업무자료 평가
2013-21-030

ISBN 978-89-6469-151-9 93320

KOICA 한국국제협력단

461-833 경기도 성남시 수정구 대왕판교로 825
Tel. 031-7400-114 Fax. 031-7400-655
http://www.koica.go.kr

업무자료 평가 2013-21-030

Ex-Post Evaluation Report on the Project of Establishing Greenhouse for Vegetable Cultivation, Mongolia

한국국제협력단

발간등록번호
11-B260003-000037-01

Ex-Post Evaluation Report on the Project of Establishing Greenhouse for Vegetable Cultivation, Mongolia

2012.12

KOICA 한국국제협력단

WORLD FRIENDS KOREA

Ex-post Evaluation Report on the Project of Establishing Greenhouse for Vegetable Cultivation, Mongolia

2012.12

KOICA
한국국제협력단

WORLD FRIENDS KOREA

The Korea International Cooperation Agency (KOICA) performs various types of evaluation in order to secure accountability and achieve better development results by learning.

KOICA conducts evaluations within different phases of phases of projects and programs, such as ex-ante evaluations, interim evaluations, end-of-project evaluations and ex-post evaluations. Moreover, sector evaluations, country program evaluations, thematic evaluations, and modality evaluations are also performed.

In order to ensure the independence of evaluation contents and results, a large amount of evaluation work is carried out by external evaluators. Also, the Evaluation Office directly reports evaluation results to the President of KOICA

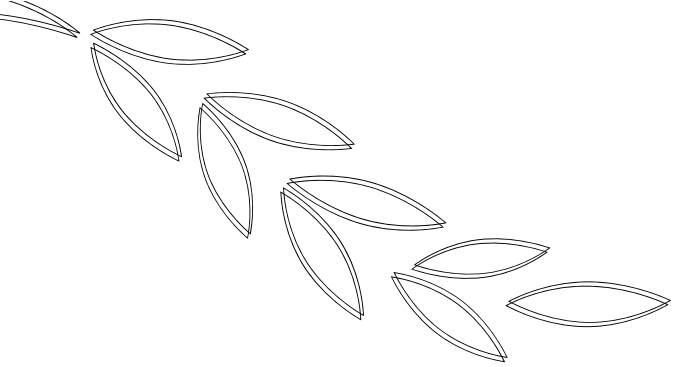
KOICA has a feedback system under which planning and project operation departments take evaluation findings into account in programming and implementation. Evaluation reports are widely disseminated to staff and management within KOICA, as well as to stakeholders both in Korea and partner countries. All evaluation reports published by KOICA are posted on the KOICA website.
(www.koica.go.kr)

This evaluation study was written by the evaluation team from ReDI. The views expressed in this report do not necessarily reflect KOICA's position

Contents

List of Abbreviations

Abbreviation	Official name
AFACI	Asia Food and Agriculture Cooperation Initiative
KOICA	Korea International Cooperation Agency
M&E	Monitoring and Evaluation
NGO	Non-Governmental Organization
ODA	Official Development Assistance
OECD/DAC	Organization for Economic Cooperation and Development Development Assistance Committee
PMC	Project Management Consulting
PSARI	Plant Science and Agriculture Research Institute
RDA	Rural Development Administration
TOR	Terms of Reference



Executive Summary

Executive Summary

This report is on the Ex-post evaluation of the 'Project of Establishing Greenhouse for Vegetable Cultivation' in Mongolia (hereafter the project) which was implemented by Korea International Cooperation Agency (KOICA) between 2008 and 2009. It was conducted by utilizing the Organization for Economic Cooperation and Development's Development Assistance Committee (OECD/DAC) five evaluation criteria - Relevance, Efficiency, Effectiveness, Impact and Sustainability.

Due to the restraints in natural environment, Mongolia has had difficulties to cultivate fresh vegetables. The project supporting greenhouse installations was enforced for vegetable cultivation expansion in Mongolia. During the project, KOICA supported providing commercial plastic houses and research glasshouse in two project-targeted sites, Ulaanbaatar and Darkhan. KOICA also dispatched related experts who specialize in greenhouse cultivating techniques and environment management to provide education training and supervision.

The objective of this evaluation is to figure out whether the project had achieved the following: to establish an operational model to make commercial greenhouses successful and to contribute in creating a wide range of data for greenhouse cultivation research. For this evaluation, we assessed the projects' output, outcome, and impact to see if it has contributed to positive achievements in performance evaluation and process evaluation.

In the first phase of the evaluation, we conducted Issue Analyses and Context Analysis in order to figure out key external factors affecting the process and

results of the project. Those factors were closely related to Mongolian environmental conditions for vegetable cultivation such as severe climatic conditions and the traditional meat-based diet. During the first phase, we re-conceptualized the results into the following categories: inputs, outputs, outcomes and impact. To draw conclusions based on logical framework and evaluation matrix, we developed the evaluation matrix that included the specific criteria and indicators.

For further evidence, evaluation results are based on literature reviews, meetings with domestic and on-site workers, evaluation seminars on beneficiaries and participants, consultations with on-site agricultural specialists, and comparative analysis with related projects. Through this process, it examines whether or not it is possible to expand on post-projects that enforced demonstration project. The key findings from the evaluation are as follows:

(Relevance) The project was designed to meet the needs of the Mongolia expanding and diversifying vegetable cultivation through the "Green Revolution National Program - 2nd Phase (2004-2012)" which was initiated by the Mongolian Government. In this regard, the project was highly relevant to the policy priorities of partner country government. The overall objective of the project was to establish commercial greenhouses operated by private agriculture companies and to construct glasshouses for the purpose of enhancing greenhouse agriculture related researches at the Mongolia Agriculture University. At the end of the evaluation, we figured out that KOICA and partner country government adopted proper criteria for beneficiary and project site selection, however, there were difficulties in investigation process due to the lack appropriate records regarding the selection process. There is also room for improvement in terms of localized design and construction of greenhouse and glasshouse.

(Efficiency) In terms of timeliness, the project was implemented appropriately because it began concurrently with the partner governments' "Green Revolution"

and "White Revolution" initiatives. With regards to the efficiency of communication channels and problem-solving mechanism, meetings for project implementation were held once in every couple of months. Different problems on education and research were solved through active dialogue and cooperation among the stake-holders involved in the project.

(Effectiveness-outputs) Regarding the greenhouse facilities, the satisfactory levels of such high-tech automated installations among the beneficiaries were high. However, according to the results of the on-site evaluation team, many greenhouse managers were dissatisfied about heating effectiveness. This is partly due to the fact that installation materials for greenhouse and heating arrangements are not suitable for local climatic conditions. Also, the beneficiaries had difficulties finding lecture rooms during the training courses, since there are no facilities for classrooms at the project sites. In terms of technical assistance, training and education for greenhouse cultivation and management techniques were provided to the local farmers by the cultivation and management experts. During the evaluation, it was confirmed that the newly transferred technologies were being used by the Mongolian farmers at the time of the assessment. By publishing the crop cultivation textbook, useful information on various cultivation techniques was disseminated among the farmers. The textbook was highly utilized by the locals since it allowed them to practice these techniques that are suitable for the environment. The quality of the seeds provided at the beginning of the project was also satisfactory.

(Effectiveness-outcome) In terms of commercial greenhouse, this project has created a business model for the production and sales of tomatoes and cucumber. Compared to the existing cultivation period of 4 months for non-heating plastic greenhouses and cultivation period of 6 months on non-heating glass greenhouses, there is an effective extension period for 4 to 5 months with the heating plastic and glass greenhouses. Based on our economic analysis, plastic greenhouse is

more economically feasible than field cultivation. There also seems to be positive outcomes throughout the experimental results such as the enhanced effects of extended production period, diversification of crops for research, variety development experiments, etc.

(Impact) Since there is limitation in measuring the project's influence on the actual lives of beneficiaries based on this demonstration project, this evaluation focuses on the long-term influences that focus on "spread of techniques and expansion effect" along with "synergy effects on commercial greenhouses and greenhouses used for research." In case of Darkhan's research-purpose greenhouses, it inspired beneficiaries willing to cultivate vegetables using greenhouses as a demonstration model, contributing to the culture of knowledge and skills of greenhouse vegetable cultivation for farmers and students. In case of Ulaanbaatar, beneficiaries have continued to apply the cultivating techniques instructed by the dispatched expert. Related to linkage (synergy) in the activities and outcomes of research greenhouses and commercial greenhouses, it has been found that more time is needed to find detailed connection to the products.

(Sustainability) In regards to sustainability of the project, when it comes to greenhouses' operating authority at the end of the project, the biggest problems were the exit strategies were incomplete. Thus the strategies for ensuring the sustainability of the project after the end of its implementation phase need to be improved. When looking at follow-up management and procedures in this project, KOICA has provided assistance on taking part on follow-up management, while underground heat rays and new equipments were additionally supplied. The Rural Development Administration (RDA)'s Asian Food and Agriculture Cooperation Initiative (AFACI) has settled on a contract with Plant Science and Agriculture Research Institute (PSARI) in Darkhan, and it is interesting to see how the research project has taken place for three years for plant breeding and cultivating skills on tomatoes and strawberries.

(Cross-cutting issues) Although gender equality was not considered during the project, the percentage of female beneficiaries was high during the project's promotion process. Such results are reflected on Mongolia's attributions where females are considered to have high social status in its socialist history. This project was executed as small-scale demonstration project, producing small influences in the environment while there was no special consideration on the environment during the project execution process.

Based on the results from the comprehensive ex-post evaluation, the following suggestions for future KOICA projects are as following:

First, it is important to understand the local climate and various environmental conditions while conducting the preliminary study. Although greenhouses constructed in Mongolia for this project were equipped with Korean high technology, several limitations were identified regarding adaptation to local environment. In order to overcome these restraints, following aspects need to be addressed in project planning stage: the design and use of materials that can withstand large temperature differences, the installation of brick walls for thermo-conservation and the consideration of constructing northern-type or half-basement type greenhouses. In addition to applying measures for climatic conditions, considerations of proper and reliable water supply need, the location of greenhouse installations, the quality of the soil, adequate and reliable supply of electricity, central heating systems should be provided by the local government, and lastly, sector policies, institutions and regulations of the partner government should be further researched.

Second, project inputs should be differentiated in accordance to the beneficiaries' specific characteristics and detailed project objectives. The objectives of the project were differentiated into the following categories: for research purposes, for commercial purposes, for educational purposes and for the specific purpose as a pilot project. Also, the characteristics of beneficiary groups were diverse

including government officials, private agricultural companies, researchers, university professors and students, farmers and residents. However the detailed objectives depending on the different purpose of the project as well as the various characteristics of the beneficiaries were not fully considered during the project planning stage. The detailed objectives of the project need to be differentiated depending on the characteristics of the beneficiary groups in future projects.

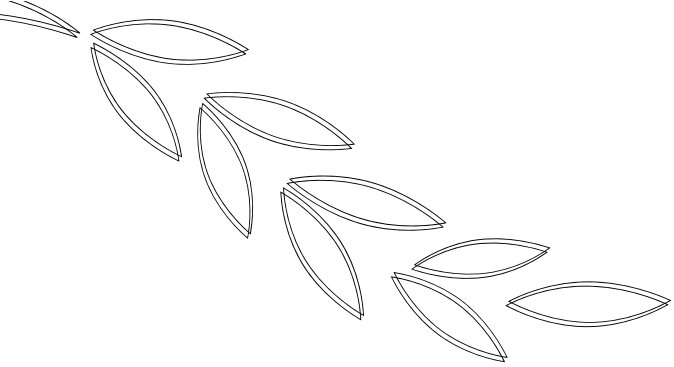
Third, the transfer of practical technology is one of the most important key elements for the success of agriculture projects. Therefore, to ensure the sustainability and the success of the project, the proportion of Technical Assistance (TA) or Technical Cooperation (TC) such as learning skills, and education in managing soil and greenhouse within the project should be expanded. During the field research in Mongolia, a number of the project related stake-holders have stressed that transferring and training the practical knowledge and skills are one of the most crucial elements for the project success and its sustainability.

