

PROJECT COMPLETION REPORT

Project Completion Report – Summary Sheet

NARDF Reference Number:	PP- 411/2007/08		
Project Title:	Increasing availability of maize source seed in the mid western hills of Nepal		
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Collaborating organizations:	District Agriculture Development Office (DADO), Dailekh; National Maize Research Program (NMRP), Rampur; Social Service Centre (SOSRC), Dailekh; Sustainable Agriculture Development Organization (SADO), Dailekh		
Start Date:	June 2007	End Date:	May 2010
NARDF Funding Envelope:	NARC through NARDF		
NARDF Priority area:	Commercialization, diversification and development of entrepreneurship on farm outputs (crop, horticulture, livestock, and fisheries) including post harvest value addition to farm outputs and the development of markets		
Original budget	2478742.20	Actual expenditure:	2104197.40

1. Researchable constraint/problem the project aimed to address

The unavailability of quality source seeds of desired varieties of maize is the main reason for the stagnant productivity in the context of Dailekh district. It requires 900 ton seeds to cover all area by improved seeds and there are no institutes involved in seed production and maintenance except Agriculture Research Station, Dailekh in very small quantities (around 1500 kg foundation seeds annually). So it is clear that without involvement of private sector especially local organizations, it is impossible to produce and disseminate the seed in adequate quantity. In this context, community based seed production (CBSP) program may be the best option to co-ordinate public-private partnership in seed production and marketing. Seed marketing through co-operative involving all stakeholders may be the sustainable approach for developing effective marketing network. As informal seed sector contributes

more than 95 % seed demand, the on farm seed selection and saving should be developed and extended which is the most sustainable and reliable source of seed for ultra poor farmers in remote areas. The project aims at development of sustainable seed production, marketing and dissemination system through co-operative and farmers' capacity build up in quality seed production.

2. Target group/users

The target groups for this project are resource poor farming communities of remote areas of mid western region. They will be benefited through participatory variety selection (PVS) and revolving seed multiplication program where quality source seed is not available due to absence of organized marketing channel as well as their economic condition who can not afford the seed. The Quality Protein Maize (QPM) varieties disseminated through participatory variety selection (PVS) will be helpful to overcome the malnutrition problem of the rural children in some what extent. Similarly, farmers involved in Community Based Seed Production (CBSP) programme will be benefited from commercialization of the product, i.e. source seed. Seed entrepreneurs, agro vets and other stakeholders involved in seed marketing are also assumed as target groups/users. Finally, government organizations, extension workers, Non Governmental Organizations (NGOs), International Non Governmental Organizations (INGOs), Community Based Organizations (CBOs) and other line agencies will also get benefit directly or indirectly.

3. List of key results/recommendations arising from the research

In the initiation of the project, Deuti and Shitala were recently released varieties. Initially, Deuti was disseminated to limited number of farmers in working sites of Agriculture Research Station, Dailekh but after launching of this project this variety has spreaded to large number of farmers. Four groups produced the improved seed of Deuti from the year of the project initiation (2007/08).

Farmers preferred S99TLWQ-HG-AB along with Deuti and Shitala in Participatory Variety Selection (PVS). This variety (S99TLWQ-HG-AB) has been released as "**Poshilo Makai-1**" in 2008 and it is the only Quality Protein Maize (QPM) variety yet released in Nepal.

Six groups are producing certified seed of Arun-1 and Deuti around 20-25 ha area in different parts of Dailekh. Similarly, Lakhatara seed production group produced seed of Poshilo Makai-1 in the year 2009. Large amount of seed has been produced and marketed by these groups. In the years 2007, 2008 and 2009 they produced around 21, 22 and 31 tons of maize seeds respectively (Table 1). About **15, 16 and 26 tons** of maize seeds were sold by these groups in the year 2007, 2008 and 2009 respectively. Agriculture Research Station helped the groups to find the traders / institutions for the sale of their product i.e. seeds. Farmer groups have their regular saving system and funds. This fund has been utilized for buying necessary

items like insecticide (Celphos, bags, and group operation etc).

Three groups (**Jivan Jyoti Seed Production Group, Saltada; Deuti Seed Production Group, Badalamji and Chandrakiran Seed Production Group, Ritha**) have constructed seed storage house through partial support from Agriculture Research Station, Dailekh and by their own resource. Each farmer's group has sufficient items and instruments like seed bin, weighing balance, bag sewing machine and rooms to store their seeds.

Inspired from the Community Based Seed Production (CBSP) program on maize, Jeevan Jyoti Seed Production Group, Saltada has initiated the seed production program on **wheat (WK-1204)** from the year 2008. Nepal Agriculture Research Council honored this group as the "**best farmers' group**" all over Nepal during Nepal Agricultural Research Council (NARC) day in **Baishakh 25, 2066**.

Table 1: Community based maize seed production and marketing of different groups from 2007 to 2009

Group	Variety	Amount of seed sold, kg (2007)	Income (@Rs 20/kg)	Amount of seed sold, kg(2008)	Income (@Rs 25/kg)	Amount of seed sold, kg(2009)	Income (@Rs 30/kg)	Total, Rs
Bindhyabasini Seed Production Group, Bindhyabasini	Deuti	3800	76000	3700	92500	6100	183000	351500
Jeevan Jyoti Seed Production Group, Saltada	Deuti	4300	86000	5100	127500	5700	171000	384500
Sagarmatha Seed Production Group, Bhainsekhori	Arun-1	3100	62000	3400	85000	3600	108000	255000
Basantamala Seed Production Group, Kimugaon	Deuti	3500	70000	3600	90000	5600	168000	328000
Chandrakiran Seed Production Group, Ritha	Arun-1	2500	50000	2650	66250	2800	84000	200250
Deuti Seed Production Group, Badalamji	Deuti	3500	70000	3700	92500	5000	150000	312500
Lakhatara Seed Production Group, Lakhatara	Poshilo Makai-1	-	-	-	-	2500	75000	75000
Total		20700	414000	22150	553750	31300	939000	1906750

4. Dissemination of results and prospects for adoption

The activities were conducted at Saltada, Ritha, Bindebasini, Badalamji, Bhainsekhori and Kimmugaon of Dailekh district with active participation of farmers. The results have been already been disseminated to participating farmers during their active involvement in implementation of activities. Neighboring farmers have also visited the program sites and made interaction with visiting scientists and technicians and they also have demanded such

programs in their sites with the technical support from Agriculture Research Station, Dailekh.

During the period of 2007/08 to 2009/10, it was annually produced more than 50 kg of breeder seed and more than 500 kg foundation seed of each variety Deuti, Arun-1 and Mana-1 to support seed production program, by providing to farmers. Breeder and foundation seeds of improved maize varieties like Deuti, Arun-1 were produced at the station by maintaining effective time isolation among the varieties (20-25 days). The early varieties were planted earlier than the full season variety (Deuti). Breeder seeds of each variety were maintained by modified ear to row selection method.

Six farmers' seed production groups and one co-operative have been formed. More than 15 mt of certified seeds of different maize varieties were produced and marketed per year through groups and a co-operative. Three new high yielding maize varieties were identified through participatory variety selection (PVS) and were disseminated during project period through Community Based Seed Production (CBSP) program.

- Three trainings in each year were conducted for the farmers involved in seed production program
- **Four** interaction workshops /meetings on seed production and marketing were organized at farmers' field and ARS, Dailekh and this was helpful for the development of marketing network
- A total of 500 copies of booklets were published in Nepali language as *Samudayak Makai Bii Utpadan Tatha Bebasthan Prabidhi*.
- 50 copies of final technical report were prepared and distributed to concerned institutions
- One video documentary has been prepared and copies have been distributed to different farmers' community based seed production (CBSP) groups and other concerned institutions related to agriculture.
- At the end of project period, one day Stakeholders' workshop / meeting on maize seed production and marketing was organized at ARS, Dailekh. Representatives from DADOs, NGOs, and farmers' groups and media persons participated in that workshop/meeting. This has further helped in the dissemination and adoption of the program outputs.

5. Indicators of potential future impact [list up to five indicators, based on current knowledge]

- Resource poor farming communities of remote areas of mid western region will be able to obtain seeds of improved maize at reasonable price.
- Farmers involved in the community based seed production (CBSP) program will be able to commercialize their produce i.e. source seed.
- Farmers, extension workers and all other stakeholders involved in maize production will be aware on the suitable new and high yielding varieties of maize in Dailekh and

surrounding condition.

- Outcomes of project will be considered as a basis for program planning in district and national level to improve the livelihood of resource poor farmers from river basin to mid hills through adaptation of maize seed production technology.
- The situation of stagnant productivity of maize in Dailekh and surrounding districts will get improved in the coming years.
- The Poshilo Makai-1 variety of maize disseminated through participatory variety selection will be helpful to overcome the malnutrition problem of the rural children to some what extent.

6. Lessons learned

A good co-operation was received from the participating farmers and collaborative institutions in the implementation of research activities and provided a great chance to share the knowledge, experience and expertise among them. However, in the initial stage it was felt somewhat difficult in the implementation of the program regarding management of community based seed production (CBSP) on maize and its marketing. It is very difficult to emerge seed traders from the local environment and from the groups itself. Mostly hill farmers use to have land in fragmented situation and it may create problem in community based seed production. Generally, poor hill farmers do not get sufficient food throughout the year and it is difficult to save seeds from small land holding farmers. Farmers usually feel difficult in storing of seeds for long period (when seed demand gets high up to Paush Magh). General attitude of farmers' are credit/ program oriented and in such a situation question arises whether they can continue the activities in the absence of supporting organization.

There was a timely release of research fund and it became helpful for in time procurement of research supplies. The frequent supervision of the research activities by stakeholders and National Agricultural Research and Development Fund (NARDF) staff was found satisfactory. District Agriculture Development Office (DADO) and multidisciplinary staff helped to improve program standard and making the success of program activities in time.

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7. Project Leader's Ratings of Project Achievements/Success		
Description	Rating	Note
Implementation performance	4	Refers to activity completion, input availability, budget management, collaboration and participation of the target group during implementation
Output Delivery	4	Refers to planned outputs and OVI's in the Log frame, including the development of clear recommendations for broader dissemination
Uptake and adoption: By Farmers By dissemination agents By scientists	A A A	Refers to the project purpose, development and implementation of dissemination/uptake strategies, initial response of stakeholders and target groups and prospects for impact

Rating	Status
4	Highly successful
3	Limited success
2	Mostly successful
1	Unsuccessful

Rating	Status
A	Expect to be fully adopted
B	Part/some outputs expected to be adopted
C	Unlikely to be adopted

Annex 8: Main Project Completion Report

1. Background

Maize (*Zea mays*) is a crop of paramount importance not only for food security in the hilly areas of Nepal but also because of its diversified use which covers 70 % of the total area under maize and mid western region covers 13 % (Gurung, 1999). Similarly, maize is by far the most important cereal in the subsistence agriculture of the middle hills of Nepal (Tiwari, 2001). It is difficult to think any crop important than maize for subsistence farmers in the hills. In 2002/03 the total area, production and productivity of maize in Dailekh district was 20700 ha, 40243 mt and 1.94 mt/ha respectively, while their respective values were 19941 ha, 33394 mt and 1.67 mt/ha for 2008/09 (DADO, 2003 and 2009). The productivity of maize is low and remains stagnant over years (DADO, 2004). Dailekh is one of the food deficit districts and 83 % population has food sufficiency for only six months and less. Additional 10527 mt food grain should be produced to meet the food deficiency of the district with the existing production of grains. This situation will further worsen in the future due to increasing population growth rate and stagnant crop productivity (DDC, 2003). Among various constraints for higher production of maize, lack of suitable varieties for specific eco-zones, and varietal choice and lack of good quality seed with farmers and is mainly concentrated in nearby areas of district head quarter. Farmers largely grow old and obsolete varieties that give low yields.

