving purchase costs amounting to MNT 1.9 billion.

4 Project Plan

4.1. Project Scope and Description

SECTION 1. BASIC PROJECT INFORMATION		
1.1	Country	Mongolia
1.2	Title	Establish a national smart greenhouse complex for training and production, and increase the domestic greenhouse vegetable supply
1.3	Location(s)	21st khoroo (Rashaant), Songino Khairhkan District, Ulaanbaatar, Mongolia
1.4	Duration	60 months (2024–2028)
1.5	Budget (total)	USD 10 million
1.6	Objectives	Sustainable and inclusive vegetable production and distribution to ensure food and nutrition security in Ulaanbaatar
1.7	Beneficiary	School children, students, local producer cooperatives, government officers, general consumers of UB
1.8	Implementing organization	MoFALI and MULS

SECTION 2. PROJECT RATIONALE	
	SITUATION ANALYSIS: Please provide a brief introduction to the current social and economic situation related to the Project (geographic region and beneficiaries, etc.). Describe the problem or critical issue the project seeks to resolve, how it was identified, and how the Project will address the problem. If relevant, an analysis of gender equality needs to be described.
2.1	Over the last 25 years, Mongolia has become a vibrant democracy, with a per capita gross domestic product (GDP) tripling, an increase in school enrollment, and a dramatic decline in maternal and child mortality. Mongolia's long-term development prospects are promising (NORDEA 2020) because of its vast agricultural and mineral resources and an increasingly educated population. Currently, the mining sector holds the key to the national economy, accounting for 27% of GDP, 19% of the state budget, 88% of exports, and around 4% of the country's workforce. However, the mining-dependent economic structure is highly dependent on exports, and imports from a single market inevitably face risks of global market volatility (EBRD, 2019). With the new long-term development policy, Vision-2050, the Mongolian government envisions a more diversified economic system that balances the mining industry and other industries, including the minerals processing industry, finished products, agriculture, and industrial sectors (Mongolian Government, 2020). The new policy encompasses climate-resilient, sustainable agriculture to ensure food and nutrition security and increase agriculture export capacity. Modernized and industrialized agriculture is highlighted by utilizing innovations, such as information communications technology (ICT), bio, and food technology. Bringing foreign investment is suggested as one core strategy. This strategic direction allows the country to replace its current imports and aims to export agricultural products to its neighbors in the region.
	Agricultural Development in Mongolia Mongolia's economy has been experiencing rapid growth and change since the transition from central planning to the early 1990s. In 2011, mineral exports were the main driver of achieving average incomes, while the agricultural sector played an important role in generating income and creating jobs in Mongolia's economy. Agriculture accounted for 13.2% of GDP in 2016, providing employment to 31.1% of the population, producing about 80% of the total agricultural output, and generating more than 10% of annual export earnings. The lowest productivity in the sector is 1.1 MNT. MNT 7.7 million, the highest in the mining sector, because of adverse weather conditions, low investment in agricultural modernization, weak research and development capacity, and lack of expansion services (FAO, 2020). There are also challenges in the post-harvest process and production of quality agricultural products. Mongolia's current food and agricultural value chains are weak. Implementing the national food control system and food safety standards is insufficient, and it is difficult to support exports. Significant investment is required in a reliable value-added system at all stages of production, from raw materials to processing and distribution. These include competitive procurement, storage, processing, packaging, transportation, and end-sales (FAO, 2020). Vegetable production Vegetable production (with 17,415 small and hourly farmers) contributes to economic, social, and nutritional outcomes in the agricultural sector. Production includes wheat, barley, vegetables, and fodder plants. However, agriculture is not sufficiently diversified

	and relies heavily on livestock production (ADB, 2020). Mongolia is a net importer of vegetables, and government policies support import substitution. Mongolia is fully self-sufficient in meat and potatoes, its major exports. However, it produces only two-thirds of other vegetable needs and imports it at high prices during the off-season, substituting for income and economic benefits. After the collapse of the Soviet Union, state support for national and regional agricultural research and expansion centers declined. Cultivation techniques are unsuitable for water productivity and were exacerbated by climate change. Productivity is further limited because of the lack of access to high-yield, climate-resistant varieties. Mongolia currently imports approximately USD 114 million worth of vegetables and other unprocessed food products, including USD 5.15 million worth of cabbages and USD 3.62 million worth of onions. Consumption has stagnated since 2015 and has fallen below the levels set out in the National Nutrition Guidelines. Most small farmers choose to sell their produce to traders and intermediaries because traders come to the farms in their vehicles and buy vegetables for cash at the farm door price. Farmers generally sell all their produce at once and harvest near the lowest prices because they lack storage facilities. Bypassing such intermediaries by selling directly to retailers and corporate buyers may result in higher prices for farmers. However, not all farmers can meet the quality requirements set by retailers to meet consumer demand. Vegetables are in high demand by people who care about their health, and a more balanced diet can be beneficial to public health. About 90% of the fruits are imported from China. The Mongolian diet, dominated by meat and bakery products, limits the consumption of fruits rich in vitamins and minerals. According to the study, one of the main causes of nutritional imbalance was the high prevalence of food insecurity among households, with 23% reporting "severe" food insecurities. The government supports innovative initiatives like mechanizing farms and water-efficient irrigation, making vegetable production 100% self-sufficient by 2025, meeting the growing demand, and addressing food security. This support will have a positive effect on providing the population with the nutrients, energy, and vitamins it needs to maintain a diverse and balanced diet. It is hoped that the benefits of an improved diet for children will reduce the lag. Sustainable agriculture Mongolia is one of the most vulnerable countries to climate change because of its geographical location, climatic conditions, and lifestyle. Climate change increases the risk and burden of economic sectors highly dependent on nature and the climate, leading to droughts and heavy snowfalls. It is vital to introduce environmentally friendly technologies and increase efficiency and productivity, including the widespread use of renewable energy, in the long run, to mitigate and overcome climate change. The Government of Mongolia supports implementing the long-term policy for developing the agricultural sector from 2021 to 2030. One of the most important plans is to make the agricultural sector environmentally friendly, highly productive, sustainable, and adaptable to climate change. Implementing technology-based agriculture will help strengthen agricultural production capacity, reduce the risk of unforeseen circumstances, and meet domestic demand.
2.2	**COUNTRY DEVELOPMENT STRATEGIES AND POLICIES:** Please describe how the Project relates to other relevant national development strategies and policies and provide the ongoing status of their implementation, results, and effects.