Fourth, in order to sustain the project's long-term effectiveness the following actions are required: cooperation with other institutions or organizations implementing ODA projects, and the consideration and the development of an appropriate action plan for the consigning of the project's management to private agriculture companies. In the case of the commissioned greenhouses management there is a need for a clear Terms of Reference (ToR). In addition, detailed conditions which include compulsory outputs and monitoring mechanism are required in the consigning contract. At the end of the management contract, the extension or termination should be determined based on performance evaluation in entirety. Conducting technical cooperation with other agencies would be desirable in order to maximize the effect of the project and in an effort to ensure its sustainability.

As discussed, there are several major constraints when it comes to crop cultivation in Mongolia. First of all, the severe climate condition of the country has negative

impacts on the agricultural industry. Secondly, the traditional meat-oriented diet is considered as one of main constraints for a balanced intake of nutrients in Mongolia. The importance of the project should be highlighted with regard to attempting to overcome those constraints by establishing greenhouse facilities and transferring cultivation technology. Considering the Government's initiatives called 'Green Revolution' and 'White Revolution', which intended to improve vegetable cultivation and the expansion of the vegetable industry, the impact of the project would have significance for the country.

Based on the lessons drawn from this evaluation, the report intended to provide practical and effective recommendations to KOICA's agricultural development policies and project formulation/implementation. In order to enhance the effectiveness of future KOICA projects, it is important to reflect on the recommendations presented in this evaluation in every phase of the projects development, such as identification of needs, development studies, planning, implementation, and in the evaluation of the project.



Evaluation Outline

Chapter

I Evaluation Outline

1. Goal of Evaluation

Due to severe climatic conditions, Mongolia has had difficulties in cultivating fresh vegetables and establishing farming-oriented agricultural structure. Also, as Mongolian society traditionally practices meat-based eating habits, there have been several constraints regarding the intake of balanced nutrients. Since the vegetable cultivation period in Mongolia for fresh vegetables that supply the vitamins, dietary fibers, and micronutrient only can last for four to five months (usually during May to September), it is important to find a extension methods for growing crops using controlled horticulture while developing a variety of cultivation techniques.

Thus, due to the restraints in natural environment, the project supporting greenhouse installations was enforced for vegetable cultivation in Mongolia. During the project, KOICA has supported in providing commercial plastic houses and research glasshouse in two project-targeted areas, Ulaanbaatar and Darkhan. KOICA also dispatched experts who specialize in greenhouse cultivating techniques and greenhouse environment management to provide education training and supervision.

This evaluation tries to figure out whether the project had achieved the following: to establish an operational model to make commercial greenhouses successful, to contribute in creating a wide range of data for greenhouse cultivation research, and to enforce in analyzing whether or not education and expansion effects. For this evaluation, we assessed the projects' output, outcome, and

impact to see if it has contributed to positive achievements in performance evaluation and characteristics in progress.

2. Project Information

Figure 1 provides core aspects of the project.

Figure 1. Main Contents of the project

Section		Contents	
Project Goal		Construct greenhouses that suit Mongolia's current conditions for vegetable production	
Project Description		• Install commercial-purpose plastic greenhouses and research-purpose plastic and glass houses • supply technical cooperation by dispatching experts and offering training courses	
Costs for Both Countries	Korea (1,4 million USD)	Installation of Greenhouse (1,050,000 USD)	• One glasshouse (Darkhan) • 4 single-span greenhouses (Darkhan) • 4 three-span greenhouses (Ulaanbaatar)
		Training courses in Korea (80,000 USD)	10 trainees for greenhouse crop cultivation and environment management: one month
		Dispatched Specialists (230,000 USD)	• One specialist of crop cultivation in greenhouse: 8 months • One specialist in greenhouse environment management: 1 month • One specialist in planning out and supervising construction: 1 month
		Support Equipments and Others (40,000 USD)	Equipments used for greenhouse installation and vegetable seeds Fees for project management and evaluation
	Mongolia	Support Specialists	Dispatch specialists whose research fields are related to food and agricultural sector
		Others	Provide an office and transportation expenses

Figure 1. continued

Section		Contents
Targeted Regions for Projects		Ulaanbaatar and Darkhan
Size of Project/Period		1.4 million USD/2 years (2008-2009)
Beneficiary		Citizens of Mongolia, public officials and professionals of related fields
Expected Effects	Korea	To spread Korea's greenhouse management and cultivating techniques
	Mongolia	To contribute to creating jobs and decrease poverty by increasing the productivity within Mongolia
Agency	Korea	KOICA PMC : Rural Development Administration(RDA) Construction : Joongwon Green Industrial Company, Ltd.
	Mongolia	Ministry of Food and Agriculture

3. Evaluation Criteria

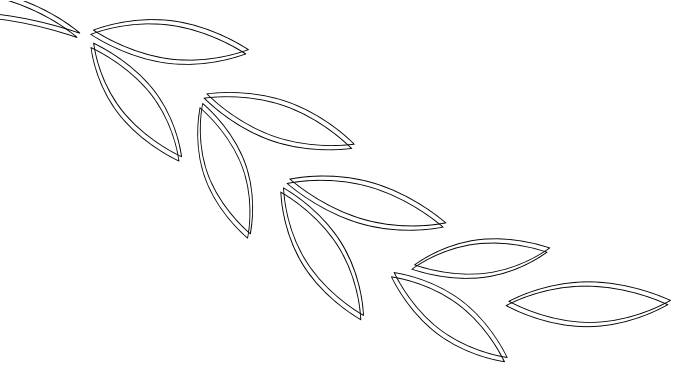
This evaluation follows OECD/DAC evaluation guideline, evaluating on the project's relevance, efficiency, effectiveness-outcome, impact, and sustainability. Figure 2 shows the items in entirety used for evaluation that includes performance evaluation and process evaluation.

Figure 2. OECD/DAC Evaluation Criteria

Criteria	Detailed Evaluation Items	Data Collection Methods
Relevance	■ Is there a consistency with the policies under the partner countries' agricultural field?	Literature review and interviews with project workers
	■ Are the selection criteria and procedures for targeted partner country adequate?	
	■ Did it effectively reflect the needs of beneficiaries and implementing agencies?	

Figure 2. continued

Criteria	Detailed Evaluation Items		Data Collection Methods
Efficiency	■ Is there a communication channel between the parties and has the communication been smooth and active?		Literature review and interviews with project workers
	■ What are the methods to solve unexpected problems?		
Sustainability	■ Are there exit strategies for each party? If there is, are the strategies adequate?		Literature review and interviews with project workers On-field study
	■ Has an agreement been reached on optimal amount of budget used for partner countries and relevant ways of human resources used to sustain project outcomes?		
	■ In order to maintain sustainability, are there enforced budgets or human resource allocation by both parties?		
	■ Are beneficiaries recognizing the project's contribution and outcomes?		
	■ Is there any post-project management efforts in local government and institutes to maintain progress?		
Cross-cutting Issues	■ (Gender equality component) Throughout the project, has it considered the influence on gender equality? ■ (Environment component) Through the project, has it considered the influence on the environment?		Literature review and in-depth interviews with project workers
Effectiveness	Output	■ Have the greenhouses and additional facilities established as planned? ■ Have the greenhouse management skills and cultivating techniques been properly acquired? ■ Has the textbook for greenhouse crop cultivation been developed and been actively utilized? ■ Have the seeds been provided as planned?	Analysis of data from implementing agencies, interviews with project workers
	Outcome	■ (Research greenhouses) With experiments using a variety of vegetables, has there been an increased effect in productivity? ■ (Commercial greenhouses) Was there creating effect on business model for stable greenhouse management and operation? (economic analysis)	Analysis of data from implementing agencies, Interviews with beneficiaries Economic analysis
Impact	■ Has there been a synergy effect on the linkage between the outcomes of research-purpose greenhouses and commercial-purpose greenhouses? ■ Were there positive influences on spreading vegetable cultivation skills and greenhouse installation?		Analysis of data from implementing agencies, Interviews with beneficiaries



Evaluation Results

Chapter

Ⅱ Evaluation Results

1. Relevance

Evaluation Objectives under Relevance
As a part of process evaluation, it analyzes the relevance in the selection process of project inputs and reflection of development needs of partner country under the project's planning stage.

1) Consistency with Partner Countries' Government Policies

By looking at the changes of agricultural policies made by Mongolian government, the government increased the level of importance on agriculture after the 2007 National Grain Crisis, causing changes in its policies. The following provides the main points and characteristics in the three phases of Mongolian government's 'Green Revolution.'

□ Phase 1 of 'Green Revolution' (1998-2003): In 1997, agricultural practices began for agricultural self-sufficiency for gardening vegetables. Major crops include Mongolia's four basic vegetables - potatoes, carrots, onions, and lettuces.

□ Phase 2 of 'Green Revolution' (2004-2012): Along with basic crops, it also relied on the productivity on fresh vegetables such as tomatoes and cucumber. The number of lands suitable for farming decreased while productivity increased. The consumption of vegetables has increase by importing products made in China.

□ Phase 3 of 'Green Revolution' (2013-): Recently, new programs (with the focus on increasing productivity, diversifying cultivated crops, industrialization, and branding) are being prepared to cultivate more types of crops in order to increase its vegetable market. The government began to promote on supporting greenhouses to provide cultivation during winter and to provide storehouses. Agriculture Extension Center is being managed for agricultural education.

As mentioned above, Mongolian government is focusing on 'Green Revolution' to attempt in increasing the productivity of crops. Thus, more than 2,000 agricultural sites were benefited through the first 'Green Revolution' phase, and productivity has grown each year.[1] When the project was first established in 2007, it showed how the Mongolian government focused on increasing the productivity of fresh vegetables like tomatoes and cucumber that requires more advanced cultivating techniques. Additionally, this was the point in time where the government began to be interested in increasing controlled horticulture, assuring the relevance in the government's direction and proposed time.

2) Appropriate selection of the Target Beneficiaries and Implementing Agencies

Mongolian government originally has planned to construct greenhouses all throughout the country through this project. However, due to the limitation in project's budget and technical level of controlled horticulture in Mongolia, it reduced the number of targeted areas to just two sites. The targeted sites have been finalized to Darkhan and Ulaanbaatar, where Darkhan was supposed to install research greenhouses while Ulaanbaatar was supposed to install commercialized greenhouses.

1) Government of Mongolia, Green Revolution Second Phase(2005-2012). Ulaanbaatar.

Darkhan is a region that traditionally had specialized in agriculture, thus implications can be made that it is relevant in the sense since there is an institution (Plant and Agricultural Science Research Institute in Mongolia Agriculture University) that has done professional research on the cultivation of crops. Ulaanbaatar is also relevant since it has been benefited by specialized agricultural project that is located 30 kilometers from the city (20 minutes by car), where implications can be made that it met conditions of market accessibility required to make successful suburban controlled horticulture business.

