



RNR RC Wengkhar Extension Material Bo - FC/008 / 2009

Quality Maize Seed Production through Community Based Seed Production Approach

An Extension Manual

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November, 2009

Published by:

RNR RC Wengkhar
Council for RNR Research of Bhutan
Ministry of Agriculture

Financial Assistance (Publication):

AMEPP-IFAD, PFO Khangma Trashigang
(Agriculture Marketing and Enterprise Promotion Program)

Financial Assistance (Field Work)

European Union - Agriculture Sector Support Project (EU ASSP-DoA)
FAO Netherlands Partnership Program - Seed Support (FNPP-DoA)
Biodiversity Utilisation and Conservation Asia Program (BUCAP-NBC)

Content information:

T.B Katwal and Namgay Wangdi, Field Crops Research, RNR RC Wengkhar

Layout, Design and compilation:

Lhap Dorji, Research Communications RNR RC Wengkhar

Citation:

Katwal, T.B, Dorji, L and Wangdi, N (2009. *Quality Maize seed production through Community Based Seed Production Approach: An Extension Manual*.
RNR RC Wengkhar Extension Material - 008 / Bo-FC/2009
RNR RC Wengkhar, Council for RNR Research of Bhutan
Ministry of Agriculture

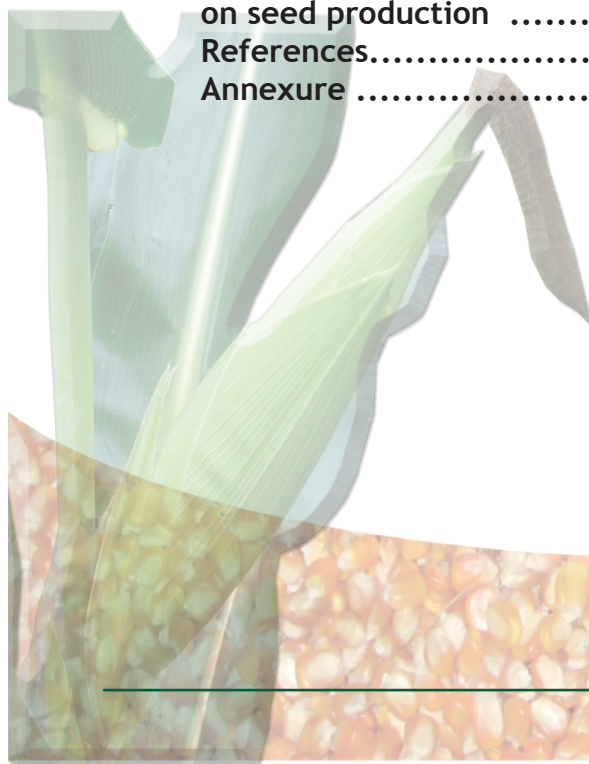
Published:

November, 2009



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Acknowledgement

RNR RC Wengkhar acknowledges the following agencies and individuals:

- European Union - Agriculture Sector Support Project (EU- ASSP), FAO - Netherlands Partnership Program (FNPP) - Seed Support Program of the Department of Agriculture, Ministry of Agriculture and Biodiversity Conservation and Utilisation Project (BUCAP), National Biodiversity Centre, Serbithang, Ministry of Agriculture for their financial supports for the centre to initiate and promote CBSP approach.

- The Agriculture Marketing and Enterprise Promotion Program (AMEPP-IFAD), PFO Khangma is acknowledged for the financial supports to publish the contents of our work into an extension manual.

- CIMMYT - Nepal and particularly Dr. Ortiz Ferarra and Dr T P Tiwari, CIMMYT Scientists are appreciated for the technical guidance provided to us in our field work as well as for sharing their experiences with us.

- D.B Rana, RSC Tsirang, N B Adhikari, RNR RC Wengkhar, Sangay Wangdi, RSC Lingmethang, Riki Wangchuk, RNR EC Martshalla, Karchung, Gup of Martshalla and Ugyen Wangdi, RNR EC Saleng for their active collaboration in implementing CBSP approaches with us.

Foreword

Development of methods and promotion of approaches like the CBSP in maize has come on time especially when we are facing the problems of seed quality deterioration. Maize farmers in Bhutan highly depend on the traditional seed production system. However, most of these traditional or informal system although popular are observed to be not following recommended practices.

Community Based Seed Production approach can appropriately be used as a way to revive maize seed quality since it is based on the informal system of seed selection and farmers traditional practices. The application of this approach entails improvement in maize seed selection methods through cooperative approach of organizing farmers into seed growers groups not only fits well with our concepts of cooperative development but will also be able to bring about improvements in the overall production of maize by improving the cultivation practices. However, it's success will depend on proper application of the approach and adjusting it in the process to fit in our farming conditions.

RNR RC Wengkhar has initiated the application of the approach in pilot sites and is found to be an effective way to improve the seed quality in the test sites. The application of this concept can fit well with the programs in the extension system through which farmers can be trained and CBSP groups can be formed. Linking these groups to the formal seed production system by developing linkage between CBSP groups and Seed Production agencies has high scopes of partnership development and sustainable quality seed production.

This manual is the first attempt to document the steps to fit the approaches into our farming conditions and thus the manual will continue to be revised from time to time for which, the National Maize Research Program Coordination, RNR RC Wengkhar and RNR RC Bajo would like to welcome any feed backs and suggestions from the users of this publication.

On behalf of RNR RC Wengkhar, Council for RNR Research of Bhutan, I would like to extend our appreciation for the supports provided by our collaborators in Maize Research Program and particularly in the establishment of CBSP sites from which this manual is developed in the first place. This Manual on CBSP is a collective effort of both research and extension and I hope that the contents of this manual contribute towards improving the quality of our maize seed in days ahead by replicating the establishment of CBSP groups in our maize growing areas.

With Best Wishes

Dr. Tashi Samdup
Director
Council for RNR Research of Bhutan
Ministry of Agriculture

November, 2009

1. Introduction

The availability of quality seed is the primary input for crop production. The total annual maize seed requirement of the country is estimated to be about 850 Mt of which 95 % of the requirement is met through farmers seed. This indicates that majority of our maize farmers depend on the seeds selected and maintained through their seed production system. Thus the informal seed production and exchange is a major source of maize seed for our farmers.

The dissemination and diffusion of improved varieties is highly dependent on the availability of quality seeds. Inadequate availability of high quality seed has been a concern of the Ministry of Agriculture and this issue cannot be addressed unless efforts are made to strengthen the seed production - informal seed production system as in our case. As our farmers cultivate open pollinated varieties whose seed production is easier in comparison to hybrids, the improvement of the informal seed production system of OPVs will be able to improve seed quality.