Mongolia, along with other UN member states, approved the SDG Program until 2030 in 2015 and announced its commitment to sustainable development. The deadline is less than 10 years, and many of these goals are difficult to achieve, especially in a sustainable food system. Therefore, the Government of Mongolia is intensifying its efforts to ensure food security, improve nutrition, and support sustainable food production.

Providing adequate, safe, and nutritious food for all will also develop the private sector, create jobs and livelihoods, and attend to natural resource management, climate change, biodiversity, gender equality, governance, health, education, and nutrition. Therefore, the Government of Mongolia will take a unified approach to developing the food and agriculture sectors. During this decade, the government will intensify efforts to increase sustainable food production, improve nutrition, increase employment and value, build capacity, and promote good governance.

Particular attention will be paid to the involvement of farmers, herders, small and medium enterprises, and Mongolia's youth in developing this action plan. These efforts will be based on the government's actions, such as strengthening cooperation with partners and stakeholders. Several key ministries, international development partners, civil society, farmers' organizations, youth organizations, and the private sector are expected to participate.

Mongolia carried this vision further in a new long-term national development policy document called Vision-2050, adopted in 2020. It aims to transform the country into a leading regional power by 2050 by fighting poverty, creating a greener economy, improving the education system and gender equality for enhanced job access, and redefining the Mongolian social strategy in a more citizen-centered way. It also aims to offset the negative trends caused by the COVID-19 pandemic. Vision-2050 was approved by the Mongolian Parliament on May 13, 2020.

The Government considered the necessity of developing a long-term development policy document that summarizes the past 30 years and envisions the next 30 years. Mongolia's long-term development policy has 9 fundamental goals and 50 objectives that will be carried out in three periods: 2020-2030, 2031-2040, and 2041-2050.

2. Human Development – Safe Living Conditions

Favorable living environment

Target 2.5. Create a wealthy, healthy, safe, and comfortable living environment for the people by ensuring food security

Implementation phases and general direction of the activities:

Stages	Objectives	Activities
Stage I (2020-2030)	Create a healthy and safe living environment	• Strengthen the registration system, quality management, control, and verification at all levels of the food network. • Support the production of innovation-based goods and provide safe and nutritious food.
Stage II (2031-2040)	Create a comfortable living environment	• Improve hygiene, safety standards, and requirements for food supply and distribution, and create a reliable and sustainable food production to cultivate healthy food consumption, including organic, fortified, and regulated food.
Stage III	Create an	• Lead the development path of the food processing

Stages	Objectives	Activities
(2041–2050)	environment that satisfies living needs	industry by improving the eco-food export conditions for the Mongolian brand.

❖ Activities to implement within the target

Strengthen the food control systems at all stages of the food chain, such as registration, quality management, inspection, and certification processes

2.5.16. Set up the food safety control system by establishing tracking systems for potato and vegetable production processes, including reserved seed potatoes and vegetable seeds, soil conservation, soil processing, cultivation, irrigation, harvesting, storage, transportation, sales, and retail trade.

2.5.19. Introduce hazard analysis and critical point control principles, food safety management systems, a food chain (from primary production to the consumer) control system, and standards in the food processing industry.

Improve the availability of safe and nutritious food for all

2.5.20. Implement national food policies aimed at stabilizing food supply and availability, ensuring food safety at all stages of the food chain, and improving the national food standards in line with the international and regional standards.

2.5.21. Promote innovative manufacturing of organic and nutrient-enriched products, regulatory services, and product variety.

2.5.23. Strengthen social protection measures to protect poor and vulnerable groups living in food-insecure households.

8. Regional Development (Ulaanbaatar Capital City)

Sustainable Agriculture

Target 8.3. Develop agriculture as a leading sector of the economy that is environmentally friendly, adaptable to climate change, risk-bearing, responsive to social development trends, needs, and requirements, responsible, highly productive, and sustainable.

Implementation phases and general direction of activities:

Stages	Objectives	Activities
Stage I (2020–2030)	Intensify the resource utilization and commercialization of agricultural production and transform the sector from quantity to productivity and quality.	• Adhere to the principles of a green economy in agricultural production, strengthen the capacity to adapt to climate changes and risks, and develop smart systems based on insurance, registration, and information. • Improve the utilization of the total crop rotation fields, ensure the main cultivated crops meet the domestic demand fully, and increase the production of other functional crops. • Develop specialized markets, supply chains, and value chains for agricultural raw materials and products, and boost their economic potential and effectiveness. • Provide the population sustainably with food supply from agricultural production and supply the processing industry with high-quality raw

Stages	Objectives	Activities
		materials.
Stage II (2031–2040)	Fully utilize agricultural resources and compete for sustainable production, efficiency, and productivity.	• Develop agricultural production with a science–based sustainable development orientation, build capacity to apply knowledge, introduce advanced technologies and innovations, and strengthen cooperation. • Establish quality assessments for agricultural products, and strengthen the exchange trading system. • Develop intensive agriculture and farming, and build an ITP.
Stage III (2041–2050)	Develop "Smart" agriculture.	• Support and develop science based–green production, business, and agricultural tourism. • Renew the research and development system of the agricultural sector, and expand the production. • Increase export through the production of high–capacity, organic, and branded products, and create new sources of income for the economy.

National Food Vegetable Program

There is a need to increase vegetable crop areas, develop protected soil production, strengthen vegetable seed production, irrigation, storage, and support domestic vegetable production. The goal of the "National Vegetable Program" implemented with our project is to sustainably develop vegetable production throughout the year and meet domestic demands by supporting household farmers, specialized vegetable enterprises, and cooperatives. The following objectives will be implemented within the framework of the program objectives.

2.2.1. Support the cultivation of protected soils, increase the variety of crops, increase the yield per unit area, provide fresh vegetables in winter and spring, and reduce dependence on imports.

