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Community Based Seed Production—A Sustainable Seed Production Model for Subsistence of Bhutanese Maize Farmers

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Abstract: Bhutanese maize farmers grow different open-pollinated traditional varieties and improved high yielding varieties recommended by the national maize program. All most every maize farmer uses the recycled seeds from their farms for planting in the next season. Farmers traditional or informal seed system was found to be poorly organized and unscientific that has resulted in the deterioration and contamination of seed quality. Bhutanese maize farmers living in remote areas are highly constrained by the inconsistent supply and poor access to good quality maize seed. The formal public seed sectors lack adequate resources to produce and supply good quality seeds. This called for an urgency to identify and adapt an innovative and a sustainable seed production approach to service the subsistence needs of Bhutanese farmers in a cross-pollinated crop, like maize. The community based seed production (CBSP) approach was introduced and evaluated under the Bhutanese maize production system as an alternative farmer based seed production model. A total of seven farmers CBSP groups were formed and promoted as a smallholder seed enterprise. The technical skills of these CBSP group members on maize seed production were improved through practical demonstrations and trainings. The CBSP groups were supplied with high quality source seed of new maize varieties by the national maize program. For long term, the sustainability of CBSP groups were linked to the formal seed sector in the country for marketing the seeds. The CBSP approach has proven to be a successful small scale maize seed production model under highland maize production ecosystem that has improved the production and supply of good quality maize seeds. The Bhutanese experiences with CBSP in maize, its merits for small holder Bhutanese maize farmers and lessons learnt from the CBSP model are discussed in this paper.

Key words: Seed system, sustainability, CBSP, open-pollinated variety (OPV), seed replacement rate, CBSP groups.

1. Introduction

Maize is a major food crop and widely cultivated by Bhutanese farmers for subsistence. It is cultivated in about 28,000 ha with an average national yield of about 2.83 metric tonnes (MT)/ha and the estimated total annual production is 79,826 MT. The average land holding size per household is 3 acres [1], on which farmers cultivate different crops for subsistence. Maize farmers grow only open-pollinated varieties (OPVs) and almost their entire seed requirement is recycled from their traditional or informal seed system. It has been established that 98% of Bhutanese farmers meet their total cereals seed requirement from the informal traditional seed system managed by themselves from their farm saved seed or from other informal sources [2].

Availability of good quality maize seed is one of the key constraints of the farmers. Maize farmers and agriculture extension workers have reported the continuing degeneration of maize seed quality. Seed degeneration is associated with maize plants becoming very tall, grain mixtures in the cobs due to contamination by pollens from neighboring fields,

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open husk cover and the increasing susceptibility of maize varieties to the diseases, like gray leaf spot (GLS) and turcicum leaf blight (TLB).

Maize seed degeneration is underpinned by the lack of a suitable seed production system for a cross-pollinated crop, like maize. The formal seed sector represented by erstwhile Druk Seed Corporation (DSC) and now National Seed Center (NSC) under the Department of Agriculture is relatively weak due to the limited human and financial resources. This has crippled the production and supply of good quality maize seeds. Farmer's traditional or informal seed system is poorly organized and unscientific. In the backdrop of a weak formal seed sector, farmers were compelled to continue depending on their traditional seed system. Further in 2007, there was a severe outbreak of GLS caused by *Cercospora zeae-maydis*, which called for an urgency to identify GLS tolerant maize varieties and immediate seed replacement by putting in place a rapid seed multiplication system of new GLS tolerant varieties [3].

Seed is the most basic input for agriculture and a sustainable seed system is fundamental to ensure the production and supply of high quality seeds at affordable price to the farming communities [4]. A good seed production strategy and an efficient seed production and distribution system are necessary to ensure the sustained supply of seeds to the farmers. Increasing dependency on a weak seed systems leads to a much slower adoption of new varieties, low yield and the increasing incidences of pest and diseases [5]. Seeds systems are either formally or informally depending on who is involved in the seed production and supply chain [6].

