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Promotion of Participatory Agrobiodiversity Conservation Approach for enhancing Livelihoods of Poor Rainfed Farmers of Nepal

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ABSTRACT

Regional Agricultural Research Station (RARS) Khajura initiated the implementation of agro-biodiversity conservation activities under Western Terai Landscape Complex Project (WTLCP) in mid-westernterai (Bardia) and far western terai (Kailali and Kanchanpur) during the year 2008-2011, with an objective to enhance the livelihoods of the poor rainfed farmers and conservation of agro-biodiversity conservation good practices. Four agro-biodiversity conservation practices i.e. zero tillage, pilot demonstration and production of HNPV in farm level, verification and validation of stress tolerance rice and UG99 wheat and pigeonpea in degraded lands and agro-forestry system were successfully conducted. Significant achievements were made in identification of suitable stress tolerance rice (submergence and drought tolerance). ZTD wheat sowing has been adopted by the farmers of Kailali and Kanchanpur. Introduction of farmers' preferred UG99 wheat var. NL1073 which was preferred by the farmers for its high yield disease free traits. Under capacity building a total of 192 farmers were trained under stress tolerance rice, Ug99 wheat, and ZTD and pigeonpea package of practices in agro-forestry system. Farmers were trend with IPM component for effective pest management. This project helps to establishing strong linkage with line agencies and other stakeholders for delivery of suitable agricultural technology to the farming community for agro-biodiversity conservation in the region.

Keywords: Agrobiodiversity, ZTD, HNPV, IPM, Rice, Wheat, Agro-forestry

INTRODUCTION

Biodiversity is essential for food security and nutrition and offers key options for sustainable livelihoods (Singh *et al*., 2010). Environmental integrity is critical for maintaining and building positive options for human well-being. Existing knowledge warrants immediate action to promote the sustainable use of biodiversity in food security and nutrition programs. Since agriculture begun some 12,000 years ago, approximately 7000 plant species and several thousand animal species have been used for human food (Singh *et al*., 2010). Today, certain traditional and indigenous communities continue to use 200 or more species in their diets but the general global trend has been towards diet simplification, with consequent negative impacts on human food security, nutritional balance and health. Biodiversity contributes directly to food security, nutrition and well-being by providing a variety of plant and animal foods from domesticated and wild sources. Biodiversity can also serve as a safety-net to vulnerable households during times of crisis, present income opportunities to the rural poor, and sustain productive agricultural ecosystems. Biodiversity and agriculture are strongly interdependent and the basis of agriculture. It has enabled farming systems to evolve ever since agriculture was first developed some 10,000 years ago (Singh and Singh,2000).Agricultural biodiversity performs ecosystem services such as soil and water conservation, maintenance of soil fertility and biota, and pollination, all of which are essential to human survival. In addition, genetic diversity of agricultural biodiversity

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provides species with the ability to adapt to changing environment and evolve, by increasing their tolerance to frost, high temperature, drought and water-logging, as well as their resistance to particular diseases, pests and parasites for example. This is particularly important regarding climate change (Singh *et al*., 2010 and Singh and Singh 2009).