The standardized selection process for project sites (location for greenhouse installations) that is specified in the report through enforced consultation shows how these two targeted areas meet the requirements successfully. Those two sites have high transportation accessibility as well as being feasible in supplying water and electricity. In Ulaanbaatar, the existent company that implemented business projects have facilitated controlled horticulture using glasshouses which indicates that there is no problem in supplying water and electricity. In Darkhan, it was possible to utilize existing sewerage system, electrical installation and district(local) government's heating service that is used through Research for Plant Science and Agriculture.

Another important standards applied in the selection process of beneficiary are the experiences and knowledge in vegetable cultivation. When looking at Ulaanbaatar, the project's goal is to construct business model for commercial greenhouses in order to provide sustainable vegetable cultivation. In order to accomplish such goal, a private agricultural project called Tumen Suikh has been selected as the beneficiary to manage greenhouse. The related official document by Mongolian government explains the beneficiary selection, and it includes how Tumen Suikh is composed of specialists who engaged in greenhouse vegetable projects for 15 to 20 years, and they have actively participated and supported in many events sponsored by Ulaanbaatar City Government and the Ministry of

Food and Agriculture. As part of the Mongolian government's initiative 'Green Revolution,' Tumen Suikh has also been taking responsibility in providing vegetable cultivation education for farmers that was enforced by the Mongolian government.

In case of Darkhan, it is important to note that the historical background on research related to Mongolia's vegetable cultivation is rather short-lived. There is no research institutes that focus on facility-controlled horticulture in Ulaanbaatar. From the results found in research data and consultations with Agriculture University of Mongolia and its affiliated institutes that focus on agriculture, we were able to find out that there is no institute in Ulaanbaatar that levels with Plant Science and Agriculture Research Institute in Darkhan on the capability of executing research in breeding vegetables and cultivation techniques.

However, there were some difficulties in clearly understanding the selection process of beneficiary and project sites due to the absence of organized data that explains the selection process with clearly-written criteria for both research greenhouses and commercial greenhouses. Later, in cases of similar KOICA projects in the future, it is necessary to produce and preserve data and record on beneficiary selection process and procedure.

Lastly, the implementing agency of this project is Rural Development Administration (RDA) that has members who acquired many experiences on the participation of developing countries through researches on agricultural techniques and education institutes. This is a relevant institute that would achieve its goals in installing greenhouses and providing relevant skills. Specifically, this institute has the human resources in dispatching short-term and long-term experts of vegetable cultivation and greenhouse environment management. Thus, it is selected as a relevant implementing agency based on the project's objectives.

3) Reflection of the Demands(needs) of Beneficiaries

Related to installed greenhouse facilities, same suggestions were raised for both project sites. These problems indicate that the height of the ceiling is too high and there are limitations on trapping heat during the winter because there is only boiler that does not have supplementary equipments for heat, making the cost of heat very high. Similarly, the evaluation team asked a question about whether the design of the greenhouse or the height of the ceiling or heating arrangements were taken into consideration, and Plant Science and Agriculture Research Institute in Darkhan answered that since the preliminary research group took all the climate-related data (on wind speed and precipitation), they thought that the research group will apply installing greenhouses that suits the climate of Mongolia. The research institute said there were limitations in making suggestions because they did not have any experiences in constructing greenhouses. The currently installed greenhouse does not have the right modification in Mongolia's climate, and it has displaced on Korean-style greenhouses. Thus, although KOICA has established greenhouses with high-tech facility that is fully-equipped in automation, it does not necessarily provide demands in Mongolia effectively. Therefore, implications are made on how it is problematic that there are high heating expenses on installed plastic greenhouses and glass houses. There is a high possibility of damaged plastics and glass due to high daily ranges of temperature during the winter, and equipments can be malfunctioned due to cold weather conditions. According to the advices made by local agriculture specialists, they make judgments on the needs of making choices and planning different materials in case of cold weather conditions in the winter, installing brick walls and northern greenhouses (installing tree panel outside plastic houses), and making considerations on installing semi-basement greenhouses.

According to the interviews with local agricultural specialists, such Korean-style plastic houses are usually large-scale and need a variety of installation materials,

making the cost of installation charges very high. Due to the specified climate conditions in Mongolia, findings show that cost-spending lacks relevancy since it is not possible to cultivate plastic greenhouses during the winter. It is rather well used across Mongolia, where the single-span type rain shelter greenhouse supplied by Mongolian government as a means of the governmnet's support in agricultural has a cultivating period between April and September. In this case of rain shelter greenhouse, this becomes more relevant for farmers to apply in cultivation because of its affordability and convenience in installation.

When looking at the project, there were reasons of experimenting Korean-style greenhouse's adoption to Mongolia's local condition, education for demonstration farms, and installation of fully equipped high-tech greenhouses for demonstration purposes, there was a big gap between the technology level of KOICA-funded greenhouse and the technology level of Mongolia's farmer's greenhouses. Thus, when KOICA plan and implement similar type of projects in the future, it is important to figure out the technology level, beneficiaries' need, cost-benefic efficiency in local conditions.

Picture 1. Plastic Green house Provided by KOICA

Picture 2. Commercial-purpose Greenhouse in Mongolia

Picture 3. Standardized (Rain-shelter) Plastic House in Mongolia

Picture 4. Plastic House used by local farmers in Mongolia

2. Efficiency

Evaluation Objectives under Efficiency
Considering the environmental factors during the project, it analyzes the efficiency of the changes of project process when looking at wide ranges of inputs that become optimized. It draws conclusions by analyzing the concerned parties, structural factors for promoting efficiency of communication, and structural factors that hinders the progress of projects.

1) Inputs (Timeliness, Budget, Components, etc.)

This project began at the point of time when Mongolian government has actively promoted in the increase of vegetable cultivation through 'Green Revolution' (to increase fresh vegetable cultivation) and 'White Revolution' (to increase the number of plastic houses and glass houses), concluding that the time was relevant to maximize project's outcomes and impact. The size of this project is small as 1.4 million USD, which indicates that it is efficiently spent and has been a relevant case considering its small amount of resources. However, when looking at the

project's components, 1.05 USD out of 1.4 million USD are used for greenhouse installations, making it limited for components of technical cooperation that include training (80,000 USD) and dispatching related experts (230,000 USD). At the time evaluation team was doing its field research, many of its members have heavily emphasized how it is important to provide education on such things like how to cultivate and harvest vegetables and to teach technical skills in order to guarantee both project growth and sustainability. It can be predicted that it would have been possible to have had better goal accomplishments if the proportions of simple infrastructure support was smaller and technical training was higher.

The investment of human resources is found suitable in this project such as dispatched specialists who are experts on cultivation techniques and environmental management for greenhouses. Currently, it is said that the specialists had tremendously contributed to improved sustainability and to successful management. However, it was pointed out that there is room for improvement when it comes to the allocation of budget for specific purposes. The project budget has not included accommodation, transportation, and translation for Darkhan site although this region is 300 kilometers away from Ulaanbaatar where the experts stayed. This limited active involvement of the experts's engagement in Dharhan site. Thus, it was difficult to train technical skills by having to go to Darkhan region continuously.[2] Therefore, for future similar projects, it needs to have more efficient project budget allocation by considering specific demands.

2) Stake-holder Analysis

We conducted an in-depth Stake-holder Analysis in order to understand the relationships of the parties concretely, and then discover the elements that have made positive and negative influences to fulfill the project goals. Based on the

2) Gwang-ryun KANG (2009.4). Mongolia Greenhouse Project launching report

results with regards to the roles and characteristics of each stake-holder, it was divided into the different levels of government, implementing agency, and beneficiary.

<Box 1> Stake-holder Analysis

☐ Stake-holder Analysis is a method used to understand the roles of each of the parties through the process of project planning, execution, and monitoring and evaluation.

☐ Through stake-holder Analysis, it analyzes what influences have enhanced and hindered on the efficiency of project system based on the roles of each party.

At the government level, major stake-holders include KOICA headquarters, KOICA Mongolia office, Ministry of Food and Agriculture in Mongolian government, Ulaanbaatar City Department of Agriculture, and Mongolia Agriculture University (PSARI in Darkhan).

At the implementing agency level, major stake-holders include PMC and a construction company from Korea conduced project management including dispatched specialists and supervision on greenhouse construction and management. Through this process, cultivating specialists (dispatched for 8 months), a greenhouse environment management specialist (dispatched for 1 month), and a construction supervision specialist (dispatched for 1 month) have been enforced by closely communicating and cooperating with local implementing agencies.

The local implementing agencies can be largely classified into private agricultural company that manages greenhouse in Ulaanbaatar and Plant Science and Agricultural Research Institute in Mongolia Agriculture University that manages greenhouse and glasshouse in Darkhan. Beneficiaries can be classified into administrators of the agriculture company and research institute, employers, researchers, professors, students, and invited research participants. Those who have participated in circuit education and regular education are also beneficiaries taught by dispatched specialists.

3) Communication Channels and Problem-solving Mechanisms

As discussed, many different categories of stake-holders are participating in this project, and this shows the importance of well-functioning communication channels and problem-solving mechanisms.

As stake-holders at Korean side, there are KOICA headquarters, KOICA Mongolia office, and PMC. Among these stake-holders, KOICA Mongolia office has communicated with Mongolian Ministry of Food and Agriculture directly. During the field study, we were able to find out that Mongolia office has held meetings with Ministry of Food and Agriculture making official documents and reports on important matters. For example, prior consultations were properly held to discussion important matters such as selection of target beneficiaries, operating body for greenhouses and discussing the releases of annual reports.

In terms of project implementation process, specialists of cultivating techniques who have an eight-month overseas duty under PMC have regular communication with greenhouse administrators at both project sites. In case there are unexpected problems with cultivation or greenhouse management, dispatches specialists will solve the problems or they would contact with the Central Office of Rural Development Administration. In this case, there were no special problems in the cases of communication or problem-solving process.

For the stake-holders in Mongolia, the project took effect according to the three-party contract among the Ministry of Food and Agriculture of Mongolia government, Ulaanbaatar City Department of Agriculture, and Tumen Suikh in Ulaanbaatar. There was no agreement about regular(fixed) meeting, but there were ten informal meetings the first year discussing on different issues. The matters that were discussed during this time include prospective project plan for the following year, method and content of education program, and selection of greenhouse cultivation crops. For project management, they published a report at the end of each year to Ulaanbaatar City Department of Agriculture and Ministry

of Food and Agriculture. There was also on-site inspection from agricultural center. In case of damages to plastic house due to severe weather conditions, the greenhouse administrators immediately contacted the Ministry of Food and Agriculture to work on the damages.[3)]

In case of Darkhan site, there was a two-party agreement between Ministry of Food and Agriculture from Mongolian government and Plant Science and Agricultural Research Institute(PSARI) in Agricultural University in Mongolia. Like Ulaanbaatar, Darkhan also has a annual report published to the Ministry of Food and Agriculture. Different problems that touch on education and research were solved through active dialogue and cooperation among the stake-holders such as agricultural education specialist, greenhouse management engineer, cultivating crop specialists from various fields, and students/professors of Mongolia Agricultural University.

3. Effectiveness

Evaluation Objectives under Effectiveness
As part of performance evaluation, it reviews whether the project has achieved its outcomes and outputs based on the project's logical framework.

