R 7542 - Participatory Crop Improvement (PCI) in High Potential Production System (HPPS)-piloting sustainable adoption of new technologies

A Final Technical Report on a Research Project Funded by the Department for International Development's Plant Science Research Programme

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EXECUTIVE SUMMARY

Participatory Crop Improvement (PCI) in high potential production systems piloting sustainable adoption of new technologies was implemented by LI-BIRD with financial and technical support from DFID, Plant Sciences Research Programme, UK and CAZS, University of Wales, Bangor. The project was implemented in Chitwan and Nawalparasi district of Nepal from 1st February 2000 – 31st January 2003 with a no cost extension from 1st February 2003 – 31st July 2003. The project activities included: validating and piloting participatory variety selection (PVS) and informal research and development (IRD) approaches, scaling up of crop varieties identified by R6746 and bred by R8071, minimum tillage in maize, wheat and lentil, scaling up of fodder and tree species preferred by the farmers in PCI I, and monitoring and evaluation of varietal spread and impact assessment of PCI II. The project activities directly involved the District Agriculture Development Offices (DADOs) of 29 districts of terai and middle hills of Nepal and covering more than 20,000 participating farmers in research and development of mandate crops.

The impact assessment of PCI II suggested that PVS is efficient in identifying farmers preferred crop varieties whereas IRD is effective in scaling up preferred varieties. The mother-baby trials (PVS and IRD) were successful in providing varietal options to farmers resulting in enhanced varietal diversity on farm. The varietal diversity has increased by 20% in 2002 as compared to 1997. In Chaite season, BG 1442 has covered almost 40% of the area in Chitwan and Nawalparasi, whereas 17% of the main season rice area is occupied by the varieties identified by PCI or bred from PPB projects. PCI II deployed 13 new rice varieties in main season rice in 2003.

Similarly, kidney bean has been widely adopted by the farmers of Nawalparsai covering almost 20 to 25% of the potential area for this crop. This crop has been popular as a cash crop.

Flemingia congesta, *Ficus roxburghii* and *Ficus semicordata* were three popular fodder species among the dairy and livestock rearing farmers in Chitwan and Nawalparasi. More than 8000 saplings were distributed during the lifespan of the project and there is increasing demand for these species by the dairy groups.

The PCI II has developed functional linkages with the 29 DADOs of terai and middle hills for scaling up main season rice in 2003. The DADOs, INGOs, CBOs and farmers from East to West and terai to hills have collaborated in conducting mother-baby trials to assess new PPB bred varieties for scaling up. The functional collaboration established by the PCI project with line (Government) agencies at different levels has influenced government extension agencies to adopt participatory approaches like mother-baby trials and IRD in their regular programmes.

BACKGROUND

- LI-BIRD has implemented a participatory crop improvement (PCI) project funded by the DFID Plant Sciences Research Programme, UK in high potential production system (HPPS) of Chitwan and Nawalparasi district of Nepal from February 2000 to July 2003.

- Many studies showed that farmers' access to new genetic materials was limited and farmers were still growing very old varieties. The major reasons behind this situation were poor linkage and coordination of research and extension systems and lack of farmers preferred varieties.

- Conventional breeding programs have tended to focus on breeding varieties suitable for irrigated and fertile conditions.

- Farmers' preferences in terms of pre and post harvest traits like micro milling, organoleptic and market traits were poorly understood. Post harvest traits were never considered as selection criteria in main stream breeding programs. National systems promote a few widely adapted varieties with less consideration in the biophysical and socio-economic conditions of Nepalese farming systems.

- Varietal choice of farmers for major crops like rice, wheat, maize, legumes and agroforestry species was very limited.

- Although the potential of the Department of Agriculture, INGOs and NGOs to adopt PVS and IRD approaches in terms of enhancing varietal choices, food security and access to new genetic materials was high, no research on demonstrating, validating and institutionalising PVS and IRD approaches were conducted.

PROJECT PURPOSE

Strategies for the introduction of new varieties and improved agronomic practices in HPPSs validated further developed and scaled up.

RESEARCH ACTIVITIES

Participatory crop improvement project in high potential production system (piloting sustainable adoption of new technology) (Fig. 1) aimed at demonstrating PVS and IRD approaches (Fig. 2) are the best option for piloting new varieties on farm through institutionalisation of these approaches by GOs, INGOs and NGOs.

Mandate crops

- Rice (*Chaite* and Main season)
- Wheat
- Lentil
- Kidney bean
- Agroforestry species (*Flemingea congesta, F. microphylla, Ficus roxburghii, Ficus semicordata, Melia azadirac*)

Since rice cultivation in Nepal is rainfed (70% of total rice area), the PCI project has provided varietal options for rainfed intermediate (rainfed lowland) and shallow rainfed bunded (upland in main season

rice) and we have found greater adoption of PPB bred varieties in the water stress domain. In the past, the conventional breeding programme was concentrated on more favourable rice cultivation but PCI project has targeted to reach resource poor farmers under rainfed rice cultivation systems in Nepal. An impact assessment on adoption was carried out (Table 1) and is described.

PCI villages

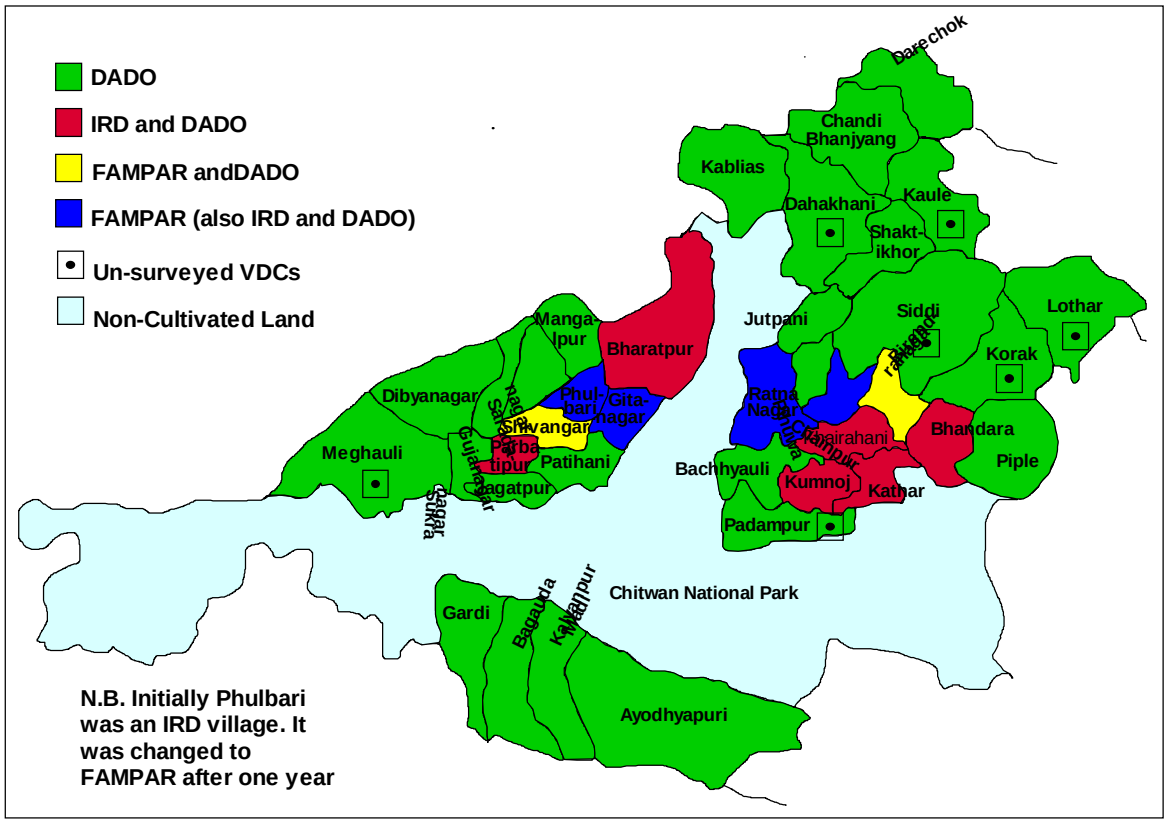


Figure 1. PCI project sites in Chitwan district. Classification of the method of PVS used in the various Village Development committees in the Chitwan district. One polygon represents a village development committee (VDC) and each VDC contains several villages. This is why some VDCs have undergone several methods of PVS, also, VDCs labelled as FAMPAR and IRD also include those villages proximal to them.

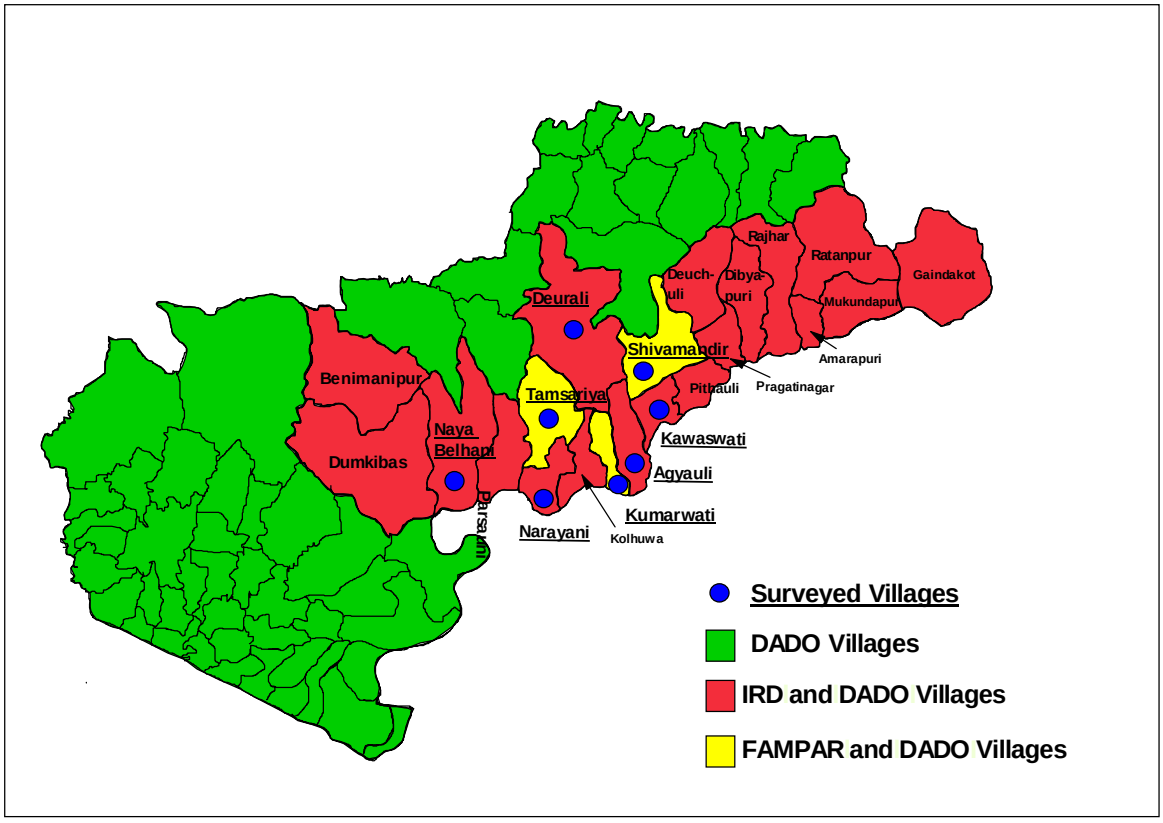


Figure 2. Classification of the method of PVS used in the various Village Development committees in the district of Nawalparasi. One polygon represents a village development committee (VDC) and each VDC contains several villages. This is why some VDCs have undergone several methods of PVS, also, VDCs labelled as FAMPAR and IRD also include those villages proximal to them.

