Food and Agriculture Organization of the United Nations

STRENGTHENING MANAGEMENT OF MAIZE STORAGE (SMMS)

April 2019

SDGs:	
Countries:	Bhutan
Project Codes:	TCP/BHU/3603
FAO Contribution:	USD 203 000
Duration:	16 November 2016 – 31 December 2018
Contact Info:	FAO Representation in Bhutan FAO-BT@fao.org

Implementing Partner

Ministry of Agriculture and Forests (MoAF).

Beneficiaries

Small-scale maize farmers, researchers and extension staff.

Country Programming Framework

CPF Outcome 2: Improved multisector participation, coordination and value chain development in food and nutrition security programmes.

BACKGROUND

Maize occupies over 46 percent of the total cultivated land in Bhutan, and its cultivation and production engages over two-thirds of rural farmers. However, much of the country's stored maize is lost to insects, moulds, etc., because of poor drying and storage practices. It is harvested in the rainy season and stored in temporary sheds in the maize fields, where the quality of the crop is compromised quite fast. In addition, these temporary sheds cannot be guarded around the clock and are far away from homesteads; they are therefore more vulnerable to wildlife depredation. The main aim of the project was to mitigate maize storage losses through the development and promotion of low-cost storage technology that was appropriate to local conditions. Three *Dzongkhags* ([districts] Centre, Eastern and Western) were selected as project sites, where maize was a major commodity and storage losses were more than 90 percent.

IMPACT

Low-cost technologies were introduced, which have already had a positive effect on reducing post-harvest losses of maize in storage. This will contribute to enhancing food and nutrition security in the target areas, and to generating higher incomes for small-scale maize farmers and their households.

ACHIEVEMENT OF RESULTS

Two rounds of surveys were conducted in nine pilot *Gewogs* (groups of villages) to determine maize post-harvest systems and post-harvest loss causes in the project sites. As part of the survey, samples of storage pests were collected and identified in the laboratory. In addition, maize cobs were collected from the project sites to assess storage losses caused by insect pests and moulds, and laboratory identification of mould (fungi) infecting maize cobs in stores was carried out. The survey revealed that the major insect pests in maize stores in all pilot sites were weevil, moth and beetle; while the most significant storage fungi involved in causing kernel rot was Aspergillus species.

It emerged from the survey that farmers stored maize in bags/containers that were ineffective in controlling insect pest infestations. Thus, super grain bags were procured and distributed to farmers, ensuring 100 percent infestation prevention; and a training programme was organized to demonstrate their use. Farmers were sceptical at first, but soon found them to be very effective in controlling pest infestation. The bags also ensured quality, aroma and freshness of grains.

The survey also revealed that farmers shelled maize by hand, which was time-consuming and laborious. Thus, hand-operated maize shellers were procured and distributed to farmers in the project sites. These were easy to operate and labour-saving, effective at shelling maize, and kernel damage was nil.

In total, 49 extension agents, 1 449 farmers and 20 technical staff members were trained on the identification and management of maize storage pests, and on improved drying and storage methods. The technical capacities of Dzongkhag Agriculture Officers (DAOs) and extension agents were strengthened through several training sessions, enabling them to identify major storage pests and recommend management measures, as well as to train farmers and other extension agents in the *Dzongkhags*, and to design and conduct surveys in other maize-growing areas.

Farmers' capacities to implement prevailing pest management measures were enhanced through training provided by the trained extension agents on good practices to be followed during the sun drying of maize, and the implementation of different pests management measures. A manual, "Good practices to minimize post-harvest storage losses of maize grown in Bhutan", was developed, which was used for training extension agents and farmers. Leaflets were also produced in both English and Dzongkha, and distributed during training to ensure rapid transfer of knowledge.

In addition, maize-shelling machines were installed in the *Gewogs*, where they were easily accessible to the community. They were effective for shelling, and kernel damage was minimal. Finally, a low-cost structure for maize drying (based on the principle of natural drying by air) and storage was designed by the National Post-Harvest Centre (NPHC) and constructed in the pilot sites, which was effective for storing maize and drying cobs, and for preventing damage from rodents.