There are many districts in the region where use of improved varieties is nil (Gurung and Regmi, 2000) and this situation has not been improved till date in the absence of any organization involved in seed production and marketing. The varietal contribution to total food output has been estimated to be more than 50 % over the past 50 years (Agrawal, 1995; Tanksley, 1989) and this should be exploited in the country like ours where majority of population are engaged in agriculture, which is subsistence in nature. As farmers can not afford higher inputs in agriculture, the access of resource poor farmers to the cheapest inputs i.e. quality seed should be increased to assure food security which is the major objective of Agriculture Perspective Plan. Seed is the most essential input for both subsistence and wealthier farmers (Tiwari *et al.*, 2006). Quality seed is one of the crucial inputs for maximization of production and use of other inputs largely depends on it. Seed based technologies offer the easier and cheapest options for increasing crop productivity to farmers.

Over 80% of the total population of Nepal derive their food security, livelihood and income from agriculture (CBS, 2005). Seed is vital for agricultural development; however, farmers have limited access to quality seeds of improved crop varieties. The formal sector in Nepal contributes less than 5% of the total seed demand of major cereal crops (Baniya *et al.*, 2000; Joshi, 2000). The National Seed company (NSC), a parastatal organisation, produced and marketed over 3000 tonnes of seed of rice, wheat, maize, lentil, jute, vegetables, and other crops in 2005, of which rice, wheat and maize had the major share. The supply situation of crops other than rice, such as wheat and maize is more alarming. In this context, farmer-to-farmer seed exchange and local seed markets meet most of the seed requirements. There has

been a declining government involvement in the seed supply system but there is no viable commercial seed supply mechanism in the place to fill the gap. The situation is even worse in remote areas with the result that resource-poor and disadvantaged communities suffer most.

Maize production in the area has been mainly constrained by low production potential of local maize varieties on the one hand and the poor access of farmers to modern varieties to the other. There is good scope for improving maize productivity through exploitation of modern location specific improved maize varieties that matches the specific niches. Involvement of farmers, researchers and extensionist on varietal testing and selection in different domains help farmers to allow selecting maize varieties which are appropriate to their needs and circumstances. Maize being an open pollinated crop, the maize varieties currently grown is deteriorating continuously in the farmer's field. Community based seed production (CBSP) is an approach to quality maize seed production in the farm community with participating in a group. This approach aims to maintain the varietal purity at the farmers' level which ultimately increases production and productivity as well as allowing extra income by selling maize seed. The government inefficient beurocratic procedures and seed regularity systems are also discouraging farmers for the use of new seeds (Tiwari *et al.*, 2006). The community based seed production (CBSP) system provides benefits to the seed-producer farmers and their groups and also provides benefits to the grower who use quality improved seed. Government monopolies in the seed business are undesirable and regulations need to be relaxed to allow the private sector and civil society to be involved.

2. Research implementation performance

The project was implemented in June 2007/08 and completed in May 2009/10. All research activities of the project were completed successfully. The performance of completed activities are as follows:

On Station source seed production

ARS, Dailekh is the only institute involved in production and maintenance of source seed of maize in the region. The source seed required for community based seed production by farmers group and for the participatory variety selection was produced at ARS, Dailekh. More than 50 kg of breeder seed and 500 kg foundation seed of each improved variety was produced annually to support seed production program, by providing to farmers. Breeder and foundation seeds of improved maize varieties like Deuti, Arun-1 and Manakamana-1 were produced at the station by maintaining effective time isolation among the varieties (20-25 days). The early varieties were planted earlier than the full season variety (Deuti). Breeder seeds of each variety were maintained by modified ear to row selection method.

Exploratory visit to project location and group formation/strengthening

An exploratory visit with collaborators prior to initiation of activities was made in order to select the suitable sites. Group discussion and meeting with stakeholders and farmers was

made to understand the interests and needs of the farmers which became helpful for effective planning and implementation of the program. Six sites (Saltada, Ritha, Kimugaon, Bhainsekhori, Bindabasini and Badalamji) for the community based seed production program and suitable areas for PVS (Dailekh, Salyan and Rolpa) were selected on the basis of farmers' interest, preference and co-operation. A team representing from collaborating organizations, DADO, seed entrepreneurs, media persons, agro vets and farmers headed by the team of ARS Dailekh visited the respective locations.

In seed production sites, farmers' group was formed including all farmers in seed production program. An authorized executive committee was formed with the active participation and agreement of all stakeholder farmers. Seed production activities, co-ordination of members, record keeping and marketing of seeds was managed to be done by the committee. One farmer seed production group was formed in each site. Technical support during seed production activities was provided by ARS, Dailekh.

Survey on different aspects of maize based cropping system in the mid western hills

Baseline survey with semi structured questionnaire was done to know the maize based cropping system prior to project implantation. Group profile of the research areas was prepared. The survey was conducted in the last (third) year also to study the impact of the implemented activities in all locations. The survey was conducted in Narayan municipality and BindabasiniVDC of Dailekh in first and third year. The information on existing seed demand, marketing system, adoption rate, farmers' perception, economic impact of the project was known. The current information on maize based cropping system was identified and future strategies for supplying source seed to remote areas was determined and identified.

Seed production program

The farmers managed seed production program was started at each locations taking 4-5 ha area in each location (20-25 ha in total). Two white maize varieties i.e. Arun-1 (early maturing) and Deuti (full season) were used in seed production program. Arun-1 variety was used in two farmers' groups while Deuti was used in four farmers' groups. The source seed (foundation seed) of these varieties was supplied by ARS, Dailekh. All technical support during seed production, harvesting and storing was provided by ARS, Dailekh. The seed production field was visited by the expert from regional seed laboratory. Frequent supervision and monitoring of the crop at different stage of growth was made by the expert from ARS, Dailekh and collaborating organizations. All inputs (seeds, fertilizers, bags and pesticides) were provided free of cost (100% subsidy) to the farmers groups during first year. The subsidy was reduced to 50% and 25% during second and third year respectively. The cost of seed was collected and deposited in saving account established by the groups as revolving fund. Monthly saving system (Rs 20/household/month) was started. This fund was realized to be helpful for the sustainability of seed production program by farmers.

Trainings and visit of farmers group

Three trainings for each seed production group were provided during the first year. Training on techniques and method of quality seed production, crop management was provided before sowing at each location. Training on harvesting, quality improvement, seed selection and post harvest management (storage, insect pest management) was given at the time of harvest on farmers' field. Two refresher trainings for each group were given during second and third year before sowing of the crop. Scientists/technicians from ARS, Dailekh and DADO provided the training. Similarly, Leader farmers' training on co-operative establishment and management was organized at ARS, Dailekh.

Formation of seed co-operative

One seed producers' cooperative named Jeevanjyoti Seed Co-operative was formed / established by involving all seed production groups and all other stakeholders during the second year of the project. This co-operative acted as an umbrella organization of all seed production group. This has helped the farmers in seed marketing by collecting seed demand and establishing linkage between seed producer groups and entrepreneurs. The future strategy for the sustainability of co-operative based marketing system was prepared during the seminar including all stakeholders of the project. The farmers' group was registered in DADO and it will continue to support the farmers' group after the completion of the project.

Supply of quality source seed to small and marginal farmers in remote areas

300 farmers from remote areas of Dailekh (Katti, Seri and Baraha VDCs) were selected. It was selected 100 farmers in each VDC in clusters. Dalits and marginal farmers were selected and given priority. Varieties used were Deuti Shitala and Poshilo Makai-1. One kg seed pack was prepared and distributed to each farmer and they grew the crop according to their own management condition. Single on farm training was given for quality seed for their own use during tasseling stage. Grain yield was recorded at maturity stage from 50 farmers / location and from 50 metre square area. Farmers' reaction was collected on different parameters through group discussion during maturity stage. The required seed for the program was provided through the project during the first year. From the second year, the equal amount of seed provided to the CBSP group was collected from each group and this seed was passed to another remote and food deficit areas (DAGs, Dalits, women). The farmer also shared the technical knowledge on quality seed selection and for this technical support was provided from ARS, Dailekh and collaborators. The best and efficient way of dissemination of quality seed to small and marginal farmers became the revolving seed multiplication program. In this program 1 kg seed /farmer of the preferred variety was provided to the participant farmers in free of cost on the condition that he/she had to give the same amount of seed to one another interested farmer in the same site or the adjacent area in the next season on compulsory basis. Seed was supplied to the farmers of the area in clusters and the previous process was followed in next area. This has helped in rapid multiplication of the most preferred varieties and the access of marginal farmers to quality seed has been increased.

Participatory variety selection (PVS) on maize (Mother-baby trial)

Site selection

This was carried out at four locations in remote VDCs of Dailekh (Bindabasini, Bajaura, Badalamji and Kalbhairab) and Salyan and Rolpa. Six mother and 35 baby trials were conducted per year was conducted. Farmers were selected covering from every social groups in a cluster as possible on the basis of interest of the farmers.

Trainings and farmers' field day

Trainings for farmers and technicians involved in the program from collaborating institute were organized on the farmers' field before sowing of seed. The technicians from the collaborating organizations working in areas were responsible for the programs and expert from ARS, Dailekh frequently visited and monitored the programs on the field. Training on on-farm seed selection was provided to the farmers during the same day. Farmers' field day was organized on each location and farmers' preference ranking for the PVS varieties was carried out by farm walk and demonstration trial (mother trial). Farmers' perception towards new varieties and their adaptability on wider environment was known.

Participatory variety selection program (Mother baby trials)

Mother trial

One mother trial / location was conducted in each location and altogether 6 mother trials per year were conducted. Eight varieties (Rampur Composite, Deuti, Manakamana-3, Shitala, Hill Pool White, Poshilo Makai- 1, Arun 1EV and Local) were included in the program. All varieties included in PVS program were grown in a relatively smaller plot in a single farmer under improved and farmers own method.

Design: Randomized complete Block Design

Plot size: 6 rows of 3 m length (13.6 m²)

Fertilizer dose:

On improved maize: 120:60:40 kg N, P₂O₅, and K₂O/ha. Half of nitrogen and full dose of phosphorus and potash was applied during sowing of seed. Rest half nitrogen was further divided in two parts. ¼ N was applied after 25-30 DAS and other ¼ was applied after 40-45 DAS (knee height stage).

Farmers' practice: According to their dose and application method and time.

Baby trial

35 baby trials/ location were conducted in a year. It was conducted relatively in large plots (100-150 m²) under farmers own management condition. Improved new varieties were sown by their respective local and sufficient amount of seed of these varieties (1 kg/farmers) were provided to the farmers. Each variety was replicated 5 times in each location. Comparison on different characteristics and grain yield was made. On the maturity stage, farmers' field

day was organized in each location and on the basis of ranking farmers' preferred variety was identified

Those mother baby trials were conducted for 2 years in the same locations and on the basis of farmers preference the best new variety was identified. The new variety was up scaled and disseminated through large scale source seed production by CBSP approach.

Preparation of documentary film

A documentary film covering the activities, impacts and achievements of the program was produced and distributed to the farmers groups, all the concerned organizations. For the preparation of the film, help was taken from the journalist photographer from Agriculture Environment and Journalism Group.

3. Situation regarding delivery of outputs/results

Technology generation and dissemination is a regular process, but the rate of uptake of technologies is very low and becoming an issue among the researchers, extension workers and other stakeholders. Seed is the first link in the food chain and seed based technologies offer the cheapest and easiest options for increasing crop productivity to farmers. However, the access of poor farmers to the seed is not increased till the date due to many reasons. As informal sector provides more than 95 % seeds, this should be developed and strengthened in remote areas where formal marketing system is almost absent.

