Inclusion of grain legumes in rice based systems in the mid-hills of central Nepal

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Abstract

Grain legumes are the important crops for improving soil condition and dietary status of humans. These crops could improve both soil and human health if grown in the prevailing farming systems. Keeping these view in mind, participatory varietals selection (PVS) on lentil (*Lens esculents* L.), mung bean (*Vigna radiata*) and cowpea (*Vigna ungiculuta*) was conducted in the central mid hills (Ramechha and Sindhuli districts) of Nepal. Five varieties of lentil (ILL 7982, ILL 6829, ILL 7537, ILL 7723 and Simal), four of mung bean (VC 3960, Kalyan, Pratiksha and Farmers' Local) and cowpea (Surya, Prakash, IT 86-2089-5F and America) were tested at different locations of those districts under rice-wheat-fallow and rice-fallow-maize systems during 2007 to 2009. All of those varieties were tested in farmers' field condition keeping farmers as a replication in RCB design with ten replications for each crop. Agronomic practices were performed by farmers as and when necessary. Among the tested varieties of lentil, ILL 7982 produced the highest grain yield of 1347 kg/ha whereas Sital produced the lowest grain yield of 1003kg/ha. Similarly for mung bean, the variety VC 3960 gave the highest grain yield of 1145kg/ha and Pratiksha produced the lowest grain yield of 975 kg/ha. Likewise, among the tested varieties of cowpea, America gave the highest pod yield of 5320 kg/ha and Prakash gave the lowest pod yield of 3400 kg/ha. These varieties were identified suitable for further promotion in different cropping patterns such as rice-lentil- maize, rice-maize/mung bean, rice-maize/cowpea systems. Simple economic analysis of the cropping systems under question indicated that inclusion of legumes in the systems seemed highly lucrative compared to maize and wheat. Therefore, it is anticipated that integration of legumes in the systems could enrich soil as well as it would be beneficial to farmers because of nutritional status attractive price in the market of these crops.

Key word: Participatory variety selection, farmers, farming systems

Introduction

Overall production and productivity of grain legumes has decreased in the last decade (MoAC, 2001/02 - 2006/07). The productivity of grain legumes ranged from 700- 1400 kg/ha during that period and it was in decreasing trend. In the hills, food insecurity is a serious problem and legumes could help mitigate this problem provided their production and productivity is given due emphasis. Integration of suitable winter and summer grain legumes in the existing systems is a viable option for increasing the cropping intensity thereby boosting production and productivity of cereals as well as grain legumes in the river basins and tars of mid hills. Also, it helps intensify the cropping patterns, improve human health as well as soil health. To achieve this objective, Outreach Research Division (ORD) under Nepal Agricultural Research Council (NARC) has initiated participatory variety evaluation systems (PVS) of suitable high yielding varieties of grain legumes in the rice based systems. To enhance the yield of these crops, identified varieties were tested in the farmer's field to scale up in the area by mobilizing local extension workers, NGOs/CBOs and farmer groups. Commonly, grain legume is produced in various physiographic regions (150-2850 m) that is from Terai to Jumla. Pigeon pea, lentil, chick pea, black gram, cow pea, mung bean

are the major grain legumes of the tropical to warm temperate whereas soybean, kidney bean, pea and rice beans are grown in warm temperate to cold temperate regions. The watershed areas of the Sunkoshi and the Tamakoshi in Sindhuli and Ramechhap districts are rainshadow areas of the Mahabharata hills. As a result, rainfall in these areas is very scanty. Rainfal pattern of Nepalthok of Sindhuli has been illustrated (Fig. 1).

