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## SEED POTATO MULTIPLICATION TO IMPROVE FOOD SECURITY OF THE PEOPLE OF PAEKAM COUNTY, RYANGGANG PROVINCE, DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

June 2021

SDGs:



Countries:

Democratic People's Republic of Korea

Project Code:

TCP/DRK/3701

FAO Contribution

USD 390 000

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Contact Info:

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### Implementing Partner

Ministry of Agriculture.

### Beneficiaries

Ministry of Agriculture, the potato research institute, potato tissue culture facilities, farm managers and farmers.

### Country Programming Framework (CPF) Outputs

Outcome 1 (Increased and sustainable food production, productivity and livelihood opportunities in agriculture, horticulture, livestock and fisheries).



### BACKGROUND

Ryanggang Province is one of the least developed regions in the Democratic People's Republic of Korea. While food security remains a major concern throughout the country, it is particularly challenging in the northern uplands of Ryanggang Province because of the low agricultural productivity and increased vulnerability to the adverse impacts of climate change. Moreover, the region is facing problems associated with degenerated varieties of potato and fruit trees, degenerated livestock breeds, post-harvest losses and a lack of farm equipment and machinery.

Low agricultural production and productivity affect the supply of food for the public distribution system, and ultimately, the nutritional status of the population. According to the 2012 Nutrition Survey, chronic malnutrition ranges from 33 to 39 percent in the northern provinces of the country.

A major constraint to increasing the productivity of potato crops in Ryanggang Province is the availability of good-quality, disease-free, high-yielding seed varieties. When seed potatoes are multiplied conventionally using tubers, new varieties become rapidly degenerated as a result of the progressive accumulation of viruses and pathogens over several cycles of asexual reproduction. Additionally, the large-scale import of seed potatoes in the late 1990s to manage the outbreak of late blight introduced new diseases into the Democratic People's Republic of Korea, including 8 of the 22 known virus and virus-like potato diseases. The implications of potato disease for food security are substantial, as viral infection has the potential to reduce yields by up to 80 percent.

To optimize the domestic production of improved varieties of disease-free seed potatoes, there is a need for capacity development along the entire seed multiplication chain. In particular, the application of *in vitro* culture of isolated tissue for the production of potato plantlets followed by several cycles of multiplication into mini-tubers and seed potatoes has already been determined as a suitable large-scale intervention by the national Academy of Agricultural Sciences. The project was therefore designed to strengthen capacities for the local production of disease-free seed potatoes in Ryanggang Province. It sought to work with various stakeholders in the seed multiplication chain to improve tissue culture techniques and micro-tuber production, as well as the planting of mini-tubers and seed potatoes on cooperative farms.

### IMPACT

The project aimed to enhance food security and livelihoods in Paekam County, Ryanggang Province in the Democratic People's Republic of Korea through the increased production and productivity of seed potatoes. The use of high-quality and disease-free seed potatoes, in turn, is expected to increase the availability of potatoes for consumption.

### ACHIEVEMENT OF RESULTS

As a result of project interventions, research institutes and seed farms in Ryanggang Province have increased their capacity to produce high-quality and disease-free seed potatoes. Moreover, according to records from the Ministry of Agriculture, the supply of certified disease-free seed potatoes has increased in the project area.

Technical support was provided to research officers and technicians at potato tissue culture factories to identify cultivars that are best adapted to local conditions. In addition, technical inputs were provided for virus indexing and the identification of potato viruses using molecular laboratory techniques. The existing capacities of laboratories were reviewed, and a list of the required equipment, instruments, reagents and laboratory consumables for their improvement was prepared. Not all items on the list reached the procurement phase as a result of both budget limitations and some items being listed on the United Nations 1718 Sanctions List. The items procured by the FAO Country Office were used to upgrade laboratory facilities for carrying out tissue culture-based protocols for the isolation of disease-free potato plant parts. Tissue culture rooms were also repaired. Additionally, equipment was installed to improve the supply and conservation of water used in potato cultivation, and greenhouses were remodelled.

Technical guidance was provided to the potato research institute for the identification of promising breeding lines. In addition, the existing operational procedures for identifying pathogens, cleaning the mother plant and producing disease-free micro seed potatoes were reviewed and subsequently amended. A standard protocol for obtaining virus-free *in vitro* potato plantlets was established and various sampling methods were established throughout the potato production process.