Although maize farmers practice a rigorous traditional selection system, their limited understanding of the nature of maize crop and the conditions under which they produce their seed tend to affect the quality. Farmers also tend to overlook essential steps in seed production that is important to maintain seed quality. Improving the seed selection procedures and strengthening the traditional system of maize seed selection can immensely contribute to improve maize seed quality.

RNR RC Wengkhar with financial supports from the EU-ASSP and FNPP- Seed Support project under Department of Agriculture and BUCAP through the National Biodiversity Centre, Ministry of Agriculture has initiated application of a suitable approach called the **Community Based Seed Production Approach (CBSP)**.

This approach which emerged from the works of CIMMYT has successfully improved the maize seed quality in countries such as Nepal. Since we have similar agro ecological conditions and farming systems with Nepal, the approach was tried in our areas such as Martshalla and Deothang in Samdrupjongkhar (2006), Broxsar in Mongar (2007), Tsholingkhar and Rangthaling in Tsirang (2008) in collaboration with RSC Tsirang, RNR RC Bajo.

The experiences and lessons from these sites showed that the approach can be effective in our situations. However, its promotion and continuity needs up scaling and replication.

The extension centres across the country can play a major role in the up scaling and replication of the approaches and contribute towards improving the seed system in our communities. Therefore, this document is developed as an extension manual to provide guides in up scaling and replication works. In developing this manual, we have tried our best to put together information from CIMMYTs successful strategies and our own experiences. Since the document is based on experiences, users are encouraged to make necessary adjustments to fit into your local conditions.

2. Quality components of maize seed

The main characters of a good quality maize cob suitable for seed are:

- Synchronised maturity (a variety should mature at the same time)
- Uniformity (uniformity in plant height, ear height, ear shape, cob size, cob length, grain fill)
- Good and closed husk cover
- Free of disease and infections
- Good Kernel shape, colour, texture, arrangement

The good characters of maize crop for seed are shown in Figure 1.



Figure 1. Good Characters of Maize (in sequence Uniform plant height, ear size, grain fill, kernel arrangements and cob size)

Since maize is a cross-pollinated crop and farmers grow different varieties close to each other there is out crossing between different varieties leading to deterioration of the good characters of the varieties. This can lead to un-uniform crops (cobs with mixture of grain, open husk cover and susceptible to lodging. These characters should be avoided and the good characters should be selected for seed crops.

3. Community Based Seed Production Program (CBSP) - The concept

Community Based Seed Production is the production of preferred crop varieties in their own locality by organizing groups of farmers adopting or following recommended practices in seed production improving their informal system of seed selection. Although CBSP can also be applied to even few numbers of farmers, cultivating crops in the same location, it is generally applied to the whole community (a village or cluster of villages geographically located near to each other).

Thus CBSP is cultivation of a crop (maize in this case) for the purpose of seed production through the improvement in the informal seed selection system. In this, farmers should agree to cultivate a good quality seeds of a preferred variety in their village or a cluster of villages following the recommended practices of seed production (proper crop management, maintaining isolation distances, roguing of plants with undesirable characters and selection of best cobs etc).

The members of the community participating in the program then become source of good quality seeds which can either be used for themselves or sold to others. Eventually, the farmers are organized into a farmers group to produce quality seeds and take up seed production as a farm enterprise. And the successful cases are replicated to other areas.

4. Advantages of CBSP

The main advantages of CBSP from the experiences in various countries where the approach has been tested and from our sites in Martshalla, Deothang, Broxsar and Tsirang are as follows:

- Improved access to good seed as farmers groups or communities get together to produce the seed of their preferred varieties
- Increase in maize production of those farmers producing seed as they have the opportunity to use quality seed
- Seeds which are produced in their own locality can adapt easily to their local environment
- Neighbouring farmers will have access to good quality seed
- Increase in household cash income through sale of good quality seed and from the premium price of seed
- There will be a faster dissemination of improved technologies like new varieties

- Lesser dependency on the formal seed production system
- Enables overall increase in the maize production
- Promotes cooperative farming and can empower farmers

Due to the similarities in agro-ecology and the farming system of the neighbouring countries like Nepal where CBSP was tested to be successful and also on the basis of our own experiences from our sites, the applicability of CBSP approach in our context is found to be appropriate.

The main features of our maize based farming system that favours CBSP approaches are as shown below:

- Majority of the farmer's keep their own seeds
- There is no reliable source of good quality maize seed
- Farmer's do not follow timely renewal of seed from a good source
- Farmer's in the remote areas have to spend time and resources to get seed
- Farmer's current practice of seed selection do not consider some of the basic seed selection procedures
- Farmer's plant mixture of varieties and the chances of out crossing is very high
- Maize is a major crop cultivated by almost every household

5. Steps in initiating a CBSP in Maize - Applying the approach

In order to replicate the success of the CBSP and to bring improvements in the maize seed quality, it is essential that the approaches of CBSP are implemented by replicating similar programs as an extension activity of the Dzongkhag and geog extension programs.

The following sections of this manual will concentrate more on the guide lines to initiate such approaches in the maize growing areas where seed quality is a problem.

5.1 Getting started with CBSP program in your geog

In starting a CBSP in any crops, plans should be made prior to the cropping season. In maize, planting time vary depending on agro ecological zones as shown in Table 1. Planning for CBSP in maize should at least begin one month before land preparation.

Table 1. Maize growing seasons

Agro ecological zones	Altitude range	Planting / sowing	Harvest	Recommended varieties
Highland maize production zone	> 1,800	March	October	Traditional
Subtropical Mid altitude Zone (main crop Maize)	1,200 - 1,800	March	October	Y a n g t s e p a , Khangma Ashom 1 and 2
Subtropical low altitude zone (main crop Maize)	< 1,200	February	October	Y a n g t s e p a , Khangma Ashom 1 and 2