2.2.2. Increase vegetable production by introducing advanced techniques and technologies and encouraging private investments to increase the volume of irrigated crops, storage and cellar capacities, direct trade networks, and specialized markets.

2.2.3. Assist vegetable seed production and test localized crops and vegetables.

2.2.4. Build human resource capacity by improving the knowledge and skills of vegetable producers, conducting training and retraining, and providing information to qualified farmers.

Government of Mongolia Action Plan for 2020–2024

3.3 Develop the production and sales network of agricultural products, fully satisfying the domestic demand for key food products and substituting import–oriented products.

3.3.1.5. Establish greenhouses that operate in all seasons to increase domestic production and reduce imports.

3.3.1.9. Introduce Good Agricultural Practices (GAPs) in agricultural production.

3.3.3. Fully meet the demand for main food products through domestic production.

	3.3.3.6. Stabilize the supply of vegetables. 3.3.11. Provide incentives to herders and farmers who increase agricultural production and supply their products to national industries. 3.3.11.1. Establish storage and sales complexes for potatoes, vegetables, fruits, meat, and agricultural products in Ulaanbaatar and other regions. The national strategy aims to improve agricultural production and the nutritional status of Mongolians through various schemes. The proposed project aims to provide technical and financial assistance for smart greenhouses and expand the value chain. To this end, Mongolia gives the Mongolian people the right to a high level of food security and agricultural development.
2.3	**JUSTIFICATION FOR INTERVENTION:** Please describe how the need for the Project was determined and the rationale or justification for the Project (why the Project is considered the most effective way to resolve the problem). The aforementioned situation analysis and national development strategies and policies clearly demonstrate the urgent need for a more diversified and balanced economic structure. Introducing appropriate and contextualized agricultural innovations, such as Smart Greenhouse Technology, to cope with extreme climate conditions and strengthen our technical capacity will greatly contribute to achieving the government's vision. This project will create efficient food and agricultural systems that will substantially increase production and competitiveness and build a sustainable food network that benefits public and private businesses. Materializing this requires the development of efficient and inclusive agricultural value chains accompanied by product quality control and a certification system. The government's strategic initiative for the national vegetable program will be supported by joint investment in establishing a National Smart Greenhouse Complex (NSGC). The comparative advantages, knowledge, and experiences of the Republic of Korea in high-tech smart agriculture and local food network promotion will contribute to the Mongolian government's endeavor in food and nutrition security for the well-being of its population. Once successfully implemented, we can increase access to nutritious vegetables for everyone throughout the year. Strategically, the project aims to create a smart greenhouse complex that will serve as a national institute and production, education, and research center to extend vegetable cultivation technology. Through this project, we will create a culture of greenhouse farming and local food consumption that is commercially viable, environmentally sustainable, and socially conscious. At the national level, this project will support and promote MoFALI's initiative to establish the NSGC. We suggest a joint investment between MoFALI of Mongolia and MAFRA of the Republic of Korea. The NSGC will serve as a national institute for smart greenhouse agriculture development that functions as a research and development (R&D) and training center for tailored and contextualized greenhouse technologies for Mongolia. Furthermore, the complex will be equipped with a high-tech commercial greenhouse model embracing agribusinesses and large-scale commercial farmers, cooperatives, and individual farmers. Scientists, greenhouse control experts, and extensionists trained by MoFALI can develop more climate-adaptive and tailored greenhouse technologies and crop varieties that will survive in extreme climates. Government extensionists will train farmers and enterprises in customizing various solutions for different groups. In addition, the complex will find the most efficient and sustainable energy uses for greenhouse

	production. Once the complex is set and running, cooperatives trained for the complex will produce safe and nutritious vegetables for the citizens of Ulaanbaatar, and stakeholders of the greenhouse value chain will benefit. Positive changes in urban middle-class consumers toward healthy local food consumption will open more opportunities for cooperatives linked up with local supermarket chains and retailers. Direct sales between producers and local consumers will increase the accessibility to fresh and nutritious vegetables for the most marginalized population of the city with the city government's promotion. This way, Ulaanbaatar City, which contains half of the country's population, will ensure food and nutrition security that aligns with the national development strategy for sustainable and inclusive agriculture, reaching out to the most marginalized communities and middle-class consumers. In the long run, smart greenhouse technologies will extend outside Ulaanbaatar City to reach rural communities.
2.4	LESSONS LEARNED: Please describe what lessons the Partner Country has learned (from the Partner Country's own and others' past experiences) in designing this Project. "Gangwon-do Agricultural Town Project in Mongolia" has been in operation for the last 16 years, which invested KRW 901 million in the agricultural sector in Mongolia, starting from the first stage from 2004 to 2006 (3 years), the second stage from 2007 to 2010 (4 years), the third stage from 2011 to 2015 (5 years), and the fourth stage from 2016 to 2019 (4 years). Through this project, 13.5 ha of three horticulture complexes were created and had been operating in three places in Zuunmod City, Bornuur county, and Bayanchandmani county in Mongolia's Tov province. The lessons from past experiences include: 1. Successful capacity development through education and training programs and the development of cultivation technology textbooks • Thirty-two agricultural officers and farmers participated in long-term (6 months) and short-term (2 to 4 weeks) training programs in South Korea from 2004 to 2017. • Mongolian vegetable experts were fostered through training programs and developed and disseminated textbooks in Mongolian on the cultivation techniques for six fruits and vegetables. • About 500 Mongolian farmers were provided technical training and advice per year. • Mongolians' vegetable cultivation capability in the agricultural town has reached the level of Korean farmers at 75%. • Vegetable experts are dispatched 4-5 times yearly to provide farmers training in other areas and stay for 7-15 days. 2. Successful transfer of greenhouse technology and improved productivity • A total of 50 crops and 110 varieties were tested from 2004 to 2006, and the final 14 crops were selected. • The first strawberries in Mongolia were grown, and hydroponic gardening was introduced. • In 2012, 40.5 tons of crops were produced with MNT 33,500,000 in sales, which highly improved productivity, compared to 20 tons of crops worth MNT 15,000,000 in sales in 2005. 3. An external evaluation conducted by the Seoul National University Graduate