The project tends to deliver technologies to end-users applying various means of promotion pathways such as through farmer-to farmer, extension workers and publications. The outputs will be disseminated to the end-users through the following uptake and up-scaling pathways:

- Personal contact of the researchers, extension workers and farmers of mid western region to the maize grower farmers of the region and other stakeholders.
- Farm visits during trial implementation, supervision and monitoring of the activities.
- Dissemination of technologies through DADOs and NGOs and field based staffs.
- Publications such as booklets, annual reports, project completion report, technical papers and seminar papers.
- Documentary preparation regarding the maize seed production activities.
- Training and meeting about quality maize seed production technologies.
- Stakeholder workshop for awareness creation on maize seed production technologies.

The sufficiency and availability of quality source seed of high yielding varieties (HYV) of maize increased

In every year/season it is produced breeder and foundation seeds of improved maize varieties like Arun 1, Deuti and Manakamana 1 in on station. The source seed required for community based seed production by farmers' groups and for the participatory variety selection was produced at Agriculture Research Station, Dailekh. During the period of

2007/08 to 2009/10, it was annually produced more than 50 kg of breeder seed and more than 500 kg foundation seed of each variety Deuti, Arun-1 and Mana-1 to support seed production program, by providing to farmers. Breeder and foundation seeds of improved maize varieties like Deuti, Arun-1 were produced at the station by maintaining effective time isolation among the varieties (20-25 days). The early varieties were planted earlier than the full season variety (Deuti). Breeder seeds of each variety were maintained by modified ear to row selection method.

Six groups produced certified seed of Arun-1 and Deuti around 25 ha area in different parts of Dailekh. Similarly, Lakhatara seed production group produced seed of Poshilo Makai-1 in the year 2009. Large amount of seed was produced and marketed by these groups. In the years 2007, 2008 and 2009 they produced around 21, 22 and 31 tons of maize seeds respectively. About **15, 16 and 26 tons** of maize seeds were sold by these groups in the year 2007, 2008 and 2009 respectively. Agriculture Research Station helped the groups to find the traders/ institutions for the sale of their product i.e. seeds. Farmer groups now have their regular saving system and funds. This fund has been utilized for buying necessary items like insecticide (Celphos, bags, and group operation etc). Three groups (**Jivan Jyoti seed production group, Saltada; Deuti seed production group, Badalamji and Chandrakiran seed production group, Ritha**) constructed seed storage house through partial support from Agriculture Research Station, Dailekh and by their own resource. Inspired from the Community Based Seed Production (CBSP) program on maize, Jeevan Jyoti seed production group, Saltada has also initiated the seed production program of wheat (WK-1204) from the year 2008. Nepal Agriculture Research Council honored this group as the **"best farmers' group"** all over Nepal during Nepal Agricultural Research Council (NARC) day in Baishakh 25, 2066. In the year 2009, Nepal Agri Seed and Input Company, Chitwan and other by local NGOs procured around 26 tons of maize seed from the groups and the Station played role for the seek of market.

Strong public-private partnership in maize seed production and marketing through farmer's groups and co-operative developed

In every year, it was organized two workshop/meetings of all stakeholders. It became very much helpful to build up relationship among different stakeholders. It became helpful in creating seed demand and marketing. One seed co-operative was established and it has been very much effective to keep farmers in single group and work in co-ordinated way. This approach has been helpful to maintain relationship among farmers, extension agents, development agencies and seed entrepreneurs.

Participatory selection and dissemination of new promising varieties of maize accomplished.

Participation was made from large number of farmers, technicians from different organizations (related to agriculture) for achieving the output. Basically, farmers selected the high yielding varieties according to their own objective and preferences. Due to this, farmers, technicians from various organizations and extension agents also got acquainted

about the development of the new maize varieties, their characteristics and yield potential. Among different maize varieties, white full season varieties were preferred and selected. Farmers preferred Deuti, Shitala and QPM (S99TLWQ-HG-AB).

Scaling up and uptake pathway developed.

In Dailekh, many farmers groups are attracted and interested to produce maize seeds and they are requesting for help and support from ARS Dailekh. Many farmers' groups have taken seeds from the previously established CBSP groups and started the seed production program. This has clearly shown that Community Based Seed Production (CBSP) program is getting popularity in Dailekh and surrounding districts also. Media and newspaper have also covered the program and telecasted from different media. This has been very much helpful in reaching the message to large mass of farmers and this CBSP concept is being very much popular. The initiation of co-operative model is the most suitable and sustainable way to ensure seed marketing and seed security. This will be a model in the days to come. A documentary film of this program has been prepared and distributed to all concerned agencies and farmers' groups. This is very much helpful for the up-scaling and dissemination of this new concept among the farmers, extension agencies and other related organizations.

4. Prospects for the adoption of the new technology and achievement of purpose

The activities were conducted at Saltada, Ritha, Badalamji, Bhainsekhori, Bindabasini and Kimmugaon of Dailekh district with active participation of farmers. The results have been already been disseminated to participating farmers due to their active involvement in implementation of activities. Neighboring farmers have also visited the experimental sites and made interaction with visiting scientists and technicians and they also have demanded such programs in their sites with the technical support from Agriculture Research Station, Dailekh.

The promotion pathways implemented for dissemination of technologies were field visits, group discussions, trainings, and publication of papers, booklets and video documentary preparation in local language. The response of stakeholders and target groups during field visits, personal contact and supervision was highly positive towards the results.

During 2007/08 it was produced 2305 kg of breeder and foundation seeds of Deuti, Arun-1 and Mana-1. Similarly their respective quantities were 2312.5 and 2457.6 kg respectively for the fiscal years 2008/09 and 2009/10 to support seed production program, by providing to farmers. Breeder and foundation seeds of improved maize varieties like Deuti, Arun-1 were produced at the station by maintaining effective time isolation among the varieties (20-25 days). The early varieties were planted earlier than the full season variety (Deuti). Breeder seeds of each variety were maintained by modified ear to row selection method.

Six farmers' seed production groups and one co-operative have been formed with the active participation of the farmers. 15 to 26 mt of certified seed of both varieties have been produced and marketed in different years through groups and co-operative. Three new high yielding maize varieties were identified through participatory variety selection (PVS) and were disseminated through community based seed production (CBSP) groups.

- Three trainings in each year were conducted for the farmers involved in seed production program
- Four interaction workshop/meeting on seed production and marketing were organized at farmers field and ARS, Dailekh and this was helpful for the development of marketing network
- A total of 500 copies of booklets were published in Nepali language as *Samudayak Makai Biu Utpadan Tatha Bebasthapan Prabidhi*.
- 50 copies of final technical report have been prepared and distributed to concerned institutions
- One video documentary has been prepared and copies have been distributed to different farmers' CBSP groups and other concerned institutions related to agriculture.

5. Key indicators of potential impact identified by project stakeholders

- Resource poor farming communities of remote areas of mid western region will be able to obtain seeds of improved maize in reasonable price. The poor and marginalized farmers thus will get benefit in two main ways: directly those who are involved in the CBSP and indirectly those that purchase seed produced by the groups either to sell on (entrepreneurs) or to grow (farmers).
- Farmers involved in the CBSP program will be able to commercialize their produce i.e. source seed.
- Farmers, extension workers and all other stakeholders involved in maize production will be aware on the suitable new and high yielding varieties of maize in Dailekh and surrounding condition.
- Outcomes of project will be considered as a basis for program planning in district and national level to improve the livelihood of resource poor farmers from river basin to mid hills through adaptation maize seed production technology.
- The situation of stagnant productivity of maize in Dailekh and surrounding districts will get improved in the coming years.
- The Poshilo Makai-1 variety of maize disseminated through participatory variety selection will be helpful to overcome the malnutrition problem of the rural children.

6. Proposed follow up

The community based seed production is an innovative strategy in making available seed of new varieties locally at a cheaper price. This is a very important means to increase maize productivity there by ensuring food security in the rural hilly areas of Nepal. Past

experience have revealed that the attempts to strengthen such activities have not always been successful because of seed marketing constraints rather than the amount of quality seed production itself (Tiwari *et al.*, 2006). Essentially, the concept of seed production is a business rather than a development activity. So, attention should be paid to the strengthening of groups by helping to establish good co-operative arrangements among their members.

During program period no marketing problem was observed. Agriculture Research Station, Dailekh helped the groups for the sale of their produced seeds. But, after commercialization of maize seed production, the government, NGOs, CBOs and ADOs should establish suitable marketing network for fast flow of products. This will help to resource poor, marginalized and disadvantaged farmers and farm community to dispose their product in reasonable price without any difficulty. By doing this the technology will be sustainable for long run.

A national level workshop on community based seed production (CBSP) and seed marketing on maize (focusing remote areas) is necessary for further dissemination of technologies in other parts of the country. It should be jointly organized by NARC and Department of Agriculture. Concerned farmers, scientists, extension officers, NGOs, INGOs, marketing agents and policy makers should be invited in that workshop for further dissemination of technologies and to develop future strategy. Research results should be also disseminated through radio and television program.

Profitability of the enterprise is the most important factor that motivates others to participate. The lessons on group building and financial profitability have to be learnt by GOs, NGO and extension workers who have been involved in non-sustainable approaches in the past. Establishing better linkages between seed entrepreneurs and the groups is one of the most important factors in getting this activity into use. Besides this, there should be policy influence on the policy makers who hold the traditional view of the need for strong regulations for seed when, in fact, deregulation is needed to improve farmers' access to seed. Government monopolies in the seed business are undesirable and regulations need to be relaxed to allow the private sector and civil society to be involved.

Other things that can make the CBSP sustainable may be as follows:

- Needs to improve the storage structures
- Start up funds is needed for seed traders
- It is better to emerge the traders from the groups themselves
- It needs to separate funds and programs for Dalits and small land holding farmers to save the seed instead of being used for household consumption
- ADOs, NGOs and INGOs have to play a lead role in co-ordinating marketing functions
- Strong technical backstopping from Nepal Agricultural Research Council (NARC), District Agriculture Development Offices (DADOs), Non Governmental Organizations (NGOs) and International Non Governmental Organizations (INGOs)
- Collaboration and linkages among multi stakeholders must be mandatory
- Planning and implementation with multi stakeholders must be mandatory

7. Lessons learned

A good co-operation was received from the participating farmers and collaborative institutions during the implementation of research activities and provided a great opportunity to share the knowledge, experience and expertise among them. A major barrier is a lack of awareness of the real constraints to establishing viable seed producer groups. In the initial stage it was felt somewhat difficult in the implementation of the program regarding management of CBSP and marketing of the produce. It is very difficult to emerge seed traders from the local environment and from the groups itself. Mostly hill farmers use to have land in fragmented situation and it may create problem in large scale community based seed production. Generally, poor hill farmers do not get sufficient food throughout the year and it is difficult to save seeds from small land holding farmers. Farmers usually feel difficult in storing of seeds for longer period (when seed demand gets high up to Paush Magh), since they do not have improved storage facilities. General attitude of farmers' are credit/ program oriented and in such a situation question arises whether they can continue the activities in the absence of supporting organization. New groups tend to be limited by capital to invest in seed and infrastructure. Start-up funds in the form of soft loans can greatly facilitate the process of forming and strengthening CBSP groups. Most of the CBSP groups face initial difficulties in financing the purchasing of seed and a soft loan or revolving funds are required for six to eight months. Marketing is a vital issue for the seed business to succeed. More efforts are needed to impart marketing skills to many farmers and groups. Seed production is only one part of the process the other is seed marketing. Seed marketing can be a major problem in community based seed production (CBSP). Farmers are rarely able to sell significant amounts of seed, which is only limited to their neighbours and relatives and mostly in grain price.