Western Terai of Nepal especially (Bardia, Kailali & Kanchanpur) is a dry and potential area for grain legumes (*chickpea, pigeonpea*), cotton and tomato also (Anonymous, 2009). The main constraints for limiting yield and quality of these crops is pod borer (*Helicoverpaarmigera)*. Due to the multiplicity of host plants and its continuity throughout the year, control of this pest with any single method has been almost impossible (Anonymous, 2010 and Anonymous, 2011). Research conducted in the past has shown the effectiveness of IPM approach (study of pest dynamics, use of bio-control agents including, botanicals, Neem products and need based application of safer chemicals for its management) for the management of pod borer (Singh *et al*., 2014a and Singh *et al*., 2011). The main objective of this project was implementation of IPM package on farm level with the main focusing on production and utilization of HNPV locally so as to reduce in the use of chemical pesticides. Long term vision of this activity was to make the BCDC as the reliable source of HNPV bio-pesticides for future application and safe to other natural enemies (Anonymous, 2011 and Singh *et al*., 2011). Wastelands referred to as degraded lands which can be brought under vegetation with proper management practices. In fact, farm forestry is a common feature of Nepalese agriculture where crops and tree plants grow together (Kumar *et al*., 2014). However the agro-forestry system is not well managed so far. Therefore, the fallow unutilized area between and among the growing trees can be planted to food crops with reasonable effort. Pigeonpea is drought tolerant, hardy and woody perennial crop which can grow in association with fruit trees and/or plantation trees under the agro-forestry system. In an effort to develop adaptation strategies for the agricultural sector, there must be interactions about the constraints created by changing climates in light of other stress factors. Agro forestry can contribute to increasing the resilience of tropical to sub tropical farming systems (Kumar *et al*., 2014). Legumes play a vital role in nutritional security (Singh *et al*., 2013a and Singh *et al*., 2013b).In Nepal, pigeonpea (*Cajanuscajan*) is the fourth most important grain legume after lentil, blackgram and soybean. Pigeonpea is grown most intensively along with maize under inter-cropping system (Singh *et al*., 2013a and Singh *et al*., 2013b) rice bund and as an alley cropping in between community forest or fruit or fodder trees. Pigeonpea in agro-forestry system which produces food and a little cash may be a candidate for wider adoption. Under rice-wheat ecosystem, the sowing of wheat is often delayed due to excess soil moisture at the harvest of rice (Hobbs, 2003b and Tripathi *et al*., 2004). Under the condition, wheat yield becomes low. In wheat, blowing of western hot wind caused forced maturity and shrinkages the seed size if planted late. It is reported that there is significant yield decline in wheat if seeding is delayed beyond first week of December. Hobbs (2003a) reported that seeding can be advanced by 8-15 days with the surface seeding and two wheel tractors respectively. It was also reported that the net benefit from two wheel tractor seeded wheat is higher (Rs 12,090/-) than the farmers practice (Rs 8065/-). There is saving of 96% land preparation cost and 70% higher yield was achieved in surface seeding compared to the farmers practice under low land and excessive soil moisture conditions. In zero tillage, 16% higher wheat yield was achieved at 51% lower sowing cost over farmers practice (Tripathi *et al*.,2003).

Submerge rice including sub -1 transgenic gene and drought tolerance rice are introduced in Nepal from IRRI/National Rice Research Program, Hardinath with the aim to cope with the climate change and flash flood prone areas. In mid and far western terai, monsoon started delay and early cessation where most of the farmers are depended upon the rainfall for rice transplanting. Drought is a great problem and sometime due to the excess rainfall occurred during the planting season, flooding is another menaces to the rice production. To overcome these problems, NARC/NRRP/RARS, Nepalgunj in collaboration with IRRI, developed Sukha-1, Sukha-2, Sukha-3 varieties for drought condition and Sworna sub-1 gene and Shambha sub-1 gene varieties for submergence condition (Kumar *et al*., 2013).Ug99, *Puccinia graminis f. sp. Tritici*, is the most virulent race of stem rust fungus yet to emerge in Nepal. First discovered in Uganda in 1999, the fungus has spread Africa, Asia and the Middle East. Ug99 can wipe out entire wheat fields, resulting in 100% crop loss. Accounting for 37% global production, are already affected by Ug99 or at potential risk. An estimated 80% of the wheat varieties currently being grown in this region are considered susceptible to Ug99.Black stem rust *(Puccinia graminis*) incidences in Nepal are at risk and outbreak of this disease might be more disastrous. Some varieties are found outstanding and resistant to Ug99 rust disease. In this aspect research is always alerted to

combat against the Ug99 disease but strategy should be made to go the farmer's level through participatory approach because this disease might be potential to settle in this region and need to verify the suitable varieties of Ug99 rust resistant varieties.

