Food and Agriculture Organization
of the United Nations

PROMOTION OF CAPACITY IN BIOCONTROL FOR SUSTAINABLE GREENHOUSE VEGETABLE PRODUCTION

March 2022

SDGs:

Country:	The Democratic People's Republic of Korea
Project Code:	TCP/DRK/3703
FAO Contribution:	400 000 USD
Duration:	1 November 2018 – 30 October 2021
Contact Info:	FAO Representation in the Democratic People's Republic of Korea FAO-KP@fao.org

Implementing Partners

Ministry of Agriculture, Academy of Agricultural Sciences (AAS).

Beneficiaries

Farmers dwelling in two cooperative farms: Samhwa Vegetable Specialized Cooperative Farm and Taesong Vegetable Specialized Cooperative Farm; and Pyongyang Vegetable Research Institute under the Academy of Agricultural Sciences (AAS).

Country Programming Framework (CPF) Outputs

Strategic Objective 2/Output 2.2.1: Innovative practices for sustainable agricultural production (including traditional practices that improve sustainability, such as those listed as Globally Important Agricultural Heritage Systems) are identified, assessed and disseminated and their adoption by stakeholders is facilitated.

Regional Initiative/Priority Area 1: Strengthening food and nutritional security.

CPF Priority area 1 - Outcome 1: Increased and sustainable food production, productivity and livelihood opportunities in agriculture, horticulture, livestock and fisheries.

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BACKGROUND

Vegetables, together with soybean, provide most of the nutrient-rich foods to a large number of people at risk of chronic undernutrition in the country. Cooperative farmers grow a wide variety of vegetables, including spinach, Chinese cabbage, red pepper, tomato, cucumber, radish, onion, lettuce, eggplant, and mushroom, both on-farm and in a protected environment, namely greenhouses and plastic tunnels.

Data on the production of vegetables in national farm production in the country are not officially reported. Using field-level data on a sample of cooperative farms that received FAO emergency assistance to restore production in the wake of floods in 2016 and drought in 2017, it is estimated that about 128 700 ha of cropped area are under vegetables. With an average yield of 18 tonnes/ha, vegetables production in the country is estimated at 2.3 million tonnes annually.

This production is equivalent to 252 g/capita/day, which is well below the FAO recommended intake of vegetables at 400 g/capita/day. In order to increase the supply of vegetables, the Government of the Democratic People's Republic of Korea has undertaken measures, including investment in infrastructure, to expand the cultivation of vegetables in greenhouses.

Among the major constraints to the expansion of vegetable cultivation are farmers' access to quality seeds, and the control of yield-limiting factors, principally insect pests and diseases. The main pests harming greenhouse vegetable production include whitefly, aphid, red spider mite, butterfly larva, diamondback moth, and moth larva. Reliance on chemical control has led to ever-increasing application of chemical pesticides, causing the level of soil residual toxicity to increase. This not only endangers public health and disrupts ecosystem services, but also threatens the sustainability of vegetable production. In addition, the continuous use of pesticides for controlling vegetable pests has resulted in raising the threshold of pest tolerance to pesticides, leading, in turn, to increasing the frequency of pesticide application, as well as the use of new pesticide products. This has led to increasing the cost of vegetable production, as well as hastening the process of environmental degradation.

Against this background, the project focused on enhancing the capacity of cooperative farmers, farm technicians, and researchers in Integrated Pest Management (IPM), for sustainable production of vegetables, as well as improved food safety.

IMPACT

The project was not able to complete all the outputs as planned. However, progress was made towards achieving the expected impacts. This includes farmers benefiting from increased productivity and profitability of greenhouse vegetable cultivation, as a result of the adoption of IPM and the reduction of the application of pesticides, contributing to improved well-being, health and safety of farmers, the public and the environment, as well as enhanced food safety and nutrition security of local people.

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Achievement of results

The project outputs were only partially achieved, because procurement of the required equipment and materials to implement the planned activities was impeded by import issues related to United Nations (UN) sanctions. However, the project successfully promoted biological control methods, and contributed to enhancing the capacity of cooperative farmers, farm technicians and researchers in IPM, for sustainable production of vegetables. This was achieved through the provision of technical guidance and a comprehensive training programme, comprising the development of IPM practices for target crops, conceptual understanding of farm-level IPM approaches in greenhouse vegetable production, the identification and disaggregation of the most common pests and diseases in greenhouses, and safe and effective use of pesticides. Further details on key activities carried out and results achieved are outlined below.