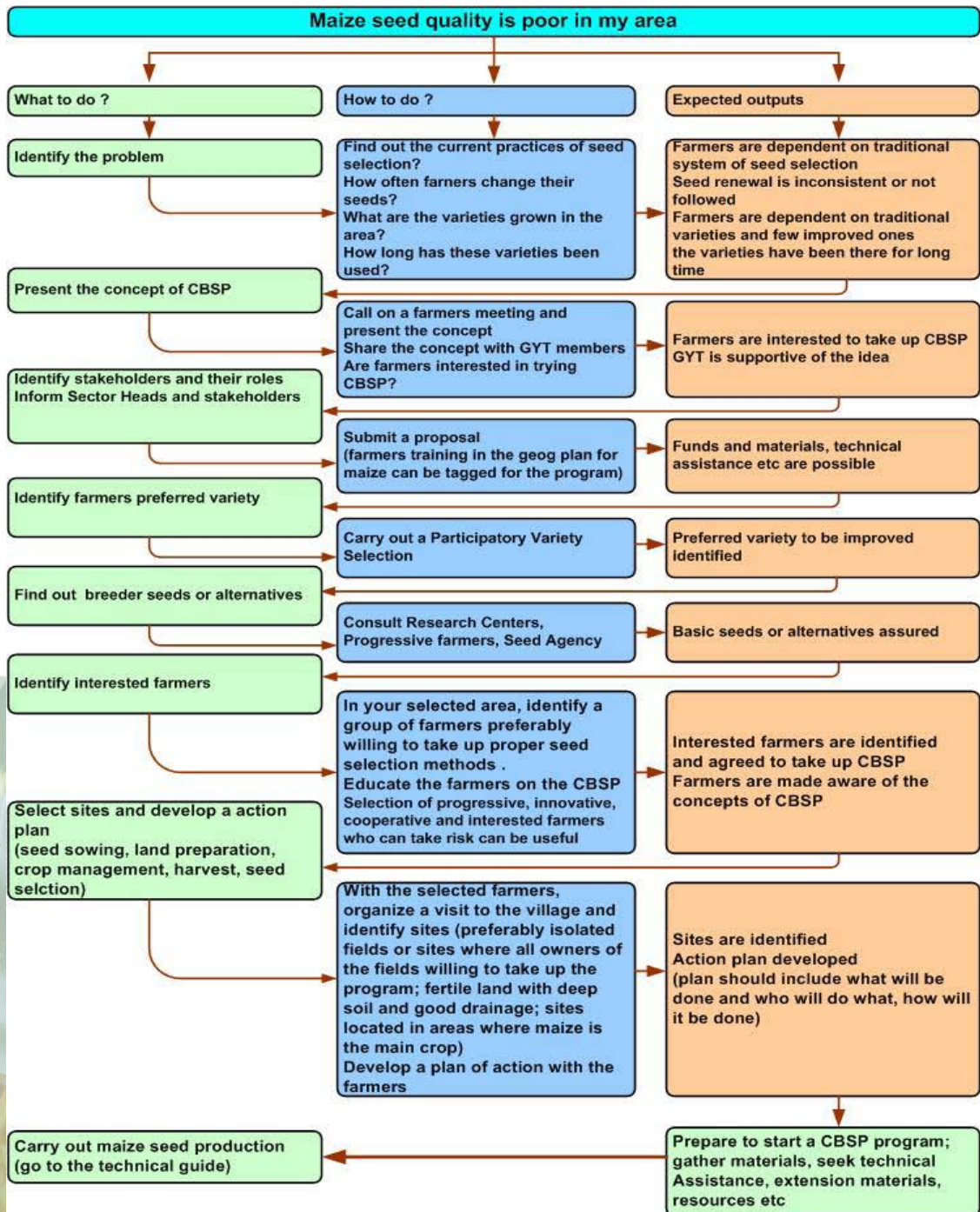
Before approaching a community or a group of farmers to start CBSP, it is essential that you have the following:

- The Concepts of CBSP (see section 2) - one should be clear on the concepts, Contact concerned agencies and individuals to clarify any doubts.
- You should consult relevant agencies for source seeds such as Research Centres or Seed Company.
- Ensure that stakeholders such as your sector heads, Researchers, Administrators are aware of the problems in maize seed in your geog.
- Ensure some funds and materials to cover costs in organizing trainings and field days
- And most importantly, there are five tips critical for success of CBSP which should be followed. These tips are shown in Box. 1.

Box 1. Tips for successful CBSP

1. The site has to be preferably near the road as it facilitates regular monitoring, seed collection and delivery of inputs
2. The site has to be secluded with good isolation to avoid field contamination through cross pollination, Site should also be in a command area so that other farmers can see or it can be used for demonstration
3. Regular monitoring and inspection by an experienced person with good knowledge on maize seed production is necessary
4. Selection of farmers to form a CBSP group is very important for the success of the group. If we select only poor farmers with limited land holding they may not be able to produce seed as whatever they produce may be just enough for their consumption
5. Farmers have to be trained on seed selection and variety maintenance techniques and, other requirements for seed production

Figure 2. Initiating a CBSP program in maize : A guide



Having assured of the above prerequisites, approach the community with the concepts. In order to guide you to initiate CBSP in Maize, follow the basic steps to initiate CBSP in a community. The step wise guide is provided in Figure 2 and illustrated in the following section.

Step 1. Identify the problem

It is possible that even if there is no problem with seeds, farmers can relate their low yield, poor crop performance with seeds degeneration. It is important that you confirm the seed quality problems of your farmers. A check list to assess seed quality is shown in **Annexure 1**.

Step 2. Inform sector heads, other stakeholders and identify the roles

Inform all stakeholders particularly your sector heads regarding the seed quality problems and the farmers interest to start up a CBSP approach. Identify the roles and responsibilities of each stakeholders such as shown in Table 2. Inform concerned stakeholders and plan your work with them as well.

Table 2. CBSP partners and their roles in order of importance

Partners	Roles
Communities	Land and labour contribution, Seed production, Participation and collaboration, Motivation
Extension agents	Develop proposal, Identify sites, Facilitate group formation, Facilitate seed production activities
DAOs	Arrange funds, Facilitate marketing of seeds Facilitate technical assistance, Coordinate linkage with other stakeholders
RNR RCs	Provide technical support, provide source seeds Renewal of start up seeds, Documentation of successful cases and sharing with others
AMS	Facilitate marketing, Facilitate marketing linkages Training on book keeping and marketing
DSC	Source of seed and also buyer of farmers seed
BAFRA	Technical assistance in quality control and advisory Seed certification
Private firms	Seed buyer and marketing

One way to formalize this is by putting up a written proposal, preferably a short one covering number of farmers willing to take up CBSP, total acreage, location,

preferred variety, materials required, costs etc). Farmers trainings and demonstration in your extension program can appropriately cover the costs. Perhaps, farmers training program in your geog plan for the year may be conducted for this particular program.

Step 3. Present the concepts of CBSP to your farmers

It is very important that your farmers understand the concepts. Therefore, organizing a meeting to discuss the poor seed quality problems, share your findings from the problem analysis and present to your farmers the concepts of CBSP - an approach to improve the informal seed selection methods and form a viable seed producers group of farmers.

You may also share the concepts with the GYT members, local administrators etc. They can also be useful in making your farmers understand the concepts.

Step 4. Identify the farmers preferred variety

You can even do this earlier in step 2 by organizing a PVS - Participatory Variety Selection by asking the interested farmers to identify their preferred variety based on their criteria for selection. A method called matrix ranking can be used to identify the preferred variety. See **Annexure 2** Matrix Ranking Method. Once their preference is identified, you should then find out a source of good seeds of this variety.