	School of International Studies concluded the project's positive results in all areas of relevance, efficiency, effectiveness, influence, and sustainability The following are the considerable lessons reflected in this project based on how the project was implemented. First, this project will establish a production system available to produce crops throughout the year through the standardization of facilities and the introduction of smart farm technology. The cultivation period of crops is relatively short, and the utilization rate of facilities is fairly low because Mongolia experiences severe annual climate changes and long, cold winters. In addition, most greenhouses are vulnerable to natural disasters, such as strong winds, which damage numerous facilities. It will promote the production of fruit and vegetables throughout the year and increase productivity by using smart farm technology. Disaster-resistant vinyl greenhouses and an ICT technology application will be planned to construct a production system impervious to natural disasters and unaffected by seasons and climate. Hence, we expect this to ensure a stable production system in the future. Second, systematic and professional technical education should be provided. During the Gangwon-do Agricultural Town project, productivity was hampered by slow-spreading technology in the local area, and there were many difficulties in selecting and producing crops suitable for the area. Furthermore, the lack of basic knowledge of local farmers about horticulture took a considerable amount of time to transfer the technology to society. This proposed project requires fostering more diverse agricultural professionals with sector-specific expertise, such as seedling producers, greenhouse control engineers, and extensionists, entrenching the Smart Farm system. Third, a diversified distribution network for the mass supply of vegetables will be strongly desired. Most vegetables are imported from China, while low quality has not led to a high consumer preference for Chinese vegetables. Since there is no local distribution network to replace imported vegetables from China, distributing local agricultural products remained a critical challenge. Therefore, this project will supply vegetables to public institutions, such as schools and hospitals, and establish a stable food network in the market by linking producers to various distribution channels to expand the vegetable value chain. This project will create a value chain that will continue to generate sustainable and secured profits even after this project ends in 2026. Based on the above lessons, the project will meet the long-term development policy of the Mongolian government by aiming to increase the production of vegetables, increase consumption, strengthen agricultural production capacity, and build a distribution structure.
SECTION 3. PROJECT DESCRIPTION	
3.1	Objective/Outcome/Output: Please outline the objectives, expected outcomes, and outputs of the Project.
	Objective (long-term outcome) Sustainable and inclusive vegetable production and distribution are achieved to ensure food and nutrition security through a smart greenhouse vegetable value chain development in Ulaanbaatar. **Outcome (within the project period of 2024-2028)** **Outcome 1.** Investigation of the greenhouse vegetable value chain, policy, and legal environment Output 1.1: Basement study of the greenhouse vegetable value chain

<table>
<tr><td></td><td colspan="3">Output 1.2: Feasibility study of the construction of the National Smart Greenhouse Complex
Outcome 2. Establishment of the National Smart Greenhouse Complex in collaboration with MoFALI and MAFRA of the Republic of Korea.
Diversified and improved vegetable value chains:
Output 2.1: Construction of the smart winter greenhouse complex
Output 2.2: Development of the cultivation technique and standard model
Output 2.3: Establishment of the education system for the vegetable cultivation technique extension for greenhouse cultivation in Mongolia</td></tr>
<tr><td rowspan="14">3.2</td><td colspan="3">Activities: Please describe what will be carried out in terms of planned activities, their timing and duration, and those responsible for each activity. It should indicate the sequence of all major activities and implementation milestones.</td></tr>
<tr><td>No.</td><td>Planned Activity</td><td>Responsible Party</td></tr>
<tr><td colspan="3">**Outcome 1. Investigation of the greenhouse vegetable value chain, policy, and legal environment**</td></tr>
<tr><td colspan="3">**Indicator:** Increased amount of vegetable production and months of adopting smart greenhouse technologies (e.g., 200% increase compared to a nonsmart greenhouse, vegetable production available from 4 months to 12 months yearly)</td></tr>
<tr><td colspan="3">Output 1.1 Basement study of the greenhouse vegetable value chain</td></tr>
<tr><td>Activity 1.1</td><td>Research study for enhancing the vegetable value chain and policy establishment ability by supplying greenhouses in Mongolia</td><td>• KREI
• MULS</td></tr>
<tr><td colspan="3">Output 1.2 Feasibility study of the construction of the National Smart Greenhouse Complex</td></tr>
<tr><td>Activity 1.2</td><td>Activity 1.2 Feasibility study for constructing a smart (Venlo type) winter greenhouse complex</td><td>• MoFALI (land, building construction, and infrastructure)
• Sketch LLC</td></tr>
<tr><td colspan="3">**Outcome 2: Establishment of the National Smart Greenhouse Complex**</td></tr>
<tr><td colspan="3">Indicator 1: Standard model of protected facilities suitable for the climate and economic condition and constricting demo farms
Indicator 2: Increased consumption of greenhouse vegetables through new value chains (no. of schools, hypermarkets, and wholesalers/retailers supplied)</td></tr>
<tr><td colspan="3">**Output 2.1 Construction of the smart winter greenhouse complex**</td></tr>
<tr><td>Activity 2.1.1.</td><td>A block of greenhouses measuring 3 hectares with engineering and technological systems for growing vegetables</td><td rowspan="4">KREI
MoFALI</td></tr>
<tr><td>Activity 2.1.2.</td><td>An administrative building and service infrastructure</td></tr>
<tr><td>Activity 2.1.3.</td><td>Objects of engineering support and arrangement</td></tr>
<tr><td>Activity 2.1.4</td><td>On-site facilities</td></tr>
</table>