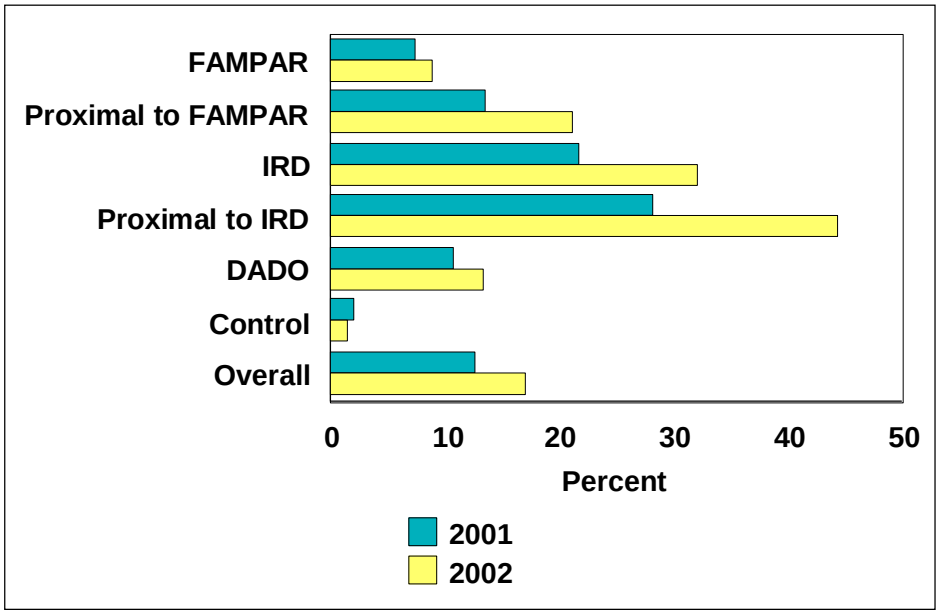
Table 1. Number of villages surveyed in 2001 to 2002 per method of evaluation and the village development community they belong to.

District	VDC	DADO	IRD	Prox to IRD	FAMPAR	Prox to FAMPAR	Control
Chitwan	Ayodhayapuri	Ayodhayapuri					
	Bagauda	Bagauda					
	Bhandara	Bhandara	Bhandara	Khurkhure			
	Bharatpur	Bharatpur	Parasnagar				
	Chainpur	Chainpur	Chainpur	Ladhari	Chainpur	Gaindaale	
	Birendranagar				Sixgroup		
	Darechok	Darechok					
	Dibyanagar	Dibyanagar					
	Ratnanagar		Debauli				
	Gardi	Gardi					
	Gitanager				Champanagar Amarbasti	Ganganagar	
	Gunganager	Gunganager					
	Jagatpur	Jagatpur					
	Kablias	Kablias					
	Chandibhanjyang	Chandibhanjyang					
	Kathar	Kathar	Kharkhutte				
	Kharihani	Kharihani					
	Kumroj	Kumroj					
	Madi Kalyanpur	Madi Kalyanpur					
	Mangalpur	Mangalpur					
	Parbatipur	Parbatipur					
	Pathihani	Pathihani					
	Phulbari	Phulbari					
	Piple	Piple					
	Pithuwa	Pithuwa					
	Ratnanager	Ratnanager	Krishna Mandir Chowk	Jayamangala			
	Saradhanager	Saradhanager					
	Shaktikhor	Shaktikhor					
	Shivanagar	Shivanagar			Radhapur	Shivanagar	
	Sukranager	Sukranager					
Makawanpur	Manahari						Manahari
Nawalparasi	Agyauli		Agyauli				
	Koluwa				Abhiyun		
	Kumarawarti		Amaltari			Dhoki	
	Naya Belhani		Belhani	Jwainthar			
	Bhadara						Rudauli
	Debaulia						
	Narayani		Bhadara	Hardiya			
	Deurali		Julbetar	Guheri			
	Kawaswati		Taruwa				
	Tamsariya				Chormara	Ranitar	
	Shivamandir				Koilapani	Bishnunagar	
TOTAL		27	12	6	7	6	2

Validate PVS and IRD approaches through monitoring and evaluation of varieties scaled up over three seasons

PVS (synonymously called FAMPAR) is useful in identifying and verifying the farmers preferred varieties whereas the IRD approach is effective in dissemination and scaling up of new varieties verified by PVS of mandate crops. Adoption study and comparison was done among FAMPAR, IRD, proximal to FAMPAR, proximal to IRD, DADO and control villages (villages where project has not

any interventions in terms of varietal deployment in any years). In Chitwan PVS was done also through DADO. So an adoption study was done in the DADO villages as well. The result revealed (Fig. 3) that higher adoption of rice varieties recorded in IRD and proximal to IRD villages as compared to other approaches. This indicates that IRD approaches are efficient for quick dissemination of seed and knowledge associated with it.



Source: Devkota et al., 2003

Figure 3. Percentage of farmers land under adopted varieties in villages in 2001 and 2002 according to the method of evaluation used in Chitwan and Nawalparasi.

Preference for 1 kg, 2 kg and 15 kg IRD approaches

We evaluated the effectiveness of 1 kg, 2 kg and 15 kg IRD seed packets in terms of varietal spread in the IRD villages. The study on these approaches of IRD in rice revealed that farmers preferred 2 kg IRD sets (2 kg rice seed in one package) followed by 15 kg demonstration and 1 kg IRD (Fig. 4). However, the spread of rice varieties from 1 kg IRD sets was more than 7 times greater than the original 1 kg seed distributed to farmers. Similarly, 2 kg IRD set increased more than two-fold compared with the original amount of seed distributed whereas 15 kg IRD/Demonstration increased by 1.43. This was due to the fact that the project reached farmers by 1 kg IRD sets as compared to 2 kg IRD and 15 kg IRD/demonstrations which facilitated the farmer-to-farmer seed flow more rapidly.

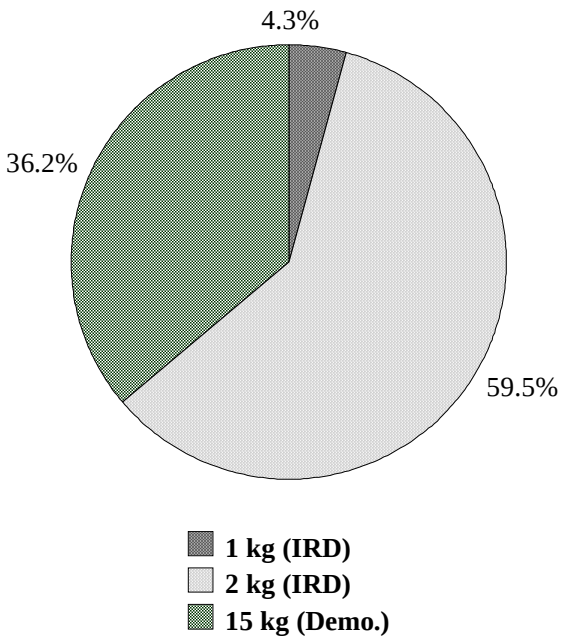


Figure 4. Preference of different sets of IRD (1 kg, 2 kg and 15 kg) reported in a survey (Respondent farmers = 144) conducted in 2003.

Deploy wide range of crop varieties preferred by the farmers.

A wide range of farmers preferred varieties identified through PVS and promoted through IRD. The number of varieties of rice, wheat, lentil and kidney bean deployed by the project increased every year (Table 2) so that farmer's choices for specific niches and production domains could be met. Therefore, after the intervention of PCI project the varietal adoption in particular domains increased greatly resulting in higher varietal diversity on farms in Chitwan and Nawalparasi from 1997 to 2002 (Fig. 5).

Table 2. Crop varieties deployed by PCI II from 2000 through to 2003.

Crop	2000	2001	2002	2003
Main season rice	Sarwati, Barsha, Pant Dhan 10, Swarna, IR 51672, Ekhattar, PNR 381	Pant Dhan 10, Swarna, Sarwati, IR 51672, Ekhattar, Barsha, PNr 381	Barkhe 2001, Barkhe 3004, IAASR 16, IAASR 32, Pant Dhan 10, Sarwati, Sugandha-1, Barkhe 1027	Barkhe 2001, Barkhe 3004, Sugandha-1, Barkhe 1027,Barkhe 2019, Barkhe 2022, Barkhe 2024, Barkhe 2029, Barkhe 2026, IAASR 16, IAASR 32, Pant Dhan 10, Sarwati
Wheat	Rohini, Achyut, BL 1724, NL 750, NL 783	NL 781, NL 783, PBW 154, Sangam, BL 297, NL 297, Rohini, BL 1724, PBW 226	BL 1473, BL 1887, Rohini, Achyut	-
Kidney bean	PDR 14	PDR 14	PDR 14, VL Bouhni, Panta Anupama	PDR 14, VL Bouhni, Panta Anupama
Chaite rice	BG 1442, NDR 97	BG 1442, Judi 115, Judi 503, Judi 521	BG 1442, Judi 141F, Judi 568, Judi 572, Judi 578, Judi 565, Judi 566	BG 1442, Judi 141F, Judi 568, Judi 572, Judi 578, Judi 565, Judi 566, Judi 567
Lentil	Unidentified	PL 406, Arial, Arun, ILL 4402	PL 4067, ILL 4001, Arun, Khajhura 1, Khajhura 2	

After the intervention of PPB project in Chitwan, the choice of rice varieties for *Chaite* and main season increased (Table 2). New PPB products were regularly available for deployment of rice varieties on farm. Also, farmers have better options available to meet their specific niches and requirements in rice cultivation. The varietal adoption in rice was reported as 13% and 17% total rice area of PVS and IRD villages in 2001 and 2002 respectively in Chitwan and Nawalparasi as compared to 0% in 1997 baseline year. Similarly, in wheat BL 1473 became the most popular variety among the farmers in Chitwan and Nawalparasi. Table 3 shows the amount of seed distributed during the second phase of the PCI project.