A training needs assessment was conducted for researchers and technicians at the potato research institute and potato tissue culture factories, as well as for farm managers and farmers working in cooperatives. The resulting trainings focused on obtaining virus-free *in vitro* plantlets, the detection of viruses, the dissemination of technologies to support the production of virus-free seed potatoes, and the application of aeroponic production systems and agronomic practices. The field-level trainings ensured knowledge and skills development for the multiplication of mini-tubers, seed potato production and storage, and seed potato micro-propagation. Overall, five research officers, 20 technicians and 30 cooperative farmers were trained. In addition, four research officers from the Ministry of Agriculture and the potato research institute took part in a study tour in Mongolia, which provided an opportunity to understand the various technologies used along the seed potato production chain, in particular, the use of advanced aeroponic techniques. Importantly, participants developed the knowledge required to adapt and apply these methodologies to the context of the Democratic People's Republic of Korea.

The project oversaw the standardization of field management practices for the multiplication of seed potatoes. To accomplish this, various agronomic practices were performed and standardized during the on-farm field trials. The project additionally supported the creation of a nucleus stock of disease-tolerant, well-adapted, high-yielding potato varieties at the potato research institute, which will be used for the year-round production of micro seed tubers. Finally, the project facilitated the establishment of a contract grower scheme by the Ministry of Agriculture. Twenty trained farmers from farming cooperatives were enrolled in the scheme, and linkages were established so that contract seed growers could access the *in vitro* micro-propagated tuberlets at the potato research facility.

## IMPLEMENTATION OF WORK PLAN AND BUDGET

Project activities were implemented on time and within the allocated budget, with a no-cost project extension being requested and subsequently granted to facilitate their completion. Some of the equipment identified for the improvement of laboratory capacities could not be procured because the application for an exemption certificate from the United Nations 1718 Sanctions Committee was rejected. Additionally, owing to external economic sanctions, cash flow through international banking channels was severely restricted. The FAO Country Office cooperated with FAO China and FAO headquarters to address challenges associated with making payments. Moreover, the potential challenge of accessing project sites was managed by the Ministry of Agriculture, who were responsible for making suitable transport arrangements.

## FOLLOW-UP FOR GOVERNMENT ATTENTION

The main area for follow-up action is to quantify the availability of certified disease-free seed potatoes in the target province at least one year beyond the implementation period. This may be achieved through a project evaluation. Moreover, periodic food security and nutrition assessments should be carried out in the target province once the Coronavirus Disease 2019 (COVID-19) situation permits. Finally, efforts to expand the application of the technologies and methodologies introduced under the project into other provinces should continue to be supported through the Ministry of Agriculture.



## SUSTAINABILITY

### 1. Capacity development

The key advancements made under the project will continue to be supported through the Ministry of Agriculture beyond the implementation period. Moreover, local ownership of project initiatives was ensured through the participatory and inclusive approach adopted by the project, which brought together local actors at various levels, including the Ministry of Agriculture, the potato research institute, potato tissue culture factories and cooperative farms. These organizational structures and the partnerships among them are expected to persist as key components of the seed potato multiplication chain.

### 2. Gender equality

Gender equality was promoted by emphasizing the equitable participation of men and women in all project interventions. Appropriate targets were fixed for the number of research officers, technicians, laboratory workers, farmers and farm managers taking part in training programmes and other relevant activities.

### 3. Environmental sustainability

Environmentally friendly technologies and practices were introduced to enhance the production of disease-free seed potatoes of improved potato varieties. This included various tissue culture-based and farm management methodologies along the seed potato multiplication chain.

### 4. Human Rights-based Approach (HRBA) – in particular Right to Food and Decent Work

Improving food security and nutrition in the target region was elemental to the design of the project. The technical support delivered has improved processes along the seed potato production chain and is ultimately expected to increase the production and productivity of potatoes for consumption by the local population.



### 5. Technological sustainability

The field-level demonstration of cost-effective management practices for the multiplication of seed potatoes reached numerous beneficiary farmers. The adoption of these practices is expected to be simple for beneficiary farmers, who are expected to continue utilizing them over the long term without further technical assistance. More generally, local knowledge has been developed through technical manuals, training manuals and reports, which are expected to be further disseminated. Additionally, the certified grower scheme introduced has also contributed to the dissemination of knowledge and practices that strengthen seed potato production processes. Importantly, the application of methodologies used both in the laboratory and in the field is expected to continue without the need for additional technical assistance.