Step 5. Confirm high quality source seeds (foundation seeds)

In case of improved varieties consult the research centres for some foundation seeds or seed agencies for certified seeds. Farmers may also prefer a traditional variety, for which the best option (provided there is standing crop in the field) is to visit the farmers maize field. With the farmers, tag around 1000 plants with good plant characters (medium height, good cob size, good husk cover etc) and ask them to harvest these separately for seed. Later select once again by looking at ear size, kernel colour, kernel arrangement and these can be a source seed. If you have started this planning when there is no crop in the field, you should start with foundation seeds from the research centres.

Step 6. Identify interested farmers

Finalize how many farmers are genuinely interested to try CBSP. Preferably, the

entire village can be encouraged but you can also start off with few interested ones. In this case, select proper sites (see step 7). Other farmers may join later after seeing the benefits. You can invite them for demonstrations and field days later in your sites to create awareness for them.

Step 7. Select sites and develop an action plan

With your interested farmer collaborators, identify a location to start the program. An isolated field far from other maize fields, or field adjoining each other with owners willing to try the approach, fields with fertile soil, may be centrally located to demonstrate the approach to other farmers later are recommended. Ideally, sites with road access is preferred for easy transportation of inputs, monitoring and facilitation of seed sales.

After selecting the site, consult your farmers again and develop an action plan (clarifying the roles and responsibilities of the collaborators (see Table 2), your roles and others as well, introduce what will be done and how it will be done). Submit the action plan to your sector head and other stakeholders from whom you require their supports.

Step 8. Preparation for launching a CBSP

Collect materials, information sheets, extension materials, budget and technical assistance to launch the program

Step 9. Starting off CBSP: Carrying out a proper maize seed selection method with a group of farmers

In carrying out a proper seed selection process with your farmers, follow the steps in maize seed selection as shown below and in Figure 3

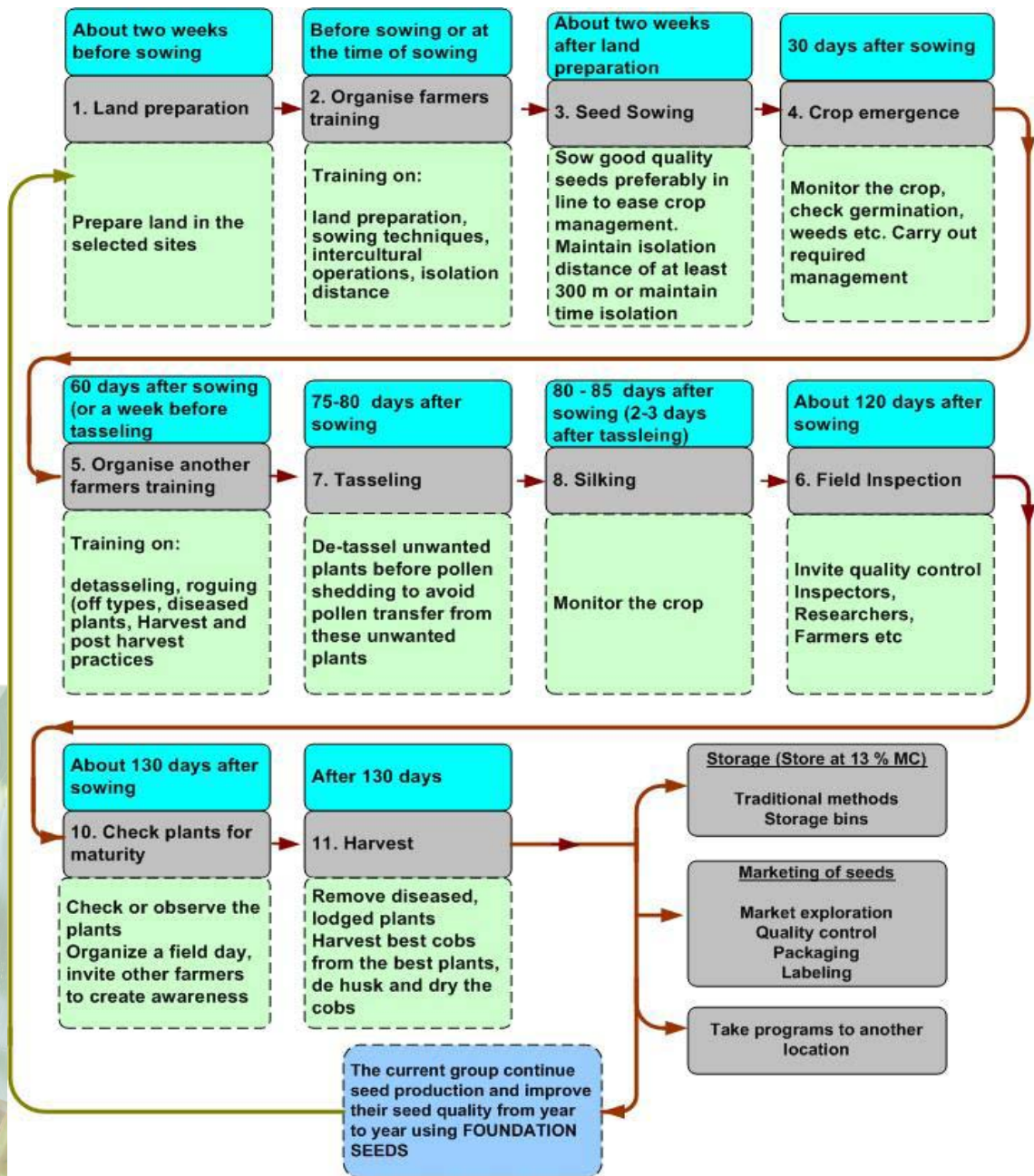
(Please note that these processes should be planned and completed prior to the maize cultivation season. Ideally one to two months before planting season or may take more depending on the local conditions)

5.2 Steps in maize seed production

After having gone through the above steps in preparing to initiate a CBSP, the next step you should take is to begin the program. Start a seed production program with your farmers following the essential steps in maize seed production. The main steps to guide you to start a seed production program are given in

Figure 3 and also illustrated in the following section.

Figure 3. Steps in maize seed production



Step 1. Land preparation

Preferably two week prior to seed sowing or planting, farmers should prepare their land. Any seeds from previous years crop if left in the field will germinate in two weeks which should be removed from the field.

While planting, ensure that the fields are located at a distance from any other fields not following the recommended practices or a cultivating a variety other than what farmers have selected. This is called maintaining isolation distance. In maize, a minimum of 200-300 meters isolation distance should be maintained (Please refer Manual for maintenance and seed production of open pollinated varieties of maize, RNR Extension material 2005 circulated to all geog extension centres. For copies contact Librarian RNR RC Wengkhhar for a copy).

Step 2. Organise a farmers training

Our experience in the east shows that at least two farmers training and a field day should be organized in a season. The first training should be organized before sowing or at the time of sowing and the second one some time after two months after sowing when the plants about to reach their reproductive stage (i.e. tasselling, silking, cob formation etc).