To address the farmers' increasing demand for good quality seed and to improve the seed quality, the community based seed production (CBSP) model was initiated by the National Maize Program with the objectives to address the issue of maize seed degeneration and rapid seed production of GLS tolerant maize varieties. CBSP seed model was emulated from the successful demonstrations of its advantages to small holder hill maize farmers in Nepal by the Hill Maize Research Project (HMRP) and the International Maize and Wheat Improvement Center (CIMMYT). According to Gadal et al. [7] and Sapkota and Pokhrel [8], the CBSP approach has been proven to be highly successful and applicable for production and supply of quality maize seeds for small holder farmers in Nepal. In Bhutan, the concept and model of CBSP were introduced through the collaboration between the Bhutanese maize program HMRP and CIMMYT. The comparable socio-economic status of the maize farmers in Nepal and a very similar maize production environment caught the attention of the Bhutanese researchers to initiate and adapt CBSP model in Bhutan. The CBSP model was first tested in two sites in 2011 and slowly expanded to nine more locations in the subsequent years. This paper described the experiences with CBSP, its advantages and lessons learnt under the Bhutanese context.

The objectives of the CBSP were:

(1) To adapt CBSP as an innovative and a sustainable seed production model for small holder Bhutanese maize farmers by integrating it with the formal seed sector in the country;

(2) To ensure the production, sustainable availability and supply of good quality maize seeds at farmers level through CBSP;

(3) To ensure the sustainability of CBSP by making it a viable small scale seed production enterprise through the consolidation of interested maize seed producer farmers into seed producer groups for income generation from sale of maize seeds.

2. Materials and Methods

The adaptation of CBSP model was a case of learning by doing. Most of the methodologies of CBSP were evolved as the work progressed. As the concept was new to the Bhutanese researchers and extension, the first step was the capacity development

and exposure visit of the selected key technical people to the CBSP sites in Nepal. Following the technical exposure visits, CBSP was initiated in two sites and later expanded to seven sites that spread in five Dzongkhags (districts) in the country. The stepwise methodologies are discussed in the following different sections [9].

2.1 Site Selection

The research team from the National Maize Program first identified the two potential sites that met the critical requirements for CBSP. The success of CBSP in maize largely depends on the selection on the site. The two most important criteria for a good CBSP site include the location and accessibility. A good CBSP site has to be in a very strategic location representing the maize production area and also be in a command area so that other farmers can see or it can be used for demonstrations. The site has to be secluded with an appreciable isolation from other maize fields to avoid field contamination through cross pollination. The isolation can be maintained in the form of distance or with good physical barriers, such as line of shrubs and trees or hill. The site has to be easily accessible and preferably connected by road for regular monitoring, delivery of inputs and collection of seeds. The two sites where CBSP were first initiated were in Jangdung and Waichur under Mongar Dzongkhag. Both sites are in the center of the maize production zone and very close to the Renewable Natural Resources Research and Development Center (RNR-RDC), Wengkhar, Mongar, which is the home for the National Maize Program. The proximity of the sites was very convenient to provide technical support and nurture the CBSP group into a viable small scale enterprise.

2.2 Selection of the Communities

Once the sites were identified, a detail consultation meeting was organized with the communities. The consultation meeting is facilitated by the Agriculture Extension Officer and while the technical aspects of the CBSP are handled by the experiences of maize experts from the RNR-RDC. One of the underlying requirement for CBSP is that the target communities of the site have to be willing to participate in group activities and interested in seed production and marketing. After the communities are made to understand the concept of CBSP, their names are listed along with their area allocated for planting maize. This is followed by the development of a suitable seed production plan. To start the CBSP, the seed of suitable variety was supplied free of cost. The agriculture exertions staff of area are then responsible to coordinate the CBSP. All the other technical expertise and support were provided by the National Maize Program. The stepwise methodology is briefly discussed below under the relevant heading.

2.3 Supply of Source Seed

To start the CBSP model, high quality basic seeds of the different varieties produced under the strict supervision of the maize research program were provided to the CBSP farmers. Since there was an urgent need of seed replacement with GLS tolerant varieties, two newly released GLS tolerant varieties, namely Chaskarpa and Shafangma Ashom, were promoted for rapid seed multiplication. The basic seeds were supplied free to the CBSP groups.

2.4 Capacity Development of Extension Staff and Farmers

Training of extension staff and farmers engaged in CBSP was very critical. They were provided at least two training at the CBSP site. The first training was organized before planting of maize, where all the concept of CBSP was explained. The second training was organized in the standing crop to demonstrate the techniques of detasseling and seed selection. The extension staff of the site and CBSP group leaders were also taken on study visit to see and interact with CBSP groups in Nepal.

2.5 Development of CBSP Manual

One simple manual on CBSP was developed as a resource material for the technical staff engaged in CBSP. This manual was published by the National Maize Program and widely circulated to all the extension staff across the country as a source book.

When the crop was ready for harvest, farmers were asked to dry and prepare the seeds which were directly purchased by the NSC at a premium price. Individual farmers of the group sale the seeds and claim dash individually. The seed quality is currently assessed by NSC and maize program staff, but in future there are plans to engage the quality regulator authority to maintain seed quality.