Table 3. Amount of seed of mandate crops used in PCI II in 2000-2003.

Crop	Seed (kg) in 2000	Seed (kg) in 2001	Seed (kg) in 2002	Seed (kg) in 2003
Rice	-	119978	5444	46737
Wheat	3787	3716	2569	-
Lentil	239	649	662	-
Kidney bean	298	571	360	-

Main season rice varietal diversity in Chitwan and Nawalparasi against the baseline year 1997.

The varietal diversity has been increased drastically after the intervention of PCI project in Chitwan and Nawalparasi district since 1997 (Fig. 6). The area under Masuli variety has been reduced from 66% in 1997 to 26% in 2003 where other many new varieties from PVS adopted on farms leading to higher varietal diversity in terms of number of farmers and area under rice cultivation.

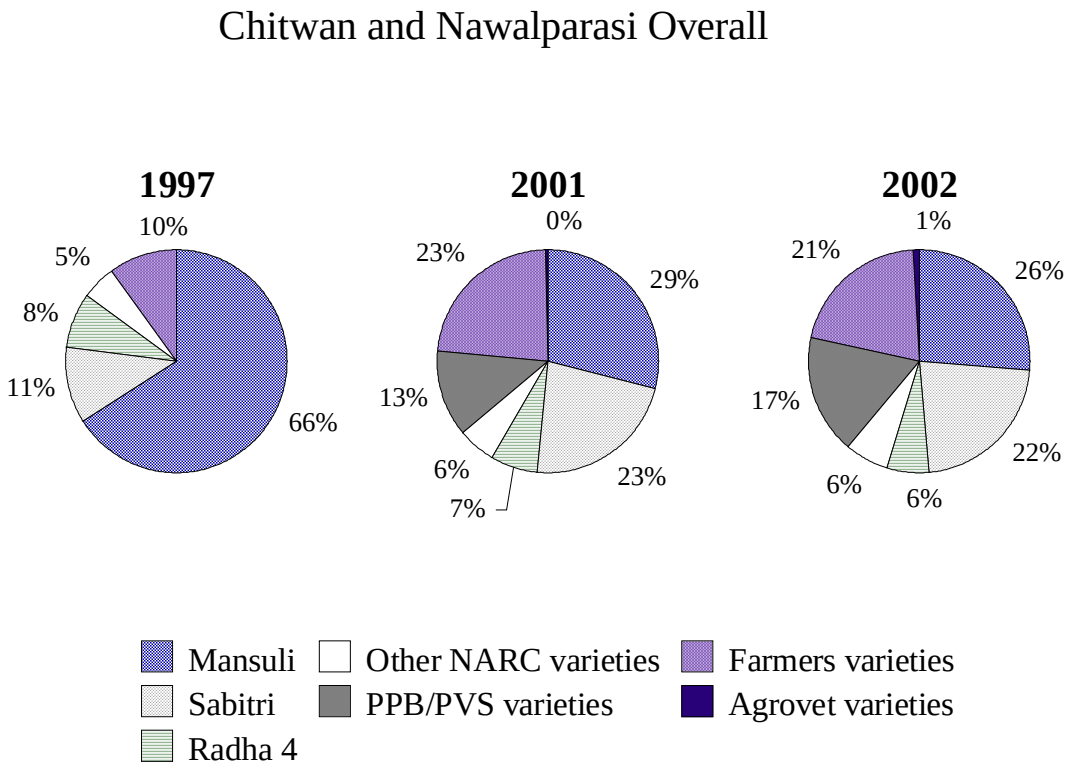


Figure 5. Percentage adoption of main season rice varieties by farmers in Chitwan and Nawalparasi estimated in a survey in 2003. (Number of farmers surveyed = 1387 in 1997 and 3227 in 2001 and 2002).

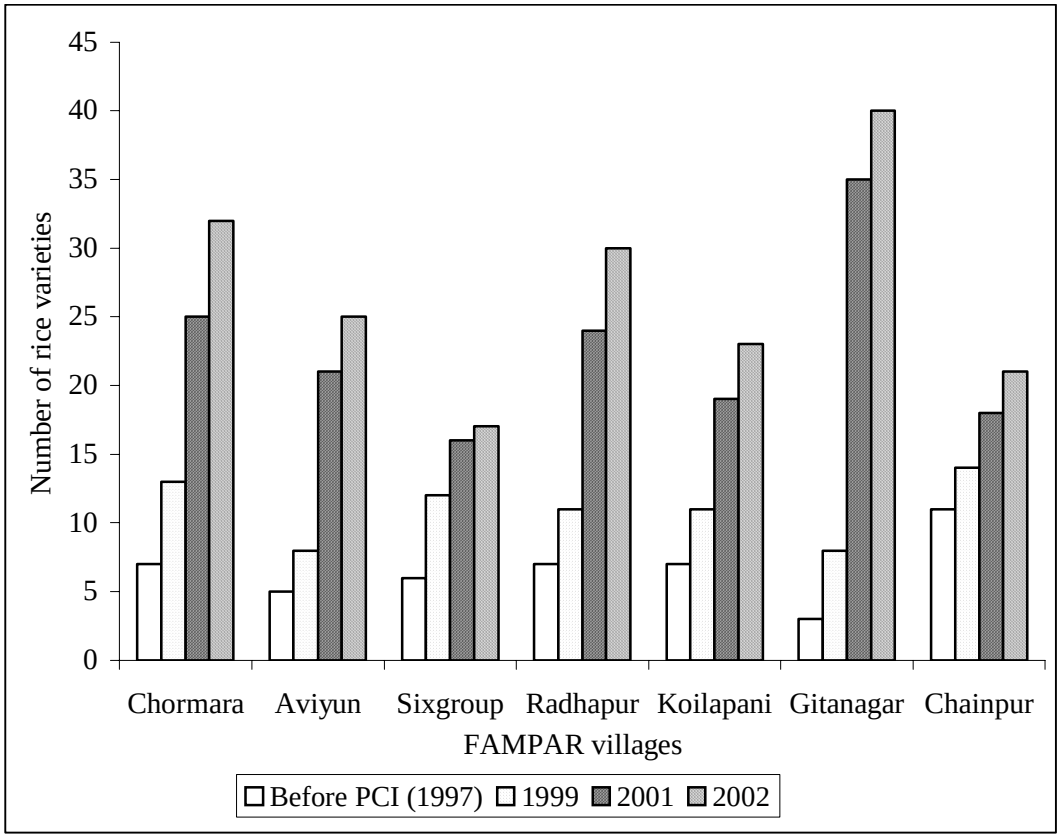
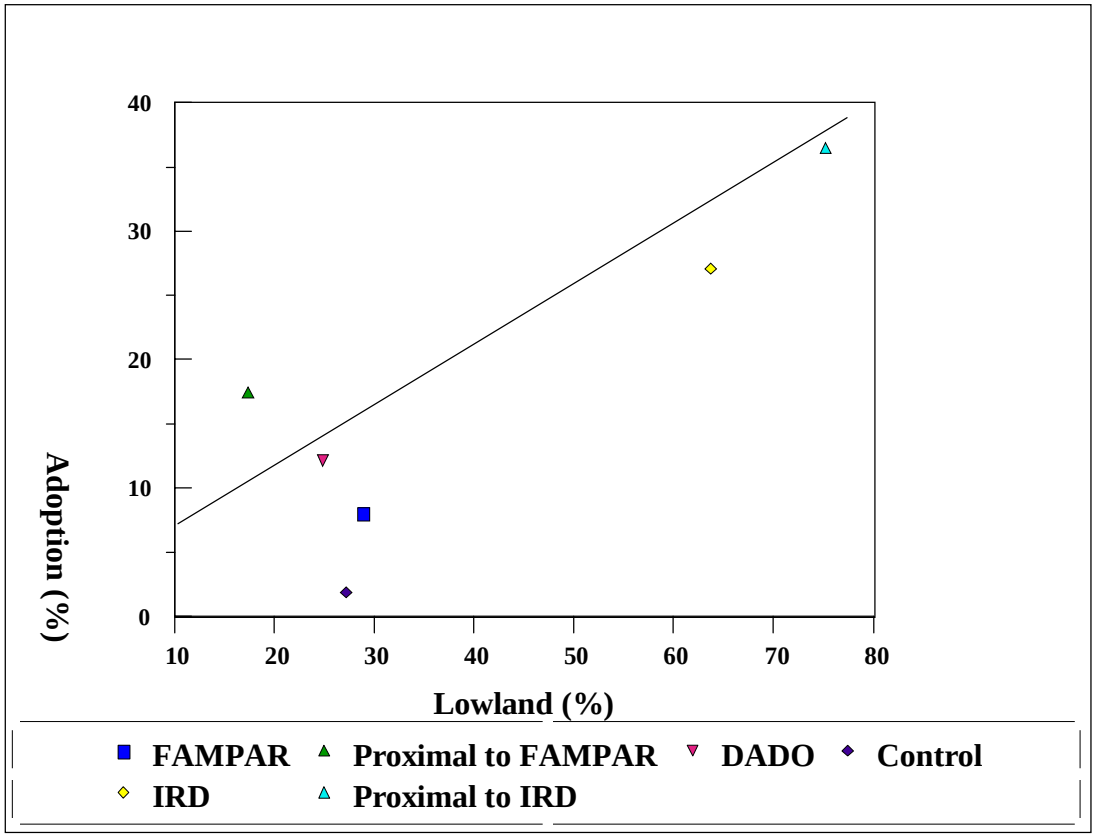


Figure 6. Varietal diversity before and after the Participatory Crop Improvement Program across all the Fampar villages, 1997 to 2002.

Rice varietal diversity by production domain.

The PCI identified- and PPB bred-varieties were mostly Swarna and Barkhe 3004 and were adopted in the lowland in IRD and its proximal villages (Fig. 7). Similarly, early and drought tolerant varieties like Panta Dhan 10, Sarwati, Barkhe 1027, Sugandha 1, Barkhe 2001 were found more suitable to shallow rainfed bunded and rainfed intermediate production domain.