1) Output Level

(1) Greenhouse Installation and Heating System

a. Greenhouse facilities

Through this project, 4 sets of three-span plastic greenhouses were installed in Ulaanbaatar site, while there is 1 single-span glasshouse and 4 single-span plastic greenhouses in Darkhan site. In each greenhouse, anthracitic heaters (boilers) are

3) Interview with officials Ulaanbaatar Department of Agriculture

installed, and automated equipments such as water supply facilities, double switch, and double-layered curtain are equipped. According to our on-site examination, the satisfactory level of such high-tech automated installations was high.

There are 7 to 8 employees working in Ulaanbaatar site where they manage 4 sets of plastic greenhouse plantation. The employees include 2 cultivation managers, 1 construction manager, 1 greenhouse manager, 1 water supply manager, 2 drainage managers, and 1 delivery worker. There are 4 plastic greenhouses and 1 glass greenhouse. At Darkhan iste, 3 researchers and 1 engineer from Plant Science and Agricultural Research Institute are exclusively working in greenhouse management. Although the students who study at Darkhan Agriculture University help manage the plantation, labor shortage continues to be a major problem at Darkhan site.

The difference between the two project sites comes from the fact that its implementing agency is private agricultural company at Ulaanbaatar and national university-affiliated research institute at Darkhan. If private projects gain profit, it will gain human resources increasing the productivity. However, public institutions cannot gain additional revenue for human resources easily from the government. Therefore, this research institute has some difficulties in recruiting management staff despite its labor shortages in greenhouse management.

b. Greenhouse Installations

According to the results of the on-site examination, many of the greenhouse managers were somewhat dissatisfied about heating effectiveness. This is partly due to the fact that installation materials for greenhouse and heating arrangements are not perfectly suitable for climatic conditions in Mongolia. The following contents were pointed out in regards to the heating effectiveness in greenhouses which were gathered during the evaluation seminar with the researchers(greenhouse managers) of Plant Science and Agricultural Research Institute in Darkhan.

□ Problems related to plastic greenhouse facilities: The installation of Korean-style greenhouses are not fully taken into consideration on the climatic conditions in Mongolia. Thus there are problems of not being able to block the heavy winds. In case of plastic greenhouses, there are limitations of blocking the cold and protecting plants with just coaled boiler and plastics within Mongolia's severe winter weather. In order to increase the effectiveness of thermo-conservation, it is necessary to additionally install wind-breakers, insulators, and thermos along with boiler equipments. (For example: installation of large tunnels on the ground)[4] Since there are no wooden covers or brick walls that protect the greenhouse, it is difficult to open the door because it gets frozen. Also there is a huge possibility that boilers and automated facilities can be broken due to the severe cold. Additionally, the freeze and control facilities are insufficient although there are water supply facilities for severe cold conditions and freeze burst. Currently, efforts are made to prevent freeze burst by draining water from the ground before winter season begins. (During the months between November and January, it is impossible to cultivate vegetables in plastic greenhouses in Mongolia.)

□ Problems with the height of the ceilings and side doors: Although both glass and plastic greenhouses are made for winter cultivation, the height of the ceilings are too high and having side doors decreases the heating effect. In order to lessen the thermal loss and to increase the heating effect, the ceilings need to be lower and the number of doors needs to be minimized to one side.

□ Problems with glasshouse materials and facilities: Related to glasshouse materials, there are problems of damaging the glass due to temperature differences, daily temperature range, and heavy winds during winter season. During the beginning of planning stages, it was necessary to have adjustments

4) Young-sam Kwon and Mok-won KIM (2011. 2). Mongolia Greenhouse Project Post-management field trip report

in glass type and thickness and the use of transparent plastics. In case for glass greenhouse, underground heated ways were additionally included as part of a follow-up, but problems of lack of lighting continued to exist. (Example: necessary to install additional facilities like supplemental lighting)[5)]

□ Problems of high heating costs to conserve heat: Similar with the above components that cause low heating effectiveness, there are problems of the need to use at least 50% of management costs on heating bills. In case of Darkhan, heating costs are around 1.5 million tugrik per year, but it is difficult to make up the costs in vegetable sales since it is not a commercial plantation.

In Ulaanbaatar, greenhouses made by KOICA have double-layered screens which is different from the existing greenhouses made of normal plastic films, allowing to harvest even in late autumn and early winter seasons. However, there are no materials (wooden panels, brick walls, and wind-breakers) that block the winds except plastics, making it difficult to use these facilities since cold winds to enter and freeze water supply facilities and doors and break automated facilities during the winter-peaked seasons.

Greenhouse managers mentioned how it is possible to have annual cultivation if greenhouses can be supplied with centralized heating system from Mongolian government. Currently, greenhouses do not get centralized heating system services but instead are using coaled boilers, but it does not fit into the calculation when stored in the expenses of coal heat during the cold seasons (November to February). Considering this, it could have helped the outcome of project if centralized heating was provided by the Mongolian government, reducing heating costs and increasing the yearly cultivating periods.

5) Young-sam Kwon and Mok-won KIM (2011. 2). Mongolia Greenhouse Project Post-management field trip report

c. Additional Facilities

In regards to additional greenhouse facilities, although greenhouses are being actively used as the visiting practical site, it is unfortunate to not have a space for lectures. Henceforth, it will be desirable to think about providing additional space to enforce education and expansion for this project. According to Ulaanbaatar City Department of Agriculture, even if there is an education program that teaches vegetable cultivation, they have to find another location for students to learn about theory. Since there are no facilities for classrooms, they have to visit the greenhouse have field classes at a different time from the theory class. In Darkhan, PSARI has visitors from all ages including kindergarteners and specialists, but they spoke their minds of having difficulties because there is no space for lectures.

(2) Acquisition of Techniques for Greenhouse Vegetable Cultivation and Greenhouse Management

Types of education and training provided through this project can be classified into four categories as below.

- □ Lecturing tours for farmers provided by cultivation specialists (total of 8 times)
- □ Regular education for the project beneficiaries provided by cultivation specialists (duration of 8 months)
- □ Regular education for farmers and the project beneficiaries provided by greenhouse environment management specialists (1 month)
- □ Invited training in Korea (1 month)

a. Lecturing tour for Farmers Provided by Cultivation Specialist (total of 8 times)

There was a specialist dispatched for 8 months as a cultivating specialist in

this project and he provided lecturing tours for farmers in both Ulaanbaatar and Darkhan regions. Through these efforts, related-agencies in Mongolia also began to show an interest in the importance of education. Most of the students are highly responsive to the activities and are highly alert to learn.[6)]

Figure 3. Major Information on Lecturing Tours Provided by the dispatched Cultivation Specialist

Targeted Regions to Provide Lecture	Duration(Number of Participants)	Description
Songinokhairkhan Division	5 days (51 participants)	Basis theories of vegetable cultivation in facilities, seedling techniques, managing and fertilizing soils, environment management techniques, techniques for water management in facilities, field placement, cultivating skills for tomatoes and cucumber, and techniques for preventing insect damages
Citizens of Ulaanbaatar	5 days (24 participants)	
Bagahuur	2 days (20 participants)	Seedling techniques, cultivating skills for tomatoes and cucumber, and field placement
Adventist Development and Relief Agency in Mongolia	1 day (15 farmers from different regions of Mongolia)	Cultivating skills for tomatoes, field placement (drip-watering, mulching cultivation, festination cultivation, and ventilation)
Farmers in each Ulaanbaatar region	4 days process (25 participants)	Basic theory of vegetable cultivation in facilities, seedling techniques, cultivating skills for tomatoes and cucumber, field placement, environment management techniques
Farmers in Hang-ol region and Foster Farmers by Ministry of food agriculture and light industry	2 days process (20 participants)	Seedling techniques, cultivating skills for tomatoes, control techniques for environment-friendly insect damages, and field placement
Farmers in Songinokhairkhan Division	1 day process (25 people)	Management skills for facilities environment, cultivating skills for cucumber
Darkhan Regional Education Research Center, students in agricultural schools, circuit education for farmers	5 days process	Seedling techniques, sowing seeds of different fruits, cultivating techniques for tomatoes, present and prospects of Korea's controlled horticulture, plug-seedling techniques, techniques for cultivating cucumber

(Source: Gwang-ryun KANG (2009.11). Mongolia Greenhouse Project Final expert report)

6) Gwang-ryun KANG (2009. 6. 20). Mongolia Greenhouse Project Mid-term report

b. Regular education for the project beneficiaries provided by cultivation specialist (duration of 8 months)

The dispatched cultivation specialist has provided regular education on cultivating management for greenhouses in Ulaanbaatar and Darkhan during the dispatched period (April to November 2009). For the greenhouses in Ulaanbaatar, the dispatched specialist visited the site once every two days in order to communicate closely with greenhouse managers. He enforced on supervising specifically on crops' seedlings, growth and development, and harvesting process.[7] For Darkhan region, he visited the site once a week during the seedling and growth season (May and June), and afterwards, once every two weeks or once a month in order to provide guidance in crop management (grafting and harvesting).[8]

When looking at the contents of what are taught and guided, there are tomatoes, cherry tomatoes, chili, eggplants, cucumber as seedling plants, scattering dwarfing seedlings, growth, mulching, nipping, fruit setting, harvesting, and scattering pest control method, especially in providing lessons for major cultivating techniques such as seedling technique, mulching cultivation, and fertilized cultivation.[9]

c. Regular education for farmers and the project beneficiaries provided by greenhouse environment management specialist (1 month)

Greenhouse environment management specialist in this project was dispatched for 1 month (June 2009) and he has provided education and trainings for farmers and greenhouse managers in both Ulaanbaatar and Darkhan regions. During the dispatched period, they have continuously provided management and education and guidance in facility controlled horticulture, environmental control, and technical education.[10]

---

7) Interview with greenhouse managers at Tumen Suikh

8) Interview with greenhouse mangers at PSARI

9) Gwang-ryun KANG (2009.6.20). Mongolia Greenhouse Project Mid-term report

10) Young-sam KWON (2009.7.30). Mongolia Greenhouse Project Final expert report

Figure 4. Regular education provided by greenhouse environment management specialist

Targeted regions and locations that provide education	Duration (Number of participants)	Contents
Ulaanbaatar region Managers and seekers of controlled horticulture	5 days (25 participants)	Practice basic skills of greenhouse, techniques on controlling environment indoors (heating management), effects and methods of indoor water management and carbon dioxide effect in fertigation cultivation, characteristics and practices of covering material and watering materials, field placement on facilities and environment control
Darkhan region Managers hands-on workers controlled horticulture	1 day (20 participants)	Facilities and environment control techniques (heating management during winter and summer seasons, water management and fertigating cultivation indoors)

(Source: Young-sam KWON (2009.7.30). Mongolia Greenhouse Project Final expert report)

d. Invited training in Korea (1 month)

Ten trainees were invited to Korea from February 12, 2009 to March 12, 2009 for 29 days. They are from each of the following sectors: Ministry of Food and Agriculture's Policy Implemented Coordination Department, Ulaanbaatar City Department of Agriculture, a public official from Ministry of Food and Agriculture in Darkhan-Wol Aimag, Plant Science and Agricultural Research Institute in Darkhan, and greenhouse plantation in Ulaanbaatar.[11)]

The contents of the invited training include introduction of Korea's agricultural industry and Rural Development Administration, present conditions of agricultural mechanization, present conditions on breeding, organic farming, map structure of farm village, farm-work safety, fruit industry and research conditions, controlled horticulture projects, research and conditions of controlled horticulture research and conditions, major characteristics of tomato breed, theory and practice of tomato cultivating skills in facilities, theory and practice of cucumber cultivating

11) RDA (2009. 1). Mongolia Greenhouse Project Korea invited training plan

skills in facilities, theory and practice of seedling management techniques, management of seedling plantation, structural characteristics of house facilities, theory and practice of soil facilities nourishment and water management system, theory and practice of green vegetables cultivating techniques, theory and practice of disease and insect pesticide control techniques, theory and practice of controlled horticulture environmental management techniques, and on-site practice for cultivating strawberries, green vegetables, tomatoes, and cucumber.[12]

According to our field study and consultations with trainees, it has been evaluated that such invited training was beneficial for theory and practice, and there were suggestions that the contents of lectures have been beneficial for Mongolian agricultural practices.[13] As Mongolia is known to have high social status for women, the percentage of women participating in the training program was high. During the invited training, 7 out of 10 participants were women.[14]

(3) Textbook Publication on Greenhouse Cultivation

When the project first began, there was no plan to publish textbooks. However, there have been active suggestions from the dispatched specialist in the necessity of having textbooks that contain practical cultivating techniques for Mongolian farmers. Thus, the need for textbooks has become one of the major components of the project. The contents of the textbook are organized for techniques that are suitable for Mongolia, based on Korea's vegetable cultivation facilities. Based on the foundations of Korean techniques, textbooks were produced based on the data gathered during the visits of different agricultural regions and suggestions that were spoken by them.