Implementation of work plan

The start of the project was delayed, therefore a four-month no-cost extension was requested and approved (from 31 August 2018 to 31 December 2018), in order to complete all project activities. Procurement and delivery were carried out in a timely manner, and the procured items were delivered to the project sites.

Two visits to Bhutan were envisaged for the international consultant, as per the work plan. However, the consultant was unable to carry out the second visit, which involved the training of extension agents, owing to administrative constraints. Therefore, the training programme was conducted by the technical staff of NPPC and NPHC, using the training materials developed by the consultant.

The project's performance in managing risks was excellent. Although no environmental risks were posed by the project, social risks such as socio-economic position and gender were identified. To avoid these risks, the Project Management Unit, in close consultation with the DAOs and extension agents: i) selected farmers irrespective of their socio-economic position in the community; ii) invited an equal number of male and female farmers to the training activities; and iii) gave equal opportunity to express doubts and comments during the training.

Follow-up for government attention

Post-harvest structures that are already being built in pilot sites should be monitored for their utility and efficacy in preventing post-harvest losses.

It is possible that the majority of farmers cannot afford to pay for the maize drying and storage structure (BTN 60 000 per structure). It is therefore recommended that the Government actively seek funding for this purpose, through the mobilization of funds from the Gewog Development Fund (GDF), or support from projects implemented by Global Environment Facility (GEF), Small Grant Program (SGP), FAO, International Fund for Agricultural Development (IFAD), etc.

Sustainability

1. Capacity development

The project encouraged farmers to adopt the proven technologies. The participation of government extension officers and farmers, and improved maize storage promoted the dissemination of the technology and guaranteed the sustainable extension of outputs.

The project results will be presented to the Annual Conference of the Department of Agriculture, and will be included in the training curricula of farmers and extension agents. The project activities will be incorporated into NPPC's 12 five-year plan (FYP) and overall annual work plans, which will be implemented by NPPC researchers and extension agents in the *Dzongkhags*.

The new technologies developed during the project will be replicated in other maize-growing areas supported by various projects implemented by IFAD, FAO, GEF, European Union (EU), Japan International Cooperation Agency (JICA), etc.

2. Gender equality

Although gender-specific interventions were not included in the project, there was equal participation of male and female farmers during the training sessions held in the pilot sites. It emerged from the survey that maize shelling was carried out by women, manually, and was a time-consuming and laborious task. As mentioned above, the project introduced hand-operated maize shellers, which were women-friendly and effective. In addition, super grain bags of 100 kg capacity, which were distributed for the storage of maize in the first year of the project, were replaced by more transportable ones of 50 kg capacity.

3. Environmental sustainability

The project interventions carried out in the pilot sites were environmentally friendly. The super grain bags for storing maize are not made of hazardous materials and do not emit hazardous gases. The maize storage structure is simple and consists of locally available materials, such as bamboo, planks, stones and mud; and functions on the basis of natural drying by air circulation.

The survey revealed that farmers sun dry and grind maize, and mix it with sand, smoke, etc. to control maize storage pests. A few farmers also used pesticides. The National Plant Protection Centre (NPPC) and project stakeholders encouraged farmers to continue with the prevailing pests management measures. However, the use of pesticides was discouraged, as they posed health risks for consumers and handlers.

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

Maize is Bhutan's major crop, both in terms of cultivated area and production, engaging over two-thirds of rural farmers. Therefore, decreased storage losses of maize will have a positive impact on the food supply of the country.

5. Technological sustainability

As a result of the project interventions, DAOs and extension agents have a clear picture of pests, storage and drying problems in maize, as well as of different interventions to be carried out to reduce post-harvest losses. They can replicate project activities and interventions in other maize-growing areas without further technical assistance. Farmers can easily use super grain bags and shellers, keeping in mind the necessary precautions. They can identify major storage pests such as weevil, beetle and moth, and implement pests management measures.