Dissemination of Zero Till Drill (ZTD) in wheat a resource conservation technology in the intervention sites for it's scaling up was another important good practice done at farm level (Laik *et al.*, 2014 and Singh *et al.*, 2014b). Similarly, in IPM approach, this program implemented different approaches: establishment of pheromone traps, use of sunflower as a trap crop, preparation and use of both NSKE and HNPV etc. Likewise, in Ug99 rust resistant genotypes NL 1053, NL 1073, Bijay including Gautam as check were disseminated for verification and scaling up. Similarly, stress tolerance rice varieties Sukha-1, Sukha-2, Sukha-3, Sworna sub-1 gene and Shambha sub-1 gene were disseminated for verification and scaling up in intervention sites. Likewise, In integration of pigeonpea in agro-forestry system and degraded lands, pigeonpea genotypes ICPL88039, Rampur Rahar-1, Bageswori, and ICP 7035 were introduced for verification and scaling up in intervention sites (Anonymous, 2011).This paper highlights the achievement of agro-biodiversity activities, which includes Four activities i.e. Zero Till Drill (ZTD) demonstration to promote resource conservation technology, pilot demonstration of HNPV production for the management of Pod borer in chickpea, pigeonpea, and cotton & tomato, participatory evaluation and dissemination of Ug99 rust resistant wheat varieties and rice varieties for drought and submerged condition and promotion of pigeonpea in degraded lands and in agro-forestry systemin Bardia, Kailali and Kanchanpur districts from 2008 to 2011.

MATERIALS AND METHODS

Zero Till Drill (ZTD): Initiated ZTD wheat demonstration at Motipur VDC (Bardia) and Masuriya VDC (Kailali) in 2008 and extended to Gadaria VDC, Kailali in 2009, and Suda VDC, Sundarpur, Kanchanpur in 2010. Problematic areas of above mentioned districts were selected for large plot demonstration of Zero till drill (ZTD). Initially required amount of seeds, fertilizer, herbicides (Post emergence) also provided to the farmer as a subsidy. Recommended seed rate @120 kg/ha was used with seed dressing of fungicides. Orientation training on ZTD including all aspects was provided by RARS, Khajura. All cultural practices and other management approaches were applied as per recommendation (Hobbs, 2003b, Singh *et al.*, 2014b)

Helicoverpa Nuclear Polyhedrosis Virus (HNPV):

Started in 2008 at Motipur and Belawa VDC, Bardia, involved 19 farmers and 24 farmers respectively. Chickpea seed of variety Abhrodhi was provided @ 3 kg/farmer. Similarly, started in 2009 at Masuria, Kailali through the help of unity Agro-biodiversity conservation and development committee (UABD) involved 17 farmers and chickpea seed of variety Sita was provided @3 kg/farmer. Likewise, started in 2010 at Baisebechuwa VDC, Kanchanpur in collaboration with *laljhadi saving & credit cooperatives*, involved 24 farmers and chickpea seed of variety Tara was provided @3 kg/farmer. Farmer selection was done by preliminary visit and discussion with farmers and wherever possible existing farmer groups were contacted in consultation with local line agencies/NGOs working in the area. Farmers were selected who were planting chickpea, pigeon pea, or tomato. Required quantity of seed for selected farmer was provided wherever possible. Training on production of HNPV was organized for the farmers. Necessary equipments (*Refrigerator, centrifuge and grinder and trays*) were provided. Pheromone traps was established in fields of selected farmers. Neem seed kernel extract (NSKE) was prepared by collecting neem seeds. Five saplings of neem were provided to each farmer. Bird perches were established in the field of selected farmer. Supervision and monitoring was done as per necessity by RARSN. All cultural practices and other management approaches were also applied as per recommendation.

Ug 99 and stress tolerance rice

Farmer selection and group formation was done before intervention of the participatory trials on wheat and rice in Masuria VDC, Kailali, Shankharpur and Sundarpur of Kanchanpur district. Training on the management of Ug99 wheat rust disease and stress tolerance rice was provided to the participated farmers. Initially five PVS set in each crops was conducted in the project areas. Fifteen baby trials in each crops was conducted in the project areas. Data on specific traits was recorded and preference ranking and organoleptic taste was conducted in the project areas. Seeds of mentioned disease and stress tolerance varieties of rice and wheat were collected in the group and save the seed for next season (Kumar *et al.*, 2013). All sorts of cultural practices and other management approaches were applied as per recommendation.