---

12) RDA (2009. 1). Mongolia Greenhouse Project Korea invited training plan

13) Interview with greenhouse managers at Tumen Suikh and PSARI, and officials Ulaanbaatar Department of Agriculture (invitation trainees)

14) RDA (2009. 1). Mongolia Greenhouse Project Korea invited training plan

<Box 2> Suggestions in Mid-Term Report from Dispatched Expert Regarding Textbook Publications

Cultivating techniques on vegetables grown in controlled facilities (greenhouses) have been falling behind, and there are no education institutions that have the space to teach these skills along with no textbooks, even though most of the farmers are eager to learn new cultivating skills. Therefore, it is under difficult situations to improve cultivating skills. Therefore, if textbooks that teach about cultivation get published in Mongolia, it is possible to say that textbooks will be highly influential if cultivating skills becomes improved in Mongolia.

(Source: Gwang-ryun KANG (2009.6.20). Mongolia Greenhouse Project Mid-term report)

Regarding the textbook's quality, all of those who were interviewed gave positive responses. It has been evaluated that there are specific information that are useful, especially since the textbooks contain information about controlled horticulture, crop management, coal management, and contents of matter on management. However, there are suggestions that there is information that are explained more advanced than the current cultivating skills in Mongolia.[15)]

When looking at the use of textbooks, all of our interviewees from KOICA Mongolia-office, cooperative administration from the Ministry of Food and Agriculture, Ulaanbaatar City Department of Agriculture, greenhouse manager from Ulaanbaatar, Plant Science and Agriculture Research Institute in Darkhan, and Global Civic Sharing (NGO that focuses on development) gave positive responses on the textbooks, and they have been well used. The textbooks that were printed during the project have mostly been destroyed and so it is under the situation where more textbooks need to be printed, and Ministry of Food and Agriculture is currently planning to make more textbook copies. Henceforth, textbooks will contribute in securing sustainability for project effectiveness.

15) Interview with greenhouse mangers at PSARI

<Box 3> Results from the Interview with the Director of Overseas Cooperation in Ministry of Food and Agriculture in Regards to Textbook Use

There is important information on textbooks produced by the dispatched specialist. Along with basic information on plant resistance and controlled horticulture, there are also specific information on crop management. A lot of people are requesting to obtain the textbook because there are also pictures that illustrate very clearly. Textbooks are given to around 1,000 instructors who teach in agricultural education program sponsored by farm bureau, and Ministry of Food and Agriculture and Agriculture Universities also use such textbooks.

(Source: Interview with the Director of Foreign Cooperation in Ministry of Food and Agriculture)

(4) Seeds Supply

During the project implementation which took place in 2009, seeds were provided to be cultivated for one year, and most of the beneficiaries were satisfied about the quality of the seeds that came from Korea. The harvested tomatoes and crops are also considered to have good tastes. However, based on interviews with the beneficiaries, it is important to supply seeds and find improvements that are suitable for Mongolia's earth (nutrients and soils) and climatic conditions (sunshine and rainfall). By taking into consideration on how each household consumes little amount of vegetables per day, it is important for the vegetables to have thick skin in order to have longer preservation period.

There are many kinds of seeds supplied for greenhouses in Ulaanbaatar. Different kinds of vegetables are supplied, including cucumber, tomatoes, cherry tomatoes, chili, eggplants, cabbage, broccolis and lettuces, and such plant spacing for each vegetable varies. Greenhouses in Darkhan were also supplied with seeds that include cucumber, tomatoes, cherry tomatoes, lettuces, broccolis, cabbages, and head lettuces.

After the project was completed, it has been researched that more seeds have been supplied through the support of other projects promoted by Ministry of

Food and Agriculture. For Ulaanbaatar project, the people have been cultivating seeds on cherry tomatoes that are self-purchased and Israeli tomato seeds provided by Ministry of Food and Agriculture. Israeli tomatoes do not taste as good as Korean tomatoes but it has been evaluated to be more suitable for storage because the skin is thick. For Darkhan project, aside from seeds provided by self-procurement and government, they are cultivating tomato and strawberry seeds provided by Asia Food and Agriculture Cooperation Initiative (AFACI).

2) Outcome Level

(1) Commercial-purpose Greenhouses: Creation of business model for stable Greenhouse Management and Operation

This project has created a business model for the sales of tomatoes and cucumber derived from the greenhouse vegetable cultivation in private agricultural enterprise (Tumen Suikh). According to the annual report from Tumen Suikh and interviews with greenhouse managers, the following shows the creation effect of business model for stable greenhouse management and operation.

a. Effect on Cultivation Period Extension

The dual-heating plastic greenhouses installed by KOICA have higher thermo-conservation compared to existing greenhouses, allowing the seedling to be made in March, planting starting from April 1, and cultivating and harvesting from May 5 to mid-November (around 9 months). Compared to the existing cultivation period of 4 months for non-heating plastic greenhouses and cultivation period of 6 months on non-heating glass greenhouses, there is an effective extension period for 4 to 5 months.[16] The heating period is between September 15 to November 15, and during these heating periods, heating is supplied from 6 AM to 6 PM. The amount of harvest during the heating period is similar with the amount of harvest during

16) Tumen Suikh (2009), Annual report on greenhouse management in Ulaanbaatar

the summer, but since it allows an extension for cultivation period using heating, the annual crop harvesting per 1 m^2 will allow the increase of 4 to 5 kg.[17]

b. Annual Sales Profit per Unit Area

The profit for greenhouse cultivation is different for each crop. Since leaf vegetables such as lettuces and cabbages are dominated by imported products from China, the rate of return is lower than other crops such as tomatoes and cucumber. Thus the greenhouse mangers at Tumen Suikh preferred to grow tomatoes and cucumber. The annual sale in 2010 for 4 sets of three-span greenhouses (4000 m^2) were 103,581,000 tugrik, and the annual running costs that include heating costs, labor costs, and transportation costs are 19,570,000 tugrik. The net profit by taking out the running costs from yearly costs is 87,611,000 tugrik, thus by dividing the number of greenhouses (3-greenhouses * 4 sets = 12-greenhouses), the net profit for each house is around 7,300,917 tugrik. The following shows the each of the sales and amount in running costs.

Figure 5. vegetable Production from Heated Plastic Greenhouse with 4000m^2 Area

No	Name of Vegetable	Cultivated Area (㎡)	Amount of Harvest (kg)	Cost of Total Sales (Tugrik)
1	Cucumber	1000	5380	27,362,000
2	Cucumber	1000	3630	23,573,000
3	Small Tomatoes (Korea)	1000	1720	39,690,000
4	Tomatoes	330	266	5,852,000
5	Chili	164	220	2,200,000
6	Broccoli	164	160	1,120,000
7	Cauliflower	82	120	574,000
8	Cabbages	82	150	1,050,000
9	Chinese Cabbages	178	270	2,160,000
10	Chinese Cabbage – second cultivation	506	506	3,600,000
	Total			107,181,000

(Source: Tumen Suikh (2010), Annual report on greenhouse management in Ulaanbaatar)

17) Tumen Suikh (2009), Annual report on greenhouse management in Ulaanbaatar

Figure 6. Total Cost during Cultivation Period from Greenhouses with 4000m^2 Area

Number	Items	Expense Costs (in tugrik)
1	Electricity Bills	2,300,000
2	Heating Bills (Coal)	680,000
3	Water Bills (Water Supply)	650,000
4	Shipping Fee	2,300,000
5	Seeds	1,600,000
6	Fertilizers	800,000
7	Chemicals	40,000
8	Soil Cover (Plastic)	600,000
9	Personnel Expenses	10,000,000
10	Other Materials	250,000
11	Real-estate Tax	350,000
	Total	19,570,000

(Source: Tumen Suikh (2010), Annual report on greenhouse management in Ulaanbaatar)

c. Effects on Business Model Creation and Greenhouse Management

The above-mentioned expenses on sales and profits show how KOICA-funded greenhouses can function as a business models for greenhouse cultivation in Mongolia, showing that it has stably accomplished administrative control. However, it has been said that there will be heavy constraints to make it a working model for other projects and farmers for the following reasons: the project's beneficiary already has accumulated experiences of greenhouse cultivation and there is no installation costs for greenhouses burdened to the beneficiary.

Even though this project has provided commercial-purpose greenhouses, it lacks the support in marketing strategies and market buildup, limiting the project's outcome. In case of Mongolia, even if the productivity increases through the introduction of greenhouses and new cultivation techniques, there are still many constraints hindering actual sales increase. Substantial amount of leaf vegetables have been imported from China, making the price competition low for vegetables

produced in Mongolia. Vegetable cultivation is almost impossible during the winter (November to February), which makes it difficult for farmers to supply vegetables to large-scale grocery chains and supermarkets on a stable manner throughout a year. Due to these characteristics of Mongolia's vegetable market environment, this project needed to consider having extra sales and marketing strategies for actual wholesale market and wholesale merchants.

d. Economic Feasibility of Mongolia's standardized Greenhouse Cultivation

As seen above, there is effectiveness in the creation of business models for KOICA greenhouses but there are several limitations when it comes to the model's expansion to normal farms in Mongolia. This evaluation has conducted a comparative analysis on the economic feasibility of vegetable cultivation through standardized plastic greenhouses (small, unheated, rain shelter greenhouse, 6 m * 20 m) and normal outdoor cultivation.

● Percentage of Planted Acreage for Vegetables

Mongolia's total agricultural planted acreage in 2011 was around 346,000 ha, and planted acreage used for vegetable products was around 7,800 ha, comprising 2.3% of the total acreage. The total acreage of farmland has annually increased 14.3% on average from 2007 to 2011, while planted acreage for vegetables also increased around 6.2% each year.