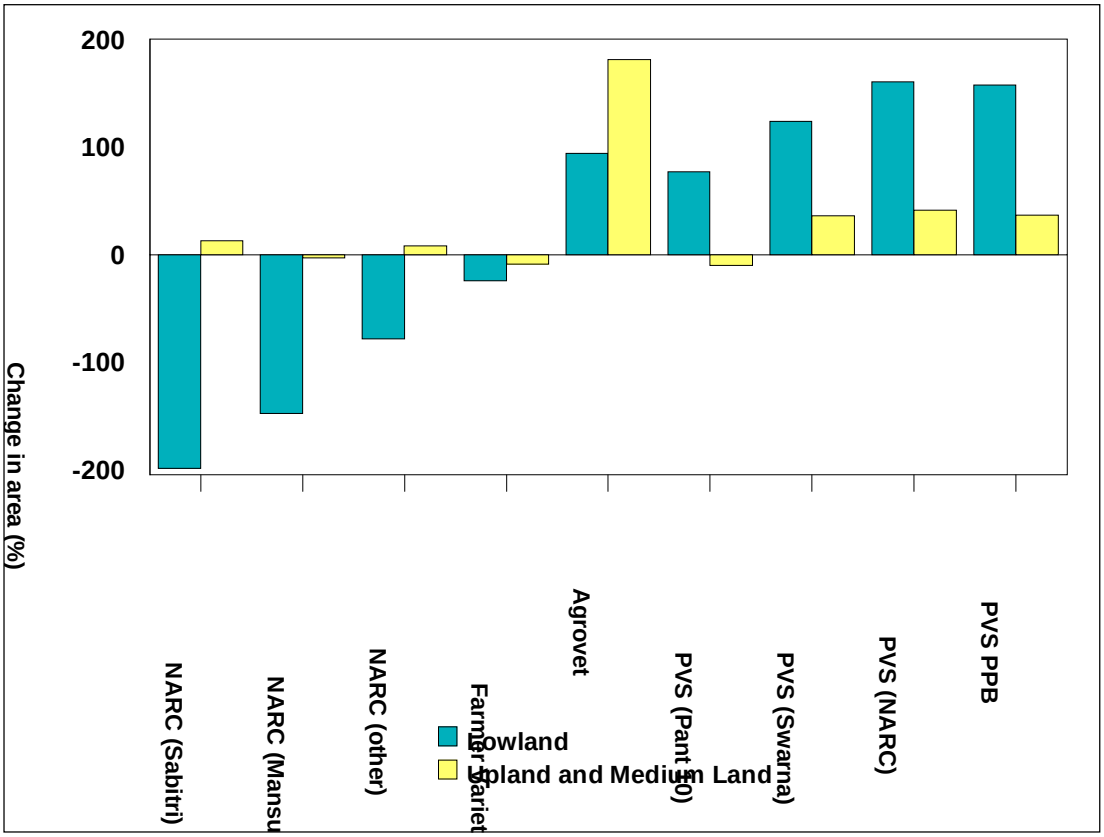
Source: Devkota *et al.*, 2003

Figure 7. Percentage lowland of villages sorted by mode of evaluation, in relation to the percentage of varietal adoption recorded within them (averaged over 2001 and 2002).

Table 4. Area of villages under upland, medium land and lowland by ha and by percentage in impact study sites in Chitwan and Nawalparasi district in 2003.

Participatory approaches	Upland (ha)	Upland (%)	Medium land (ha)	Medium land (%)	Lowland (ha)	Lowland (%)
FAMPAR	16	3	430	69	181	29
IRD	65	17	73	19	242	64
Proximal FAMPAR	2	2	98	81	21	17
Proximal IRD	4	3	25	22	88	75
DADO	224	27	403	48	208	25
Control	12	18	38	55	19	27
Overall	323	15	1067	50	759	35

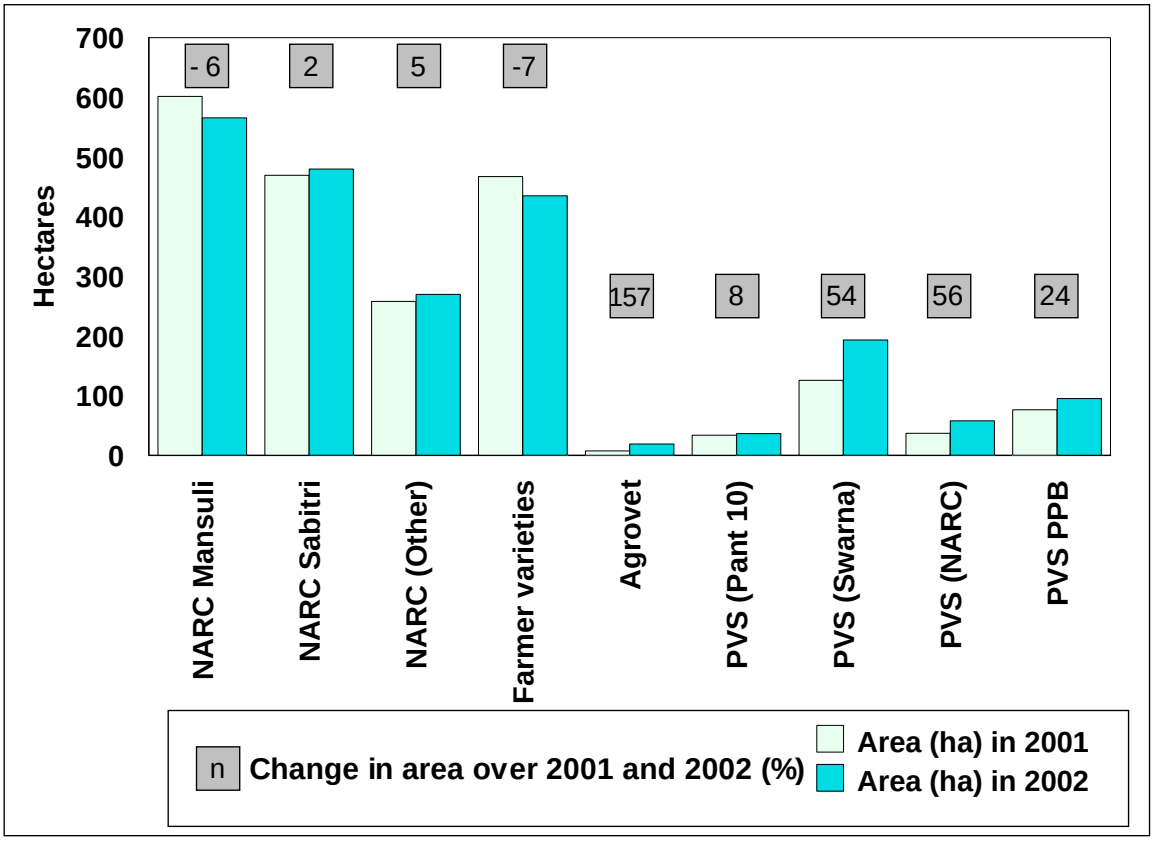
The PVS and PPB bred varieties have been successful in finding its domain in rainfed as well as irrigated rice cultivation systems in Chitwan and Nawalparasi districts (Table 4). For example Pant Dhan 10, Sarwati, Sugandha 1 and Barkhe 1027 have been adopted in Shallow rainfed bunded environments whereas Swarna and Barkhe 3004 adopted in lowland area. Barkhe 2001 and Barkhe 2014 are two promising varieties bred by PPB project getting popularities in irrigated and rainfed intermediate production domains (Fig. 8).



Source: Devkota *et al*., 2003

Figure 8. The change by percent in the area of varieties grown in lowland villages and upland and medium land villages from 2001 to 2002.

Similarly, the PVS and PPB bred varieties are spreading rapidly in their production domains. The impact study conducted in 2003 revealed that the adoption of PPB bred varieties in 2003 increased by 24% as compared to 2002 (Fig. 9). Also the PVS varieties from other sources like NARC and Swarna increased by 56 and 54% respectively in 2003 as against 2002.



Source: Devkota *et al*., 2003

Figure 9. Area grown of all categories of varieties over all surveyed villages, in hectares, in 2001 and 2002, and the change in area between both years (%).

The varietal diversity in the six PVS villages was assessed in an impact study in 2002. The result suggested that the varietal diversity increased each year from the intervention of the PCI project in Chitwan and Nawalparasi. This was mainly due to the introduction of PPB bred varieties in the PVS process. The highest varietal diversity (more than 40 rice varieties) was reported in Gitanagar village of Chitwan district in 2001 and 2002 where the PPB project started in 1998. This was due to the spill over of the rice varieties form the PPB villages to the PCI project area in Gitanagar.

The highest adoption of the PVS varieties was reported in Chaite season rice (Fig 10). Before 1997, BG 1442 was not reported in project sites but the variety was so popular, it replaced CH 45 rapidly with 44 and 40% adoption in 2001 and 2002 respectively in Chitwan and Nawalparasi. The adoption of BG 1442 was observed to be highest (more than 80%) in East Chitwan. In recent years there has been an increase in varietal options in Chaite season available to the farmers of terai and middle hills of Nepal.

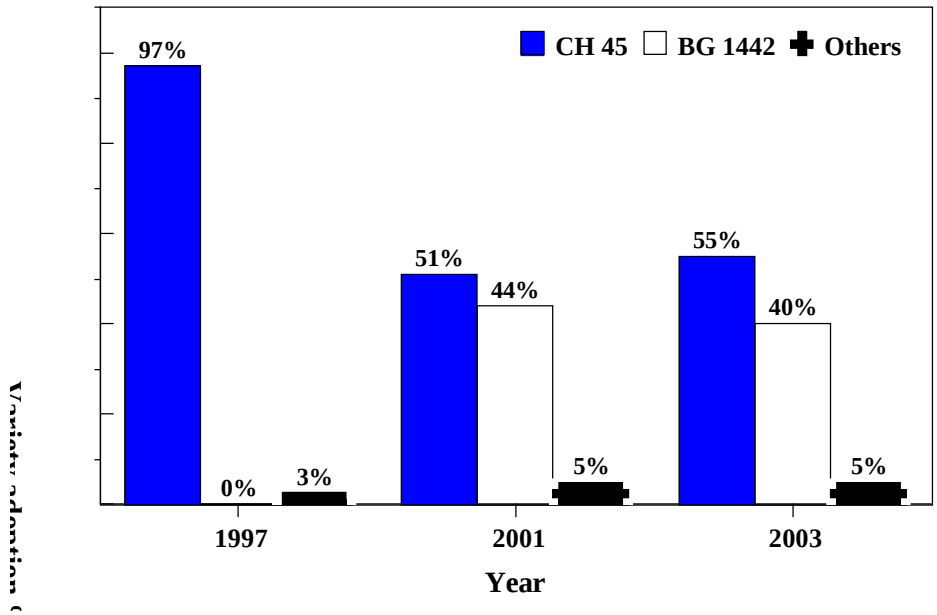


Figure 10. Chaite rice variety adoption by farmers in different years in Chitwan and Nawalparasi estimated in a survey in 2003. (Number of household surveyed 679 and 1061 in 1997 and 2002 respectively).