Profitability of the enterprise is the most important factor that motivates others to participate. The lessons on group building and financial profitability have to be learnt by GOs, NGO and extension workers who have been involved in non-sustainable approaches in the past. Establishing better linkages between seed entrepreneurs and the groups is one of the most important factors in getting this activity into use. Besides this, there should be policy influence on the policy makers who hold the traditional view of the need for strong regulations for seed when, in fact, deregulation is needed to improve farmers' access to seed. Government monopolies in the seed business are undesirable and regulations need to be relaxed to allow the private sector and civil society to be involved.

There was a timely release of research fund and procurement of research supplies. The frequent supervision of the research activities by stakeholders and NARDF staff was found satisfactory. Districts Development Offices and multidisciplinary staff help to improve and making success of program activities in time.

8. Publications and contacts

- A total of 500 copies of booklets were published in Nepali language as *Samudayak Makai Biu Utpadan Tatha Bebasthapan Prabidhi*.

- 50 copies of final technical report have been prepared and distributed to concerned institutions
- One video documentary has been prepared and copies have been distributed to different farmers' CBSP groups and other concerned institutions related to agriculture.

Shrestha, S. (2010). Final Technical report on Increasing availability of maize source seed in the mid western hills of Nepal. Agriculture Research Station, Dailekh.

Subas Shrestha (2010). *Samudayak Makai Biu Utpadan Tatha Bebasthapan Prabidhi (Nepal Verson)*. Agriculture Research Station, Dailekh.

Annual report, ARS, Dailekh (2009/2010). Increasing availability of maize source seed in the mid western hills of Nepal. Published by Agriculture Research Station, Dailekh.

Internal Reports:

Project trimester report for the period of June 2007 to September 2007
 Project trimester report for the period of October 2007 to January 2008
 Project trimester report for the period of February 2008 to May 2008
 Project trimester report for the period of June 2008 to September 2008
 Project trimester report for the period of October 2008 to January 2009
 Project trimester report for the period of February 2009 to May 2009
 Project trimester report for the period of June 2009 to September 2009
 Project trimester report for the period of October 2009 to January 2010
 Project trimester report for the period of February 2010 to May 2010
 Annual report for the period of first year of the project (2007/08)
 Annual report for the period of second year of the project (2008/09)
 Annual report for the period of second year of the project (2009/10)
 Project compilation report (2009/10)

All these reports can be obtained from Agriculture Research Station, Dailekh and National Agricultural Research and Development Fund (NARDF), Kathmandu, Nepal.

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References:

- Agrawal, R.L. (1995). Seed Technology. Kalyani Publisher, New Delhi, India.
- Annual Report (2003). District Agriculture Development Office, Dailekh
- Annual Report (2004). District Agriculture Development Office, Dailekh
- Annual Report (2009). District Agriculture Development Office, Dailekh
- Baniya, B.K., A. Subedi, R.B. Rana, C.L. Paudel, S.P. Khatiwada, D. K. Rijal, & B.R. Sthapit, (2000). Informal rice seed supply system and storage systems in mid-hills of Nepal. In: A scientific basis of in situ conservation of agrobiodiversity on: farm: Nepal's contribution to the global project (B Sthapit, M Upadhaya and A Subedi editors) pp 79-91.
- CBS (2005). Statistical Year Book of Nepal. Government of Nepal. Central Bureau of Statistics, Kathmandu.
- District District Development Committee (2003). Periodic District Development Plan. DDC, Dailekh.
- Gurung, D.B. (1999). Potentialities and constraints of maize based cropping systems in mid and far western mid hills of Nepal: A survey report. ARS, Dailekh. HARP PP01/98.
- Gurung, D.B. and Regmi, H.N. (2000). A survey report on the status of maize based mixed/inter cropping systems in the mid and far western hills of Nepal. HARP PP-32/99, Report No. 1. Agriculture Research Station, Dailekh.
- Joshi, K.D. (2000). Strengthening the farmers' seed system in Nepal. Biotechnology and Development Monitor No. 42: pp 15-17.
- Tanskey, S.D., W.D. Young, A.H. Peterson and M.W. Bonierb (1989). RFLP mapping in plant breeding: a new tool for old science. Biotechnology 7(3): 257-267.
- Tiwari, T.P. 2001. Participatory crop improvement for maize/millet intercropping with trees in the middle hills of Nepal. PhD thesis, School of Agricultural and Forestry Sciences, University of Wales, Bangor, UK.
- Tiwari, T.P., Ferrara, G. Ortiz, Sah, S.N., Prasad, R.C., Karki, T.B. and Gurung, D.B. (2006). Community based seed production (CBSP) of open pollinated varieties (OPVs) of maize in the hills of Nepal. Hill Maize Research Project (HMRP), International Maize and Wheat Improvement Centre (CYMMYT) and National Maize Research Programme (NMRP): 22

Annex 8: Main Project Completion Report NARDF Technical Paper Series Report

Abstract

Poor access of farmers to improved maize seeds is the main production constraint for maize cultivation in mid western hills of Nepal. There is good scope for improving maize productivity through exploitation of modern location specific improved maize varieties that matches the specific niches. Involvement of farmers, researchers and extension workers on varietal testing and selection in different domains help farmers to allow selecting maize varieties which are appropriate to their needs and circumstances. It requires about 900 tons of seed to cover all areas by improved seeds in Dailekh and there are no institutes involved in seed production and maintenance except ARS, Dailekh in very small quantities (about 1500 kg of foundation seed). It is very clear that without the involvement of private sector especially local organizations, it is impossible to produce and disseminate the seed in adequate quantity. In this context community based seed production program (CBSP) may be the best option to co-ordinate public-private partnership in seed production and marketing. It is an approach of producing and distributing seeds with the participatory involvement of farmers' groups. Participatory variety selection (PVS) led to the identification of Deuti, Shitala and Poshilo Makai-1 as promising varieties in Dailekh condition. These varieties were found to be superior to local and other tested varieties in terms of grain yield and other parameters. Under mother-baby trials, these three varieties were observed to be better than Arun-1EV, Manakamana-4, Hill Pool White and Local and farmers' preference was also towards those varieties. It has been initiated, developed and formalised a community-based seed production (CBSP) approach for a sustainable seed supply system in the command areas of Agriculture Research Station, Dailekh. ARS, Dailekh provided source seed of improved varieties of maize (Deuti and Arun-1) and technical support to six community based seed production groups. Two white maize varieties i.e. Arun-1 (early maturing) and Deuti (full season) were used in seed production program. Arun-1 was used in two farmers' groups, while the Deuti was used in 4 farmers' groups. Large amount of seed was produced and marketed by these groups. In the years 2007, 2008 and 2009 it was produced around 21, 22 and 31 tons of maize seeds respectively and 15, 16 and 26 tons of maize seeds were sold by the groups in the year 2007, 2008 and 2009 respectively. Agriculture Research Station helped the groups to find the seed market for the sale of their produce. Since it has been established a co-operative, marketing in coming years will be done through the cooperative. Market promotion committee should take lead role to find market, and play a proactive role to continue the programme even if outside support is ceased.

Keywords

Promising varieties, Community based seed production, participatory variety selection, mother baby trial, seed market, co-operative, market promotion committee, public-private partnership

1. Introduction

Maize (*Zea mays*) is a crop of paramount importance not only for food security in the hilly areas of Nepal but also because of its diversified use which covers 70 % of the total area under maize and mid western region covers 13 % (Gurung, 1999). Maize is the principal staple food security crop for hill farmers. Despite staple food crop it serves as a multifaceted demand as feed and fodder for livestock, staking materials for climbing vegetables and fuel as a source of energy. It is difficult to say any crop more important than maize for the subsistence farmers in the hills of Nepal. So this crop cannot be ignored by hill farmers. The population growth rate in the country per year is rising by 2.25% (ABPSD, 2006) while the growth rate of the productivity by 1.6% between 1984/85 to 2002/03 (Sherchan, 2004) however, its production has been partially accomplishing the food requirement therefore, time has come to enhance the yield of the crop without affecting the environment from the existing cultivated land to fulfill the demand of increasing population. The total area, production and productivity of maize in Dailekh has been estimated to be 19941 ha, 33394 mt and 1.67 t/ha respectively (DADO, 2008). But the respective values have been estimated to be 16093 ha, 30577 mt and 1.90 t/ha (CBS, 2007). The cropping pattern has been mainly dominated by maize-wheat system where majority of cultivated land is upland dry (74.69 %) and 68.28 % area of total cultivated land is without irrigation (DADO, 2008/09). The productivity of maize is very low and remains stagnant over years (DADO, 2004). Poor access of farmers to improved seeds is the main production constraint for maize cultivation in mid western hills of Nepal (Gurung *et al.*, 2007). Dailekh is one of the food deficit districts and 83 % population has food sufficiency for only six months and less. Additional 10527 mt food grain should be produced to meet the food deficiency of the district with the existing production of grains. This situation will further worsen in the future due to increasing population growth rate and stagnant crop productivity (DDC, 2008).

Among various constraints for higher production of maize, lack of suitable varieties for specific eco-zones, and varietal choice and lack of good quality seed with farmers and mainly concentrated in nearby areas of district head quarters. There are many districts in the region where use of improved varieties is nil (Gurung and Regmi, 2000) and this situation has not been improved till date in absence of any organization involved in seed production and marketing. The varietal contribution to total food output has been estimated to be more than 50 % over the past 50 years (Agrawal, 1995; Tanksley, 1989) and this should be exploited in the country like ours where majority of population are engaged in agriculture, which is subsistence in nature. Seed based technologies offer the easier and cheapest options for increasing crop productivity to farmers. Maize production in the area was constrained by low production potential of local maize varieties on the one hand and the poor access of farmers to modern varieties to the other (Gurung *et al.*, 2007). There is good scope for improving maize productivity through exploitation of modern location specific improved maize varieties that matches the specific niches. Involvement of farmers, researchers and extension workers on varietal testing and selection in different domains help farmers to allow selecting maize varieties which are appropriate to their needs and circumstances. Government monopolies in the seed business are undesirable and regulations need to be relaxed to allow the private sector and civil society to be involved.

As quality seed is one of the crucial inputs for maximization of production, use of other inputs largely depends on it. Seed is vital for agricultural development; however, farmers have limited

access to quality seeds of improved crop varieties. The formal sector in Nepal contributes less than 5% of the total seed demand of major cereal crops (Baniya *et al.*, 2000; Joshi, 2000). The National Seed company (NSC), a parastatal organisation, produced and marketed over 3000 tonnes of seed of rice, wheat, maize, lentil, jute, vegetables, and other crops in 2005, of which rice, wheat and maize had the major share. The supply situation of crops other than rice, such as wheat and maize is more alarming. In this context, farmer-to-farmer seed exchange and local seed markets meet most of the seed requirements. There has been a declining government involvement in the seed supply system but there is no viable commercial seed supply mechanism in the place to fill the gap. The situation is even worse in remote areas with the result that resource-poor and disadvantaged communities suffer most.

Maize being an open pollinated crop, the maize varieties currently grown is deteriorating continuously in the farmer's field. Community based seed production is an approach to quality maize seed production in the farm community with participating in a group. This approach aims to maintain the varietal purity at the farmers' level which will ultimately increase production and productivity as well as allowing extra income by selling maize seed. As farmers can not afford higher inputs in agriculture, the access of resource poor farmers to the cheapest inputs i.e. quality seed should be increased to assure food security which is the major objective of Agriculture Perspective Plan. It has been reported that the productivity of crops can be increased from 20 to 50 % (Mathema and Gurung, 2006) by using only improved seeds but unavailability of improved seeds is the main production constraint for maize cultivation particularly in the remote hill districts. Thus, the community based seed production program is one of the potential options for sustainable seed supply and production in these hill districts. By this program, the production and productivity of maize can be increased contributing to increment of food sufficiency at the household level leading to help reduce the poverty. Therefore this program was initiated with the aim of supplying the quality seed in larger mass of farmers through formal as well as informal seed sector and increasing food security by providing the source seed to target groups as a cheapest input for increased crop production.