3. Results and Discussion

The CBSP approach in maize has been proven very successful in addressing the issue of seed production and supply in most of the maize growing countries [10, 11]. CBSP involves organizing farmers or a community into a seed producer group. Farmers of the group grow the same variety and produce good quality seeds to avoid the problem of out-crossing. They have to follow all technical requirements for seed production. Group members have to be trained on the skills of quality seed production and provided with good start-up seed initially.

CBSP has far reaching advantages, such as access to quality seeds, earning cash by selling the seed to seeds company and other farmers; fellow farmers in the communities can have better access to good quality seed. Seed security for the poor farmers can be ensured at the Geog (block) level through farmer to farmer seed exchange. CBSP also entails faster yield gains and dissemination of suitable varieties through participatory varietal selection (PVS) process [12, 13] and farmer to farmer seed exchange. Today, there are seven functional maize CBSP groups producing high quality maize seeds (truthfully labeled seeds) of all the released varieties (Table 1).

Based on the successful experiences, the CBSP group model was expanded to five maize growing districts. Currently, there are seven CBSP groups spread in the five major maize growing Dzongkhags, with about 180 members who produce quality seeds and supply to the NSC (Table 1). In 2013, the seven CBSP groups produced around 42 MT valued at 1.54 million Nu (1 USD = 65 Nu). These CBSP groups have started to play an important role in meeting the objectives of National Maize Program to increase the seed replacement rate from 24% to 50%. The seed production capacity of the seven CBSP groups has increased from 17 MT in 2011 to 42 MT in 2013 (Table 1). If 100% seed replacement is to be done, the total requirement for the country is estimated at 105 MT [14], of which CBSP groups are already meeting 40% requirement annually.

During the GLS epidemic time, in the high altitude

Table 1 The details of CBSP groups and their status.

Name of site	Total members	Year of start	Variety	Quantity of seed sold (MT)			Total income for three years
				2011	2012	2013	(Nu million)
Shafangma	20	2011	Shafangma Ashom	1.10	7.00	10.6	0.34
Waichur	20	2011	Yangtsepa	9.00	7.00	14.8	0.55
Jangdung	28	2011	Chaskharpa	5.48	5.90	11.87	0.42
Norgaygang	25	2011	Yangtsepa	0.45	0.16	0.50	0.02
Tsangkhatar	20	2011	Chaskharpa	1.37	0.67	1.00	0.05
Changmey	53	2012	Yangtsepa	0.00	6.00	2.55	0.15
Gagaling	14	2012	Chaskharpa	0.00	0.36	0.50	0.01
Total	180			17.40	27.09	41.82	1.54

1 USD = 65 ngultrum (Nu).

maize growing areas above 1,500 m above sea level where there was an urgent need to supply seed of GLS tolerant maize varieties, 80% seed replacement was accomplished by GLS affected farmers through rapid seed production of two GLS tolerant maize varieties by the seven CBSP groups [15]. CBSP schemes are most commonly initiated where the formal seed system is unreliable and the seed supply infrastructure is poor [16]. In the Mekong Delta in Vietnam, Tin et al. [17] have also concluded that farm-saved seeds produced informally by farmers are important for food and seed security and should be recognized and supported by the government as an important strategy for the agricultural development. Similarly, CBSP could play a significant role in conservation of maize genetic diversity under traditional farming system [18, 19] which is prevalent in Bhutan.

Based on the merits of CBSP, it has been fully integrated into the national maize seed production scheme (Fig. 1).

4. Lessons Learnt

Several lessons have been learnt from the evaluation and adaptation of CBSP model in Bhutan. These lessons are critical for scaling up of the CBSP scheme and its replication in new areas for sustainable maize seed production under the Bhutanese context. CBSP basically entails the strengthening of the informal seed production system for production of good quality seed at the farm level. It involves the organization of interested farmers or a community into a seed producer group. Farmers of the group grow the same variety and produce good quality seeds to avoid the problem of out-crossing. They have to follow all technical requirements for seed production. Farmers have to be trained on the skills of seed production and