### 6. Economic sustainability

Micropropagation-based seed potato multiplication has increased the yields of potato cultivation in the target area. In addition to bolstering food security, this also increases the profitability of farming activities. The Ministry of Agriculture has also provided the required financial support for the application of technologies and methodologies introduced by the project in other provinces. No additional external funding is anticipated for supporting project sustainability.



## DOCUMENTS AND OUTREACH PRODUCTS

- ❑ **N Orgodol.** 2019. End of Assignment Report – Potato tissue culture laboratory during 06 to 31 May 2019. 32 pp.
- ❑ **Kim Il Ha.** 2019. Back to Office Report. 3 pp.
- ❑ **B.C. Mandal.** 2021. Advances in cultivation of potato in the Democratic People's Republic of Korea. 8 pp.

## ACHIEVEMENT OF RESULTS - LOGICAL FRAMEWORK

<b>Outcome</b>	Improved capacity of researchers and farmers in Ryanggang province of DPRK to produce disease-free seed potatoes of improved varieties through tissue culture-based technology of accelerated regeneration in potato seed multiplication chain		
	<b>Indicator</b>	CPF Output A1-1: Enhanced capacity of research institutes and seed farms to produce quality disease-free potato seed	
	<b>Baseline</b>	Lack of quality disease-free potato seed	
	<b>End Target</b>	At least 30% increase in supply of certified disease-free potato seed, increase efficiency of tissue culture-based protocol for screening, cleaning high-yielding potato varieties, regeneration and multiplication of potato tuberlets into seed potato	
	<b>Comments and follow-up action to be taken</b>	According to the records of the Ministry of Agriculture, the supply of certified disease-free seed potatoes has increased in Ryanggang Province as a result of project interventions. However, in order to quantitatively measure the increase in the supply of certified disease-free seed potatoes, the project impact evaluation will need to be carried out in the target province at least one year after project completion. Additionally, periodic food security and nutrition assessments in the target province, which are to be carried out in close collaboration with the World Food Programme, were not feasible at the end of the implementation period due to the COVID-19-related travel restrictions and the non-presence of international staff inside the country.	
<b>Output 1</b>	Micropropagation facility for production of disease (late blight and viruses)-free potato micro-tubers and rapid generational advance to seed potatoes established		
	<b>Indicators</b>	<b>Target</b>	<b>Achieved</b>
	N/A	N/A	75%
<b>Baseline</b>	N/A		
<b>Comments</b>	The laboratory facility for tissue culture-based protocols was upgraded. The facility is used for the isolation of disease-free potato plant parts, <i>in vitro</i> culture in nutrient media and mini-tuber production. Not all items identified by the international consultant could be provided (due to the rejection of the exemption certificate from the sanction committee). However, some of the selected items, which were not categorized in the UN sanction list, were provided. The international consultant reviewed the existing operational procedures for the micropropagation of seed potatoes, identified gaps and provided necessary technical guidance and inputs for their revision.		