2. Materials and Methods

Series of activities were conducted at Rittha, Saltada, Bhainsekhori, Kimugaon, Badalamji Katti, Seri, Baraha and Bindebasini of Dailekh district and Salyan and Rolpa districts in 2007/08 to 2009/10. The detail materials and methods of each activity are as follows:

1. On Station source seed production

ARS, Dailekh is the only institute involved in the production and maintenance of source seed of maize in the region. The source seed required for community based seed production by farmers' groups and for the participatory variety selection was produced at Agriculture Research Station, Dailekh. During the period of 2007/08 to 2009/10, it was annually produced more than 50 kg of breeder seed and more than 500 kg foundation seed of Deuti, Arun-1 and Mana-1 to support seed production program, by providing to farmers. Breeder and foundation seeds of improved maize varieties like Deuti, Arun-1 were produced at the station by maintaining effective time isolation among the varieties (20-25 days). The early varieties were planted earlier than the full season variety (Deuti). Breeder seeds of each variety were maintained by modified ear to row selection method.

2. Exploratory visit to project location and group formation/strengthening

An exploratory visit with collaborators prior to initiation of activities was made in order to select the suitable sites. Group discussion and meeting with stakeholders and farmers was made to understand the interests and needs of the farmers which became helpful for effective planning and implementation of the program. Six sites (Saltada, Ritha, Kimugaon, Bhainsekhori, Bindabasini and Badalamji) for the community based seed production program and suitable areas for PVS (Dailekh, Salyan and Rolpa) were selected on the basis of farmers' interest, preference and co-operation. A team representing from collaborating organizations, DADO, seed entrepreneurs, media persons, agro vets and farmers headed by the team of ARS Dailekh visited the respective locations.

In seed production sites, farmers' group was formed including all farmers in seed production program. An authorized executive committee was formed with the active participation and agreement of all stakeholder farmers. Seed production activities, co-ordination of members, record keeping and marketing of seeds was managed to be done by the committee. One farmer seed production group was formed in each site. Technical support during seed production activities was provided by ARS, Dailekh.

3. Survey on different aspects of maize based cropping system in the mid western hills

Baseline survey with semi structured questionnaire was done to know the maize based cropping system prior to project implantation. Group profile of the research areas was prepared. The survey was conducted in the last (third) year also to study the impact of the implemented activities in all locations. The survey was conducted in Narayan municipality and BindabasiniVDC of Dailekh in first and third year. The information on existing seed demand, marketing system, adoption rate,

farmers' perception, economic impact of the project was known. The current information on maize based cropping system was identified and future strategies for supplying source seed to remote areas was determined and identified.

4. Seed production program

The farmers managed seed production program was started at each locations taking 4-5 ha area in each location (20-25 ha in total). Two white maize varieties i.e. Arun-1 (early maturing) and Deuti (full season) were used in seed production program. Arun-1 variety was used in two farmers' groups while Deuti was used in four farmers' groups. The source seed (foundation seed) of these varieties was supplied by ARS, Dailekh. All technical support during seed production, harvesting and storing was provided by ARS, Dailekh. The seed production field was visited by the expert from regional seed laboratory. Frequent supervision and monitoring of the crop at different stage of growth was made by the expert from ARS, Dailekh and collaborating organizations. All inputs (seeds, fertilizers, bags and pesticides) were provided free of cost (100% subsidy) to the farmers groups during first year. The subsidy was reduced to 50% and 25% during second and third year respectively. The cost of seed was collected and deposited in saving account established by the groups as revolving fund. Monthly saving system (Rs 20/household/month) was started. This fund was realized to be helpful for the sustainability of seed production program by farmers.

5. Trainings and visit of farmers group

Three trainings for each seed production group were provided during the first year. Training on techniques and method of quality seed production, crop management was provided before sowing at each location. Training on harvesting, quality improvement, seed selection and post harvest management (storage, insect pest management) was given at the time of harvest on farmers' field. Two refresher trainings for each group were given during second and third year before sowing of the crop. Scientists/technicians from ARS, Dailekh and DADO provided the training. Similarly, Leader farmers' training on co-operative establishment and management was organized at ARS, Dailekh.

6. Formation of seed co-operative

One seed producers' cooperative named Jeevanjyoti Seed Co-operative was formed / established by involving all seed production groups and all other stakeholders during the second year of the project. This co-operative acted as an umbrella organization of all seed production group. This has helped the farmers in seed marketing by collecting seed demand and establishing linkage between seed producer groups and entrepreneurs. The future strategy for the sustainability of co-operative based marketing system was prepared during the seminar including all stakeholders of the project. The farmers' group was registered in DADO and it will continue to support the farmers' group after the completion of the project.

7. Supply of quality source seed to small and marginal farmers in remote areas

300 farmers from remote areas of Dailekh (Katti, Seri and Baraha VDCs) were selected. It was selected 100 farmers in each VDC in clusters. Dalits and marginal farmers were selected and

given priority. Varieties used were Deuti Shitala and Poshilo Makai-1. One kg seed pack was prepared and distributed to each farmer and they grew the crop according to their own management condition. Single on farm training was given for quality seed for their own use during tasseling stage. Grain yield was recorded at maturity stage from 50 farmers / location and from 50 metre square area. Farmers' reaction was collected on different parameters through group discussion during maturity stage. The required seed for the program was provided through the project during the first year. From the second year, the equal amount of seed provided to the CBSP group was collected from each group and this seed was passed to another remote and food deficit areas (DAGs, Dalits, women). The farmer also shared the technical knowledge on quality seed selection and for this technical support was provided from ARS, Dailekh and collaborators. The best and efficient way of dissemination of quality seed to small and marginal farmers became the revolving seed multiplication program. In this program 1 kg seed /farmer of the preferred variety was provided to the participant farmers in free of cost on the condition that he/she had to give the same amount of seed to one another interested farmer in the same site or the adjacent area in the next season on compulsory basis. Seed was supplied to the farmers of the area in clusters and the previous process was followed in next area. This has helped in rapid multiplication of the most preferred varieties and the access of marginal farmers to quality seed has been increased.

8. Participatory variety selection (PVS) on maize (Mother-baby trial)

8.1 Site selection

This was carried out at four locations in remote VDCs of Dailekh (Bindabasini, Bajaura, Badalamji and Kalbhairab) and Salyan and Rolpa. Six mother and 35 baby trials were conducted per year was conducted. Farmers were selected covering from every social groups in a cluster as possible on the basis of interest of the farmers.

8.2 Trainings and farmers' field day

Trainings for farmers and technicians involved in the program from collaborating institute were organized on the farmers' field before sowing of seed. The technicians from the collaborating organizations working in areas were responsible for the programs and expert from ARS, Dailekh frequently visited and monitored the programs on the field. Training on on-farm seed selection was provided to the farmers during the same day. Farmers' field day was organized on each location and farmers' preference ranking for the PVS varieties was carried out by farm walk and demonstration trial (mother trial). Farmers' perception towards new varieties and their adaptability on wider environment was known.

8.3 Participatory variety selection program (Mother baby trials)

8.3.1 Mother trial

One mother trial / location was conducted in each location and altogether 6 mother trials per year were conducted. Eight varieties (Rampur Composite, Deuti, Manakamana-3, Shitala, Hill Pool White, Poshilo Makai- 1, Arun 1EV and Local) were included in the program. All varieties included in PVS program were grown in a relatively smaller plot in a single farmer under improved and farmers own method.

Design: Randomized complete Block Design

Plot size: 6 rows of 3 m length (13.6 m²)

Fertilizer dose:

On improved maize: 120:60:40 kg N, P₂O₅, and K₂O/ha. Half of nitrogen and full dose of phosphorus and potash was applied during sowing of seed. Rest half nitrogen was further divided in two parts. ¼ N was applied after 25-30 DAS and other ¼ was applied after 40-45 DAS (knee height stage).

Farmers' practice: According to their dose and application method and time.

8.3.2 Baby trial

35 baby trials/ location were conducted in a year. It was conducted relatively in large plots (100-150 m²) under farmers own management condition. Improved new varieties were sown by their respective local and sufficient amount of seed of these varieties (1 kg/farmers) were provided to the farmers. Each variety was replicated 5 times in each location. Comparison on different characteristics and grain yield was made. On the maturity stage, farmers' field day was organized in each location and on the basis of ranking farmers' preferred variety was identified

Those mother baby trials were conducted for 2 years in the same locations and on the basis of farmers preference the best new variety was identified. The new variety was up scaled and disseminated through large scale source seed production by CBSP approach.

9. Preparation of documentary film

A documentary film covering the activities, impacts and achievements of the program was produced and distributed to the farmers groups, all the concerned organizations. For the preparation of the film, help was taken from the journalist photographer from Agriculture Environment and Journalism Group.

3. Results

On station source seed production

Agriculture Research Station, Dailekh is the only institute involved in production and maintenance of source seed of maize in the Mid Western Region. The source seed required for community based seed production by farmers group and for the participatory variety selection was produced at ARS, Dailekh. During 2007/08 it was produced 2305 kg of breeder and foundation seeds of Deuti, Arun-1 and Mana-1. Similarly their respective quantities were 2312.5 and 2457.6 kg respectively for the fiscal years 2008/09 and 2009/10 (Table 1) to support seed production program, by providing to farmers. Breeder and foundation seeds of improved maize varieties like Deuti, Arun-1 were produced at the station by maintaining effective time isolation among the varieties (20-25 days). The early varieties were planted earlier than the full season variety (Deuti). Breeder seeds of each variety were maintained by modified ear to row selection method.

Table 1: Production of breeder and foundation seed of different varieties of maize at ARS, Dailekh from 2007/08 to 2009/10

Year	Breeder seed (kg)			Foundation seed (kg)			Total (kg)
	Deuti	Arun-1	Mana-1	Deuti	Arun-1	Mana-1	
2007/08	52	52	56	1130	510	505	2305
2008/09	52	52	56.5	1137	510	505	2312.5
2009/10	51.94	50.96	102.9	1453	739.9	58.9	2457.6
Total (kg)	155.94	154.96	215.4	3720	1759.9	1068.9	7075.1

Exploratory visit to project location and group formation

An exploratory visit with collaborators prior to initiation of activities was made in order to select the suitable sites. Group discussion and meeting with stakeholders and farmers was made to understand the interests and needs of the farmers which became helpful for effective planning and implementation of the program. Six sites for the community based seed production program on the basis of farmers' interest, preference and co-operation (Table 2). Altogether there were 148 farmers including all six farmers' groups with 85 male and 63 female farmers. Similarly, on the basis of socio-economic status, 97, 34 and 17 farmers were included in the groups from upper caste, janajati and dalit respectively. A team representing from collaborating organizations, DADO, seed entrepreneurs, media persons, agro vets and farmers headed by the team of ARS Dailekh visited the respective locations. In seed production sites, farmers' group was formed including all farmers in seed production program. An authorized executive committee was formed with the active participation and agreement of all stakeholder farmers. Seed production activities, co-ordination of members, record keeping and marketing of seeds was managed to be done by the committee.