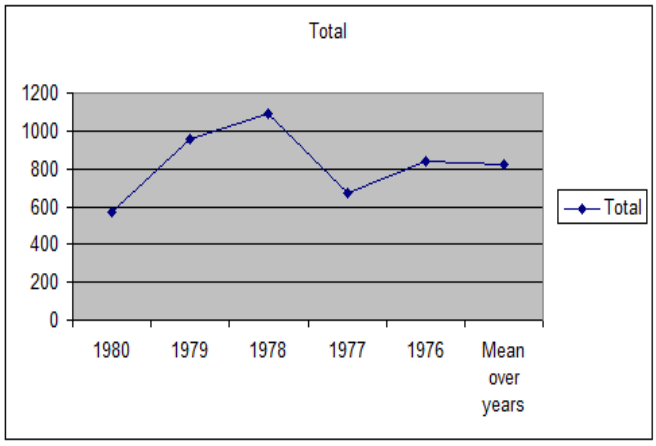

Fig. 1 Rain fall patterns (mm) in Nepalthok of Sindhuli district

Methodology

Five lentil varieties (ILL 7982, ILL 6829, ILL 7537, ILL 7723 and Simal), four mung bean varieties (VC 3960, Kalyan, Pratiksha and Farmers'Local)and four cow pea (Surya, Prakash, IT 86-2089-5F and America) varieties were tested in the different locations of the Sunkoshi and Tamakoshi river basin areas of the Sindhuli and Ramechhap districts during 2007 to 2009. Planting was done in rows at a distance of 45 x 10 cm apart for cowpea while broadcasted for lentil and mung bean under rice-wheat-fallow and rice-fallow-maize systems. All of these varieties were tested in farmers' field condition keeping farmer as a replication in RCB design with ten replications. Agronomic practices were performed by farmers as and when necessary. Individual plot size was 20-25 square meter whereas net harvested area per plot was 10 square meter. Seed rate was applied at 25-40 kg/ha depending upon crops. Fertilization was done with FYM 5-10t/ha along with 20:40:20 kg NPK /ha. Pre-sowing irrigation was given for mung bean and cowpea while lentil was planted in residual moisture. Some supplementary irrigation was applied if available. For the control of pest like aphid and brown bug, Thiodane 35 EC, at 2 ml per litre of water was applied twice viz; first at flowering and second after first picking of dry pods of mung bean. For other crops, plant protection measure were applied as per need.. A total of thirty stratified random samples in each crop (lentil, cow pea and mung bean) were decided to estimate the yields of these crops from the project area..Minimum of five samples were collected from each site. Yield and agronomic parameters recorded were plant height, number of pods per plant, number of plants per square meter. After harvesting, samples were collected separately for drying/ threshing and yields were estimated (Table 1 and 2). Besides grain yield, green bio-mass of the cow pea and mung bean was also recorded. Data were collected according to the standard norms as suggested by the National Grain Legume Improvement Program, Rampur. Simple descriptive statistics was used to separate the means recorded from the plots.

Results and discussion

Soil status

A total of 40 soil samples were analyzed to know the present status of the major plant nutrient, OM (organic matter), soil texture and pH. From the soil analysis, it was known that the nitrogen content was low to medium, (0.068 - 0.146%), phosphorous status was medium to high (107-492 kg/ha) and potash status was low to very high (60-940 kg/ha). Half of the collected soil samples were slightly acidic to nearly neutral pH (5.5-7.4) while rest of samples were moderately acidic (pH >5.2). OM content ranged from 0.982 - 2.2% which was very low. None of the sample showed more than 2.5% OM which was also medium. Soils texture was dominated by silt loam (60%), loam (20%) and clay loam (20%) in those sites.

Integration of grain legumes in rice and maize based cropping systems

Testing and verification of six different grain legumes (lentil, pea, cowpea, mungbean, pigeon pea and soybean) was initiated in Pakarbas and Bhatauli VDCs of Ramechhap and Jhangajholi and Sitalpati VDCs of Sindhuli districts. Among these crops pigeon pea and soybean were badly affected by long dry spell during summer 2009. Grain legumes are the deep rooted crop which can be grown with residual moisture in normal rain fall pattern. In case of poor moisture storage, or uneven distribution of rainfall crop performance could be improved by supplementary irrigation during branching in lentil whereas flower initiation stage in cowpea and mung bean. Pre-sowing irrigation is followed by a supplementary irrigation is common in all the crops if moisture is not enough for germination (Rathore and Sharma, 1999/2000). In this study also legume crop performed well provided light irrigation during moisture stress condition in rice based systems.

Promising varieties of lentil, mung bean and cowpea, namely Maheshwar Bharati, Kalyan and Surya respectively, were evaluated in rice-lentil-maize and rice-wheat-grain legumes cropping patterns in rice based system. Of sixty farmers, thirty participated adopting rice-wheat-mung bean and rice-wheat-cow pea patterns. Overall performance of individual crop in the evaluation trial was highly satisfactory both in winter and spring seasons (Table 1 and 2).

Table 1. Agronomic performance of lentil under rice-lentil-maize cropping patterns in Sindhuli and Ramechhap during winter 2008

Testing On-farm sites	Cropping pattern	Grain yield range (kg/ha)	Mean grain yield (kg/ha)
Pakarbas	Rice-lentil-maize	1050 – 2600	1948
Bhatauli	Rice-lentil-maize	1710 – 2400	1894
Jhangajholi	Rice-lentil-maize	950 – 2540	1740
Range/Mean, (kg/ha)		950 – 2600	1860

Table 2. Agronomic performance of cow pea and mung bean under different cropping patterns in Sindhuli and Ramechhap during 2009