6. Economic sustainability

Farmers preferred natural drying of maize (by air circulation) to drying by electricity. The investment in drying by electricity was huge, and had to be monitored on a regular basis. As mentioned above, a low-cost structure based on the principle of natural drying by air was designed and constructed in the project pilot sites. Super grain bags were promoted for the storage of maize, and proved effective in preventing storage pests infestation. They are available in local markets, and easily affordable at BTN 100-200 per bag. In addition, they last for a long time, if properly taken care of.

Hand-operated maize shellers for use at household level are easily affordable (BTN 100 per sheller), and available in hardware shops.

DOCUMENTS AND OUTREACH PRODUCTS

- Report: Survey findings on maize post-harvest system and post-harvest losses in Chukha, Dagana and Mongar Dzongkhag. NPPC. December 2018. 26 pp.
- Manual: Good practices to minimize post-harvest storage losses of maize grown in Bhutan. NPPC. December 2018. 15 pp.
- Report: Detection of mould (fungi) infecting maize cobs in project pilot sites NPPC. December 2018. 1 pp.
- Report: Laboratory analysis of storage losses due to storage insects and moulds. NPPC. December 2018. 3 pp.
- Report: Quantification of major storage insect pests in the Pilot Gewogs. NPPC. December 2018. 2 pp.
- Leaflet: Maize storage pests identification and management (in English and Dzongkha). NPPC. December 2017.
- Leaflet: Maize harvesting and drying (in English and Dzongkha). NPPC. December 2017.
- Leaflet: Use of super grain bag (English and Dzongkha). NPPC. December 2017.
- Audio-visual material: Use of super grain bag. NPPC. December 2018.
- Leaflet: Maize curing and maize drying and storage shed. NPHC. December 2018.

ACHIEVEMENT OF RESULTS - LOGICAL FRAMEWORK

Expected Impact	The country's level of food and nutrition security improved with increased maize availability	
Outcome	Reduced food losses helped to expand the food basket of the Bhutanese people	
	Indicator	Maize post-harvest losses reduced by adoption of technology
	Baseline	Farmers' post-harvest loss 38% of production
	End Target	Post-harvest loss of maize reduced to below 20% after two years in the pilot sites
	Comments and follow-up action to be taken	The technologies introduced (particularly maize dryer, sheller machine) have already had a positive effect on reducing the losses of maize in storage. They are likely to positively impact on food and nutrition security of the target groups. Post-harvest structures that are already being built in pilot sites should be monitored for their utility and efficacy in preventing post-harvest losses.

Output 1	Identified and documented maize drying and storage problems, their severity and the extent of spread		
	Indicators	Target	Achieved
	Maize drying and storage problems identified and documented	One study	Yes
Baseline	No systematic study undertaken on post-harvest losses of maize		
Comments	The international consultant developed training materials and questionnaires, and extensively discussed these with NPPC and NPHC staff, who would be training extension staff in the pilot sites. As part of the training and survey, samples of storage pests were collected and identified in the laboratory. Major pests were weevil, moth and beetle. A report with details was developed and printed.		
Activity 1.1	Hire international consultant (IC)		
	Achieved	Yes	
	Comments	The consultant spent ten days in Bhutan in February 2017, to develop formats and questionnaires for the survey of post-harvest operations of maize in pilot sites; as well as questionnaires for the assessment and identification of maize loss in stores, and pests involved in causing such losses. It was not possible for the consultant to carry out the second visit, to train extension agents of the project sites, as per the work plan, owing to administrative constraints. Thus, the training of extension agents was conducted by the technical staff of the NPPC and NPHC, using training materials developed by the consultant.	
Activity 1.2	Survey major maize areas, document storage pests, collect samples and identify them		
	Achieved	Yes	
	Comments	Two rounds of surveys were conducted in nine pilot Gewogs to document maize drying and storage problems. As part of the survey, samples of storage pests were collected and identified in the laboratory. In addition, maize cobs were collected from the project sites to assess storage losses caused by insect pests and moulds. Laboratory identification of mould (fungi) infecting maize cobs in stores was carried out. The survey revealed that the major insect pests in all maize stores in all pilot sites were weevil, moth and beetle; while the most significant storage fungi involved in causing kernel rot was Aspergillus species. Other pests that caused maize storage losses were rodents and birds. A detailed report of the survey findings was printed.	
Output 2	Built capacity of farmers, extension staff and other central programmes concerned with improved management of storage systems and with improved drying techniques		
	Indicators	Target	Achieved
	Capacities of key stakeholders - farmers, extension agents (EAs), technical staff from central programmes (CPs) - built on improved storage and drying of maize.	50 EAs, 15 CPs, 200 farmers	Yes
Baseline	0		
Comments	49 EAs, 20 CPs, and 1 449 farmers were trained in improved drying and storage methods, including proper use of super grain bags. In addition, a 16-member team visited Nepal and exchanged ideas on maize storage, pests and drying.		