Table 2: Formation of community based maize seed production groups at different sites of ARS, Dailekh from

Group	Ethnicity			Number of farmers on the basis of sex		
	Upper	Janajati	Dalit	Male	Female	Total
Bindhyabasini Seed Production Group, Bindhyabasini	21	3	4	20	8	28
Jeevan Jyoti Seed Production Group, Saltada	10	9	0	12	7	19
Sagarmatha Seed Production Group, Bhainsekhori	5	7	1	5	8	13
Basantamala Seed Production Group, Kimugaon	18	2	2	12	10	22
Chandrakiran Seed Production Group, Ritha	21	4	2	14	13	27
Deuti Seed Production Group, Badalamji	22	9	8	25	14	39
Total	97	34	17	88	60	148

Similarly, one seed producers' cooperative named Jeevan Jyoti Seed Co-operative was formed / established by involving all seed production groups and all other stakeholders during the second year of the project. This co-operative acted as an umbrella organization of all seed production group. This has helped the farmers in seed marketing by collecting seed demand and establishing linkage between seed producer groups and entrepreneurs. The farmers' group was registered in DADO and it will continue to support the farmers' group after the completion of the project.

Survey on maize based cropping pattern in the mid western hills

Baseline survey with semi structured questionnaire was done to know the existing cropping pattern of the location prior to project implantation. The current information on maize based cropping system was identified (Table 3). The survey was conducted in Bindebasini, Rittha, Badalamji, Bhaisekhor, Narayan Municipality and Saltada. From the survey the following were identified as the major cropping pattern.

Table 3: Predominant cropping pattern of Dailekh district

Agro-eco-zones	Cropping Patterns	
	Irrigated	Rainfed
1. Tar, Lower Valleys, Foot Hills	1. Rice – Wheat 2. Rice - Lentil 3. Rice - Tori 4. Rice - Onion 5. Rice - Rice 6. Rice - Spring Maize 7. Rice - Winter Vegetables	Maize - Wheat Maize - Potato Maize - Wheat + Pea Maize - What + Tori Maize - Lentil + Cow-pea Upland Rice - Fallow Upland Rice + Maize - Fallow
2. Mid Hills	1. Rice - Wheat 2. Rice - Onion 3. Rice - Tori + Finger-millet 4. Rice - Potato 5. Rice - Lentil 6. Rice - Cow-pea	Maize - Wheat Maize - Potato Maize - Tori Millet + Soybean - Wheat Upland Rice - Fallow
3. High Hills		Maize + Finger-millet Maize - Fallow Maize + Bean - Fallow Potato - Fallow Vegetables - Fallow

Seed production program

The farmers managed seed production program was started in six locations taking around ha area in each location (25 ha in total). Two white maize varieties i.e. Arun-1 (early maturing) and Deuti (full season) were used in seed production program. Arun-1 was used in two farmers group, while the Deuti was used in 4 farmers' groups. The source seed (foundation seed) of these varieties was supplied by ARS, Dailekh. All technical support during seed production, harvesting and storing was provided by ARS, Dailekh. The seed production field was visited by the expert from regional seed laboratory. Frequent supervision and monitoring of the crop at different stage of growth was made by the expert from ARS, Dailekh and collaborating organizations. All inputs (seeds, fertilizers, bags and pesticides) were provided free of cost (100% subsidy) to the farmers groups during first year. The subsidy was reduced to 50% and 25% during second and third year respectively. The cost of seed was collected and deposited in saving account established by the groups as revolving fund. Monthly saving system (Rs 20/household/month) was started. This fund

was realized to be helpful for the sustainability of seed production program by farmers.

In the initiation of the project, Deuti and Shitala were recently released varieties. Initially, Deuti was disseminated to limited number of farmers in working sites of Agriculture Research Station, Dailekh but after launching of this project this variety has spreaded to large number of farmers. Two groups produced the improved seed of Deuti from first year of the project.

Farmers preferred S99TLWQ-HG-AB along with Deuti and Shitala in Participatory Variety Selection (PVS). This variety (S99TLWQ-HG-AB) was released as "**Poshilo Makai-1**" in 2008 and it is the only Quality Protein Maize (QPM) variety yet released. In the year 2009, its seed was also produced at Lakhatara of Dailekh district.

Six groups produced certified seed of Arun-1 and Deuti around 25 ha area in different parts of Dailekh (Table 4). Similarly, Lakhatara seed production group produced seed of Poshilo Makai-1 in the year 2009. Large amount of seed was produced and marketed by these groups. In the years 2007, 2008 and 2009 they produced around 21, 22 and 31 tons of maize seeds respectively (Table 3). About **15, 16 and 26 tons** of maize seeds were sold by these groups in the year 2007, 2008 and 2009 respectively. Agriculture Research Station helped the groups to find the traders/ institutions for the sale of their product i.e. seeds. Farmer groups have their regular saving system and funds. This fund has been utilized for buying necessary items like insecticide (Celphos, bags, and group operation etc). Three groups (**Jivan Jyoti seed production group, Saltada; Deuti seed production group, Badalamji and Chandrakiran seed production group, Ritha**) constructed seed storage house through partial support from Agriculture Research Station, Dailekh and by their own resource. Inspired from the Community Based Seed Production (CBSP) program on maize, Jeevan Jyoti seed production group, Saltada has also initiated the seed production program of wheat (WK-1204) from the year 2008. Nepal Agriculture Research Council honored this group as the "**best farmers' group**" all over Nepal during Nepal Agricultural Research Council (NARC) day in Baishakh 25, 2066. In the year 2009, Nepal Agri Seed and Input Company, Chitwan and other by local NGOs procured around 26 tons of maize seed from the groups and the Station played role for the seek of market.

Table 4: Community based maize seed production and marketing of different groups from 2007/08 to 2009/10

Group	Variety	Amount of seed sold, kg (2007)	Income (@Rs 20/kg)	Amount of seed sold, kg(2008)	Income (@Rs 25/kg)	Amount of seed sold, kg(2009)	Income (@Rs 30/kg)	Total, Rs
Bindhyabasini Seed Production Group, Bindhyabasini	Deuti	3800	76000	3700	92500	6100	183000	351500
Jeevan Jyoti Seed Production Group, Saltada	Deuti	4300	86000	5100	127500	5700	171000	384500
Sagarmatha Seed Production Group, Bhainsekhori	Arun-1	3100	62000	3400	85000	3600	108000	255000
Basantamala Seed Production Group, Kimugaon	Deuti	3500	70000	3600	90000	5600	168000	328000
Chandrakiran Seed	Arun-1	2500	50000	2650	66250	2800	84000	200250

Production Group, Ritha								
Deuti Seed Production Group, Badalamji	Deuti	3500	70000	3700	92500	5000	150000	312500
Lakhatara Seed Production Group, Lakhatara	Poshilo Makai-1	-	-	-	-	2500	75000	75000
Total		20700	414000	22150	553750	31300	939000	1906750

Supply of quality source seed to small and marginal farmers in remote areas

300 sets of maize of improved varieties were distributed on the basis of gender, ethnicity and socio-economic class of remote areas of Dailekh district (Katti, Seri and Baraha) (Table 5). Three improved varieties produced the higher grain yield than local (Table 6). Deuti gave the highest average yield (4302 kg/ha) followed by Poshilo Makai-1 (4240 kg/ha) and Shitala (4077 kg/ha). Farmers preferred Deuti for higher grain yield and disease and lodging resistance. It was also preferred by the farmers because of its stay green property. Majority of the farmers have shown interest to sow the new seed in the coming years and and save seed for their own use.

Table 5: Distribution of quality source seed to small and marginal farmers in remote areas on the basis of gender, ethnicity and socio-economic class

Location	Gender		Ethnicity			Socio-economic class		
	Male	Female	Bramhin/Chhetri	Janajati	Dalits	A	B	C
Seri	61	39	20	38	42	29	19	52
Baraha	53	47	27	40	33	33	36	31
Katti	76	24	33	16	51	17	28	57
Total	190	110	80	94	126	77	83	140
	300		300			300		

C: get sufficient food for less than 6 months; B: get sufficient food for 6 months; A: get sufficient food up to 12 months

Table 6: Performance of different maize varieties distributed in remote areas

SN	Variety	Grain yield (kg/ha)			Average (kg/ha)
		Katti	Seri	Baraha	
1	Deuti	4215	3972	4720	4302
2	Shitala	3821	4129	4281	4077
3	Poshilo Makai-1	4887	4103	3729	4240
4	Local	2516	2390	2825	2577

Participatory variety selection (PVS) on maize

Altogether 210 PVS sets were distributed covering different gender, ethnicity and socio-economic class of participating farmers (Table 7). In Salyan and Rolpa it was distributed 35 sets each, while in Dailekh it was 140 sets.

Table 7: Distribution of PVS sets in different locations with respect to gender, ethnicity and socio-economic class

Location	Gender		Ethnicity			Socio-economic class		
	Male	Female	Bramhin/Chhetri	Janajati	Dalits	A	B	C
Salyan	19	16	15	12	8	8	15	12
Rolpa	25	10	4	25	6	7	21	7
Dailekh	95	45	60	43	37	35	40	65
Total	139	71	79	80	51	50	76	84
	210		210			210		

C: get sufficient food for less than 6 months; B: get sufficient food for 6 months; A: get sufficient food up to 12 months

Under mother trials, it was observed highly significant difference among the varieties for all the characters recorded. Deuti (61 DAS), Shitala (60 DAS) and Poshilo Makai-1 (61 DAS) were statistically at par in terms of tasseling and late (Table 8). Local variety exhibited the earliest tasseling (49 DAS) and silking (52 DAS). Deuti (6572 kg/ha) recorded the highest grain yield followed by Poshilo Makai-1 (6111 kg/ha) and Shitala (5927 kg/ha) being statistically at par with one another and they were preferred by the farmers.

Table 8: Average of different growth and yield attributes of maize varieties under mother trials (Pooled data of Dailekh, Salyan and Rolpa)

SN	Variety	Tasseling (Days after sowing)	Silking (Days after sowing)	Grain yield (kg/ha)
1	Rampur Composite	59	63	5186
2	Deuti	61	64	6572
3	Shitala	60	63	5927
4	Hill Pool White	57	59	2981
5	Poshilo Makai-1	61	63	6111
6	Arun-1EV	52	55	3419
7	Manakamana-4	58	61	5742
8	Local	49	52	3078
	F-test	**	**	**
	LSD (5%)	2.3	2.0	973
	CV%	16	12	21

Similarly under baby trials, it was observed highly significant difference among the varieties for the grain yield recorded (Table 9). Deuti as in mother trial became the highest yielder (4765.1 kg/ha) followed by Poshilo Makai-1 (4478 kg/ha) and Shitala (4346 kg/ha). Among the eight varieties, Deuti was the most preferred variety and stood in rank 1st followed by Poshilo Makai-1 (rank 2) and Shitala (rank 3) (Table 9).