The international IPM specialist provided technical guidance to researchers at the Pyongyang Vegetable Research Institute under the Academy of Agricultural Sciences (AAS), to identify common vegetable pests, including greenhouse whiteflies, aphids, and red spider mites. The specialist also provided technical assistance on biological control methods through the introduction of the parasitoid *Encarsia Formosa*, to control whiteflies, and a bacterium (*Bacillus subtilis*) to control powdery mildew diseases; as well as predatory natural enemies for aphid and red mite control.

The IPM specialist provided technical guidance to the AAS to develop IPM practices for target crops, namely tomato, cucumber, chili pepper, and watermelon. Required technical inputs to produce resistant/tolerant varieties of tomato, cucumber, and chili pepper in the cooperative farms were also supplied; and farmers were trained in disease-control methods, to avoid the transmission of several plant pathogens, such as early blight in tomato, bacterial leaf spot in pepper, and black rot of white cabbage. Other activities in this area included, among others: i) the introduction of methods of growing healthy seedlings in cell trays in dedicated greenhouses; ii) the establishment of drip irrigation in the selected greenhouses, which contributed to reducing foliar disease in the selected vegetables; iii) the promotion of vegetable crop rotation in greenhouses in the target cooperative farms; and iv) the provision of required technical inputs to remove the possible sources of pests and diseases in the greenhouses; as well as the introduction of technical specifications and standards to prevent the entrance of pests and diseases.

Through a Letter of Agreement (LoA) signed with the AAS for the provision of in-country training, on-site practical training for researchers, technicians, managerial staff, and farmers was conducted on the conceptual understanding of farm-level IPM approaches in greenhouse vegetable production. The training was conducted mainly in Pyongyang Vegetable Research Institute, the AAS, and the two target cooperative farms; and was attended by 120 participants from the above-mentioned organizations and farms, including researchers, technicians, officials, and farmers engaged in plant protection practices inclusive of IPM in farm-level greenhouse vegetable cultivation programmes. Farmers and technicians were trained on the maintenance and management of drip irrigation systems in greenhouses; as well as on the establishment of a work routine to prevent soil-borne diseases.

A hands-on training course was conducted for agricultural cooperative farmers and relevant technicians of the greenhouses, to identify and disaggregate the most common pests and diseases in greenhouses, comprising training on routine crop monitoring, to ensure the health status of vegetable crops. Comprehensive training was also provided for selected responsible technicians at the cooperative farms on monitoring the greenhouses, to identify key pests and diseases, among other things.

In addition, training was conducted for cooperative farmers, technicians and field workers on the safe and effective use of pesticides. The training included the process of determining the application of the right quantities of pesticides in the field, risks associated with the substances of pesticides, and the best use of pesticides, among other things.

Finally, the international IPM specialist produced a booklet on IPM for greenhouse crops in the country.

Implementation of work plan and budget

The laboratory equipment, chemicals, reagents, and other items recommended by the international consultant to improve the analytical capacity of the laboratory of the Pyongyang Vegetable Research Institute under the AAS could not be procured, owing to the unavailability of these items; and because international UN sanctions impeded the import of laboratory equipment and other items and chemicals from other countries. In addition, the COVID-19 travel restrictions delayed the implementation of the Letter of Agreement (LoA) signed with the AAS.

The project experienced considerable cash constraints, as cash flow through international banking channels was severely restricted, owing to the above-mentioned UN sanctions, and also because it was affected by the COVID-19-related travel restrictions.

All project activities were implemented within the approved budget. Two no-cost extensions were requested and approved, in order to address the delays and constraints experienced.

Follow-up for government attention

It is strongly advised that funding be sought to provide the necessary laboratory reagents, chemicals, and equipment to the laboratory of the Pyongyang Vegetable Research Institute, for the mass rearing and release of produced biological agents in greenhouses.

Sustainability

1. Capacity development

Once it has been completed, the project outcome will be supported and replicated within the core programme of the Pyongyang Vegetable Research Institute under the AAS. In addition, researchers at the AAS will continue the training programme on safe and effective usage of pesticides and rearing of biological agents, beyond the project.

With regard to the partnerships and alliances created or strengthened during the project, contributing to the project's sustainability, FAO is one of the major international institutions in the country, with over three decades of experience of working with government counterpart organizations. Its operations span most parts of the country, reflecting the high level of trust and partnership that FAO has built with the Ministry of Agriculture, the Ministry of Land and Environment Protection, and other government agencies.