Another important indicator that old varieties such as Mansuli, despite a large land coverage, are decreasing in popularity, and vice versa in the case of varieties such as Pant 10, Swarna and NARC (PVS) varieties, is the amount of their seeds distributed by farmers (Figure11).

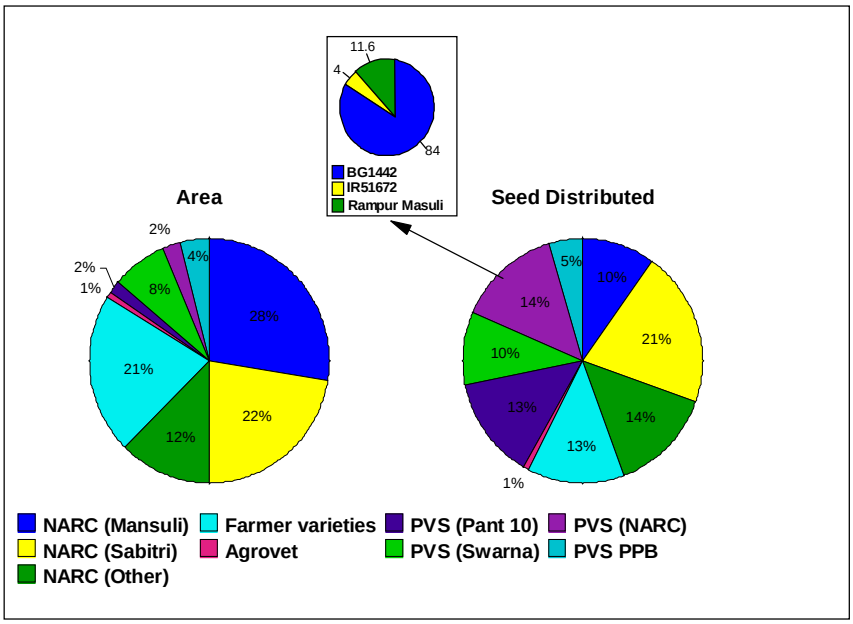


Figure 11. The pie labelled 'seed distributed' shows the percentage of seed distributed from farmer to farmer for each varietal category, (the weight of seed over 2001 and 2002 for each varietal category was averaged). The small pie indicates the composition (by percent) of the seeds spread farmer to farmer, of varieties classified as NARC disseminated through PVS. The pie on the far right shows the percentage of the study area covered by each varietal category (the figures for 2001 and 2002 are averaged).

Of all the seeds distributed by farmers in 2001 and 2002, the percentage attributable to Marmer spread of seeds such as ming 0 and NARC varieties undergoing PVS programmes far outstrip their

percentage coverage. In thansuli farmer varieties are much lower than their percentage land coverage. Seed distribution of Pant 10, and NARC varieties undergoing PVS programmes, far outstrip their percentage coverage.

Wheat

In wheat, BL 1473, Rohini and BL 1887 were the most preferred grown varieties by farmers. BL 1473 was mostly preferred where spring rice is grown because it matures early and is drought tolerant.

Kidney bean

The kidney bean was first introduced by the PCI project in Chitwan and Nawalparasi in 1997 and since then adoption of this crop has been reported very encouraging each year. The impact study 2002 on kidney bean suggested a linear trend in adoption (Fig 12). The area and production of this crop is reported to have increased two-fold each year. Kidney bean has been adopted in 25.6 and 20.4% of the total potential area in Chitwan and Nawalparasi respectively in 2002 (Table 5). The potential area of kidney bean is the total rice cultivated in Shallow rainfed bunded and rainfed intermediate production domains which accounts for 33736 ha in Chitwan. The gross return of kidney bean estimated from impact assessments revealed that it has been accepted as a popular cash crop in Chitwan and Nawalparasi.

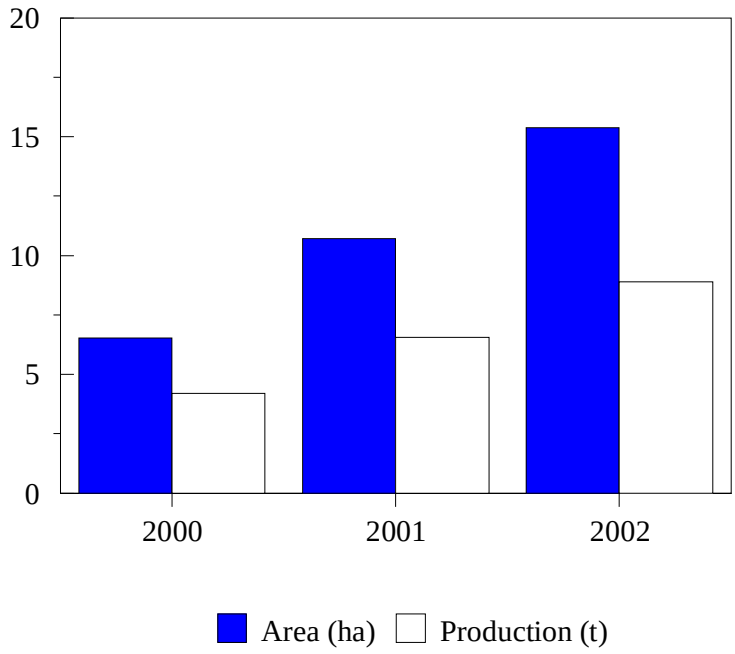


Figure 12. Trend in area (ha) and production (t) of kidney bean in Chitwan and Nawalparasi districts from 2000 to 2002.

Table 5. The potential area and adoption of kidney bean, productivity and gross return in 2002.

District	†Potential area (ha)	Actual area (ha)	No. of household surveyed	Productivity kg ha $^{-1}$	Market price £ kg^{-1}	Gross return £/ha	Per district (,000 £)
Chitwan	33736	1316 (25.6%)	327	545	0.31	175.58	227.1
Nawalparasi	4853	237 (20.4%)	80	740	0.48	357.70	84.7

†The potential area of Kidney bean is the total rice area under shallow rainfed bunded and rainfed intermediate production domain in Chitwan.

Community based seed production activities

The PCI II has put emphasis on strengthening the informal seed supply system for mandate crops. In 2002, 15 rice varieties (Table 2) were included in seed production and 5.4 t of seed distributed through different partners (Fig 13). Similarly, in 2003, a total of 46.7 t seed of 9 rice varieties were produced by the community based seed production system. Individual farmers and farmer-groups were involved in the seed production program. The major partners of PCI II in terms of seed consumption are DADOs of terai and middle hills of Nepal and individual farmers collaborating in the program.

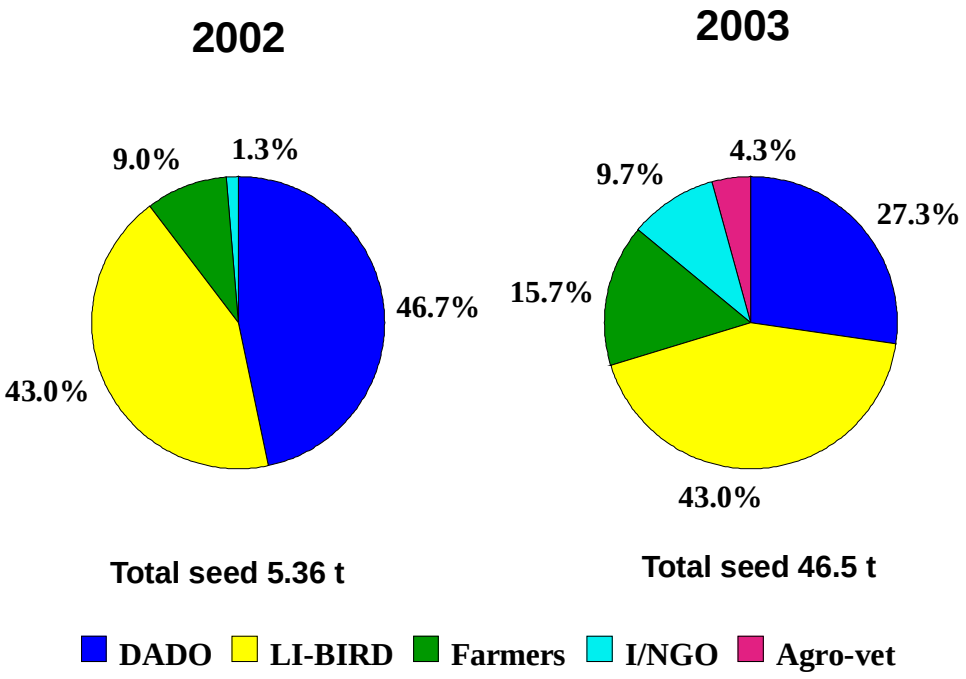


Figure 13. Seed distribution by PCI project to different partners in 2002 and 2003.

Participatory Research on Agronomic Interventions

Tillage trial using Chinese power tiller for conserving moisture and reducing cultivation cost.

An experiment using Chinese power tiller and conventional tractor was conducted in Chainpur, Chitwan by the Pragatishil Women's Group. Trials were conducted on wheat during November 2002 to April 2003 to study the total cost of cultivation, productivity and gross return under two tillage systems. Wheat variety BL 1473 was used for the study. This experiment was conducted in seven farmers' fields having both the tillage practices i.e. sowing wheat in single ploughing through Chinese power tiller and sowing wheat in conventional method using tractor. From this study it was found that grain yield, total cost and total return were not significantly different in these two practices (Table 6). Although not significant, slightly higher grain yield, total cost, total return, gross profit and B: C ratio were observed under conventional tillage systems (Table 7). The experimental site was rainfed upland, dominantly silty soil having poor to no irrigation facilities. The literature suggests that minimum or no tillage systems doe not do well under drier conditions. B: C ratio in the conventional system was higher than under minimum tillage because yield per unit input was higher in the conventional system. This experiment clearly indicated that conventional tillage under such conditions is more profitable than minimum tillage.