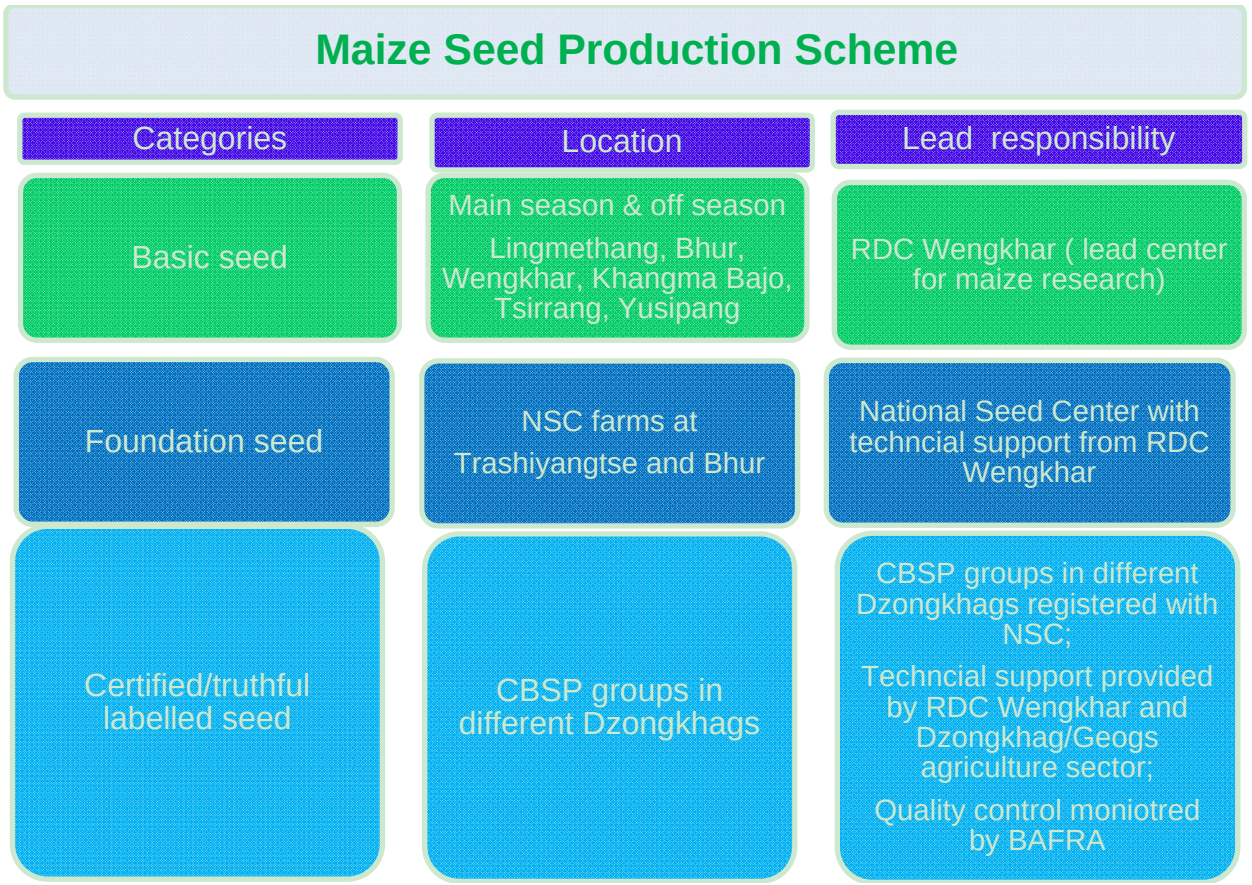

Fig. 1 National seed production scheme of Bhutan.

provided with good start-up seed initially. The support of researcher, extension and formal seed sector is very important for a sustainable CBSP group. However, the crucial bottlenecks that affect establishment of seed enterprises are as described by Langyintuo et al. [20, 21], such as high initial investment cost, lack of man power, lack of access to credits, poor marketing networks and small volume which be applied in the context of Bhutan as well. Some of the key lessons learnt from the CBSP initiative in Bhutan are briefly discussed below:

(1) CBSP has many far reaching advantages: small holder farmers who practice CBSP have much faster access to quality seed, new varieties and other production technologies which enhances their production; CBSP farmers earn cash by selling the seed to other farmers and fellow farmers in the communities; seed security of the small holder farmers can be ensured at the local level through farmer to farmer seed exchange. CBSP also ensures the faster dissemination of suitable improved varieties through farmer to farmer seed exchange. In Nepal, the CBSP model has been proven to play a vital role in production and supply of cheap seeds to small holder farmers in far flung areas, accelerate the adoption of new maize varieties, increase the much needed seed replacement rate and help the development of small scale seed enterprise through public-private partnership [22].