Cropping pattern	Grain yield range (kg/ha)	Mean grain yield (kg/ha)	Mean green bio-mass yield (kg/ha)
Rice-wheat-cowpea	1840-3800	2380	16700
Rice-maize/cowpea	1400-3500	2000	16200
Average yield	1400-3800	2190	16450
Rice-wheat-mung bean	1700-2600	2059	9830
Rice-maize/mung bean	1820-2800	2320	10200
Average yield	1700-2800	2175	9900

Seed management for winter and spring grain legumes

Community based seed production program on winter and spring legumes were conducted at Jhangajholi, Pakarbas and Bhatauli sites. Identified variety of winter and spring legumes were Maheshwar Bharati of lentil, Kalyan and Pratiksha of mungbean and Surya of cowpea were grown for seed multiplication purpose. These crops were successfully grown in those areas. Seed growers of each crop of lentil, mungbean and cowpea were highly encouraged because these crops were grown probably for the first time in those localities. Participating farmers expressed that these grain legumes fetched high price with less investment resulting in high marginal profit. From the seed production program, adequate quantity of seeds of these crops have been collected and stored at the farm house. Details of seed collected of each crop are given (Table 3).

Table 3. Seed collection of winter and spring grain legumes for different varieties at Ramechhap and Sindhuli during 2009

Location	Seed collection of lentil (kg)		Seed collection of chick pea (kg)	
	M. Bharati	Other legumes	Abarodhi	Tara
Jhangajholi	76	52	-	-
Bhatauli	85	-	16	-
Pakarbas	40	26	50	8
Total	201	78	66	8
	Seed collection of cowpea		Seed collection of mungbean	
	IT86F	Surya	Kalyan	Pratiksha
Bhatauli	4	40	45	-
Jhangajholi	12	122	140	50
Sitalpati	-	40	-	35
Total	16	202	185	85

Economical analysis of cropping patterns

Economic analysis of the cropping patterns was carried out to know the economic viability of the newly introduced grain legumes in the sites (Table 4). Different grain legumes grown in winter and spring season under rice-wheat-mungbean, rice-wheat-cowpea, and rice-lentil-maize systems were evaluated for gross return (GR) return above variable cost (RAVC) and percent change in RAVC. From the analysis it was found that maximum RAVC was recorded from the mung bean followed by cowpea, and lentil for the cropping patterns compared with sole crop of wheat and maize. It shows that these crops are highly remunerating in the systems.

Table 4. Overall economic analysis of winter and spring grain legumes in Sindhuli and Ramechhap during 2009

Description	Crops					
	Cowpea	Maize	Mung bean	Lentil	Wheat	Chick pea
Average grain yield (kg/ha)	2380	3000	2059	1860	2500	2646
Average bio-mass yield (kg/ha)	16070	15000	9830	1860	5000	3307
Gross return (Rs/ha)	150835	67500	149045	130200	60000	133965
Material cost (Rs/ha)	18500	17860	18500	16300	12860	19700
Labor cost (Rs/ha)	32800	41800	30200	30600	36800	29800
Total Variable cost (Rs/ha)	51300	59660	48700	46900	49660	49500
RAVC (Rs/ha)	99535	7840	100345	83300	10340	84465
%Change in RAVC	1169	-	1179	805	-	716

Note: Mungbean and cowpea are the alternative crops of spring maize whereas lentil and chickpea are the alternative crops of wheat in winter

Over all farmers were considering growing lentil, cowpea and mung bean at different locations of Ramechhap and Sindhuli districts in the coming years aswell. Almost all of the ethnic groups in the testing sites highly responded about the positive performance of these crops in the river basin areas of Sindhuli and Ramechhap districts. Among the tested crops, ILL 7982 and Simal of lentil, Surya of cowpea and VC 3960 of mung bean were highly preferred by the farmers over other varieties. Because these varieties were giving high grain yield, having good cooking quality, fit in the cropping patterns, and have been fetchlng handsome market price. At the same time, these have palatable taste and aroma as those of indigenous varieties in the areas.

Conclusion

Farmers have been growing two crops of cereals like rice and maize or wheat in sequential cropping patterns (rice-maize-fallow, rice-fallow-maize, and rice-wheat-fallow) in irrigated lowland conditions of river valley and tars of Sindhuli and Ramechhap districts. With the verification of winter and summer grain legumes technology, it has been possible to include additional crop during fallow period either in winter or in summer without sacrificing main crops in the new cropping patterns. Among the tested varieties, Maheshwar Bharati of lentil, VC 3960 of mung bean and America of cowpea were identified as high yielding ones. From the result of the study, it was concluded that these technologies of grain legume cultivation could be further massively up scaled in the similar domains across the country.

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