Table 6. Analysis of Variance showing the error mean square of participatory research on agronomic interventions tillage trials using Chinese power tiller for conserving moisture and reducing cultivation cost in wheat in Chainpur, Chitwan, 2003.

Source of Variation	df	Grain Yield	Total Cost	Total Return	Gross Profit	Cost Benefit Ratio
Tillage practices	1	2105627 ^{ns}	800539 ^{ns}	190032833 ^{ns}	166165276 ^{ns}	0.089 ^{ns}
Error	7	1306096	26676551	117875170	163984164	0.761

Table 7. Mean of total cost, total return, gross profit and benefit cost ratio in participatory research on agronomic interventions (Tillage trials using Chinese power tiller for conserving moisture and reducing cultivation cost) in wheat in Chainpur, Chitwan, 2003.

Treatment	Grain yield (t ha^{-1})	Total Cost (NRs ha^{-1})	Total Return (NRs ha^{-1})	Gross Profit (NRs ha^{-1})	Benefit Cost Ratio
Single Pass	4.9	22971	46604	23633.7	1.21
Conventional	5.7	23469	54274	30804.6	1.38

On-farm seed priming in wheat, maize and lentil

LI-BIRD has been conducting on-farm seed priming trials on maize, wheat and lentil, in the Chitwan and Nawalparasi districts of Nepal since 1998. The testing of on-farm seed priming technology has been expanded to other projects of LI-BIRD in Gulmi, Syangja and Tanahun districts of Nepal.

The priming has a significant effect on maize grain yield in comparatively dryer areas. In Chitwan the eastern region is dryer than western region. In 2000, we observed increased grain yield due to priming over non-priming in eastern cluster reverse observation recorded in western Chitwan. This indicated that priming was not suitable to wetter region in western Chitwan. In the Nawalparasi cluster we observed mixed results. Priming on wheat also revealed similar effect on yield in dryer region. In 2001, we observed increased grain yield of primed wheat over non-primed in both clusters.

Seed priming was popular with farmers. This technology has been scaled up in the drier region of Western Nepal and LI-BIRD's other projects like Farmers Field Schools in the Buffer Zone of Royal Bardiya National Parks, Bardiya and Livelihood Enhancement Project in Sunsari districts. Some of the collaborating farmers reported that there were practical difficulties in priming viz. priming of large volume of seeds, not suitable for high moisture condition, lack of knowledge of soil and seed moisture lead to damage of seed and lack of awareness and technical know-how.

From the four years of experience and over 300 trials of priming in maize, wheat and lentil, we can conclude that priming has significantly increased grain yield over non-priming. The effect of priming was profound in dryer areas and crops requiring less water. Farmers perceived priming as low cost or no cost technology and adopted it in maize and legumes.

Table 8. Effect of priming on the grain yield of wheat and maize in the project villages of Chitwan and Nawalparasi districts of Nepal during 1999 to 2002.

Year	Crop	Location	Number of trials	Average grain yield t ha^{-1}		t-test *p*-value	Yield difference over non-primed (%)
				Primed	Non-primed		
2000	Maize	Nawalparasi	5	2.16	2.44	0.50	-12.90
		Eastern Chitwan	7	2.62	2.40	0.23	8.40
		Western Chitwan	10	2.48	2.95	0.23	-18.95
	Wheat	Eastern Chitwan	8	3.06	3.03	0.80	0.98
		Western Chitwan	6	3.13	3.26	0.56	-4.10
	Lentil	Eastern Chitwan	6	0.970	0.96	0.68	1.00
		Western Chitwan	7	0.846	0.818	0.67	3.30
		Phulbari Chitwan	8	0.924	0.818	0.01	11.50
2001	Maize	Nawalparasi	9	2.56	2.06	0.04	19.53
		Chitwan	6	3.43	3.23	0.67	5.80
2002	Maize	Krishnamandir, East Chitwan	12	4.72	4.51	0.72	2.96

Seed priming was found to be one of the most effective methods to increase yield in drier regions. (DADO); Chitwan has adopted this practice and included it in their regular programme. Nepal Agriculture Research Council (NARC) has recommended priming as a promising technology for the drier zone of western Nepal.

Improved maize agronomy to reduce the production cost and improve overall net return per unit area of farm

An experiment using Chinese power tiller and conventional tractor was conducted in Chainpur, Chitwan by a Pragatishil Women Group in maize. The variety Arun 2 was used during April 2002 to

July 2002 to study the total cost of cultivation, productivity and gross return under one time and two time ploughing using Chinese hand tractor and farmers practice ploughing by ordinary tractor. This experiment was conducted using eleven farmers field. From this study it was found that grain yield, total return, net profit and B: C ratios were not significantly different among the three tillage practices (Table 9). Significant differences in the total cost of cultivation were found. Significantly higher total cost of cultivation was found under two time ploughing by Chinese hand tractor followed by one time ploughing by Chinese hand tractor and farmers practice ploughing by ordinary tractor. Although it was not significantly different, slightly higher productivity (3.57 t/ha) was observed under single time ploughing followed by conventional and two time ploughing. Similar results were found in total return and B:C ratio also (Table 10).

Table 9. Analysis of Variance showing error mean square in participatory research on agronomic interventions (Tillage trials using Chinese power tiller for conserving moisture and reducing cultivation cost) in maize in Chainpur, Chitwan, 2002.

Source of variation	df	Total cost	Productivity	Total return	Net profit	B:C ratio
Tillage practices	10	2850000**	0.23 ^{ns}	1980000 ^{ns}	6950000 ^{ns}	0.98 ^{ns}
Error	2	103000	1.08	9250000	8950000	0.53

Table 10. Mean of total cost, total return, net profit and benefit (B:C) cost ratio in participatory research on agronomic interventions (Tillage trials using Chinese hand tractor for conserving moisture and reducing cultivation cost) in maize in Chainpur, Chitwan, 2002.

Tillage practices	Total cost NPR ha^{-1}	Productivity t ha^{-1}	Total return NPR ha^{-1}	Net profit NPR ha^{-1}	B:C ratio
One time ploughing by Chinese Hand tractor	14411 (£ 131)	3.57	33047 (£ 300.4)	18636 (£ 169.4)	2.31
Two time ploughing by Chinese Hand tractor	16634 (£ 151.2)	3.30	30483 (£ 277.1)	13849 (£ 125.9)	1.89
Farmers practice, ploughing by ordinary tractor	13500 (£ 122.7)	3.36	31080 (£ 282.5)	17850 (£ 162.2)	2.47
LSD (at p= <0.05)	905	NS	NS	NS	NS

Exchange rate considered 1£ = NPR. 110:00

Scaling up of different agroforestry species

Agroforestry is one of the major components in the PCI project having great impact. Various agroforestry species were scaled up through this project. Some of the species were new for this district. Seven dairy groups (four in Krishnamandir, one in Pithuwa, one in Chainpur and one in Six group) including more than 1112 households (Table 11) were directly benefited through this project. More than 1100 households in these groups adopted one or more agroforestry species in wider scale in their cropping system. The number of species and participating farmers in agroforestry is shown in the table.

Table 11. Different agroforestry species distributed through various dairy groups in Chitwan during 1999 to 2003.

Year	Species	No. of farmers		Total participants	Number of seedlings		Total no. of seedlings
		Trial	IRD		Trial	IRD	
1999	Bakaino	84	-	84	1563	-	1563
	Raikhanyu	46	-	46	95	-	95
	Tanki	87	-	87	677	-	677
	Ipil-ipil	14	-	14	46	-	46
	Badahar	2	-	2	3	-	3
	Total	**233**	**-**	**233**	**2384**	**-**	**2384**
2000	Bakaino	14	23	37	700	250	950
	Nimbaro	-	13	13	-	25	25
	Badahar	-	10	10	-	20	20
	Raikhanyu	-	15	15	-	29	29
	Flemingia	16	-	16	320	-	320
	Total	**30**	**61**	**91**	**1020**	**324**	**1344**
2001	Bakaino	50	3	53	491	12	503
	Raikhanyu	-	177	177	-	272	272
	Badahar	-	101	101	-	154	154
	Nimbaro	-	72	72	-	78	78
	Pakhuri	-	117	117	-	146	146
	Tanki	-	143	143	-	296	296
	Tejpatta	-	18	18	-	18	18
	Gogon	-	16	16	-	16	16
	Flemingia	58	33	91	580	95	675
	Total	**108**	**680**	**788**	**1071**	**1087**	**2185**
2003	Raikhanyu	-	-	-	-	2250	2250
	Nimaro	-	-	-	-	1775	1775
	Flemingia	-	-	-	-	2350	2350
	Mendola	-	-	-	-	575	575
	Total	**-**	**-**	**-**	**-**	**6950**	**6950**
Grand total		**371**	**741**	**1112**	**4475**	**8361**	**12863**

Scaling up of crop varieties through DADO-LI-BIRD Partnership programme

An informal DADO-LI-BIRD partnership was established in 1997. In 2000 an agreement was signed and a Letter of Agreement completed with a formal partnership established. From the success of this partnership in terms of efficiency of dissemination, now PCI has extended its partners to 29 districts of Nepal. Various new varieties of rice, wheat, lentil and kidney bean were introduced through this

partnership program in Chitwan. About 8799 IRD sets of rice, wheat, lentil and kidney bean were distributed through this programme in Chitwan only. About 93 demonstration trials, 1285 kg seed for seed production, 7 planting density trials on rice, wheat, lentil, maize and kidney bean have been done from 2000 to July 2003. During this period more than 10 Agriculture Service Center (ASC) level farmers training, one staff empowerment workshop, one India visit, and 13 joint staff field visit and monitoring programme on different crops have been conducted (Table 12). PCI has strongly empowered the DADO staff on mother baby trials, community based seed production, data entry and statistical analysis using various computer software e.g. SPSS, Excel and spreadsheet management. DADO Chitwan have got three computers, several raincoats, field shoes, bags and umbrellas through this project.

Now varieties introduced through the DADO-LI-BIRD partnership programme occupy 13% of the total rice growing areas in DADO villages of Chitwan in 2002 having huge impact on the livelihood of the people. The area under PVS varieties in 1997 was zero while it was 10% in 2001 and 13% in 2002. Similar impact was found in the case of kidney bean. Now farmers of Chitwan grow kidney bean variety PDR 14 in 4% of their total land. Since this is the high value legume crop it has not only increased the net income but has a positive impact on the soil physical and chemical properties.

Table 12. Activities under different mandate crops through DADO-LI-BIRD partnership programme during 2001-2003 in Chitwan.