In the first part of the training, try to cover topics such as land preparation, sowing techniques, intercultural operations, isolation distance and other crop management practices suitable at this stage of the crop such as weed management, plant protection, fertilizer application. (Please note that in the process of initiating CBSP, you are also improving the overall maize cultivation techniques. Therefore, you should try to cover the entire recommended cultivation practices in maize). [\(Refer Technical guide provided in Section 6 a\).](#)

Step 3. Seed sowing

With your farmers, demonstrate proper seed sowing methods. Ideally line sowing is preferred which is suitable for carrying out intercultural operations like weeding, spraying, tagging, crop thinning, de-tasselling etc. In order to get a good crop stand, maintain planting density of about 40,000 plants/ha (16,000 plants/acre) by sowing seeds @ 25-30 kg/ha (10-15 kg/acre).

Step 4. Carry out crop monitoring

Crop monitoring should be carried out from time to time. Check if seeds have germinated or not, Inspect for disease infections, weed pressure and carry out any recommended management practices at this stage of the crop.

Step 5. Organise another farmers training

Sometime after about two months from planting, organise the second training. This time efforts should be put in to cover topics such as de-tasselling unwanted plants, plant selection and tagging, rouging and post harvest technologies. This training should be backed up by field visits and demonstrations on the topics when the crop reaches their stages such as tasselling, silking, cob formation etc. [\(Refer Technical guide provided in Section 6 b of this manual\)](#).

Step 6. Tasseling stage

When the plants start to tassel, carry out de tasselling of unwanted plants by removing the tassels from the plants or completely remove the plants i.e. rouging. Remove any other plants which do not conform to the desired characters. Demonstrate these practices to your farmers so that they can carry out these practices in the following seasons (See figure 11).

Monitor your crops from time to time until harvest.

Step 7. Harvest

Maturity of maize depends on the variety. Complete drying of silks, leaves and stems and brownish colouration of the cobs indicate maturity and its time for harvest. In maize, the physiological maturity is indicated by formation of a black or brown layer on the bottom of the seed.

Organise a field day and demonstrate any differences in the crop produce and recap on the seed selection methods. Invite stakeholders during the field day particularly quality control inspectors such as from BAFRA to create awareness on the quality seeds and also to seek their advice on quality and certification.

Let the cobs dry properly. You can follow traditional methods. Seeds from the middle portion of the cobs are of good quality, so you can discard seeds from the

top and lower portions of the cob and use for other purposes. Store seeds properly in cool and dry place following traditional methods - hanging in the attics or in the ground floor. Seeds should be dried properly up to 13 % MC and can be stored in seed bins. (for more information on storage, refer technical guideline provided in section 6b)

Step 8. Marketing

To develop seed production as an enterprise and sustain it from year to year, proper marketing is must (see section 5.4)

5.3 Formalizing CBSP into seed groups

In order to maintain seed quality (preventing varietal contamination), all farmers in the CBSP location should cultivate same variety. This is easier if there is common understanding among the members of the CBSP. Thus, the formation of a farmers group composed of the farmers participating in the CBSP program is a good option for continuity and sustainability of the seed production program.

After working with the farmers on seed selection and production, it is recommended that the farmers are organized into a formal farmers group. The group formation can also be initiated when you present your CBSP concepts to the farmers. However, it is convenient to organize them at a later stage preferably after having completed a season or during the seed production stage.

Facilitate a group formation process and establish a formal group of farmers to take up seed production as an enterprise for them and become a source of quality seeds. Facilitate a group operational mechanism (ask farmers to appoint a group leader, treasurer and a secretary among themselves, develop proper group rules and conditions, clear roles and responsibilities of the members and leaders).

5.4 Linking CBSP groups with other agencies and marketing

The success of a CBSP group in your geog will depend on the success of marketing good quality seeds from the group. Therefore, linking the group with other farmers in the geog or beyond is an important part of CBSP. There are several ways of linking them. One of the simplest way is to develop linkage and sharing information with other agencies and stakeholders.

Some of the way to share information and develop linkages are as shown below:

- Sharing of information with other Dzongkhags and geogs (Writing to gups, DAOs

in different Dzongkhags etc can be done to start off.

- Sharing of information through web for e.g. putting up an information sheet or a group profile on the Ministry's Web Site
- Initiating farmer to farmer exchange visit - bringing other farmers to visit your group and vice versa
- Seeking assistance of Agriculture Marketing Services for market exploration and setting the group into a viable enterprise
- Linking your CBSP group with Seed Supplying Agencies and registering them as registered seed growers
- Organise geog exhibitions, seed fairs or participate in similar programs held in neighbouring geogs or Dzongkhags such as the RNR Week.

5.5 Quality Control and certification

Normally, informal seed production system may not require formal certification, However, extension staff should initiate "truthful labelling" with germination %, Date of packing, % mixture on the seed bags and name of group. Germination test can be carried out by following the steps shown in Box 1. It is suggested that as you proceed with seed production, seek the supports of quality control authorities such as BAFRA (Bhutan Agro Food Regulatory Authority, MoA) to ensure certification of seeds at a later stage.

Box 1. A simple method of Germination test using paper towels

(Adapted from Beck et.al., (2004))

- Place about 50 maize seeds in lines on a moistened paper towel as shown in figure 5
- Cover the layer with another wet towel.
- Gently roll the layers tied with a rubber band or string.
- Place the rolls in a plastic bag or a container and keep it moist for about a week. (At least prepare three to five rolls in each test).
- After seven to ten days, open the rolls and count all normal developing seedlings in each paper rolls.
- Take the average
- A minimum of 80 % germination is the suggested standard; anything below this means the seed is not of acceptable quality.

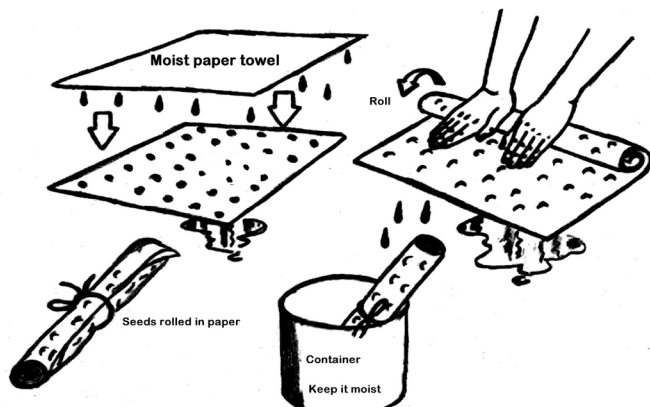


Figure 5. Germination test procedures

6. Technical guide to help you organize farmers training on seed production

In general two farmers trainings backed up by demonstrations should be organized for effective dissemination of recommended seed production practices. The following sections provide technical information useful to organize the farmers training in establishing CBSP.