Figure 7. The Proportion of Planted Acreage for Vegetables

	2007	2010	2011 (Estimated)	Yearly Average (2007-2011)
Total Acreage under Crop Cultivation (A)	202,729	315,295	345,935	14.3%
Acreage under Vegetables Cultivation (B)	6,135	7,032	7,793	6.2%
Rate of Acreage for Vegetables Cultivation (C)	3.2%	2.2%	2.3%	-

(Source: Ministry of Food and Agriculture in Mongolia, Statistical Data of Food, Agriculture, and Light Industry Sector)

● Self-Sufficiency for Vegetables

Mongolia's self-sufficiency for vegetables in 2011 was 48.3% for tomatoes, 79.6% for cucumber, 28.7% for onions and garlic, 38.2% for cabbages, and 72.5% for carrots and radishes. Most of the vegetables are cultivated outdoors, but are affected by climate changes and insect pests that cause unstable trend each year in productivity. According to our field study, the total vegetable productivity including tomatoes and cucumber comprise 7% to 9% of the greenhouse cultivated vegetable output.

Figure 8. Self-sufficiency of Major Vegetables in Mongolia

	2008		2010		2011(Estimated)	
	Productivity	Self -sufficiency	Productivity	Self -sufficiency	Productivity	Self -sufficiency
Tomato	2,805	32.9%	1,566	28.1	2,350	48.3
Cucumber	2,845	40.1%	3,352	70.6	4,374	79.6
Onion/Garlic	4,222	22.8%	5,840	28.6	6,089	28.7
Cabbage	19,328	48.5%	17,856	41.5	20,896	38.2
Carrot/radish	39,472	87.3%	46,453	82.1	53,898	72.5

(Source: Ministry of Food and Agriculture in Mongolia, Statistical Data of Food, Agriculture, and Light Industry Sector)

● Economic Analysis on Plastic Greenhouse Vegetable Cultivation (Case Study on Tomatoes)

In order to understand the establishment of business model through the economic analysis on vegetable cultivation under plastic greenhouses, tomatoes are used as the model for the analysis since it has the highest profitability, allowing us to analyze the economy of outdoor greenhouse cultivation. In this analysis, we used the 6m * 20m single-span rain-shelter plastic greenhouse, which is the normal model that Mongolian government has provided to farmers in order to increase

greenhouse cultivation. First, after estimating the spending costs in case of installing outdoor plastic greenhouses, it has been estimated that the income increase in case of crop cultivation using plastic houses. Based on these two results, economic feasibility are decided for tomato cultivation using plastic houses. The estimated results in the increased costs of outside are shown in Figure 13, where the combined costs of greenhouse installation, heating, and plastic replacement comes out to be 797,936 tugrik.

Figure 9. Estimated Cost Increase of Greenhouse Cultivation compared to Outdoor Cultivation

Classification	Analysis Results
Cost of Greenhouse Installation (1)	One house (6m*20m) = 2.5 million tugrik = material costs of plastics and reinforcements (2 million tugrik) + Installation fee (500,000 tugrik)
	Annual average cost (10 years persisting period, 10% interest rate, residual amount assumed at 0) = 648,436 tugrik = $\frac{2{,}500{,}000 \times (1+0.1)^{10}}{10}$
Yearly Heating Costs (2)	One house (6m*20m) = 87,500 tugrik = demand quantity of coals (2.5 tons) * cost of coals (350,000 tugrik/ton)
Replacement Cost for Plastics (3)	One house (6m*20m) = One time/four years = 248,000 tugrik Annual average cost = 248,000 tugrik/4 years = 62,000 tugrik
↓ ↓ ↓	
Increased Net Cost of Annual Greenhouse Cultivation	One house (6m*20m)= (1)+(2)+(3) = 797,936 tugrik

In order to estimate the income increased by greenhouse cultivation when compared to outdoor cultivation, we have made the following assumptions set by gathered references.

□ Cultivated period (April to November: on average 8 months) using greenhouses allows the period of cultivation to double compared to out-door cultivation

(June to September: on average 4 months).

- □ During the cultivated period, the output per unit area for greenhouse cultivating yield (10 kg/m^2) is 2.2 times larger than the average field cultivation (4.5 kg/m^2). This is because greenhouses have a higher yield effect.
- □ The sale price is 4,000 tugrik/kg, where the tomatoes from outdoors and greenhouse cultivation are same.

Based on the above assumptions, average annual income increase through the greenhouse cultivation, compared to outdoor cultivation, is 1,842,064 tugrik (net sales profit increase - net cost increase = net income increase).

Figure 10. Estimated Income Increase through greenhouse cultivation compared to Outdoor Cultivation

Section	Analysis Results
Increased productivity in single-span greenhouse (6m*20m=120 m^2)	Outdoor (120m^2) production output is 540 kg of tomatoes, while 1 greenhouse (6m*20m= 120m^2) produces 1,200 kg.
	Thus, the net production increase for tomatoes in 1 plastic greenhouse (6m*20m=120m^2) is 660kg/120m^2.
Increased sales profits through the production in multi-span greenhouse (6m*20m=120m^2)	Outdoor (120m^2) sales profits = 540kg * 4,000 tugrik/kg = 2,160,000 tugrik
	1 greenhouse (120m^2) sales profits = 1,200kg * 4,000 tugrik/kg = 4,800,000 tugrik
	Greenhouse cultivation net sales profit increase = 2,640,000 tugrik
↓ ↓ ↓	
Net profit earnings through greenhouse cultivation (annual average)	Net sales profits (=2,640,000 tugrik) – Increased net cost of annual greenhouse cultivation (=797,936 tugrik) = 1,842,064 tugrik

Therefore, when tomatoes are cultivated in 6m*20m single-span rain-shelter plastic greenhouses, the annual increase of net profit is 1,842,064 tugrik, broken down from the net sales profits of 2,640,000 tugrik and greenhouse cultivation cost of 797,936 tugrik. Based on the above economic analysis, plastic house has

more economic feasibility than field cultivation, allowing the value to be increased from the benefit creation through vegetable cultivation period extension and adjustment.

e. Implications

Based on the results of economic analysis, Mongolia's plastic greenhouse has more economic feasibility than outdoor cultivation, making Mongolian government to work on policy efforts to increase the number of plastic greenhouses. However, the reasons listed below shows how it is still insufficient to spill out greenhouses to average farmers.

- □ High investment costs and high heating costs to install plastic greenhouses
- □ Lack of skills, knowledge, and information on greenhouse cultivation facilities
- □ Lack of greenhouse installation skills, seeds, equipments, and water management applicable to cultivation under structure

(2) Research-purpose Greenhouses: Increase in Productivity through Variety of Cultivation Experiment

Based on our field examination and interviews, there have been positive results through different experiments in cultivating tomatoes, cucumber, and strawberries using KOICA greenhouses. Researchers at PSARI have suggested similar opinions in regards to the projects' experiments in crops cultivation.

- □ Adjustments in Production Period: Possible to secure research flexibility
- □ Diversification of Vegetables for Fields of Study: Tomatoes, eggplants, chili, bell peppers, cucumber, and strawberries
- □ Research on Cultivation Experiment: By planting 10 different kinds of vegetables, it will look at what changes and differences occur when placed in same conditions.
- □ Research on Improving Breeding: Looking at breed improvement that fits with Mongolia's current climate and soil conditions, contribute to new varieties

that will help in increasing the productivity, and produce good quality seedlings to give to the producers.

During out on-site examination, we were able to see that crops such as tomatoes, cucumber, and strawberries are continuously being experimented.

Picture 5. Research on Strawberry Breed - 1

Picture 6. Research on Strawberry Breed - 2

Picture 7. Research on Cherry Tomato Breed

Picture 8. Harvest Output of Cherry Tomato

3) Effect on production period extension through greenhouse compared to outdoor cultivation

Through 'White Revolution' (increase of cultivated vegetables grown in greenhouses), Mongolian government has experimented in year-round greenhouse cultivation in order to increase self-sufficiency. PSARI was selected to be provided centralized heating system from the government in order to examine the possibility of year-round greenhouse cultivation. In case of plastic greenhouses provided by KOICA, there is cultivation between March and October (November to February is resting phase), and there seems to be extension effect on productive period. The heating period is provided between October 1 to May 1, and yearly expenses are around 1.5 million to 2 million tugrik. Through the results of extended period of production through advanced facilities and fully-equipped greenhouse, it is possible to double its productivity when compared to outdoor cultivation.[18)]

4) Implications

As seen in the above analysis, there seems to be positive outcomes through the experimental results of a variety of crop cultivation and enhanced effects of extended productivity period. However, there is a drastic difference between the usage and objectives for research greenhouses in Darkhan and commercial greenhouses in Ulaanbaatar, but there is no indication on tailored technical assistance and additional budgets/human resources on research for PSARI during the project. Due to this, three researchers work in the management and cultivation in five greenhouses (1 glass house and 4 plastic houses), causing labor shortage problems in conducting research effectively at the same time.

18) Interviw with the vice president and greenhouse managers at PSARI

4. Impact

Evaluation Objectives under Impact
As part of performance evaluation, it reviews how the project was impacted through the effectiveness of logical framework.

※ Since there is limitation in measuring the project's influence on the actual lives of beneficiaries based on this demonstration project, this evaluation focuses on the long-term influences that focus on "spread of techniques and expansion effect" along with "synergy effects on commercial greenhouses and greenhouses used for research."

1) Effect on Spreading of Techniques for Greenhouse Vegetable Cultivation (Function as Educational Venue)

In case of Darkhan supplied with research-purpose greenhouses, it has been contributing to the culture of knowledge and skills on greenhouse vegetable cultivation for farmers and students.[19] This indicates how they have been performing their roles on the practices of environment management and cultivating skills. This project is attempting to increase the effectiveness by providing field trips and education programs geared towards from all ages, including kindergarten students to farming specialists.

As part of education and extension efforts, it has continued to cooperate in educating cultivating skills for each kind of vegetables with Mongolian central government (Ministry of Food and Agriculture) even after the cultivation experts completed their overseas jobs through KOICA. Additionally, it has cooperated with private development organization World Vision, local broadcasting station

19) Focus group interview with greenhouse managers (researchers) at PSARI

LHA, and Blue Sky Studio to provide cultivating skills education through the distribution and use of DVD (90 minutes running time).[20]

Figure 11. Education Performance on PSARI after KOICA Project completion

	Title of Course	Coordinated Institution and Organization	Affiliation of Participants	Date	Number of Participants
1	Lecture on Greenhouse Cultivation	Citizen's Assembly in Selenge	Farmers in Selenge	2010. 06.06	23
2	Practice demonstration greenhouse	Agricultural Center in Bulgan	Bulgan District Office Administrators of Agro Park	2010. 06.08	13
3	Greenhouse Cultivation	Agricultural Center in Darkhan Food and Agriculture Department in Darkhan	Greenhouse supply business	2010. 06.15	20
4	Greenhouse Cultivation, Water Supply System	Ministry of Food and Agriculture, Youngwon Blue Meadows Corp.	Greenhouses in central region	2010. 07.06-07	100
5	Practical education in demonstration greenhouse	Agro Consulting Center	Farmlands in Uvurhangai	2010. 08.15	42
6	Demonstration Greenhouses Skills Education	World Vision, Zuun kharaa	Selenge Supply greenhouse in the regions of Mandal, Bayangol, Saikhan, and Hotul Project participants	2010. 08.21	50
7	Demonstrated Greenhouses Skills Education, Public Relations in Research Institutes	Noyon Hairhan NGO in Uvurkhangai	Workers of Small and Medium Sized Private Agricultural Businesses	2010. 10.06	10
	Total				258

(Source: PSARI (2010), Annual reports on greenhouse management in Darkhan)

In case of Ulaanbaatar, they have continued to apply the cultivating techniques

20) PSARI (2010), Annual reports on greenhouse management in Darkhan

instructed by dispatched specialists taught during the project. According to the records in the annual report from the Tumen Suikh in Ulaanbaatar, greenhouse managers have followed the cultivation method by seedling from late March to early April, transplanting in late April or early May, and harvesting between June to November. As of August 2012 during our field study, tomatoes have been cultivating according to the steps listed above (following the instructions that the dispatched experts taught), and they have been harvested and put on sale once every three days starting from July.