Activity 1.1	Upgrading laboratory facility for tissue culture-based protocol for isolation of disease-free potato plant parts, in-vitro culture in nutrient media and following minituber production	
	Achieved	Yes
	Comments	<p>The international consultant on laboratory potato tissue culture and propagation was recruited and provided technical support to relevant research officers and technicians at potato tissue culture factories. Superior potato cultivars that are adapted to local conditions were identified by reviewing performance over the past cropping seasons.</p> <p>The international consultant also provided the required technical inputs for virus indexing and the identification of local potato viruses using the double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) test method. The method is fast and allows for the detection of several viruses in large numbers of regenerated plants. The international consultant visited three potato tissue culture factories, which were located in Pyongyang, Paekam county and Samjiyon county. As per the records of the tissue culture factories, the factory in Pyongyang produces 200 000–500 000 virus-free potato mini tubers per year and the factory in Paekam county produces nearly 75 000 potato plantlets per year.</p> <p>In collaboration with technical staff at the tissue culture factories, the international consultant reviewed the existing functional capabilities of the laboratories and prepared a list of additionally required equipment, instruments, chemical reagents and consumable lab supplies. Detailed technical specifications of the equipment, materials and supplies were also prepared in consultation with technical staff and research officers at the tissue culture laboratories. The allocated budget, however, was not sufficient to procure the entire list of laboratory requirements and, consequently, only selected items went further through procurement process. The items listed included the following: laminar flow cabinet (3); precision plant growth chamber (2); autoclave (2); dry sterilizing oven (3); hot plate/magnetic stirrer (3); freezer (3); water distilling unit (3); analytical balance (2); precision balance (2); benchtop pH meter (1); and other equipment and items.</p> <p>Some of the items listed for procurement were on the 1718 Sanctions List. Therefore, the FAO Country Office submitted the request for an exemption certificate to the Security Council Committee established in accordance with Resolution 1718. However, the request was not approved by the Committee, limiting the ability of the project to provide the necessary support for upgrading the capacity of laboratories for virus diagnosis and efficient tissue culture. The FAO Country Office, however, procured some of the items that were not on the sanctions list. These items upgraded laboratory facilities for carrying out tissue culture-based protocols for the isolation of disease-free potato plant parts in selected potato tissue culture factories.</p> <p>Through the project, a high-density polyethylene water supply pipe, polypropylene mesh ground cover (which prevents weeds from growing by blocking sunlight, while allowing air and water through to nourish plants) and greenhouse film were provided to improve water conservation and water supply efficiency for potato cultivation. The working conditions for tissue culture propagation and greenhouses were improved in selected tissue culture factories by repairing tissue culture rooms and remodelling greenhouses. Additionally, under the technical guidance of the international and national consultants, the potato research institute identified promising breeding lines through the introduction and testing of advanced breeding materials.</p>
Activity 1.2	Designing and implementing procedures for micro-propagation	
	Achieved	Yes
	Comments	<p>The international consultant, in close collaboration with relevant research officers at the potato research institute, reviewed the existing operational procedures for diagnosing pathogens, cleaning the mother plant and the production of clean, disease-free micro-seed potatoes. The existing gaps in operational procedures were identified and technical guidance was provided for the amendment and finalization of operational procedures.</p> <p>The standard protocol for obtaining virus-free <i>in vitro</i> potato plantlets was established, which included the steps for selecting and marking healthy plants in the field, pre-sprouting selected tubers, detecting viruses in pre-sprouted tubers and transferring sprouts into media. In addition, sampling methods were established. These included (i) the ELISA test for sampling <i>in vitro</i> plantlets, (ii) the sampling of tubers or mini-tubers, (iii) sampling plants in the field and in greenhouses and (iv) the detection of potato viruses by ELISA test.</p>

<b>Output 2</b>	A pool of trained human resources in place for implementing full range of activities involved in potato micro-propagation and clean tuber seed production		
	Indicators	Target	Achieved
	N/A	N/A	90%
<b>Baseline</b>	N/A		
<b>Comments</b>	<p>A training needs assessment was conducted for researchers and technicians at the potato research institute and selected potato tissue culture factories and for farm managers and farmers in cooperatives throughout Paekam County, Ryanggang Province. The trainings covered the protocols for obtaining virus-free <i>in vitro</i> plantlets and the detection of viruses, the dissemination of technologies to support the production of virus-free seed potatoes, and the use of aeroponic production systems and agronomic practices. Five research officers, 20 technicians and 30 cooperative farmers attended the training programme.</p> <p>The cooperative farm-level trainings were implemented through a Letter of Agreement (LOA) signed between the FAO Country Office and the Ministry of Agriculture. The target farms for the field-level training included Chonsu farm, Puhung farm and Okchon farm from Paekam County and Boso farm from Samjiyon City. These field-level trainings covered key areas involved in the field multiplication of mini-tubers, seed potato production and storage, and seed potato micro-propagation</p>		
<b>Activity 2.1</b>	Training needs assessment		
	<b>Achieved</b>	Yes	
	<b>Comments</b>	The training needs assessment was conducted by the national consultant, with technical guidance provided by the international consultant. Training needs were assessed for researchers and technicians at the potato research institute and also for farm managers and farmers in cooperatives in Paekam County, Ryanggang Province.	
<b>Activity 2.2</b>	Designing and implementing the training programme		
	<b>Achieved</b>	Yes	
	<b>Comments</b>	<p>Based on the training needs assessment for seed potato production, the national consultant prepared the design for the training programme and the international consultant provided necessary technical assistance. Five research officers, 20 technicians and 30 cooperative farmers were trained.</p> <p>The international consultant formulated the terms of reference for the study tour in the area of seed potato system development. Four research officers from the Ministry of Agriculture and the potato research institute participated in the study tour, which took place in Mongolia from 30 July to 13 August 2019. Importantly, the conditions for potato cultivation in the area of Mongolia where the study tour took place are similar to the northern upper lands of Ryanggang Province, which has one cropping season, from May to September. Study tour participants had the opportunity to understand technologies used along the seed potato production chain, including the use of new, advanced aeroponic techniques in one of the most prestigious and globally renowned agricultural research establishments, the Institute of Plant and Agricultural Sciences, Darkhan-Uul. After completing the study tour, participants were well equipped with the knowledge required to develop aeroponic facilities and to make appropriate adjustments for the introduction of seed potato production technologies that are locally modified for use in the Democratic People's Republic of Korea.</p>	