Year	Activities	Main season rice	Wheat	Kidney bean	Chaite rice	Lentil	Maize	Total
2001	IRD	2455	150	200	750	50	-	3605
	Demonstration	4	13	12	4	12	-	45
	Planting density trial	4						4
	Seed priming trail	-	50	-	-	-	50	100
	ASC level farmers training	8						8
	Joint field visit and monitoring	2						2
2002	IRD	2500	200	225	180	135	-	3240
	Demonstration	-	10	10	-	10	-	30
	Seed production (kg)	200	238	113	-	30	-	581
	Planting density trail	3						3
	Seed priming trail	-	50	-	-	50	50	150
	ASC level Farmers training	2						2
	Staffs empowerment workshop	1						1
	Joint field visit and monitoring	9						9
2003	IRD	1420	140	130	200	64	-	1954
	Demonstration	-	6	6	-	6		18
	Seed production (kg)	170	140	130	200	64	-	704
	Joint field visit and monitoring	2						2
Total	IRD	6375	490	555	1130	249	-	8799
	Demonstration	4	29	28	4	28	-	93
	Seed production (kg)	370	378	243	200	94	-	1285
	Planting density trail	7						7
	Seed priming trail	-	100	-	-	50	100	250
	ASC level farmers training	10						10
	Staffs empowerment workshop	1						1
	Joint field visit and monitoring	13						13

Methods for PCI technology dissemination identified and promoted

The PCI II has put thrust on institutionalisation of participatory approaches by project partners like GOs, I/NGOs and CBOs. In 2003, 29 DADOs have already participated in conducting mother-baby trials and some of the DADO (Chitwan, Nawalparasi, Jhapa and Sunwari) have already started seed production of PPB bred varieties like Sugandha-1 and Barkhe 3004 through community based seed production in main season rice. Similarly, NRRP, NWRP and NMRP of NARC have active collaboration in PPB and PVS programs in rice, wheat and maize.

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Joshi, K. D., Gyawali S., and Witcombe J. R. 2002. Participatory scaling up of participatory variety selection. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference, Breeding Rainfed Rice for Drought-prone environments Integrating Conventional and Participatory Plant Breeding in South and Southeast Asia, 12-15 March 2002. IRRI, Los Banos, Laguna, Philippines.

Joshi, K. D. and Witcombe J. R. 2001. Participatory variety selection, food security and varietal diversity in a high potential production system in Nepal, 267-274. An exchange of experience from South and South East Asia: proceedings of the international symposium on participatory plant breeding and participatory pant genetic resource enhancement, Pokhara, Nepal, 1-5 May 2000.

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Papers presented in workshops and seminar

Devkota, K. P., K. D. Joshi, S. Gyawali, A. Subedi and J. R. Witcombe. 2002. Impact assessment of main season rice in Chitwan and Nawalparasi Districts of Nepal. Paper presented on “Review and Planning Workshop on “Institutionalisation of Participatory Research and Scaling up Approaches for Rice in Nepal. Dec 11-12 2002, LI-BIRD, DFID-PSP, DOA and NARC, Nepal.

Devkota, K. P., K. P. Baral, S. Gyawali, M. P. Tripathi, A. Subedi, R. Gautam, K. D. Joshi, B. R. Sthapit and J. R. Witcombe. 2003. Scaling up of Participatory Variety Selection: LI-BIRD Experiences. Workshop on "Uptake Pathway and scaling up of Agricultural technologies to enhance livelihood of Nepalese farmers". Sept. 23-24, 2003. MOAC/NARC/NARDF/DFID-HARP, Kathmandu Nepal.

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Gyawali, S., A. Subedi, K. P. Devkota, R. B. Rana, D. K Rijal, P K Shrestha, A Subedi, M. Tripathi and B. R. Sthapit. 2003. Agrobiodiversity Enhancement Through Participatory Research: LI-BIRD’s Initiatives on Plant Genetic Resource (PGR) Management. International Conference on Himalayan Biodiversity. Himalayan Resource Institute (HIRI), Biodiversity Research Group (BRG), Central Department of Zoology, Tribhuvan University, The Ecological Association of Nepal (ECOAN), Nepal Biotechnology Association (NBA). February 26-28 2003, Kathmandu, Nepal.

Tripathi, M. P., K. P. Devkota, S. Gyawali and D. Poudel. 2002. Experience on seed priming in wheat and lentil. Paper presented in winter crop workshop, NARC, 2002.

Nagarkot workshop June 10-14, 2003. Regional workshop on mother baby trial and seed supply system of Nepal.

Linking PCI technology to DADOs in the terai and middle hills of Nepal

Geographic and program foci of PCI II on rice

Based on LI-BIRD/DFID-PSP's mandates and due to the fact that a majority of the poor and marginalized farmers are living in the terai under rainfed rice culture domains, the PCI programs have focused it research initiatives on rainfed rice cultures and marginalized farming systems in high potential production systems of terai of Nepal. Basically the PCI II activities were envisioned to focus on rice, wheat, maize, lentil and agroforestry species and agronomic interventions in Chitwan and Nawalparasi districts. The institutionalisation of the participatory approaches to mainstream research and extension systems were major targets of the PCI II phase. The research initiatives started in 1997 in Chitwan and Nawalparasi scaled up in rice to 4 more districts in eastern and western terai followed by 29 districts in 2003 covering the whole of terai and some middle hills of Nepal (Fig 14).

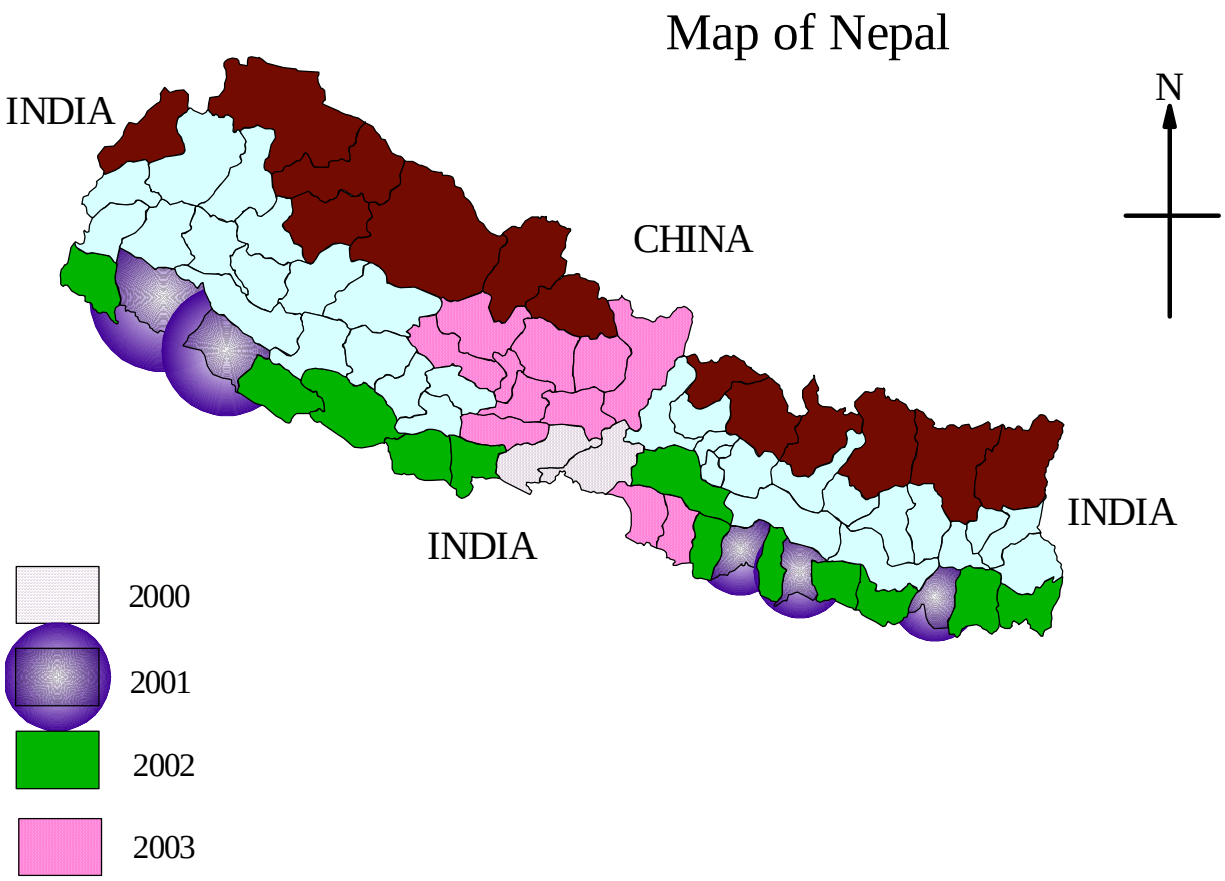

Figure 14. Year of scaling up activities in PCI phase II by districts, 2000-2003.

Contribution of PCI II to Institutionalisation of participatory approaches

The PCI project has been instrumental in demonstrating that through PPB, PVS (mother baby trials) and participatory approaches technology generation, verification and dissemination can be executed simultaneously with benefits for both the research and extension. The PCI project has been successful in influencing Nepalese agricultural research and extension from Ministerial level to farm level (Fig. 15).