Table 9: Grain yield of different maize varieties under baby trials conducted by ARS, Dailekh (Pooled data of Dailekh, Salyan and Rolpa)

SN	Variety	Grain yield (kg/ha)	Farmers' preference
1	Rampur Composite	4113.0	4
2	Deuti	4765.1	1
3	Shitala	4346.0	3
4	Hill Pool White	2561.0	8
5	Poshilo Makai-1	4478.0	2
6	Arun-1EV	3169.0	7
7	Manakamana-4	3877.0	6
8	Local	2915.0	5
F-test		**	
LSD (5%)		725.0	
CV%		21.0	

Marketing of maize seed produced by community based seed production (CBSP) Groups

Seed production is only one part of the process and the other is seed marketing. It can be the major problem in the community based seed production (CBSP). Generally farmers of hilly areas can not sell large amount of seeds and it is mainly limited to neighbours and relatives and mostly in grain price. Identification and establishment of the most appropriate marketing system in maize seed produced at local level is the immediate need for CBSP. Maize seed of produced by the farmers group of ARS Dailekh command areas is sold in a several ways such as through agrovates & farmer to farmer, directly by the farmers group and farmers group to governmental and non governmental institutions (Figure 1). Six community based seed production groups produced certified seed of Arun-1 and Deuti around 25 ha area in different parts of Dailekh (Table 4). Similarly, Lakhatara seed production group produced seed of Poshilo Makai-1 in the year 2009. Large amount of seed was produced and marketed by these groups. In the years 2007, 2008 and 2009 they produced around 21, 22 and 31 tons of maize seeds respectively. About **15, 16 and 26 tons** of maize seeds were sold by these groups in the year 2007, 2008 and 2009 respectively. Agriculture Research Station helped the groups to find the traders/ institutions for the sale of their product i.e. seeds. Farmer groups have their regular saving system and funds. This fund has been utilized for buying necessary items like insecticide (Celphos, bags, and group operation etc). Three groups (**Jivan Jyoti seed production group, Saltada; Deuti seed production group, Badalamji and Chandrakiran seed production group, Ritha**) constructed seed storage house through partial support from Agriculture Research Station, Dailekh and by their own resource. In the year 2009, Nepal Agri Seed and Input Company, Chitwan and other local NGOs procured around 26 tons of maize seed from the groups and the Station played role for the seek of market. Since it has been established a co-operative, marketing in coming years will be done through the cooperative for certain farmers groups. It has been selected 4 farmers among the farmers as the market promotion committee. They are now taking lead responsibility to find market, negotiate with traders and fix the price of seed. They should play a proactive role to continue the programme even if outside support is ceased. It is better to encourage the demand led production programme. The group should collect the demand for seed and then only the production programme should proceed.

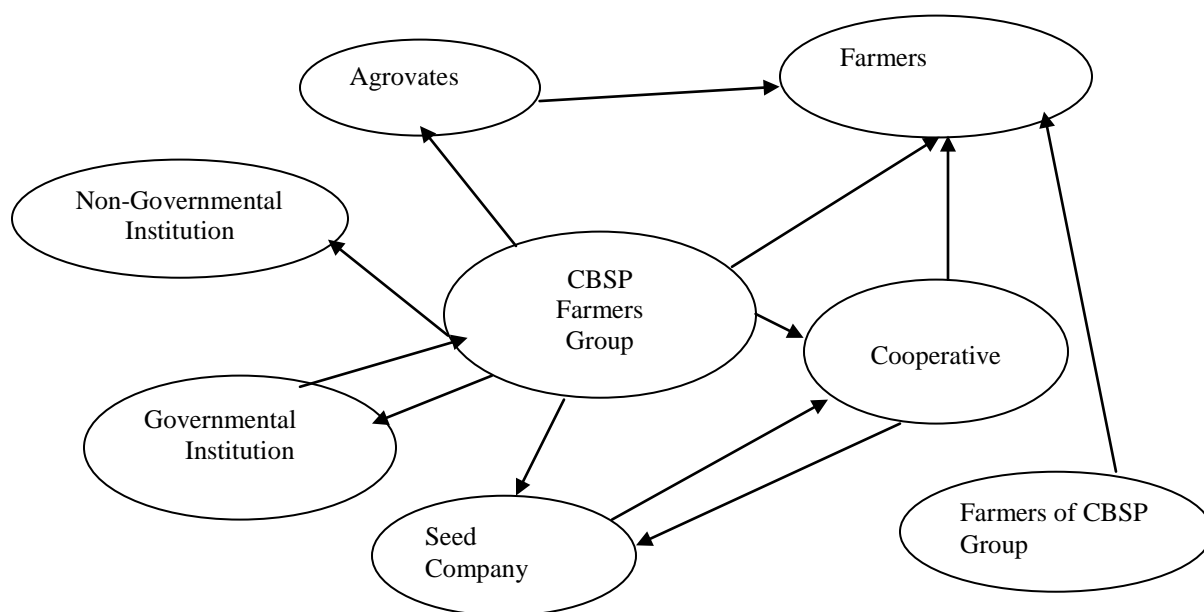


Figure 1: Sustainable marketing approach for maize seed produced

Impact assessment

In focus group discussions male and female farmers were in a good agreement to rank Deuti, Poshilo Makai-1 and Shitala as first, second and third. At the pre-harvest stage farmers liked Deuti, Poshilo Makai-1 and Shitala for longer ears, taller plants, lodging resistance, stay-green characteristic and better fodder quality. At the post-harvest stage they rated better for shelling per cent, cob size, grain size and quality, cooking quality and lower susceptibility to stored grain pests.

The impact of these varieties on the livelihoods of farmers is yet to be documented. However, farmers reported that the yield benefit from Deuti, Poshilo Makai-1 and Shitala is between 20-50% over the local variety depending on location. Farmers perceived that food availability had increased from 3 months to 6 months with the adoption of Deuti, Shitala and Poshilo Makai-1.

The yield gains from the new varieties showed that the participating farmers benefited from the new varieties given in PVS. The most important aspect is the better performance of new varieties in rainfed conditions. Substantial increase in yield and fodder for the rainfed and small holders has great implications on the livelihoods of poor people. The increased yield has helped to reduce poverty and increased food security and purchasing power of the participating farmers who had improved their living standards by using additional incomes from increased yields.

4. Discussion

Over 80% of the total population of Nepal derive their food security, livelihood and income from agriculture (CBS, 2005). Seed is vital for agricultural development; however, farmers have limited access to quality seeds of improved crop varieties. The formal sector meets less than 5% of the total seed demanded of major food crops (Baniya *et al.*, 2000, 2001). The National Seed Company (NSC), a parastatal organisation, produced and marketed over 3000 tonnes of seed of rice, wheat, maize, lentil, jute, vegetables, and other crops in 2005, of which rice, wheat and maize had the major share. The current supply of about 11 tonnes of maize seed through the National Seed Company is not enough to replace the total maize seed demand (11000 tonnes) annually in the country and the supply situation of maize is more alarming (Bania *et al.* 2001, Joshi, 2000, Tiwari *et al.*, 2006). In this context, farmer-to-farmer seed exchange and local seed markets meet most of the seed requirements. There has been a declining government involvement in the seed supply system but there is no viable commercial seed supply mechanism in the place to fill the gap. The situation is even worse in remote areas with the result that resource-poor and disadvantaged communities suffer most.

Production, dissemination and self sufficiency of quality source seed are one of the major priority areas of Nepal Agricultural Research Council and Department of Agriculture. The unavailability of quality source seeds of desired varieties of maize is the main reason for the stagnant productivity in the context of maize in Dailekh district. It requires about 900 tons of seed to cover all areas by improved seeds and there are no institutes involved in seed production and maintenance except ARS, Dailekh in very small quantities (about 1500 kg of foundation seed). So it is very clear that without the involvement of private sector especially local organizations, it is impossible to produce and disseminate the seed in adequate quantity. In this context community based seed production program (CBSP) may be the best option to co-ordinate public-private partnership in seed production and marketing. It is an approach of producing and distributing seeds with the participatory involvement of farmers' groups. In this approach, seed producer farmer associations are formed to multiply the seed of farmer-preferred varieties using a cost-effective approach having several unique futures. Seed marketing through co-operative involving the all stakeholders is the sustainable approach for developing effective marketing network (Dhakal *et al.*, 2007). It takes account of the entire seed innovation system from initial identification of new varieties through participatory varietal selection (PVS) through to commercial seed production. It involves all stakeholders, and develops strong linkages between the private sector and the community-based groups. This builds sustainable partnerships for the CBSP groups and governmental and non-governmental research and development organisations, seed traders and entrepreneurs.

The CBSP approach of seed supply began with the successful outcome of participatory crop improvement (PCI) projects that began in 1997 in Nepal. Since 2000, the rapid formation and institutional strengthening of farmers' groups to produce and market seed has been widely tested in important crops such as rice, wheat, maize, and kidney bean etc. The effectiveness of CBSP has been validated by a participatory evaluation process of the CBSP group development (Gauchan, 2006, Devkota *et al.*, 2006) and from the records kept by the groups on the seed produced by crop, variety and year and by the financial accounts. Important indicators of sustainability of this

approach is that many of these groups are running the business with little external financial support, and are independently handling the planning, production and marketing of seeds. Outside support has been limited to technical backstopping. It was found that the groups were very particular about the quality of the seeds they produced and inspected the production plots and rejected those that were considered unsatisfactory.

In Nepal, farmers of complex hillside farming systems need more varieties to fit all of the niches and to satisfy their multiple needs for grain and fodder. In the context of Dailekh district, the cropping pattern is dominated by maize-wheat system (Gurung, 1999; Gurung and Regmi, 2000; DDC, 2007) where majority of cultivated land is upland dry (76.69 %) and 93 % area is without irrigation (DDC, 2008). Maize is by far the most important cereal in the subsistence agriculture of the middle hills of Nepal (Tiwari, 2001) but improved maize technology has not yet reached to large numbers of farmers, hence a strategy is needed to scale up to larger areas to reach out more poor farmers (Mathema and Gurung, 2006). This is possible since, as been reported, through the Hill Maize Research Program (HMRP), enough seed can be made available to expand the reach of varieties developed by HMRP. In Nepal, Population 22 was tested in formal coordinated trials from 1995 to 1999 but was not released because of its late maturity. When tested in participatory variety selection (PVS) trials it was found to be the most preferred by farmers of the mid-hills who intercropped maize/finger millet in terraces that had trees on the margins (Tiwari, 2001). This demonstrated the value of involving farmers by using PVS. In PVS, validation is always by the first of the end users of a new variety i.e. farmers, in on-farm participatory trials with participatory evaluation using a mother and baby trial design (Witcombe, 2002). With Nepal as an example, the mother trials involved matrix ranking for many traits by farmers in focus group discussions (FGDs) at about 80 days after sowing, approaching harvest, and 3-4 months post-harvest. Focus groups of 5-8 farmers (male and female) ranked the varieties for each trait separately and overall. In post-harvest FGDs, farmers evaluated characteristics such as shelling percent, grit to flour ratio, taste, susceptibility to stored grain pests and market value.

Lessons from previously implemented seed projects in Nepal and findings elsewhere (e.g., Cromwell, 1997; Sperling and Ashby, 1997; Tripp, 1997, 2001; Douglas, 1984), suggest that only locally-based organisations can provide a solution in meeting the demand for quality seeds. Several District Agricultural Development offices (DADOs) in the *terai* and the hills of Nepal, several of the Nepal Agricultural Research Council (NARC) stations across country have initiated, validated and promoted the approach of community based seed production (CBSP). Similarly, Agrovets, NGOs, e.g. LI-BIRD, FORWARD, Community Development and Research Centre (CDRC), SUPPORT Foundation, INGOs CARE and PLAN, CGIAR centres-CIMMYT and projects-Hill Maize Research Project (HMRP), Agricultural Perspective Plan Support Programme (APPSP), Crop diversification project (CDP) have also promoted and validated this approach in many districts of Nepal involving thousands of seed producer farmers. The Government of Nepal has initiated a policy to encourage and strengthen farmer's seed producers groups and piloted a District-level Seed Self-Sufficiency Program (DISSPRO) particularly for increasing the access of quality seed of released, pipeline and farmer's preferred popular varieties at a reasonable price in the villages. DISSPRO is being run through the Department of Agriculture (DoA) through their DADOs network.