Such active greenhouse cultivation skills have been spreading widely to the farmers through the education provided by Ulaanbaatar City Department of Agriculture and Ministry of Food and Agriculture. Mongolian government have been promoting on spreading programs on plastic houses targeted on farmers in order to expand vegetable cultivation. Through this, they have been supported by paying only half the expenses on greenhouse installation, and they have offered training education (two to four times a year) using greenhouses provided by KOICA.

Even so, the difficulties come from the fact that private agricultural industries usually manage greenhouses in Ulaanbaatar, and this causes them to focusing more on revenues than education purposes. As Ulaanbaatar City Department of Agriculture and Ministry of Food and Agriculture have to supplement such manner, members have talked about the lack of expertise in applying agricultural education and lack of budgets. Therefore, in order to maximize the delivery of skills and expansion effects in commercial greenhouses, it is necessary to provide specialized and separated education for the creation of business models in commercial greenhouses along with general education in agricultural skills.

2) Linkage (Synergy Effect) in Research Greenhouses and Commercial Greenhouses

Related to linkage (synergy) in the activities and outcomes of research greenhouses and commercial greenhouses provided by KOICA project, it has been found that more time is needed to find detailed connection between the outcomes of the two project sites. Although there was some progress in creating the business model which the project relates to the installation of commercial greenhouses in Ulaanbaatar, the research greenhouses installed in Darkhan has a difficulty finding its variety and improvement based on the current climate conditions because it cannot be solved in a short-term matter. According to PSARI in Darkhan, the research has been continuously fulfilling in improving and cultivating techniques on tomatoes and strawberries. Based on the results, findings are going to be included in Ulaanbaatar project and try to test the profitability of cultivating different vegetables. Until then, Ulaanbaatar project continues to develop know-how on cultivating skills on major vegetables. If such roles are distributed well, it is possible to see the synergy effect on the two project's progress and linkage.[21]

5. Sustainability

Evaluation Objectives under Sustainability
This section analyzes the post-project effects that emphasize on maintaining commercial greenhouses and research greenhouses, the potentiality in managing the greenhouses and the sustainability of effect.

1) Exit Strategy

In regards to sustainability of the project, when it comes to greenhouses'

21) Interviews with greenhouse managers at Tumen Suikh and PSARI

operating authority at the end of the project, the biggest problems are that the plans are not clear and such measures are somewhat incomplete. As we have repeatedly referred here in the report, one of the targeted sites (Ulaanbaatar) is under commission due to the contract with private agricultural company for three years (June 2009 to June 2011). The condition during this time was for the company to handle greenhouse management and to test Korea's greenhouse skills, and through the cooperation between Ministry of Food and Agriculture and Ulaanbaatar City Department of Agriculture. Lastly, they will cooperate in providing the necessary education capital.

To be more specific, the contract clearly states on the following: using one out of four sets for education purposes while the other three is for cultivating new variety of seedling vegetables and fruits while using for seedling cultivation, experiments, and research.[22] According to the interviews held in Ulaanbaatar City Department of Agriculture, 30% of profits from the greenhouse's crop cultivation has been paid from Ulaanbaatar City Department of Agriculture, and Ministry of Food and Agriculture has fulfilled in providing education programs with the amount.

According to the results found on the evaluation team's field survey, yearly report of Ulaanbaatar, on-site inspection, and interviews with greenhouse managers, these procedures allowed the greenhouses to be effectively managed and crops to be cultivated as of August 2012, including the rise of professionalism and experience on controlling horticulture. The problem is that KOICA Mongolia office, Ministry of Food and Agriculture, Ulaanbaatar City Department of Agriculture, and commissioned company do not have a clear communication under rights to manage the greenhouse facilities even though the contract has already ended in June 2011. Therefore, the company are getting profits by planting tomatoes in all four sets of greenhouses. There was a payment that needed to be paid towards Ulaanbaatar City Department of Agriculture from the company at the end of

22) Official contract document between KOICA and the Ministry of Food and Agriculture

2011, but it was found that they did not pay 30% of the profits.[23]

In summary, although the contract for greenhouse commission has ended, the Ministry of Food and Agriculture has not checked on whether or not the conditions in the farming company have sincerely been fulfilled during the three years while there was no inspection on the progress of greenhouse management. Henceforth, it can be assumed that the right of authority in greenhouse management and profit distribution on greenhouses has not been discussed. During the discussion with the Director of Overseas Cooperation in Ministry of Food and Agriculture, she mentioned how there has been evaluation on monitoring the fulfilling the conditions of the contract under farming businesses, however, we have not received the evaluation report.[24]

During the stages of pulling out the dispatched specialists and the termination of the project, there were no proper exiting strategies and management procedures from Ministry of Food and Agriculture and Ulaanbaatar City Department of Agriculture.

Along with the project that commissions facilities like private businesses, it brings positive effectiveness of management production making it important on the need to provide practical economic actions and monitoring for checking on the progress along with the need to make clear statements during Terms of Reference (ToR) and contract conditions. Thus, it is necessary to provide detailed statements on which side, how much frequency, and what type of methods will be applied for monitoring.

---

23) Since Tumen Suikh is still benefitting from greenhouse cultivation until 2012, they have the responsibility to pay the 30% of profits in 2011, even though the official contract was expired in June 2011.

24) Regarding the extension or expiration of the contract with Tumen Suikh, KOICA Mongolia Office sent the official letter to the Ministry of Food and Agriculture which asks for the Ministry to conduct a performance evaluation and make a decision whether to extend the contract with Tumen Suikh in the near future.

2) Follow-up Management and Procedures

When looking at follow-up management and procedures in this project, KOICA has provided additional facilities such as underground heat rays and new equipments. According to the Plant Science and Agriculture Research Institute in Darkhan, double doors were installed and reinforcement work for workspace has been implemented in order to increase thermo-conservation on glass greenhouses, making follow-up procedures on establishing storages. In case of Ulaanbaatar, it has provided maintenance and management in applying the demand of manpower. As of August 2012, the inner film of the two-side film needs to be replaced, but it has held on parts and materials for repair, and it is possible to maintain.

Picture 9. Two-layered door Installed by the PSARI

Picture 10. Storage Constructed by the PSARI

Picture 11. Additional Thermal Facilities Provided by Follow-up Management of KOICA

Picture 12. Additional Equipments Provided by KOICA

The Asian Food and Agriculture Cooperation Initiative (AFACI) has settled on a contract with Plant Science and Agriculture Research Institute in Darkhan, and it is interesting to see how the research project has taken place for three years for plant breeding and cultivating skills on tomatoes and strawberries. Through this, technical assistance has been supplemented after knowing the project has lacked this component, and it has contributed in achieving sustainability in Darkhan. In AFACI of Rural Development Administration (RDA), it has provide technical assistance on agriculture computerization, and seed development of tomatoes. These have provided positive contributions in making better use of greenhouses.

3) Will and Capability Competence (Ownership)

Based on an interview with the greenhouse manager at the Ulaanbaatar site, it has recognized project outcomes through the acquisition of high-tech greenhouse skills in Korea, education effects, and expansion effects of Ministry of Food and Agriculture. According to the results during our in-depth interviews with PSARI in Darkhan, the following has been recognized on the project's contributions for project's beneficiary.

□ Function as Educational Venue
- Make an inspirational will on greenhouse cultivation for vegetable farming as demonstration model
- Contribute to knowledge sharing and capability building related to greenhouse vegetable cultivation among farmers and students
- Conduct a role as demonstration farm for greenhouse environment management and practices of cultivating skills

□ Preparing the Basis of Research
- Expand the possibility of finding new research topics
- Secure diversity of research through the use of greenhouses (diversification

of vegetable kinds)
- Contribute to the research of greenhouse environment management system
- Secure research flexibility through adjustments and extension of production period

□ Increase in Vegetable Productivity and Extension of Cultivation Period
- Contribute to the increase in productivity per unit and enhance vegetable quality
- Provide the basis of expanding the possibility of yearly productivity growth for fresh vegetables (advanced facilities and equipments)

□ Creating Profitability for Vegetable Cultivation
- Expand the possibility of revenue generation by controlling the productivity time while also extending production period

□ Contribute to Breed Improvement, Development of New Variety of Seedlings, and Seedling Production
- Contribute to breed improvement based on Mongolia's climate and soil conditions
- Contribute to the development of new kinds of seedlings that will assist in the increase of productivity in farms

The researchers at PSARI made the following suggestions in order to maximize the project's outcomes mentioned above.

□ Effort from Mongolia's Government
- Mongolian government and NGOs to provide cheap but good quality greenhouse installation materials
- Supply of textbooks specialized on vegetable cultivation
- Expand breed development and dissemination through Mongolia's natural

characteristics and conditions

- Make efforts to improve the conditions of greenhouse installation on local farms (including low-interest loans in banks)
- Make policies to increase the level of self-sufficiency in local vegetables and to increase vegetable consumption (including reduction of Chinese-produced vegetables)

□ Efforts from PSARI in Darkhan

- Internalize stability on cultivating skills transfer to local farmers
- Make new breed development and disseminate
- Establish yearly development plan for PSARI
- Construct cooperative measures and reinforce cooperation with other relevant institutes/projects

Ministry of Food and Agriculture have been working on the following plans to increase vegetable cultivation, and it shows how the project has certain elements to increase such positive effects.

□ Current Efforts under Ministry of Food and Agriculture

- Support part of glass greenhouse installation expenses to private businesses: support industrialization of greenhouse vegetable cultivation
- Support part of plastic greenhouse installation expenses to local farmers: diffuse greenhouse development for local farmers
- Support normal operation costs for 'Green Revolution' education program under Ministry of Food and Agriculture
- Expand Agro Parks and Agricultural Extension Centers
- Make extra publications of greenhouse cultivating skills textbook

6. Cross-cutting Issues

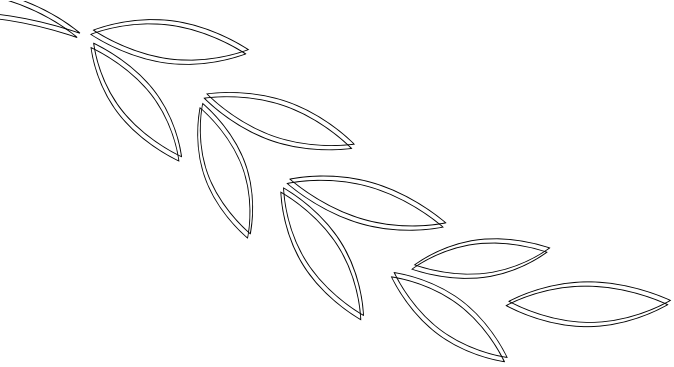
Evaluation Objectives under Cross-cutting Issues
This section analyzes on the factors that influence gender equality and environment during the planning and execution processes of the project.

1) Gender Equality

Although gender equality was not considered during the project, the percentage of female beneficiaries was high during the project's implementation process. Such results are reflected on Mongolia's attributions where females are considered to have high social status in its socialist history. Taking these factors into effect, the percentages of women in high rank officials, hands-on workers, and those who were trained through invitational training in Korea were high. There were eight out of ten women program managers (from the Ministry of Food and Agriculture, Ulaanbaatar City Department of Agriculture, Tumen Suikh in Ulaanbaatar, and PSARI in Darkhan) who were asked to have interviews with evaluation team. Invited trainees to Korea also coincide with the interviewees, and seven out of ten were women.