Pigeonpea on degraded land and Agro-forestry

Farmers selection was done before conducting

this activity in Belawa VDC-1, 3, 9, Bardia (Agro-biodiversity conservation Committee) and Baisbisawa 7, 8 Kanchanpur (MohanaLalJhadi saving and credit cooperative). Training on the integration of pigeonpea and its potential in agro-forestry system and management of degraded land was given to the participated farmers in collaboration with the district forest office. Pigeonpea varieties ICPL 88039, Rampur Rahar-1, Bageswori, and ICP7035 were planted as under storey vegetation and trees as over storey vegetation. The spaces left over by the trees were used for pigeonpea planting with recommended management practices. Seeds and fertilizers were provided to the farmers and followed standard IPM package. Pigeonpea was planted in rows between the regenerated tree saplings or fruit trees or fodder trees and the ratoon crop remain stay after harvesting the crop (Kumar *et al*., 2014).

RESULTS AND DISCUSSION

Zero till seed (ZTD): ZTD was initiated in 2008 covering 3 ha of land and 30 farmers participated in Motipur and Masuria, the area expanded to 7.71 ha at Masuria &Gadaria VDC, Kailali in 2009. Further area expanded to Sundarpur, Kanchanpur. In the year 2011 large plot demonstration done in 4 ha in Kailali and 4 ha in Kanchanpur in direct approach of RARS, Khajura but many farmers are following the technology by their own seed. Zero till seed drill machine handed over to the Unity Agro-biodiversity Conservation and Development Committee (UABDC), Masuria, Kailali during 2009. Trained the local tractor drivers of Kailali and Kanchanpur and provided orientation training each year to the participated farmers in each location with discussion, visuals and handouts. At Monakapur areas of Masuria VDC, Kailali initiated wheat cultivation aftermath introduction of ZTD (Anonymous. 2011, Hobbs, 2003b and Singh *et al*., 2014).

HNPV production and utilization

Provided all the necessary equipments (Freeze, Centrifuge, grinder machine, rearing tray) to the Belawa, Masuria and Baisebechuwa farmers group. A total of 125 farmers from Bardia, Kailali and Kanchanpur sites trained on village level Nuclear Polyhedrosis Virus (HNPV) production and eco-friendly approaches for the management of pod borer. A total of 2000 LE HNPV produced and used at farm level at the intervention sites. A total of 3038 kg chickpea seed produced in 2010-11 through this activity. A total of 335 Neem Saplings were distributed at the intervention sites for making NSKE in future (Singh *et al*., 2011).

Stress tolerant rice

Before implementation of the activity, RARSN's scientists were provided one day training on specific technologies for submergence rice and drought tolerance rice to the BCDC farmers of Shankerpur VDC, Balmi, Kanchanpur and Masuria VDC, Kailali. Under participatory approach, RARSN evaluated PVS submergence rice varieties (Sworna with sub 1, Sambha with sub 1 and IR64 with sub 1) in 9 farmers' field. The research results revealed that shambha with sub 1 gene produced the highest average yield (3333 kg/ha) followed by IR 64 with Sub 1 gene (3278 kg/ha). Likewise RARSN evaluated Drought tolerance varieties on PVS comprising Sukha Dhan-1, Sukha Dhan-2 and Sukha Dhan-3in 6 farmer's field. The data clearly indicated that drought tolerant genotype Sukha Dhan-3 performed highest mean yield (3800 kg/ha) and farmers preferred it because of its early maturity and high yielding traits. During the period, a total of 54 baby trials of Submergence rice were also distributed to the sites for wider dissemination purposes. Sambha with sub 1 gene recorded the highest average yield (3110 kg/ha) ranges 1807- 4518 kg/ha followed by IR64 with sub 1gene (2935 kg/ha) and sworna with sub 1 gene (2859 kg/ha). Based on the participatory variety selection experiment's results, RARSN has been decided to further up scaling and seed increase program of well adapted and farmers preferred variety. A total seed production of submergence rice varieties shambha sub 1 and sworna Sub-1was 2335 kg and 1400 kg respectively while drought tolerance rice var. Sukha Dhan-3 was 5899 kg. Farmers of both the sites were highly preferred to Sukha Dhan-3 for its high yielding; medium seed size and far better taste than the coarse type Radha-4 and Sarju-52. A total of 25 farmers in Shankerpur and 17 farmers in Masuria were trained for about specific technologies of stress tolerance rice (Anonymous, 2009; Hobbs, 2003c;Kumar *et al*., 2014 and Singh *et al*., 2014).