Activity 2.1	Develop and print training curricula and materials	
	Achieved	Yes
	Comments	Training curricula on good practices to minimize post-harvest storage losses of maize were prepared by the consultant and printed. Three different types of leaflets on maize storage pests management, maize harvesting and drying, and the use of super grains bags were developed and printed in both English and Dzongkha. The training curricula and leaflets were distributed to extension agents, Agriculture Research and Development Centres (ARDCs), Dzongkhags and farmers during the training programme.
Activity 2.2	Implementation of training at all levels	
	Achieved	Yes
	Comments	Training on maize storage pests identification and management, and improved drying and storage methods was conducted twice for the DAOs and extension agents of project sites, technical staff of NPHC and NPPC, and the plant protection focal point of Regional Agriculture Centres; technical staff of Food and Machinery Cooperation Limited and the National Maize Coordinator were also trained. The resource persons for the training activities were from NPPC and NPHC. The trained extension agents then trained farmers in their respective project sites. In total, 49 extension agents, 1 449 farmers and 20 technical staff members were trained on the identification and management of maize storage pests, and on improved drying and storage methods.
Activity 2.3	Study visit to a country with successful maize drying and storage	
	Achieved	Yes
	Comments	A ten-day study tour was conducted in September 2017 for nine extension agents, two NPHC and five NPPC technical staff members at National Maize Research Program and Nepal Agriculture Research Centre in Nepal. Participants acquired knowledge on different storage pests and their management practices in Nepal, and on improved drying and storage facilities. The initial budget allocated for this activity was for three officials by air route; however, within the allocated budget limit, 16 officials made a study visit by land route.

Output 3	Designed and demonstrated low-cost but appropriate storage and drying technologies for rural households		
	Indicators	Target	Achieved
	Low-cost storage and drying technologies demonstrated and distributed to project districts	Not identified in Project Document	Yes
Baseline	0		
Comments	After identifying the needs of laboratories at NPHC and NPPC, they were accordingly equipped. Based on the recommendations of the International Consultant, five improved drying structures and corn shellers each were procured, demonstrated and distributed to districts. In addition, five data loggers were purchased for monitoring temperature and humidity in stores.		

Activity 3.1	Materials for new storage and drying procedures	
	Achieved	Yes
	Comments	The consultant, in coordination with NPPC and NPHC, prepared the list of materials required for storage and drying technologies, which was submitted to FAO Bhutan for procurement. Procurement was successfully completed and the materials were deployed at the project sites.
Activity 3.2	Visit laboratories and identify needs	
	Achieved	Yes
	Comments	The consultant and the technical project staff visited the NPPC and NPHC laboratories and identified their needs. The list of laboratory equipment and other materials required was compiled and submitted to FAO Bhutan. Procurement was successfully completed, and the materials were deployed in the respective laboratories.
Activity 3.3	Procure reagents and chemicals	
	Achieved	Yes
	Comments	As above (Activity 3.2)
Activity 3.4	Procure sample equipment and low temperature equipment.	
	Achieved	Yes
	Comments	With support from the project, five maize drying structures and five corn-sheller machines were procured and distributed to the DAOs for installation in the project sites. In addition, five data loggers were procured for measuring temperature and humidity in the maize stores.

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