At the end of the project, project ownership was transferred to the Government for its sustainability. The lessons learned from the project were institutionalized and documented through their integration in the farm work plan and technical guidance.

2. Gender equality

Gender equality was promoted by emphasizing equitable participation by both men and women in all project interventions, including the distribution of inputs. Targets for the number of beneficiary farmers to participate in the training programmes and other relevant project activities were established, taking into account gender considerations.

3. Environmental sustainability

The AAS ensured environmental sustainability and protection of the environment through the project activities it carried out.

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

The project promoted the human rights principles by working towards ensuring the food security of the country's beneficiaries. Improved food security based on increased vegetable productivity was the core of the project. The beneficiary farms would retain the bulk of the production for domestic consumption, bolstering both household food and nutrition security.

5. Technological sustainability

The relevant technical knowledge and recommendations disseminated by the international consultant will be incorporated in the core greenhouse vegetable production programme of the AAS.

The comprehensive training programme ensured the improved capacity of stakeholders and beneficiaries, and the competency of the AAS to pursue the project activities without further technical assistance.

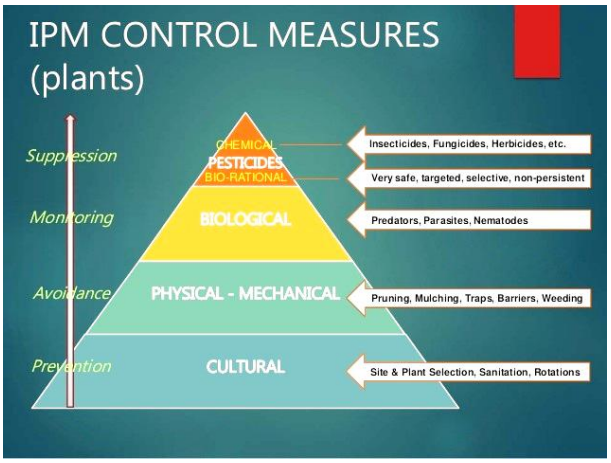
6. Economic sustainability

The AAS was fully committed in supporting the implementation of project activities, in terms of providing facilities, materials, and salaries for their researchers and officials.

Due to the prevailing operational constraints in the country, no external funds are currently foreseen.

Documents and outreach products

- **FAO.** 2019. Booklet on Integrated Pest Management for Greenhouse Crops in the DPR Korea. 33 pp.



ACHIEVEMENT OF RESULTS - LOGICAL FRAMEWORK

Expected Impact	**Food safety as well as nutrition security of local people improved as a result of increase in productivity and consumer quality of locally produced vegetables**	
Outcome	Enhanced capacity of cooperative farmers and farm technicians in promotion of Integrated Pest Management (IPM) for sustainable production of vegetables as well as improve food safety through the use of integrated pest management (IPM)	
	Indicators	– CPF Output 1.2: Capacity to develop and utilize appropriate technologies and farming practices is strengthened. – CPF Output 2.1: Enhanced capacity to develop and sustainably produce high quality food with emphasis on fruit and vegetables; and CPF Output 2.2: Enhanced efficiency of the food supply chain including food processing and safety.
	Baseline	– Limited application of IPM in production of vegetables. – Limited access to modern technology for analysis of residual chemical toxicity and heavy metal residues on vegetable produces.
	End Targets	– Develop mass rearing, culture techniques and greenhouse application techniques of selected natural enemies of vegetable pests – greenhouse whitefly, aphid, red spider mite; – Develop associated culture and application techniques of selected biological control agents. – Upgrade analytical methods and procedures for detection of chemical residual toxicity and heavy metal contamination of vegetable products.
	Comments and follow-up action to be taken	– The international IPM specialist provided technical guidance (and prepared a technical manual) on the introduction of the parasitoid, *Encarsia Formosa*, to control whiteflies, and a bacterium (*Bacillus subtilis*) to control powdery mildew diseases, only at the pilot level in the greenhouse. However, the planned mass rearing and release of the aforementioned biological control agents could not be achieved, because procurement of the required equipment and materials was impeded by import issues related to UN sanctions. It is advised that the necessary laboratory reagents, chemicals, and equipment be provided to the Pyongyang Vegetable Research Institute under the AAS, for the mass rearing and release of produced biological agents in the greenhouses. In addition, the required chemicals were not supplied to the AAS to develop the associated culture and application techniques of selected biological control agents, due to international sanctions. – For reasons given above, it was not possible to procure the required chemicals, equipment, reagents, and other relevant items to upgrade the analytical capacity of laboratories for the detection of residual chemical toxicity and heavy metal contamination of vegetable products. Thus, it was not possible to achieve this envisaged end target during the project.
Output 1	Greenhouse mass rearing of biological control agents parasitizing common vegetable pests (greenhouse whitefly, aphid and red spider mite) under the climatic conditions of DPRK and their application techniques developed	
	Indicators	Target / Achieved
	N/A	N/A / Partially
Baseline	N/A	
Comments	The international IPM specialist provided technical assistance to the Pyongyang Vegetable Research Institute under the AAS on how to introduce the parasitoid, *Encarsia Formosa*, to control whiteflies and a bacterium (*Bacillus subtilis*) to control powdery mildew diseases. However, the planned biological control agents' mass rearing and release could not be achieved, because procurement of the required equipment and materials was impeded by import issues related to UN sanctions.	
Activity 1.1	Select and introduction of effective biological control agents for mass rearing	
	Achieved	Partially
	Comments	The international IPM specialist provided technical guidance to researchers at the Pyongyang Vegetable Research Institute, under the AAS, to identify common vegetable pests, including greenhouse whiteflies, aphids, and red spider mites. The IPM specialist also provided technical assistance on biological control methods, through the introduction of: i) the parasitoid (*Encarsia Formosa*) to control whiteflies; ii) a bacterium (*Bacillus subtilis*) to control powdery mildew diseases; iii) seven-spot ladybird-beetle (*Coccinella septempunctata*), which is a predatory natural enemy for aphid control; iv) and *Phytoseiulus persimilis*, a predatory natural enemy for red mite control.