	Activity 2.1.5	Transportation costs for import and delivery of equipment	
	Activity 2.1.6	Costs of work on the package preparation of initial permits, development of design, and estimate documentation and services of the customer-developer	
	Output 2.2 Development of the cultivation technique and standard model		
	Activity 2.2.1	Inputs and raw materials for production	MoFALI KREI MULS
	Activity 2.2.2	Preparation for cultivation	
	Activity 2.2.3	Experimental cultivation	
	Activity 2.2.4	Production cultivation and development of distribution network	
	Output 2.3 Establishment of the education system for the vegetable cultivation technique extension for greenhouse cultivation in Mongolia		
	Activity 2.3.1	To learn from the experiences of countries with well-developed, smart, and high-tech greenhouses	MoFALI KREI MULS
	Activity 2.3.2	To produce educational programs that strengthen the abilities of agronomists, agricultural officials, and farmers	
	Activity 2.3.3	To organize educational and training programs	
3.3	**Budget:** Please provide a brief requirement of the activities. The budget requirement is not full and well-defined. The detailed budget requirement will be fully elaborated after the PCP is selected.		
	Activity	**Contents**	**Proposed budget (in USD)**
	Outcome 1. Investigation of the greenhouse vegetable value chain, policy, and legal environment		
	Output 1.1		
	Activity 1.1.1	Research study for enhancing the vegetable value chain and policy establishment ability by supplying greenhouses in Mongolia	30.0
	Output 1.2		
	Activity 1.1.2	Activity 1.2 Feasibility study for constructing the smart (Venlo type) winter greenhouse complex	34.4
	Outcome 1 Total		**64.4**
	Outcome 2. Establishment of the National Smart Greenhouse Complex		
	Output 2.1 Construction of the smart winter greenhouse complex		
	Activity	A block of greenhouses measuring 3 hectares with	4,854.3

	2.1.1.	engineering and technological systems for growing vegetables	
	Activity 2.1.2.	An administrative building and service infrastructure	496.8
	Activity 2.1.3.	Objects of engineering support and arrangement	786.9
	Activity 2.1.4	On-site facilities	805.2
	Activity 2.1.5	Transportation costs for import and delivery of equipment	110.0
	Activity 2.1.6	Costs of work on the package preparation of initial permits, development of design, and estimate documentation and services of the customer-developer	476.7
	Output 2.1 Total		**7,529.92**
	Output 2.2 Development of the cultivation technique and standard model		
	Activity 2.2.1	Inputs and raw materials for production	569.0
	Activity 2.2.2	Preparation for cultivation	24.07
	Activity 2.2.3	Experimental cultivation	109.7
	Activity 2.2.4	Production cultivation and development of distribution network	987.6
	Output 2.2 Total		**1,690.37**
	Output 2.3 Establishment of the education system for the vegetable cultivation technique extension for the greenhouse cultivation in Mongolia		
	Activity 2.3.1	To learn from the experiences of countries with well-developed, smart, and high-tech greenhouses	135.0
	Activity 2.3.2	To produce educational programs that strengthen the abilities of agronomists, agricultural officials, and farmers	15.3
	Activity 2.3.3	To organize educational and training programs	35.0
	Output 2.3 Total		**155.3**
	Outcome 2		**9,375.59**
	International and Mongolian Expert Cost		**560.0**
	Total Project Budget		**10,000**
	Required Financing		**9,935.6**

SECTION 4. STAKEHOLDER ANALYSIS	
	TARGET BENEFICIARY: Please describe the following information: a) direct and indirect / wider beneficiary group, b) the number of beneficiaries with gender segregation, if necessary (e.g., 300 children rather than children in 3 schools), c) how the target group was identified, d) why they were selected as a target group, e) how intended beneficiaries have been involved in the Project design and their expected role in Project implementation and evaluation. If relevant, the target group should be disaggregated by sex.
4.1	Direct beneficiaries: (Please provide an estimation – national consultants/experts) • Citizens of Ulaanbaatar City: Provides 4% of the greenhouse vegetable demand. The total population of Ulaanbaatar City is 1.5 million. • Suburban citizens • Greenhouse operators: Training for about 200 farmers and agronomists yearly. There are 2,650 households and 350 companies operating greenhouses nationwide, and 10% of them will be trained. • Agriculture researchers and students
	OTHER STAKEHOLDERS: Please describe other stakeholders (e.g., partner government agency, international organization, NGO, donor agency, etc.), if any, including a) name/group, b) respective role(s) and cooperation/coordination mechanism, etc.
4.2	• MoFALI officers and experts (extensionists) • Ulaanbaatar's government (Department of Agriculture) • KREI (other agriculture development agencies) • MULS, IPP • Seeds company • Greenhouse material suppliers • Supermarket chains, wholesalers, retailers • Nonbeneficiary local farmers and cooperatives • Existing vegetable value chain actors • Livestock farmers and value chain actors

SECTION 5. PROJECT MANAGEMENT AND IMPLEMENTATION	
	PROJECT MANAGEMENT: Please describe a) who will be responsible for the planning and management of the Project operations and for coordinating other bodies and organizations associated with the Project, b) what arrangements will be established to ensure effective coordination with other relevant programs and activities.
5.1	The Project Steering Committee (PSC) of the project will consist of MoFALI, KREI, and MULS. MoFALI, as the contracting party, will be responsible for the planning and management of the coordination within the country. For the joint investment in National Smart Greenhouse Complex, MoFALI will provide the infrastructure for the project site (land, water, fence, road, electricity, etc.) KREI will provide technical support by inviting smart greenhouse and value chain experts from Korea. For maintenance and sustainability purposes, basic greenhouse building materials are procured mainly within the recipient country. MoFALI and KREI will import the required high-tech equipment and materials. Developing new value chains will be supported by MoFALI and KREI.

The following documents as annexes are required to be submitted together with the PCP.

Annexes

Annex 1. Project Location Map

The project area is 4.2 hectares and is located in front of the Rashaant station in the 21st khoroo, Songinokhairkhan district, Ulaanbaatar, Mongolia. The project area is owned by MoFALI, and the land possession certificate number is 000438612.

In 2021, the engineering-geological survey for implementing a smart greenhouse complex in this project area was carried out by the construction design and engineering geology company, Sketch, LLC, as requested by MoFALI.