a. Topics to be covered in the first training before sowing of the crop

This training should cover the general cultivation practices of maize but with more emphasis on the following:

Site selection:

The selection of site for seed production plot is very important. Select a site that suits the conditions explained in the following sections (see Figure 6). You should consider the following key points:

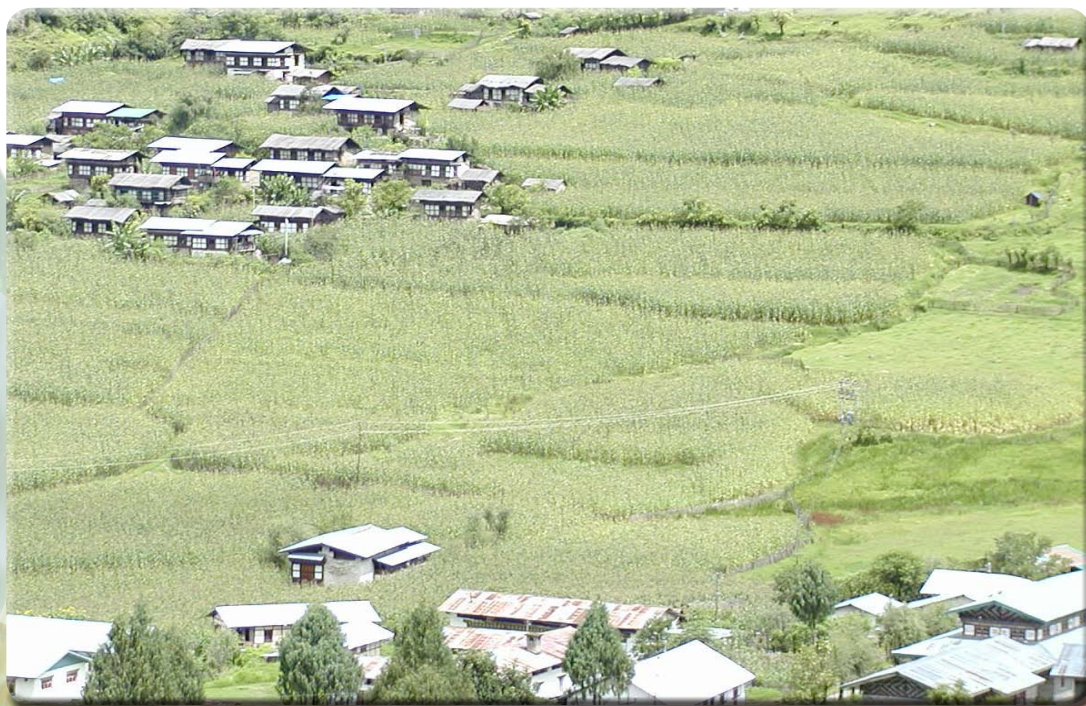


Figure 6. A suitable site in the middle of the community with members cultivating the same variety, a perfect site for CBSP

Isolation distance:

Since maize is a cross pollinated crop, seed production plots should be isolated to prevent contamination from unwanted pollens.

Isolation can be maintained through various ways as mentioned below:

Distance isolation:

Seed production plots can be isolated through distance isolation by maintaining at least 200 meters away from maize fields with other varieties. This is called distance isolation. However, isolation distance in our context of small landholding size and clustered fields adjoining each other is often found to be impractical.

Isolation by barrier:

Natural barriers like forest or fodder trees planted along the bunds can serve as barriers to the flow of pollen in such situation. However, you should be careful with shading effects from the natural barriers and wild animal damages. Isolated fields away from neighbouring fields can be suitable site as shown in Figure 7.



Figure 7. An example of a seed production site with good isolation by barriers and isolation by distance from neighbouring fields

Time Isolation:

Pollination in maize takes place when the maize plants tassels and the silks start to emerge. Tasselling takes place some time 75 to 80 days after sowing followed by silking 2 to 3 days after tasselling. Manipulating the time of sowing for seed production by about 25 days (early or late) can prevent unwanted pollen flow from other maize plants of the same maturity time. This is called time isolation (see Figure 8). In time isolation, always plant the early variety first.

Second Planting. Planted 30 days after the first planting



Figure 8. Time isolation or sequential planting in RSC Lingmethang

Farmers may cultivate different varieties of different maturity. In case non seed growers use early varieties, seed production plots should be sown 25 days after others have planted their crop and vice versa.

These methods of isolation can be suitable in mid and low altitudes but at higher elevations, the effects of temperature can be a major problem. One important factor which can also have a major affect in isolation by time in our farming conditions is from the problems of stray animals in which these methods cannot be suitable unless preventive measurers are put in place such as proper fencing.

Combination of time and distance isolation:

This is one often best option to produce genetically pure seed. Wherever such situation arises the best mechanism would be the farmers close to each other

agree to plant same variety.

Land preparation:

This is similar to normal maize production field. Advice farmers to collect and burn all infected stubble to reduce Gray Leaf Spot and Turcicum Leaf Blight before preparing the land.

Fertilization:

Farmers should be trained how much and when to apply fertilizer.

- Fertilizer quantity depends on soil fertility status of the selected location. If possible get the soil tested at NSSC and follow their recommendations
- Farmers should be advised to apply well decomposed farm yard manure (FYM). In general, application of 15 t/ha well decomposed FYM is recommended
- Apply chemical fertilizer at the rate of 60:30:30 kg/ha N:P:K.
- 50% Nitrogen and Full dose of Phosphorous and Potassium applied as basal dose.
- The remaining half dose of N should be top dressed applied in two split doses (First top dressing at knee high stage and second just prior to tasselling).



Figure 9. FYM - a readily available source of nutrients in the village

Seed rate:

For normal crop the seed rate is 25-30 Kg/ha or 10 - 15 kg/ac. For seed production use 10-15% less seed rate. This is vital to ensure good seed set and development. It will also allow better or full expression of the plant characters type which helps in identification of desirable plants and to eliminate off-types.

Seed Priming:

Seed priming is a low cost, low risk intervention that increases and stabilize yields. Seed priming is a technology where seed is soaked in tap water for a period that is less than the “safe limit” of 16-18 hours for maize and then dried in shade by spreading the seed on a tarpaulin for 15-30 minutes and then sown the same day. Direct benefits of seed priming observed in maize are faster emergence, better and more uniform stands, less need to re-sow, more vigorous plants, better drought tolerance and weed control, earlier flowering, earlier harvest and higher and stable grain yield.

Line sowing and Spacing:

Sow seed in lines with row to row distance of 75 cm; plant to plant of 25 cm

Inter cropping:

If inter cropping is common practice of the locality, allow them to follow. But additional fertility improvement is needed for the inter crop.