(2) Need for a feasible seed production site: selection of CBSP site is critical for its success. The site has to be preferably near the road as it facilitates regular monitoring, seed collection and delivery of inputs. The site has to be secluded with good isolation to avoid field contamination through cross pollination. In the Bhutanese context, many naturally isolated sites that are separated by valleys and forest are abundantly available for CBSP. The CBSP site has to be in a command area, so that other farmers can see the seed production and it can be used for demonstration to other farmers.

(3) A willing community: the first step is to sensitize the farmers on the concept of CBSP and find out their interest in taking up seed production as potential farm enterprise. Selection of farmers to form a CBSP group is very important for the success of the group. If only poor farmers with limited land holding are selected, they may not be able to produce seed, as whatever they produce may be just enough for their consumption. Under Bhutanese maize production environment, there are communities who are secluded from other villages and are ideally isolated for seed production. As CBSP requires cultivation of one variety to avoid mixtures, the whole community has to be willing to participate.

(4) Monitoring: regular monitoring and inspection by an experienced person with good knowledge on maize seed production is necessary for successful and good quality seed production. The agriculture extension officer of the area needs to devote his time to nurture the CBSP group.

(5) Training on seed selection techniques: CBSP farmers are expected to produce good quality seed and hence they have to master the art and skill of seed production. Farmers have to be trained on seed selection and variety maintenance techniques. Several rounds of training on the standing crop that focused on detasseling, crop management and seed selection should be organized.

(6) Assured supply of source seed: for good quality seed production, the CBSP groups have to be assured of high quality source seed. For the all CBSP groups, the National Maize Program supplies the high quality foundation seed annually as the source. The foundation seed of the different varieties are produced in the NSC farms. As the CBSP groups have become the seed producers for NSC, the channel for obtaining foundation seed has also been defined and put in place in the national seed production scheme (Fig. 1). The CBSP group who are the seed producers should change the source seed annually to produce high seed quality. Technically, seed of OPVs should be recycled

for a maximum of three seasons without significant yield loss [16].

(7) Mainstreaming of CBSP groups with formal sector for long term sustainability: for long term sustainability, it is important to mainstream CBSP into the formal seed sector. Complementarity between the formal and informal seed system is a win-win situation, as both sectors benefit equally. In the Bhutanese context, all the CBSP groups have been linked to NSC that represents the formal sector and to the RNR-RDC for technical advice. The formal sector ensures the continuous technical support, the supply of source seed and the help in marketing the seed produced by CBSP groups. The formal sector also guarantees the seed quality produced by the informal sectors. Creating strategic linkages and building partnerships with the formal sector represented by national seed sector, research centers and extension system is seen as one of the key strategies for the development and sustainability of small seed producers groups in Cameron [23].

(8) Cleaning, packaging and marketing: currently, the packaging, quality control and marketing are taken care by the formal sector, as the CBSP group produces the seed for the formal sector. However, the packaging of seed, quality control and marketing could be an important issue, if the CBSP groups start to independently market their produce. For a stable market, the assurance of quality is very important and hence the involvement of the Bhutan Agriculture and Food Regulatory Authority (BAFRA) for quality control has been foreseen and indicated in the national maize seed production scheme (Fig. 1).

(9) Future prospects for CBSP: it has been established that CBSP can be definitely scaled up to support and improve the existing farmer's informal seed system, which supplies 98% of their seed requirement. It can improve the access to quality seed and enhance production. It can also be a good farm enterprise for small farmers, if they are committed to work together as seed producers. The CBSP and delivery system have been proven as a viable alternative seed production scheme for making improved seeds available to farmers across the entire West and Central African region [24].

5. Conclusions

CBSP is efficient and a sustainable seed production model for small holder Bhutanese maize farmers, especially when the formal sector can not service the need of the farmers. CBSP can particularly benefit small holder farmers in the far flung areas who do not have easy access to quality seed.

CBSP groups have the prospects of being developed into a small scale seed enterprise in future, which can produce and supply quality seed at the farm level. The CBSP groups can be a sustainable seed enterprise, as the cultivation of OPVs of maize will continue and the demand for locally produced high quality seeds will continue to rise. At present, farmer's seed replacement rate is very low and expected to increase due to more awareness on the advantages of using high quality seed. This situation promises a viable seed business of the CBSP groups. For successful CBSP, the support of the formal seed sector is vital for the supply of high quality source seed, packaging, guarantee of seed quality and marketing of the seed. For long term sustainability, CBSP has been integrated with the formal seed sector for seed production of open-pollinated maize varieties.

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