〈location map of the project〉

Description	2021–2024				2025				2026				2027				2028			
	2021	2022	2023	2024	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Outcome 1. Investigation of the greenhouse vegetable value chain, policy, and legal environment																				
Output 1.1 Basement study of the greenhouse vegetable value chain																				
Activity 1.1 Research study for enhancing the vegetable value chain and policy establishment ability by supplying greenhouses in Mongolia																				
Output 1.2 Feasibility study of the construction of the National Smart Greenhouse Complex																				
Activity 1.2 Feasibility study for constructing smart (Venlo type) winter greenhouse complex																				
Outcome 2: Establishment of the National Smart Greenhouse Complex																				
Output 2.1 Construction of the smart winter greenhouse complex																				
Activity 2.1.1: A block of greenhouses measuring 3 hectares with engineering and technological systems for growing vegetables																				
Activity 2.1.2: An administrative building and service infrastructure																				
Activity 2.1.3: Objects of engineering support and arrangement																				
Activity 2.1.4: On-site facilities																				
Activity 2.1.5: Transportation costs for the import and delivery of equipment																				
Activity 2.1.6: Costs of work on the package preparation of initial permits, development of design, and estimate documentation and the services of the customer-developer																				
Output 2.2 Development of the cultivation technique and standard model																				
Activity 2.2.1: Inputs and raw materials for production																				
Activity 2.2.2: Preparation for cultivation																				
Activity 2.2.3: Experimental cultivation																				
Activity 2.2.4: Production cultivation and development of distribution network																				
Output 2.3 Establishment of the education system for the vegetable cultivation technique extension for greenhouse cultivation in Mongolia																				
Activity 2.3.1: To learn from the experiences of countries with well-developed, smart, and high-tech greenhouses																				
Activity 2.3.2: To produce educational programs that strengthen the abilities of agronomists, agricultural officials, and farmers																				
Activity 2.3.3: To organize educational and training programs																				

Annex 2. Cost Estimation of Outcomes

WITH AN AREA OF 3 HECTARES FOR THE PRODUCTION OF VEGETABLES

Location: 21st khoroo, Songinokhairkhan district, Ulaanbaatar, Mongolia
Land owner: **AGRICULTURE SUPPORT FUND**
Total land area :12 hectares

2022.01.17

№	Type of Cost	Total cost by USD	Total cost by MNT	Үнийн индекс	Final total cost by MNT
1	A block of greenhouses of 3 hectares with engineering and technological systems for growing vegetables	*4,854,342$*	*13,834,873,456₮*	1.22	*16,878,545,616₮*
2	Administrative building and a service infrastructure	*496,825$*	*1,415,952,637₮*	1.22	*1,727,462,217₮*
3	Objects of engineering support and arrangement	*786,872$*	*2,242,584,705₮*	1.22	*2,735,953,340₮*
4	On-site facilities	*805,212$*	*2,294,855,342₮*	1.22	*2,799,723,517₮*
5	Transportation costs for the import delivery of equipment	*110,000$*	*313,500,000₮*	1.22	*382,470,000₮*
6	Costs of work on the preparation of a package of initial permits, the development of design and estimate documentation and the services of the customer-developer	*476,667$*	*1,358,500,000₮*	1.22	*1,657,370,000₮*
	Totol for Venlo greenhouse plant /Block of greenhouses 3 hectares/	*7,529,918$*	*460,266,140₮*	1.22	*26,181,524,691₮*
	Per cost of 1 hectares	*2,509,973$*	*7,153,422,047₮*	1.22	*8,727,174,897₮*

Note:

1. The investment cost was calculated based on the turnkey price offer of the Russian Federation distributor of Venlo winter greenhouse of EN 13031-1 standard and the general plan developed by "Sketch" LLC.
2. According to the appendix to the Order No. 93 of the Minister of Construction and Urban Development of Mongolia dated April 16, 2021, it is an unaccounted cost of the construction price index for 2020.
3. In accordance with BD81-106-16, this estimate is used only for investment planning and construction cost estimates and is not used for financing.
4. Under the turnkey terms, the price includes the payment of taxes and fees to be paid in Mongolia, and the costs of assembly, installation, operation, supervising and consulting.
5. The appendix includes direct costs of a 3 hectare winter venlo greenhouse.

Location: 21st khoroo, Songinokhairkhan district, Ulaanbaatar, Mongolia

Land owner: **AGRICULTURE SUPPORT FUND**

1. Block of greenhouses 3 hectares - vegetables production

№	Type of Cost	Total cost by USD	Total cost by MNT
1	Preparation of the construction site, vertical layout	183,333$.	522,500,000₮
2	Installation of strip foundations with a pile base and a pile field for intermediate supports	207,597$.	591,652,077₮
3	Complete metal structures (8.0 x 4 m, rack height 5 m) with window (checkerboard) ventilation system, with external and internal gates	1,056,790$.	3,011,852,392₮
4	Glazing of the roof, side and façade translucent fencing, including the cost of	405,511$.	1,155,707,300₮
5	Intra-greenhouse passages and passages for shop transport	52,976$.	150,981,600₮
6	Layout of the surface of the production area of the greenhouse with the formation of slopes	50,413$.	143,678,304₮
7	Final sand layout with sealing and fabric coating	21,769$.	62,042,904₮
8	Components of the main distributor of the heating system	61,928$.	176,494,857₮
9	Heating system, including suspensions, distributors, shut-off and control valves, etc.	695,703$.	1,982,753,740₮
10	UV disinfection system with drainage reverse use	49,162$.	140,110,883₮
11	Drip irrigation system, including drip lines, with units for the preparation and supply of mineral fertilizer solution, water storage tanks, backup water supply system	273,991$.	780,875,414₮
12	Rawhenia CO2 (waste gas) feeding system, including greenhouse wiring, CO2 fan, recirculation fans	125,022$.	356,313,023₮
13	Electrodequainting system for seedlings on an area of 1,500 incl. power distribution cabinets for the electric lighting system, lamps and cable products	54,160$.	154,355,244₮
14	Automated control system for mineral nutrition of plants and climate control with a set of equipment, weather station, control cabinets and cable products	329,359$.	938,672,036₮
15	Technological tray system for growing plants on trays	312,445$.	890,468,535₮
16	Power supply of the greenhouse unit including power cable products (on-site networks 0.4 kV)	219,775$.	626,357,325₮
17	Curtain system (heat-shielding and reflective horizontal and vertical screens), including the service area	335,930$.	957,400,263₮
18	Substrate for cultivation (mineral wool mats 20 cm wide) and cubes for	89,396$.	254,778,002₮
19	Covering the production area of greenhouses with a covering cloth	30,015$.	85,541,924₮
20	Collection and transport trolleys, packaging hoses, laboratory equipment for EC, pH and temperature control, sulphur tablets, secateurs, calibration liquids for 1 year, portable luxmeter and CO2 measuring instrument	67,875$.	193,443,085₮
21	Tomato Sorting Machine, Packing Machine	138,790$.	395,551,728₮
22	Installation supervision of the supplier of imported equipment	92,401$.	263,342,822₮
	Total	**4,854,342$.**	**13,834,873,456₮.**