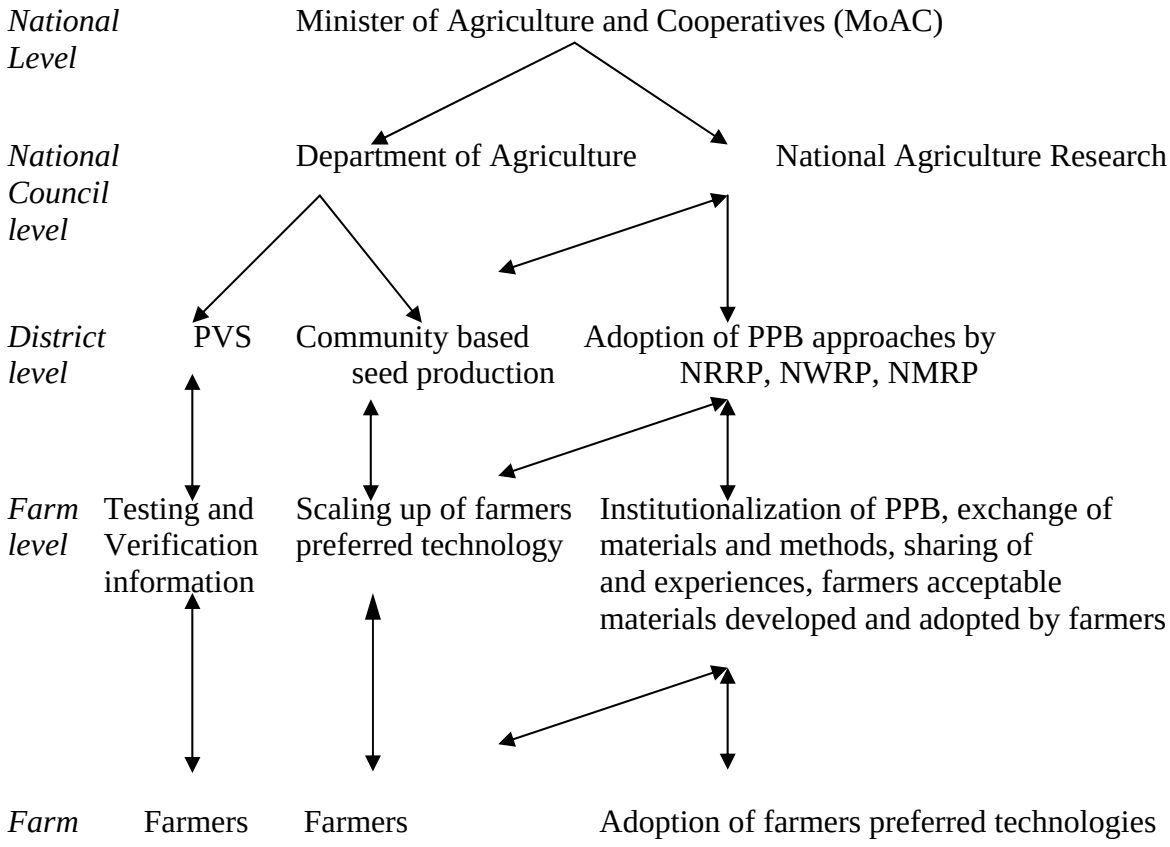

Figure 15. Contribution of PCI II to institutionalisation of participatory approaches at various levels (vertical and horizontal) within mainstream research and development processes.

Flow of genetic materials

When we began with PCI I there were suspicions among DADOs and NARC on participatory approaches. Restricted flow of genetic materials those were identified through PCI projects. Until 1999, DADO Chitwan joined hands with PCI project to accept the approaches and genetic materials identified and developed by PCI I and PPB project. In recent years, the DADOs whole terai and some middle hills have accepted the PPB materials easily for testing, verification and scaling up of preferred materials either identified by PVS or bred through PPB in rice. Recently, the strength of PCI approaches on incorporating farmers' knowledge in varietal improvement has been realized by the NARC, therefore, PPB has been adopted by the main stream breeding programs. In 2003, more than 45 t seed of rice varieties either identified or bred through PCI projects were accepted by the 29 DADOs for testing, verification and scaling up. The participatory approaches have increased farmers' choices on varietal selection in *chaite* and *main* season rice. Large quantities of genetic materials of wheat, maize, lentil, kidney beans and agroforestry species have also been deployed on farms through the participatory approaches.

Therefore the LI-BIRD/DFID-PSP's network with DoA, NARC and other action oriented actors like I/NGO, CBO, farmers and farmers' groups are quite critical for completing the technology design, development and dissemination process. The priorities and focus of PCI II project is to support the varietal improvement initiatives of PVS and PPB in the public sectors research and extension system through institutionalisation of PCI approaches.

The PCI approaches have put emphasis on strengthening farmer's informal network of seed management at a local level. In an impact study, it was found that farmers exchanged 5 t seed of BG 1442, 6.2 t of Pant Dan 10 and 2 t of Sworna in study villages of Chitwan and Nawalparasi in 2001 and 2002 (Fig. 16).

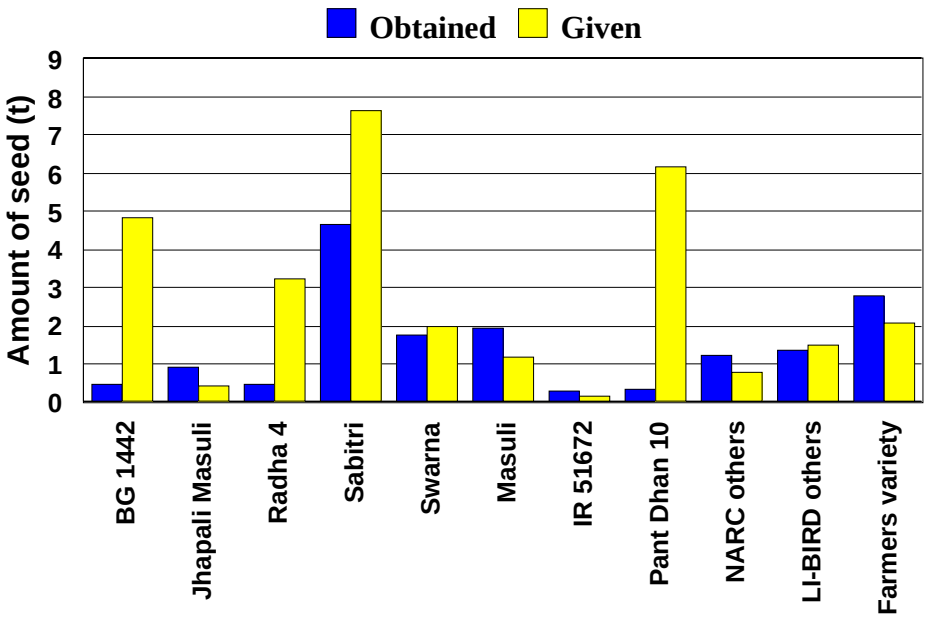

Figure 16. Amount of main season rice seed received and given by the farmers through informal seed supply system in Chitwan and Nawalparasi districts, 2002. (Number of farmers =1681)

The emerging changes, challenges and opportunities

Some institutional challenges have emerged after changes in mindsets of national research and extension systems and in private entrepreneurs in Nepal. The acceptance of PVS and PPB approaches has created a vast demand on the regular supply of information, knowledge and genetic materials to scale up the impact of these approaches. After the demolition of Agriculture Input Corporation (AIC) in Nepal, the importance of community based seed production adopted by PCI project has been greatly increased and appreciated in the light of poor functioning of public sector seed supply system. Realizing the great demand of PPB bred varieties by DADOs and farmers throughout the terai and hills of Nepal, there is a challenge in front of PCI projects to address the supply of farmers preferred technologies on a regular basis. In recent years, the private entrepreneurs, aggravates and seed producers groups have started cereal seed production and are willing to collaborate with PCI projects for scaling up of PPB products. The PCI II has already established linkages for scaling up of PPB bred rice varieties with some of the seed entrepreneurs within the country. The positive impacts of these initiatives of PCI projects are coming up in recent years but how far PCI projects act as a source of knowledge and materials remains a challenge after the termination of current funding.

CONTRIBUTION OF OUTPUTS

The outputs of the project will directly contribute to the development goals of DFID/PSP UK. The PCI II has been successful in validating that PVS and IRD approaches are the best options for on-farm varietal selection and scaling up of farmer preferred varieties in different crops.

The assessment of 1 kg, 2 kg and 15 kg of IRD approaches for varietal adoption and spread revealed that 59.5% farmers liked 2 kg sets. However, the varietal spread was higher from 1 kg seed (7.5 fold increased adoption) than other approaches.

The varietal diversity was greatly increased in shallow irrigated, shallow rainfed bunded and rainfed intermediate production domains in Chitwan and Nawalparasi in 2002.

New PPB bred varieties Sugandha-1, Barkhe 1027, Barkhe 2001 and Barkhe 3004 were mostly preferred by the farmers for their superior post harvest qualities in Chitwan and Nawalparasi.

The impact study on *Chaite* season rice suggested 40% adoption of BG 1442 in Chitwan and Nawalparasi in 2002.

The overall adoption of main season rice was 17% in Chitwan and Nawalparasi in 2002.

The community based seed production through farmers and farmers groups was strengthened. Two seed producer groups namely Unit BUJ Birdie Samoa, Partisan and Dev Jewel Kristi Samoa, Henagar formed after the sensitisation training on Seed production and Marketing in Chitwan.

In 2002, LI-BIRD collected 46.7 t seed produced by the seed producer groups and farmers in the project villages. The seed was used for PVS, IRD, demonstrations and seed prosecution programs in next years.

The PCI II has established a functional relationship on mother-baby trials with DADOs of terai and middle hills of Nepal. The collaboration for mother-baby trials in main season rice has been increased from 2 districts in 2000 to 29 districts in 2003. The DADOs of Jhapa, Chitwan and Kailali have already included the PPB bred varieties into their seed multiplication programs and there is growing demand for Sugandha-1, Barkhe 2001 and Barkhe 3004 for scaling up in post PCI II.

What further market studies need to be done?

The scaling up of mandate crops of PCI is greatly influenced by the market. For example promotion of quality rice (Sugandha-1) is highly influenced by market prices. The focus group discussion with rice mill owners, whole sellers and some of the big industrialists have been done to understand the potential to scale up PPB bred varieties. Similarly, the marketing of kidney bean must also be understood to increase the impact of these crops.

How the output will be available to intended users?

The community based seed production program will improve the availability of seed of farmer-preferred varieties. Strategically community based seed production has been initiated in Jhapa, Morang (Collaboration with DADOs in Eastern Nepal) Chitwan and Nawalparasi (Central Nepal), Bardiya and Kailali (Collaboration with DADOs Western Nepal).

The DADOs and scientist from NARC are involved in the process of implementing mother-baby trials in the terai and middle hills of Nepal. Therefore they are exposed to the participatory approaches and sensitised to adopt the approaches. The Technical staff of the PCI were invited to deliver lectures and share experiences of participatory research and development in various forms such as training, workshop and seminar at local, national and international level.

The outputs of PCI were shared by organizing workshops and seminar, publication and journal and research papers.

What further stage will be needed to develop, test and establish manufacturer and products?

The PCI II has already demonstrated that the GOs and other collaborators have initiated the process of institutionalisation of PVS and IRD approaches. However, the capacity of the partners need to be strengthened and the PCI projects need to supply PPB products and knowledge associated with these. The PCI III phase has been requested for extension which will look after these activities in future.

How and by whom, will the further stages be carried out and paid for?

The 20 months extension of PCI Phase III has been requested for Plant Sciences Research Programs of DFID. The third phase (requested to DFID PSP, UK) will mainly focus on scaling up institutionalisation of PCI technologies by GOs for its sustainability in the long run as an exit strategy of the project. Simultaneously, the impact of the PCI project will be assessed in the next phase and the results will be widely disseminated. The PCI III will be implemented by LI-BIRD jointly with other partners in Nepal.