Activity 1.2	Develop adaptive techniques for application of bio-control agents on vegetables under the conditions of greenhouse cultivation in DPRK	
	Achieved	Partially
	Comments	This activity was marginally achieved. This was because, as mentioned above, it was not possible to procure the required equipment for the mass rearing of insects, testing, and field release, owing to import issues related to UN sanctions. Therefore, the project could not release the biocontrol agents, such as wasps and predators, into the greenhouses in mass quantities to control the pest and diseases. Limited project inputs were provided, which were procured locally, including polyvinyl chloride (PVC) layflat hose (32 mm), greenhouse cover film, voltage, a frequency stabilizer, an inverter generator, a laminar flow cabinet, a dry oven, a high-capacity thermostatic orbital shaker, a magnetic stirrer with hotplate. However, the provided items were insufficient to fully achieve the targets of this activity.
Activity 1.3	Develop IPM practices for the production of vegetables	
	Achieved	Yes
	Comments	The international IPM expert provided technical guidance to the AAS to develop IPM practices for the target crops, namely tomato, cucumber, chili pepper, and watermelon. According to the technical booklet developed by the IPM specialist, Pyongyang Vegetable Research Institute has already developed resistant rootstocks for tomato (Maxifort rootstock), pepper (Grafter rootstock), and watermelon (Sinju; kyong Sin Jom No. 2 rootstock), which was the practical solution against soil-borne diseases and nematodes, such as bacterial wilt. In addition, the IPM specialist provided required technical inputs to produce the resistant/tolerant varieties of tomato (Variety Onsil No. 15 & 16 for grey mould), cucumber (Onsilooi No. 21 & 31 for powdery mildew and downy mildew respectively), and chili pepper (variety Gochu No. 8 for phytophthora) in the cooperative farms. The IPM specialist provided farmers with technical assistance for the hot water treatment method for tomato (50 °C for 25 minutes) and pepper (52 °C for 30 minutes), which was the physical disease control method used to avoid the transmission of several plant pathogens, such as early blight in tomato, bacterial leaf spot in pepper, and black rot of white cabbage. In addition, the following activities were carried out by the IPM specialist: – The introduction of the method of growing healthy seedlings in cell trays in dedicated greenhouses. The specialist provided the required technical knowledge on sterilizing plastic trays with chemicals, such as copper-based solution, bleaching, as well as techniques for growing seedling under a cage of insect-proof mesh. – The establishment of drip irrigation in the selected greenhouses. The drip irrigation lines were maintained to avoid clogging. This practice contributed to reducing foliar disease in the selected vegetables. – The promotion of vegetable crop rotation in greenhouses in the selected cooperative farms. In addition, technical knowledge was transferred to the technicians on the selection of vegetable plants, based on their botanical family. – The provision of required technical inputs to remove the possible sources of pests and diseases in the greenhouses. Based on this technical recommendation, a 3-metre-wide weed-free strip was installed with covered mulch outside the greenhouses. – The introduction of technical specifications and standards to prevent the entrance of pests and diseases in the greenhouses, including lateral ventilation with insect-proof mesh, fitting the greenhouses with a double door, installing yellow sticky traps near two doors, cleaning/removing boots/shoes before entering the greenhouse, the positioning of footbaths at each greenhouse entry, the disinfecting of tools/equipment used, and the application of a disinfectant, sodium hypochlorite. – With technical guidance and advice from the IPM specialist, the temperature in the greenhouse was regulated and monitored as per the type of vegetable, such as tomato (18 °C and 27 °C). In addition, adequate ventilation was introduced and practised in the greenhouses to manage humidity, in order to control the most common phytosanitary problem of grey mould caused by *Botrytis cinerea*.