Ug99 resistant genotypes

In Suda VDC, Sundarpur, Kanchanpur, UG99 PVS trials results revealed that varied the yield performances. The data indicated that the genotype NL1073 (2672 kg/ha) produced the highest average yield than the check Gautam(2452 kg/ha). Likewise in Masuria, Kailali; similar kind results obtained i.e. the genotype NL1073 (3680 kg/ha) produced the highest average yield followed by NL1053 (3640 kg/ha) than the check Gautam(2880 kg/ha). Under baby trial of UG99 wheat, the total seed production of UG99 wheat genotype NL1053 (1660 kg) and NL1073 (2600 kg) was produced from 15 farmers field in Masuria, Kailali while in

Kanchanpur, the total seed production of UG99 wheat genotype NL1073 (2320 kg) and NL1053 (1377 kg) was produced from 15 farmers field. Farmers preferred the wheat var. NL1073 because of its high yielding, good taste of bread and good weight for marketing purposes and even high demands in local farmers therefore farmers were save the seed. Concerned BCDC were collected the farmers' level seed production and sell seed to the farmers and other stakeholders. Mean performance of Ug99 resistant genotypes in Kailali and Kanchanpur (Anonymous, 2009; Anonymous, 2010 and Anonymous, 2011).

During 2010, pigeonpea varieties planted in 90 farmers (ICP7035), 80 farmers (Bageswori), 10 farmers (RR-1) and 50 farmers (ICPL88039) in degraded land along the bank of river side and along with the forest or in between forest/orchard. Each farmer planted in 1 katha per variety. A total seed of Pigeonpea genotype ICP7035 (153 kg), Bageswori(348 kg) and Rampur rahar-1(6 kg) was produced at Baisebechuwa, Kanchanpur under this system. Similarly pigeonpea genotype ICP7035 (63 Kg) and Bageswori(163 kg) was produced at Belawa, Bardia. During the project period, RARSN provided slot of one day training on pigonpea in degraded land and agro-forestry system to the participated farmers and interacted with the Mohana Lal Jhadi Saving and Credit Cooperatives Baisebechuwa and ABD conservation development committee, Belawa. A total of 20 farmers (8 male and 12 female) participated at Baisebechuwa and 30 farmers (28 male and 2 female) at-Belawa during the training program. Long duration varieties ICP7035 and Bageswori were adopted in the agro-forestry system and in degraded land. Result of pigeonpea showed that long duration genotypes perform better in agro-forestry system of mid-west and far terai and covered about 3.6 ha areas. A total of 31 farmers participated at Baisebechuwa, Kanchanpur and Belawa VDC, Bardia during the training program. In the year 2011, a total of 70 farmers have involved in pigeonpea production covering 112 kattha of land in which Bageswori and ICP 7035 occupies same proportion of area in above mentioned sites (Anonymous, 2009; Anonymous, 2010 and Anonymous, 2011).

CONCLUSION

Significant achievements were made in identification of suitable stress tolerance rice. ZTD wheat sowing was also adopted by the farmers. Chickpea variety Avrodhi, Tara, Sita disseminated in intervention sites and preferred by farmer. Project helps to establishing strong linkage with line agencies and other stakeholders for delivery of suitable agricultural technology to the farming community for agro-biodiversity conservation in the region. These activities plays pivotal role in nutritional security and biodiversity conservation in the intervention sites of Bardia, Kailali and Kanchanpur districts.

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