Thinning:

For seed production about 43,000 plants should maintained to reach the harvesting period. If inter cropping is practiced in seed production plots, plant density could be reduced up to 40,000 plants per hectare. Remove unwanted plants to reduce the plant density.

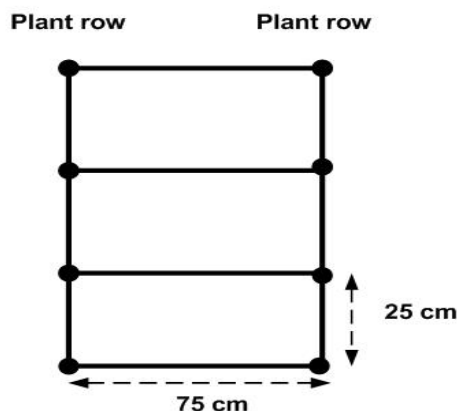


Figure 10. Row to row and plant to plant distance

Weed Management:

Minimum of two weeding is necessary for seed production. First weeding should be done at 20-25 days after crop emergence and Second weeding at 40-45 days after crop emergence

Disease management:

GLS and TLB are the two main diseases in our maize growing areas. Refer extension materials on disease prevention control and management tips available in your centre or from your nearest RNR RCs. Consult NPPC for technical advice and chemical procurement.

Insect Management:

Shoot borer and army worm are the main problems. Arrange sufficient chemicals in consultation with NPPC.

b. Topics to be covered in the second training after the maize crop has germinated and is almost close to flowering

Rouging:

The removal of undesirable plants not conforming to the desired characters such as tall, diseased, impure plant (wrong variety etc) through careful monitoring of the seed production plots is called rouging. All unwanted plants should be removed from the plots before tasselling to prevent transfer of unwanted pollens. The unwanted plants are also called off type plants.

De-tasselling:

It is the removal of tassel prior to pollen shed or before silk emergence for various purposes (see Figure 11). Tassels are removed to achieve necessary genetic purity and to increase seed / grain production of maize crop. The detassled plants can be fed to animals. Tassels from off-type and diseased plants from male rows also should be removed to prevent pollination from the pollen grains of these undesirable plants. Research shows that de-tasselling can lead to up to 6.9% yield increment. Detasselling also reduces shading and lodging effects. These removed tassels are nutritious and can be used as fodder.

Selection:

Seed selection should take place twice. Most farmers select their seeds once when the crop is harvested. Which is technically not right since there can be mixtures of cobs from plants with both desired and unwanted characters. A cob may look good but it can be from a tall plant prone to lodging. Therefore, farmers should be trained on selecting seed first from standing crop. They should rogue all unwanted plants and keep only those that suits the desired characters.



Figure 11. De-tasselling unwanted plants

Another round of selection should be done by looking at the ear characters such as grain types, grain filling, row arrangement etc. Selected ears should be shelled, dried and grains should be packed for seed in the following year.

Kernels: Grains of maize

De husked cobs: Cobs with husk cover removed

Ear: Cobs without husk cover

Bulk Harvesting:

Seed is harvested when the kernels attain physiological maturity when black layer is formed at the base of the seed and the kernels have reached their maximum dry matter accumulation. Generally harvest will begin when the moisture level of the seed is between 30 and 38%. Plants from the borders are discarded as there are chances of contamination by foreign pollen. Bulk harvest other crops and keep separately.

Storage:

Storage of maize seed for prolonged periods at temperatures above 10°C leads to deterioration of seed quality. Therefore, seed should be stored at or below 10 °C at 13 % MC and at relative humidity levels between 45 to 55 % to maintain the

desired moisture content and seed quality.

In some communities, large community grain silos and also smaller silos suitable for individual households are available. Store seeds in these silos to prevent damages. Check seeds from time to time when in storage.



Figure 12. Seed storage methods (traditional and in silos)

Packaging and marketing:

Proper packaging, standard weight and labelling (showing name of group, date of packaging, germination rate %, Date of expiry) is very important. Groups should market their seeds in these proper packages. In the initial stages, when there is minimum capital for groups to procure these materials, explore supports to improve marketing and labelling from agencies such as AMS, and Area Development Projects projects in your region, Dzongkhag or the Ministry of Agriculture through the Department of Agriculture.

Facilitate marketing of seeds by linking your group with agencies, farmers, individuals requiring seeds. Share information on seed groups with others.

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Annexure 1. Check list to assess seed quality

Different varieties will have different characters but usually the following parameters are preferred. Visit fields with standing crops. Observe the crops or ask a farmers having seed stock. Record your observation against each normal parameters for good quality seeds and check if there is any difference. This difference will determine the quality of farmers seed.

Criteria	Normal	Observation Record here	Is there any difference? Mention Yes or No
Plant characters	Plant height is uniform		
	Cob size is uniform		
	Crop matures at the same time		
	The kernel rows are uniform		
Seed selection method	Plant selection is done during standing crop		
	Off type plants have been rogued out (removed)		
	No incidences of pest and diseases particularly TLB and GLS		
	Cobs are also selected		
	Selected plants and cobs are harvested separately		
	Seeds are selected from the plant in middle of the field		
	Kernels from the middle of the cob is shelled for seed		
Seed mixture	All farmers planting in same cultivation season should have same variety		
	There are no variety mixtures		
Seed Change	Seed is changed from time to time		
Germination test	Germination is > 80 %		

If you find more yes than no, indicates the seed is of poor quality

Annexure 2. Matrix Ranking Method for Participatory Variety Selection

Participatory Variety Selection can be done in a simple way by organising a quick ranking exercise. It is usually used to identify farmers preference, in this case- a preferred variety.

Materials required: The following materials are useful for this exercise.

Chart Paper, Markers, Tapes, Models or diagrams to represent different maize varieties

Steps

1. Invite your farmers at a meeting
2. Find out from the farmers - their preferred varieties or maize varieties that are commonly cultivated by them. List them a chart paper
3. Find out by asking them, the factors which makes them decide on choosing the best varieties. These factors are the criteria / criterion based on which farmers are selecting their variety. This is the farmers criteria. Examples of these criteria are such as high crop yield, good kharang taste, high kharang recovery, good tegma taste, resistance to pest and disease, early or late maturing, large cob size, good kernel arrangements etc.
4. Write down the farmers criteria on a chart against the different varieties as shown in the table below:
5. Ask each farmers to compare these varieties based on each of the criteria
6. Rank them accordingly (use scores of 5 for the best and so on with 1: the worst)
7. Continue this with all farmers (if group is small) or (about 10-15 farmers if group is large) An example is shown in table below.
8. The variety with the highest score is their preferred variety (Variety E and B in the example).
9. Present the results to the farmers and conform whether the variety is their preferred choice or not. Sometimes, varieties with the highest score may not necessarily be the best one because of farmers preference for a specific character.