<b>Output 3</b>	Field management practices and procedures for potato seed multiplication chain (micro-tuber/mini-tuber/seed potato) adapted to northern highlands standardized		
	Indicators	Target	Achieved
	N/A	N/A	90%
<b>Baseline</b>	N/A		
<b>Comments</b>	The field management practices along the seed potato multiplication chain were standardized through the field trials conducted in Paekam county.		
<b>Activity 3.1</b>	Designing and implementing field activities in potato seed multiplication chain		
	<b>Achieved</b>	Yes	
	<b>Comments</b>	The field trials of agronomic practices were carried out. The trials involved the multiplication of laboratory-propagated potato tuberlets into seed tubers at selected cooperative farms. Various agronomic practices were applied to test the effects of sowing dates, seeding rate, depth of sowing, planting geometry, fertilizer application, harvesting, post-harvest storage and number of proliferation cycles. Additionally, potato-based double cropping was tested. With guidance and supervision from the Ministry of Agriculture and the potato research institute, technicians at cooperative farms measured the potato cultivation yields from selected field trial units. The effects of different combinations of field practices were compared.	
<b>Output 4</b>	A nucleus stock of disease-tolerant well adapted high-yielding potato varieties established		
	Indicators	Target	Achieved
	N/A	N/A	Yes
<b>Baseline</b>	N/A		
<b>Comments</b>	The laboratories at the potato research institute established a nucleus stock of disease-tolerant high-yielding potato varieties. In addition, the international consultant provided the necessary technical inputs for the establishment process. The national consultant collaborated with research officers at the potato research institute for the establishment of the nucleus stock.		
<b>Activity 4.1</b>	Maintenance of purified potato plant parts (stems) for production of ex-plants		
	<b>Achieved</b>	Yes	
	<b>Comments</b>	The laboratories at the potato research institute kept the basic stems from high-yielding, well-adapted potato varieties. These basic stems will be used in the production of micro-seed tubers for proliferation as and when required in the future. Additionally, the nucleus stock at the potato research institute will be used for the production of micro-seed tubers year round.	
<b>Output 5</b>	Contract growers' scheme established for quality potato seed production and storage in Paekam county		
	Indicators	Target	Achieved
	N/A	N/A	90%
<b>Baseline</b>	N/A		
<b>Comments</b>	Under the guidance of the national and international consultants, the Ministry of Agriculture established the contract grower scheme at cooperative farms (Okchon farm and Chonsu farm) for quality seed production and storage in Paekam County. The contract grower scheme was instrumental in controlling pest and disease attacks and dividing labour among the cooperative farms during the peak period.		
<b>Activity 5.1</b>	Establishment of a pilot potato seed production scheme based on laboratory micropropagation and field multiplication into seed tuber		
	<b>Achieved</b>	Yes	
	<b>Comments</b>	The Ministry of Agriculture, with the guidance of the national consultant and technical inputs from the international consultant, selected 20 trained farmers at the cooperative farms and enrolled them as contract seed growers. Contract seed growers were organized into a scheme under the supervision and management of the cooperative seed production farms. In addition, the national consultant facilitated the establishment of linkages between the contract seed growers and research officers at the potato research institute to ensure the continued access to <i>in vitro</i> micro-propagated potato tuberlets for field multiplication into seed tubers.	



**Partnerships and Outreach**

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