The dissemination of improved maize varieties has been done through the Nepal Agricultural

Research Council (NARC) Agricultural Research Stations such as Pakhribas, Kabre, Dailekh and Lumle; through the National Maize Research Programme, Rampur; the Hill Maize Research Programme (HMRP), CIMMYT, Kathmandu; the District Agriculture and Development Offices (DADOs); and partner NGOs such as, LI-BIRD, FORWARD, CEPRED, TTRI, ABTRACO, CAERD, DOS-Gorkha. Of these the HMRP is perhaps the most important and has provided a platform to spread the variety to more than 20 districts in the mid-hills and have an influence in promoting community-based seed production (CBSP). The effectiveness of this approach has also been reported (Koirala *et al.*, 2004; Rajbhandari, 2004) and also validated in most of the districts mentioned above by 2004 and 2005 through the monitoring visit of multi-stakeholders. The effectiveness of these approaches was evidenced by their uptake by several partners both governmental and non-governmental, other projects and CGIAR centres (Joshi, 1999 and Joshi *et al.*, 2006). Similarly, Devkota *et al.* (2005) have reported positive impact of CBSP on poverty reduction. PVSs or CBSP have contributed to more than 50% production increases over local varieties (Mathema and Gurung, 2006). Farmers preferred improved varieties due to traits such as higher yield, taste, non-lodging and better forage palatability for animals. One major impact of improved maize germplasm testing was the release of Deuti (ZM-621) and Shitala (Population-44) varieties, recommended for the mid-hills of Nepal.

On-station source seed production of maize in Dailekh was initiated with the funding of HMRP in 1999 at ARS, Dailekh. Then after, Community Based Maize Seed Production (CBSP) program was started in two VDCs viz. Bindhyabasini and Kalbhairab in 2000. A total of 5,320 kg of Mnakamana-1 seeds of maize was produced in these sites. The program was extended to 24 hectares in 10 additional VDCs viz. Jammukandh, Naulektuwal, Dullu, Rani Ban, Toli, Baluwatar, Bhawani, Baraha, Lakuri, and Awalprajul) in 2001 and produced about 29,480 kg of 'Manakamana-1' variety. In the following year, CBSP was carried out in Kimugaun and Nayagaun of Narayan municipality 6 and 7 and produced 22 tons of improved seeds from about 22 hectares. This program was continued in the same sites for three years and about 62 tons of seeds were produced. In 2006, the program was launched in Awalparajul and Baraha VDCs (Saltada and Ritha). As a result of this program, seed production group of Saltada of Baraha VDCs produced 10,100 kg of Arun-1 and 14,525 kg of Manakamana-1 in Ritha. About 1500 kg seeds of Deuti were produced in Awalparajul. Tenth plan aims to reduce poverty from 38% to 30% and agriculture growth rate from 3.3 to 4.1 % by the end of this plan by dissemination of new sustainable technology and source seed. White varieties of maize are strongly preferred in this region and there is no varietal choice to farmers of this region (Gurung, 1999) and use of improved varieties is almost absent in many VDCs of Dailekh. The demand of quality seed is ever increasing and the requirement of improved seed to cover the areas under maize is 900 ton/year in dailekh (DADO, 2009) and there are no any institutions/organizations, NGOs and CBOs involved in source seed production, dissemination and marketing except ARS, Dailekh. Seed demand of farmers is met to a little extent by community based seed production program (CBSP) run by ARS, Dailekh in two sites producing around 15 ton of improved seed (Annual Report, 2005). But due to lack of well organized marketing system, lack of farmers' approach in marketing and storage problem for longer period, the precious source seed are not fully utilized for grain production. The maize seeds produced by ARSs are in great demand but the demand is not for foundation seed to be utilized as source seed for certified seed production. It is utilized mainly for direct food grain production and being utilized for certified seed production in a very limited scale (Rajbhandari, 2004). Seed is the first link in the food chain and seed based technologies offer the

easiest and cheapest options for increasing crop productivity to farmers. However, the access to new maize seed is limited which could be one of the major reasons for stagnant productivity.

5. Conclusion and implication

Poor access of farmers to improved maize seeds is the main production constraint in mid western hills of Nepal. Formal seed sector contributes less than 5% of seed requirements in major cereals crops and the remaining is supplied by informal sectors. The availability of improved seeds increases if farmers organize and run seed production programme at the community level. Six community based seed production (CBSP) program on maize has been started in Dailekh to fulfill the seed requirements. The community based seed production is an innovative strategy in making available seed of new varieties locally at cheaper price. This is a very important means to increase maize productivity thereby ensuring food security in the rural hilly areas of Nepal. Furthermore, this approach enhances togetherness and empowers farmers by enhancing their skills on how to produce quality seed locally. The yield gains from the new varieties showed that the participating farmers benefited from the new varieties given in participatory variety selection (PVS). The most important aspect is the better performance of new varieties in rainfed conditions of farmers' fields. Substantial increase in yield and fodder for the rainfed and small holders has great implications on the livelihoods of poor people. Key factors in the success of the CBSP programme is linking groups with DOA/DADO, NARC commodity research programs and NGOs. The most important factor is establishing market linkages with seed entrepreneurs and seed traders.

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7. References

- ABPSD, 2006. Area, Production and Yield of Cereal Crops in Nepal in pages 4-10. Statistical Information on Nepalese Agriculture, Agri-Business Promotion and Statistics Division, Singh Durbar, Kathmandu, Nepal
- ABPSD, 2006. Executive summary. In: pages 1-3 Statistical Information on Nepalese Agriculture, Agri-Business promotion and Statistics Division, Singh Durbar, Kathmandu, Nepal
- Agrawal, R.L. (1995). Seed Technology. Kalyani Publisher, New Delhi, India.
- Annual Report (2005). Agriculture Research Station, Dailekh
- Annual Report (2004). District Agriculture Development Office, Dailekh
- Annual Report (2008). District Agriculture Development Office, Dailekh
- Annual Report (2009). District Agriculture Development Office, Dailekh
- Baniya, B.K., A. Subedi, R.B. Rana, C.L. Paudel, S.P. Khatiwada, D. K. Rijal, & B.R. Sthapit, (2000). Informal rice seed supply system and storage systems in mid-hills of Nepal. In: A scientific basis of in situ conservation of agrobiodiversity on: farm: Nepal's contribution to the global project (B Sthapit, M Upadhaya and A Subedi editors) pp 79-91.
- Baniya, B. K.; A. Priyadarshi; and D. N. Mandal. 2001. Maize hybrid research at Khumaltar. In: 46-54. Sustainable Maize Production system for Nepal, Proceedings of Maize Symposium, CIMMYT, Kathmandu, Nepal
- CBS (2005). Statistical Year Book of Nepal. Government of Nepal. Central Bureau of Statistics, Kathmandu.
- Devkota K. P., Tripathi M. P., Gyawali S., Sunwar S., Poudel D., Shrestha P. K., Joshi K. D. and Witcombe J. R. (2005). Community-Based Seed Production: An Initiative for a Sustainable Seed System in Nepal. Paper presented in good practices workshop, LI-BIRD, Pokhara.
- Cromwell, E. (1997). Local Seed System Activities: Opportunities and challenges for regulatory frameworks. In: R. Tripp (Ed). New Seed and Old Laws. Intermediate Technology Publications, London, UK.
- Devkota, K.P., Tripathi M., Chaudhary M., Gurung M., Poudel H., & Gyawali S. (2006). Final Technical Report of R8071-Participatory Plant Breeding in High Potential Production Systems-Validating PPB products, testing different breeding methods and scaling up of new rice varieties. Available at www.dfid-psp.org

- Douglas, J. E. (Ed) (1984). Successful seed programs: A planning and management guide. West View Press Boulder, Colorado, USA.
- District Development Committee (2007). Periodic District Development Plan. DDC, Dailekh.
- District Development Committee (2008). Periodic District Development Plan. DDC, Dailekh
- Dhakal, R., Gautam, I.P., Acharya, U.K. and Sharma, S.R. (2007). Deliverable achievements, maize seed production and marketing effort of ARS, Dailekh in mid western hills of Nepal. Proceedings of hill maize research project, partnership meeting. Agriculture Research Station, Dailekh: 23-27.
- Gauchan, D. (2006). Assessment of the Outcomes of Rice-fallow Rainfed Rabi Cropping (RRC) Project in Nepal Terai. A report of the RRC outcome assessment in Kapilvastu, Saptari and Jhapa districts, Nepal. Bangor, UK: CAZS-Natural Resources, University of Wales.
- Gurung, D. B. 1999. Survey Report of different mid hill-district of mid and far western development region of Nepal.
- Gurung, D.B. and Regmi, H.N. (2000). A survey report on the status of maize based mixed/inter cropping systems in the mid and far western hills of Nepal. HARP PP-32/99, Report No. 1. Agriculture Research Station, Dailekh.
- Gurung, D.B. *et al.* (2007). Abstracts. In: Proceedings of 25th National Summer Crops Research Workshop on maize research and production in Nepal, June 21-23, 2007. National Maize Research Program, NARC, Kathmandu, Nepal: 315-320.
- Joshi K D, Biggs S, Gauchan D, Devkota K P, Devkota C K, Shrestha P K & Sthapit B. R. (2006). The evolution and spread of socially responsible technical and institutional changes in a rice innovation system in Nepal Discussion Paper 8 Wales, Bangor: CAZS-Natural Resources, University of Wales. Available at www.dfid-ppsp.org.
- Joshi, K. D. (1999). Small scale seed production in Nepal. A Research Report prepared for Overseas Development Institute, Portland House, Stag Place London, UK.
- Joshi, K.D. (2000). Strengthening the farmers' seed system in Nepal. Biotechnology and Development Monitor No. 42: pp 15-17.
- Koirala K. B. and D. B. Gurung., 2001. Sustainable Maize Production Systems in Nepal. Proceedings of Maize Symposium 2001.
- Koirala, K.B., Gurung, D.B., Pokhrel, B.B., Acharya, G.P., Prasai, H.K., Poudel, R. & Bhattarai, M. (2004). Community based seed production: Experience from Western and Mid-Western Hills of Nepal. Proc. 24th National Summer Crops Research Workshop on Maize Research and Production in Nepal. (Sherchan D. P. et al eds.). National Maize

Research Programme, NARC, Rampur, Nepal

- Mathema S.B. and Gurung K. (2006) Impact Assessment of the Hill Maize Research Project (HMRP), Kathmandu, Nepal.
- Rajbhandari, N.P. (2004). Developing a strategy for a sustainable maize seed supply system in Nepal: Challenges, Potential and Options. Proceedings of 24th National Summer Crops Research Workshop on Maize Research and Production in Nepal. (Sherchan DP *et al* eds.). National Maize Research Programme, NARC, Rampur, Nepal.
- Sperling, L. & Ashby, J. A. (1997). Participatory Plant Breeding: emerging models and future development. In: R. Tripp (ed.). *New Seed and Old Laws*. Intermediate Technology Publications, London, UK.
- Sherchan, D. P. 2004. Maize Research Highlights (2002 to 2004). Contributing to food security and Improving the Livelihood of the Nepalese people. In: pages 1-14. Proceedings of the 24th National Summer Crops Research Workshop on Maize Research and Production in Nepal,
- Tanskey, S.D., W.D. Young, A.H. Peterson and M.W. Bonierb (1989). RFLP mapping in plant breeding: a new tool for old science. *Biotechnology* 7(3): 257-267.
- Tiwari, T.P. 2001. Participatory crop improvement for maize/millet intercropping with trees in the middle hills of Nepal. PhD thesis, School of Agricultural and Forestry Sciences, University of Wales, Bangor, UK.
- Tiwari, T.P., Ferrara, G. Ortiz, Sah, S.N., Prasad, R.C., Karki, T.B. and Gurung, D.B. (2006). Community based seed production (CBSP) of open pollinated varieties (OPVs) of maize in the hills of Nepal. Hill Maize Research Project (HMRP), International Maize and Wheat Improvement Centre (CYMMYT) and National Maize Research Programme (NMRP): 22
- Tripp, R. (1997). Regulation and regulatory reforms. In: R. Tripp (ed.). *New Seed and Old Laws*. Intermediate Technology Publications, London, UK.
- Tripp, R. (2001). Seed provision and agricultural development, The Institute of Rural Change, Overseas Development Institute, London.
- Witcombe, JR. 2002. A Mother and Baby trial system. In: Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference,, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila. Appendix, 79.