	Note:
1	According to the appendix to the Order No. 93 of the Minister of Construction and Urban Development of Mongolia dated April 16, 2021, it is an unaccounted cost of the construction price index for 2020.
2	Under the turnkey terms, the price includes the payment of taxes and fees to be paid in Mongolia, and the costs of assembly, installation, operation, supervising and consulting.

Annex №2

Байршил: **Улаанбаатар хот, Сонгинохайрхан дүүрэг, 21-р хороо**
Газрын ашиглагч: **AGRICULTURE SUPPORT FUND**

2. Administrative building and a service infrastructure

№	Type of Cost	Total cost by USD	Total cost by MNT
1	Administrative building		
2	Installation of foundations for internal walls and installation of floors	39,835$.	113,528,800₮
3	Installation of external and internal fencing from frame-sheathing panels	126,075$.	359,312,800₮
4	Installation of floors, ceilings and partitions	78,967$.	225,054,544₮
5	Installation of plumbing equipment and sewerage (main)	8,744$.	24,921,787₮
6	Installation of hot and cold water supply system	6,041$.	17,215,957₮
7	Installation of power supply and lighting system	17,160$.	48,906,000₮
8	Installation of windows, doors, gates	24,889$.	70,932,824₮
9	Heating, ventilation and air conditioning device	25,553$.	72,824,796₮
10	Fire-fighting equipment	11,999$.	34,196,580₮
11	service infrastructure		
12	Installation of main pipelines for water supply, drip irrigation, drainage solutions, etc.	53,686$.	153,006,392₮
13	Installation of floors and bases for tanks for storage of water and drainage solutions	21,248$.	60,557,228₮
14	Installation of units for the preparation of mineral fertilizer solutions, UV disinfection systems and the reverse use of drainage	12,695$.	36,180,931₮
15	Installation of a warehouse-refrigerator. (2 refrigerating chambers)	69,935$.	199,314,000₮
	Total	**496,825$.**	**1,415,952,637₮.**

	Note:
1	According to the appendix to the Order No. 93 of the Minister of Construction and Urban Development of Mongolia dated April 16, 2021, it is an unaccounted cost of the construction price index for 2020.
2	Under the turnkey terms, the price includes the payment of taxes and fees to be paid in Mongolia, and the costs of assembly, installation, operation, supervising and consulting.

Газрын ашиглагч: **AGRICULTURE SUPPORT FUND**

3 External engineering networks

№	Type of Cost	Total cost by USD	Total cost by MNT
1	HVS water supply network	31,416$.	89,536,750₮
2	Flood control networks (storm flood) to the existing sewerage up to 140 m	124,802$.	355,686,934₮
3	Industrial sewerage	4,406$.	12,557,765₮
4	Drainage sewerage	5,500$.	15,675,000₮
5	Transformer substation 400 kVA with switchgear	406,476$.	1,158,457,322₮
6	On-site power supply lines 10/0,4 kV	44,093$.	125,664,176₮
7	Heating network	102,693$.	292,674,509₮
8	Heating pipeline	49,867$.	142,120,000₮
9	Exterior lighting	14,667$.	41,800,000₮
10	Communication lines	2,952$.	8,412,250₮
	Total	**786,872$.**	**2,242,584,705₮.**

4. On-site facilities

№	Type of Cost	Total cost by USD	Total cost by MNT
1	Boiler room 10 MW	729,671$.	2,079,563,063₮
2	Roads and driveways (on-site) made of 3 x 1.75 m plates	53,167$.	151,525,000₮
3	Solid waste platform	4,092$.	11,662,932₮
4	Checkpoint	2,259$.	6,437,932₮
5	Platform for turning equipment	7,283$.	20,757,462₮
6	Fencing of the territory (from reinforced concrete panels 2.5x2.5. The total length without gates is 1,900 m.)	8,740$.	24,908,954₮
	Total	**805,212$.**	**2,294,855,342₮.**

Note:

1. According to the appendix to the Order No. 93 of the Minister of Construction and Urban Development of Mongolia dated April 16, 2021, it is an unaccounted cost of the construction price index for 2020.
2. Under the turnkey terms, the price includes the payment of taxes and fees to be paid in Mongolia, and the costs of assembly, installation, operation, supervising and consulting.

4.Хүлэмжийн төслийн туслах барилга байгууламжийн өртөг

№	Зардлын төрлүүд	Нийт зардал /Ам.Доллар/	Нийт зардал /Төгрөг/
1	Уурын зуухны барилга 10 МВт	729,671$.	2,079,563,063₮
2	Автозам зам, явган зам (газар дээрх).	53,167$.	151,525,000₮
3	Хатуу хог хаягдлын талбай	4,092$.	11,662,932₮
4	Шалгах нэвтрүүлэх цэг	2,259$.	6,437,932₮
5	Ачиж буулгах талбай	7,283$.	20,757,462₮
6	Нутаг дэвсгэрийн хашаа	8,740$.	24,908,954₮
	НИЙТ ШУУД ЗАРДАЛ	**805,212$.**	**2,294,855,342₮.**