Criteria / Criterion	Variety A	Variety B	Variety C	Variety D	Variety E
Eg: Cob size	1	2	4	3	5
Kernel arrangement	4	5	2	1	3
Resistance to disease	4	3	1	2	5
Maturity (Early maturing)	3	2	5	1	4
Plant height (medium)	3	5	4	2	1
High yield	3	4	2	1	5
Good taste	5	3	2	1	4
High tegma yeild	3	5	2	1	4
Total	26	29	22	12	31



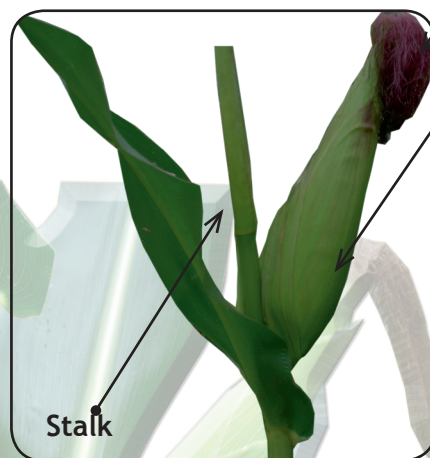
Annexure 3. Parts of maize plant



The Tassel produce pollens



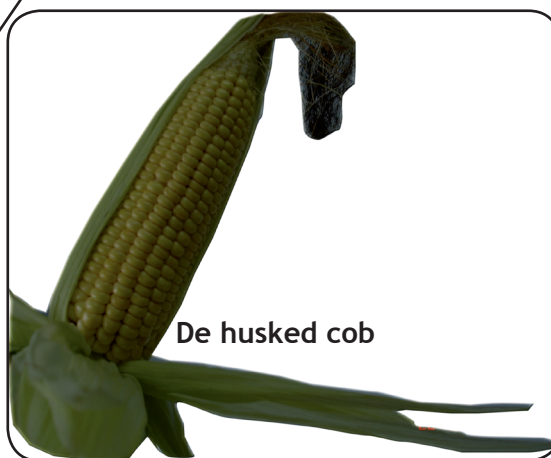
The grains of maize after shelling also called kernels



Stalk

The silk receives the pollen

Maize cob with husk



De husked cob



Cobs ready to be shelled

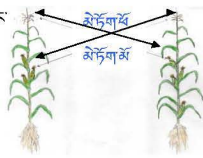
Annexure 4. Extension Material Seed selection in maize



"Walking the extra Mile"
RNR RC Wengkar, Council for RNR Research of Bhutan
Ministry of Agriculture



གེ་བླ་ཞིང་ནང་ལས་སོན་འདམ་ཁ་རྒྱལ་ཐངས་སྒྲིལ་ལས།

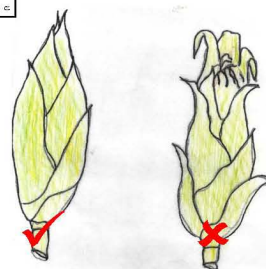
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2 གེ་ཟའི་སོན་འདི་ཞིང་ནང་ལས་འདུལ་བྱུང་དྲ་བརྟགས་དཔྱད་ཡིགས་
མོམ་གྱི་ཐོག་ལས

- ཤིང་གི་སྒྲོམ་ཚད་བར་མ།
 - ཤིང་སྒྲོབས་ལྷགས་ཅན་དང་སྤྱིང་སྤྱིང་།
 - གེ་ཟའི་ཤོ་ལོ་ལེགས་ཤོས་₂ ཡོད་མི
- འདམ་ཁབ་བརྒྱུ་བསྐྱེ་སེལ་དགོ།

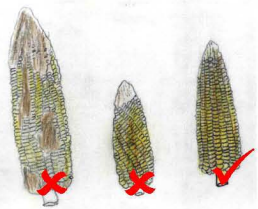


འདས་ཁ་བརྒྱབ་ཚེ་བའི་ལུས་ལས་
གེ་ཟེམ་བཅུ་ཚུ་ཚོ་དོས་འཇིན་
འབད་ནི་དོན་ལས་རྟགས་བཀལ་
སྟེ་བཞག་དགོ།




རྩྭ་གསལ་པ་ཀལ་སྟེ་བཞག་མི་
གེ་བ་བསྟུ་རྩེ་བའི་ཤུལ་
ལས་ ཤོ་ལེ་འཕགས་ཀོ་
ལེགས་ཤོ་མེད་མི་ནང་
དང་འབྲུབ་མེད་མི་སྟོམ་
རྩེ་བར་མ་ཡོད་མི་རྩེ་དམ་
འཁྱུ་བ་དགོ་པ་ཞིང་།

མོ་ལོ་འདས་ཁ་རྒྱབ་ཚར་བའི་གྲུང་ལས་། བཀས་ཀོ་བཤུབ་ཞིན་པ་ལས་།
མོ་ལོ་གཅིག་ནང་ལུ་གྲུང་འབྲང་མི་དང་གྲུང་གཅིག་ནང་ལུ་མོན་གྲངས་ཁ



མངམ་ཡོད་མི་དང་ནང་
འབྲུག་མེད་མི་དེའམ་ཤོ་ལོ་
མགུལ་མ་ཆུག་ཚན་ཚང་
སོན་ཡོད་མི་རྩུ་སེལ་དགོས་
ཡིན།།

6) **མོན་ཕྱི་དོན་ལས་སྤོལ་འདུལ་བར་བྱུལ་ལས་སོན་འདོད་**
 རྒྱུ་ལག་པ་ལ་ལྟུང་ལ་ལེགས་སོན་སྐྱེས་དགོས་ཡིན། མཛོད་ཁང་ནང་ལུ་
 རྒྱུ་ལག་པ་ལས་སྤོལ་འདོད་དོན་ལས་སོན་ཀ་ཇི་ལུ་ཕྱི་ལྟོ་ཀ་ར་ལྟུང་ལག་པ་ལས་
 བསེས་སྟེ་བཞག་དགོ།
 ལང་ན་མོན་ཀ་ཇི་ལུ་
སྒྲ་མ་ལ་ཐ་ཡོན་ལྷེ་
 ཀ་ར་ལ་འདྲེ་
 སྐྱ་བསེས་སྟེ་བཞག་དགོས་ཡིན།

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Published by : RNR RC Wengkharr, Monggar and AREP-JICA
 Content by : Horticulture Research, RNR RC, Wengkharr
 Design, layout and compiled by : Research Communications, RNR RC, Wengkharr, Monggar
 Tel/Fax : 841449 / 841450, 841102 (F) Email : rcnrc@wengkharr.com
 Material prepared by : Deki Dams, RNR EC Manbi, Lhachola, RNR EC Gangzoo and Lhakpa Tshering, RNR EC Khoma, Lhuntee
 Text edited by : Sangay Dorji, Dzongkha Focal Person, Dzongkhag Administration, Monggar