2) Environment

This project was executed as small-scale demonstration project, producing small influences in the environment while there was no special consideration on the environment during the project execution process. Even with the severe problems of air pollution in the city regions of Mongolia, coal boilers have been installed. The use of coal boilers would have been inevitable choice for large-scale greenhouses like KOICA greenhouses, but it could have been possible to consider different measures of using waste heat that comes out of power plants.



Conclusions

Chapter

Ⅲ Conclusions

1. Lessons learned and Recommendations

1) Project Planning Stage

(1) Importance of thorough preliminary study on local environmental conditions

□ Importance of providing greenhouses that fits the local Mongolian climate conditions rather than introducing Korean-style greenhouses: The installed greenhouses are partially not modified into Mongolia's local climates, and instead show strong characteristics of Korean-style greenhouses. Therefore, although KOICA greenhouses are high-tech facilities that include automated facilities, it does not effectively reflect on local demands. Based upon this, examinations are made showing how the current installed plastic greenhouses and glass greenhouses possess problems like the high costs of heating bills, plastic and glass damages due to daily temperature ranges, and equipment failures due to cold weather conditions.

□ Importance of understanding all environment conditions including water, soil, location of installation, and the use of centralized heat provided by the government: Along with climate conditions, understanding the different environment conditions have been considered. In case of Darkhan PSARI, the location of greenhouses has been pointed out as somewhat unsuitable

due to the lack of separate water source for the KOICA-funded greenhouses. Even with the location of greenhouse installation, there have been cases of having negative influence on the growing process because greenhouses have been installed under the location that often have shades.[25] In case of Ulaanbaatar projects, KOICA's dispatched specialists did not point out the quality of soil in the preliminary survey, but they later pointed out the importance of reinforcement in using fertilizes after the project began. Also, it has been pointed out that there is a limitation on cultivation period extension since the KOICA-funded greenhouses in Ulaanbaatar doesn't have access to the government's central heating system.

□ List of factors to be checked in future similar projects: For such reasons, thorough reviews are needed in project planning stage by looking at the following elements.

- Soil Quality: Necessary to know whether or not there is suitability on the vegetable production based upon soil conditions in targeted areas when installing greenhouses (example: soil quality, components of soil, fertility of soil, and nutrients)
- Location of Installation: Necessary to understand if crops are suitable for growth for targeted site when installing greenhouses (examples: measure of sunshine, shade, whether or not the structure fits with wind break)
- Water supply: Continuously having water supply is mandatory in crop production, and it is necessary to provide separate source of water for greenhouses only (example: necessary to install extra water facilities or install underground tube wells)
- Circumstances of Supplying Electricity: In order to use greenhouse facilities and lighting, water supply facilities, and heating facilities, it is mandatory to provide stable electricity, thus it is necessary to confirm on the conditions

25) During the interview with the researchers at PSARI, they mentioned the location was proposed by them at the beginning of the project.

of electricity (example: in case there is no stability, necessary to include materials like medium-sized generators)

- Government's System, Policies, and Regulations: Necessary to understand the policies and regulations related to farming, vegetable cultivation, installation of greenhouse facilities, and crop sales
- Greenhouse design: Necessary to plan out greenhouses that fit with local climate conditions – height of ceilings (needs to be low and resistant to heavy winds, need to consider semi-basement style), wind break (necessary to install wooden panels or brick walls), utilization of soil covering (consideration to use tunnels), lighting (number and type), and underground heat rays.
- Greenhouse Materials: Necessary to reflect local climate conditions (example: transparent plastic greenhouses installed instead of glass greenhouses in order to lessen the damages during several daily temperature ranges and heavy winds, or using strong plastics suitable for local weather conditions)

(2) Necessity to Understand the Inputs Characterized in different types of Beneficiaries and Detailed Project Objectives

□ Research Objectives: Research greenhouses have big differences on the usage and objective goals compared to commercial greenhouses in Ulaanbaatar, but the objectives of research greenhouses and differentiated inputs (technical assistance for research, research-related materials, and participation of specialized researchers) have not been defined during the planning stages of this project.

□ Commercial Objectives: For commercial greenhouses in Ulaanbaatar on the other hand, divided components of education are necessary that include not only cultivation techniques but also marketing strategies. Therefore, detailed elements need to be adjusted on targeted area's characteristics

and objectives in future projects.

□ Educational Objectives: Although this project has executed as a demonstration to expand education, there is no lecture rooms to provide education for students and visitors, making it difficult for the implementing agencies to provide education and trainings for farmers, students and visitors. For future-related projects, it is desirable to put small-scaled classrooms and additional facilities.

□ Demonstration and Extension Objectives: As the project is fulfilled as demonstration project, it demands comprehensive approach in vegetable industrialization on the following listed below.

- Obstacles of Vegetable Industrialization (Importance of related industry development): Problems of market settlement, distribution, infrastructure like road conditions
- Necessary Matter to Expand Vegetable Industrialization: education on seeds, seedling period, cooperative purchasing of materials/credit, foster in mutual-aid project (insurance), cooperative purchasing, and businesses specialized seedling periods.

(3) Necessity of Raising the Importance of Technical Cooperation

□ Importance of Technical Cooperation to Secure Sustainability: The successful element for farming project is applied through learning skills, and education in managing soil and greenhouse become very important. This project used 1.05 million USD out of the total budget of 1.4 million USD in greenhouse installation, making it evident to see the limitation in the use of technical cooperation with 310,000 USD that include training (80,000 USD) and dispatched specialists (230,000 USD). For future-related projects, the proportion of technical cooperation needs to be bigger in order to secure project's

progress and sustainability. Most of those whom we have met in local survey of evaluation team have emphasized on the importance of learning skills like what type of vegetables are growing and harvesting in order to secure project progress and sustainability.

- What farmers have the most difficulty during vegetable cultivation: crop management, depth of seeding, seed procurement, and time of harvesting
- What needs to be improved on KOICA project: Although there is meaning of showing advanced skills for demonstrating greenhouses, technical cooperation should be stronger. If there is not enough technical education, only demonstration farms will get the privilege and it will not expand to near-by farmlands.

2) Implementation Stage

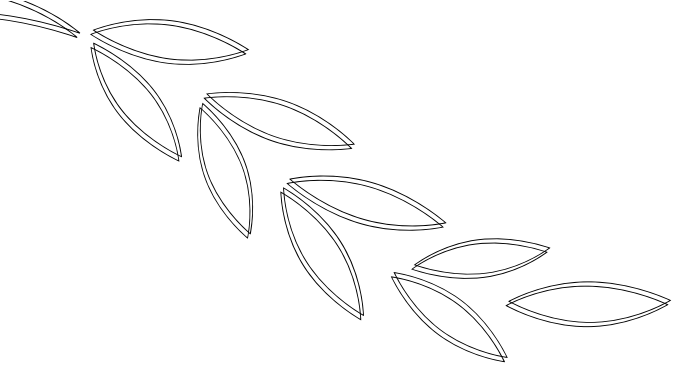
□ Necessary to change the process of dispatching specialists: When long-term dispatched specialists are needed, there are difficulties dispatching related experts for long-term in Korea. Rural Development Administration was the implementing agency for this project that dispatched specialists of vegetable cultivation and greenhouse environment for both short-term and long-term periods, but it is hard to find long-term dispatched specialists other than retired specialists. Therefore, future similar projects need to use suitably on work-site specialists and retired specialists, and it is necessary to have management plan in using sector specialists in partner countries.

3) Follow-up Management and Sustainable Utilization

□ Notes on Commissioning for Private Companies: The project took place on commercial greenhouses by having a contract through the commission with private agricultural company, Tumen Suikh. By commissioning the greenhouse facilities to private businesses, it can be positive in the effectiveness of

management and productivity, but problems can exist on conditions such as lack of details in contract, incomplete monitoring while fulfilling contract conditions, and lack of follow-up actions after contract gets terminated. Therefore, it is necessary to have clear Terms of Reference (ToR) and detailed statement of contract conditions while also having practical coercive measures and monitoring. It needs to include what agents, how much frequency, and what methods will be used for monitoring. Additionally, it needs to be clear in performance evaluation that determines in extending or terminating the contract.

□ Importance of securing sustainability by connecting with other initiatives/projects: In order to secure sustainability after finishing the project, AFACI by Rural Development Administration has made a two-way contract and the institute has worked on the research project for three years focusing on improving breed and cultivating skills in tomatoes and strawberries. Through this, additional technical assistance has been provided even after the completion of the KOICA project. This leads to satisfy the objectives of research on greenhouse cultivation, contributing to achieving sustainability of Darkhan greenhouses. It is desirable for future similar projects to find a connection on other innitiatives/projects that work on technical cooperation and try to secure sustainability in maximizing project's effect through cooperation. For example, in order to continue education program for greenhouses, it will be possible to assign management and education to the Korean NGOs that have had successful outcomes by making a contract follow-up management. In case of commercial greenhouses, connections of agricultural association or farmer organization and connections of other farming projects are needed in order to maintain profits.



References

References

<KOICA Reports>

KOICA (2007. 11). Mongolia Greenhouse Project Feasibility study.

KOICA (2008. 5). Mongolia Greenhouse Project Implementation plan.

KOICA (2009. 11). Mongolia Greenhouse Project Mid-term evaluation report

KOICA (2010. 12). Mongolia Greenhouse Project completion evaluation report

KOICA Mongolia Office. Official letters with the Ministry of Food and Agriculture

<Government of Mongolia>

N. Bayarsukh (Deputy Director), The Science and Technology Systems in Mongolia. Ulaanbaatar: Plant Science and Agriculture Research Institute, Mongolian State University of Agriculture.

Ministry of Food and Agriculture of Mongolia. Statistical Data of Food, Agriculture and Light Industry Sector. Ulaanbaatar.

Government of Mongolia (2003), Economic Growth Support and Poverty Reduction Strategy. Ulaanbaatar.

Government of Mongolia, Green Revolution Second Phase(2005-2012). Ulaanbaatar.

<Beneficiary reports>

PSARI (2010, 2011), Annual reports on greenhouse management in Darkhan

Tumen Suikh (2009, 2010, 2011), Annual reports on greenhouse management in Ulaanbaatar

<PMC(RDA)>

Gwang-ryun KANG (2009.4). Mongolia Greenhouse Project launching report

Gwang-ryun KANG (2009.6.20). Mongolia Greenhouse Project Mid-term report

Gwang-ryun KANG (2009.11). Mongolia Greenhouse Project Final expert report

Young-sam KWON (2009.7.30). Mongolia Greenhouse Project Final expert report

Young-sam KWON and Mok-won KIM (2011.2). Mongolia Greenhouse Project Post-management field trip report

RDA (2009. 1). Mongolia Greenhouse Project Korea invited training plan

Ex-post Evaluation Report on the Project of Establishing Greenhouse for Vegetable Cultivation, Monglolia

Published by the Korea International Cooperation Agency(KOICA)
825 Daewangpangyo-ro, Sujeong-gu, Seongnam-si,
Gyeonggi-do, Korea 461-833
C.P.O Box 2545
Tel: 82-31-740-0114, Fax: 82-31-740-0655
Website: http://www.koica.go.kr

ISBN: 978-89-6469-151-9 93320