Annex 3. Risk Management

Risk elements	Impact on program progress and success	Probability	Mitigation measures
Financial risks:			
Insufficient capital to be invested in stimulating economic growth in the target areas of the program	Low to medium	Medium	• Ensure necessary assurances are in place from lending sources before the commencement of the project for contributions or additional funds • Have a contractor in the project team who specializes in financial management • Establish strict financial control and management accounting from the start of the project
Inflation changes taking effect on financial investment	Low to medium	Medium	• Align project financing with inflation forecast
Declining demand as a result of market saturation	Low	Low	• The demand for vegetables is stable • Make sales contracts with sellers
Choosing the wrong marketing strategy	Low	Low	• The market assessment and detailed research results conducted by the professional and well-experienced project team and international experts will reduce the risk.
Political risks			
Government policy stability	Low	Low	• This is reflected in Mongolia's long-term development policy "Vision-2050" and Government Action Plan.
Implementation risks			
Unforeseen challenges: Delay of greenhouse construction	Low to medium	Medium	• Select a construction contractor with an effective construction plan and resource management
Operation risks			
Equipment failure	Low to medium	Medium	• Select reliable and quality equipment and conduct specialized operations, regular maintenance, and scheduled inspections
Reduction of product quality and yield	Low to medium	Low	• Recruiting qualified specialists • Learning from the best practices of smart

Risk elements	Impact on program progress and success	Probability	Mitigation measures
			greenhouse farming in Korea and following the advice of experts • Regular staff training
Electricity and heat outages	Low	Low	• Building our own generator and stockpiling refined coal and fuel
Plant stress associated with greenhouse microclimate change	Low	Low	• The intelligent sensor of smart greenhouses responds to small changes in humidity and temperature, and it has a sensor for measuring CO2 levels and developing preventive measures.
Natural and climatic risks			
Adverse effects of climate change: floods, droughts, winds, and storms	Low to medium	Medium	• Regular use of agricultural weather forecasts, reviews, and recommendations–Эрсдэлийн сан байгуулах • Establish a contingency fund

References

Chapter 3.1.

관계부처 합동. 2012. “Country Partnership Strategy for Mongolia (2012-2015).” Related Ministries Joint.

관계부처 합동. 2016. “Country Partnership Strategy for Mongolia.” Related Ministries Joint.

관계부처 합동. 2020a. “Comprehensive Implementation Plan for International Development Cooperation (2020).” Related Ministries Joint.

관계부처 합동. 2020b. “Country Partnership Strategy for Mongolia.” Related Ministries Joint.

관계부처 합동. 2021b. “The 3rd Comprehensive Implementation Plan for International Development Cooperation.” Related Ministries Joint.

KOAA. 2015. “Overseas Correspondent Report on Mongolia.” KOAA.

KOTRA Ulaanbaatar Trade Center. 2021. “Entry Strategies by country: Mongolia (2021).” KOTRA.

MAFRA. 2013. “Overseas Agricultural Development Project Manual (Mongolia).” MAFRA.

Ministry of Foreign Affairs (MFA). 2016. “Overall Conditions of Mongolia” “Diplomatic Publications.” MFA.

Min-Jung Kim. 2020. “Smart Farm Global Trends and Entry Strategies: Russia/CIS/China/Southeast Asia.” KOTRA.

Related Ministries Joint. 2021a. “Comprehensive Implementation Plan for International Development Cooperation (2022).” Related Ministries Joint.

[Online materials]

ODA Integrated Reporting System. <https://stats.koreaexim.go.kr/odastats.html>. search date: September 28, 2021

Korea Policy Briefing. <www.korea.kr>. search date: September 27, 2021

The Presidential Committee on Northern Economic Cooperation. <https://www.bukbang.go.kr/bukbang/>. search date: September 27, 2021

ODA Korea. <https://www.odakorea.go.kr/>. search date: September 29, 2021

OECD.Stat. <https://stats.oecd.org/>. search date: September 28, 2021 – October 6, 2021.

[Articles]

Blue House. September 10, 2021. "Joint Declaration for Development of Korea-Mongolia Strategic Partnership." Korea Policy Briefing.

Chapter 3.4.

2019. Mongolian Gangwon-do Agricultural Town Operation Report: Agricultural Exchange between Korean Gangwon-do and Mongolian Tuv Aimag for 16 Years. GWARES.

Gangwon-do office. 2005-2019. Office white paper.

GWARES. 2007. Local Adaptability Test of Korean Crops in Mongolia. 2006 Test report. pp. 185-203.

Hong Jin Kim, Bo Ra Kim, Jeong Hoo Park, Won Soo Yoo, Pyung Rae Lee. 2020. The Vision of Future Cooperation between Korea and Mongolia in the New Northern Era: Cooperation Tasks and Practical Methods by Sector. Research report 20-05. Korea Institute for International Economic Policy.

Hye Yeong Jang. 2016. Revisiting Korean Local Governments' Public Development and Cooperation. Oughtopia 31(2):133-161. Kyung Hee Institute for Human Society.

Hyeon Woo Lee, Jeong Ik Son. 2008. Mongolian Vegetable Greenhouse Installation Project Case. Rural Resource 50(4):25-39. Korean Society of Agricultural Engineers.

Jae Hee Won. 2016. Science and technology ODA Project Case ② - Agricultural Technology: Mongolian Gangwon-do Agricultural Town Building and Operation Outcomes and Implications. Science & Technology Policy 220(11):28-37. Science & Technology Policy Institute.

Ji In Kim. 2020. Effective Policy Making Process in Local Government's International Development and Cooperation Project; while Focusing

on the Gangwon-do Agricultural Town Building Project. A master's thesis for Hallym University Graduate School of Global Cooperation.

Jong Seob Kim, So Hee Park. 2018. Mongolian Gangwon-do Agricultural Town Operation Project Outcome Evaluation Report. Seoul National University Institute of International Affairs.

KOICA home page (www.koica.go.kr).

KOICA ODA statistics site (stat.koica.go.kr).

MOFA. 2016. Mongolia overview. MOFA Northeast Asian Affairs Bureau. Northeast Asian Division

Seung Eun Jeong. 2014. Mongolian Agriculture Status. World Agriculture No. 172. pp. 187-205. Korea Rural Economic Institute.

So Hee Park, Jong Seob Kim. 2018. The Local Government in Development Cooperation: Its Comparative Advantages. Journal of International Area Studies 27(3):119-140. Seoul National University Institute of International Affairs.