Activity 1.4	Training workshop	
	Achieved	Partially
	Comments	With the technical guidance of the international consultant, and through an LoA signed with the AAS for the provision of in-country training, on-site practical training for researchers, technicians, managerial staff, and farmers was conducted on the conceptual understanding of farm-level IPM approaches in greenhouse vegetable production. The training was conducted mainly in Pyongyang Vegetable Research Institute under the AAS (Pyongyang City); Taesong Vegetable Specialized Cooperative Farm, North Hwanghae Province; and Samhwa Vegetable Specialized Cooperative Farm, South Pyongan Province. It was attended by 120 participants from the above-mentioned organizations/farms, including researchers, technicians, officials, and farmers engaged in plant protection practices inclusive of IPM in farm-level greenhouse vegetable cultivation programmes at each targeted research institute, the AAS, and the two farms. Farmers and technicians were trained on the maintenance and management of drip irrigation systems in the greenhouse, through the LoA signed with the AAS. In addition, workers, farmers and technicians were trained on the establishment of a work routine to prevent soil-borne diseases in the greenhouse, such as maintaining personal hygiene before entering the greenhouse, wearing suitable colours (e.g. avoiding yellow clothing), and appropriate clothing. The hands-on training course was conducted for agricultural cooperative farmers and relevant technicians of the greenhouses, to identify and disaggregate the most common pests and diseases in greenhouses, and comprised training on routine crop monitoring to ensure the health status of vegetable crops in the greenhouses. Comprehensive training was also provided for selected responsible technicians at the cooperative farms on monitoring the greenhouses, to identify the key pests and diseases on a weekly basis; as well as training on drawing greenhouse maps and scouting. Finally, the farmers and farm technicians of the cooperative farms were trained on the use of sticky traps, such as yellow sticky cards, and blue sticky traps to collect species like whiteflies, thrips, leafminers, fungus gnats, and winged aphids.
Output 2	Capability of detection and analysis of toxic chemical residues of vegetable products improved	
	Indicators	Target / Achieved
	N/A	N/A / Partially
Baseline	N/A	
Comments	The capability of detection and analysis of toxic chemical residues of vegetable products could not be carried out, owing to the unavailability of the required equipment and chemicals for testing and analysis. In addition, it was not possible to procure the required equipment for the analysis of chemical residues, owing to the above-mentioned import issues related to UN sanctions.	
Activity 2.1	Upgrade existing laboratory for analysis of pesticide reduces and develop a standardized operational procedure (SOP)	
	Achieved	No
	Comments	The procurement of equipment for the analysis of chemical residues and installation equipment in designated locations was not achieved, owing to the above-mentioned issues experienced with importing this equipment. As a result of this, the subsequent planned activities, involving the preparation of an operational manual for residue analysis and standard operating procedures (SOPs), and the development of documents for the operation and management of the laboratory could not be implemented.
Activity 2.2	Training on testing of analysis of pesticide residues in vegetables	
	Achieved	Partially
	Comments	Through the LoA signed with the AAS, training was conducted for cooperative farmers, technicians and field workers on safe and effective use of pesticides. In addition, the AAS used technical inputs in the IPM booklet prepared by the IPM specialist. The training included the process of determining the application of the right quantities of pesticides in the field, risks associated with the substances of pesticides, and best use of pesticides. Farmers were trained on: i) understanding pesticide labels, including on how to store pesticides; ii) how to dispose of pesticides safely; and iii) the possible risks associated with their use and precautionary measures to minimize the risks; the personal protective equipment to be used; the routes of pesticides entering a human body, including contact, inhalation and ingestion; and the importance of wearing chemical resistant gloves, and of wearing suitable clothes, such as long-sleeved shirts and long trousers.

Partnerships and Outreach
For more information, please contact: Reporting@fao.org

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