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## Discussion Paper

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### **Adoption of Main Season Rice in Chitwan and Nawalparasi Districts of Nepal from 2001 to 2002.**

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## ACRONYMS

CAZS-NR	CAZS Natural Resources
CBOs	Community-based organisations
COB	Client-Oriented Breeding
DADO	District Agricultural Development Office
DFID	Department for International Development
DoA	Department of Agriculture
FAMPAR	Farmer Managed Participatory Research
FAO	Food and Agricultural Organisation of the United Nations
FYM	Farm Yard Manure
HPPS	High Potential Production Systems
IRD	Informal Research and Development
JT	Junior Technical Assistant
JTA	Junior Technical Assistant
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
NARC	Nepal Agricultural Research Council
NGOs	Non-government organisations
NSB	National Seed Board
PCI	Participatory Crop Improvement
PSP	Plant Sciences Research Programme
PVS	Participatory Varietal Selection
UK	United Kingdom
VDC	Village Development Committee

# **ADOPTION OF MAIN SEASON RICE IN CHITWAN AND NAWALPARASI DISTRICTS OF NEPAL FROM 2001 TO 2002**

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## **SUMMARY**

This report describes the outcomes of a participatory crop improvement (PCI) project funded by Department for International Development (DFID) Plant Sciences Research Programme (PSP) in Nepal and implemented by LI-BIRD and CAZS Natural Resources (CAZS-NR) in collaboration with Department of Agriculture (DoA), Nepal Agricultural Research Council (NARC) and several non-government organisations (NGOs). The study was done in October-November 2002 covering 3227 households from 58 villages of Chitwan and Nawalparasi districts in Nepal.

The adoption of main season rice varieties identified by the project through participatory varietal

selection (PVS) or bred using client-oriented breeding (COB) was 18% within two to six years of intervention. The level of adoption for new rice varieties was also high in terms of the number of adopting households. Of the various category of rice varieties surveyed, only varieties identified by PVS or bred by COB had an increasing trend in adoption. Varieties such as Sabitri, some of the released varieties and landraces were less affected due to interventions as they remained more or less unchanged in terms of area of adoption and number of adopting households. Modern varieties promoted by farmers' seed system, Radha 4 and Masuli were most affected after the intervention of the project. Nevertheless landraces and modern rice varieties promoted by farmers' seed system represent over 50% of the total rice varietal richness in the entire study area and occupied nearly 24% of rice area. PVS and COB created a range of varietal choices for the less favourable areas where the crop is grown under rainfed conditions or with limited irrigation or, for example, in long-standing water. Rice varietal diversity increased considerably in the study villages through the replacement of old, obsolete and disease-susceptible varieties with new, better-adapted, early-maturing, higher-yielding and farmer-preferred varieties. This has led to an overall improvement in productivity and food security.

The study indicated that adoption is the result of an interaction between land type and rice variety.

One of the important findings from the study was that the pattern of seed distribution could be used as an indicator of future varietal adoption. In

general there was an association between the rate of increase in area of adoption and the amount of seed distributed. Some of the PVS and COB varieties had the highest rate of seed distribution in the villages. The evidence from seed distribution and the changes in adoption from 2001 to 2002 indicated that level of adoption was increasing substantially over time.

The findings from the current study largely strengthen the earlier findings that the levels of adoption in informal research and development (IRD) methods are high. The high adoption levels proximal-to-IRD and IRD villages were due to the higher rate of seed distribution through farmer-to-farmer networks as well as the suitability of most varieties to the villages.

## INTRODUCTION

This forms part of a broader impact assessment (Witcombe *et al.*, 2004) of participatory crop improvement in the low altitude regions of Nepal. The study described here is specifically concerned with the adoption of main season rice varieties in Chitwan and Nawalparasi districts and whether the extent of adoption of new varieties is related to the particular form of participatory varietal evaluation used.

The study area included most parts of Chitwan and eastern part of the Nawalparasi district (both inner *terai*). Much of the area in these districts are favourable agricultural environments forming part of what DFID has defined as High Potential Production Systems (HPPSs) where water and other abiotic constraints are non-limiting.

HPPSs are typically areas of low on-farm varietal diversity because the original landrace diversity has been

replaced by the introduction of modern, high-yielding varieties. However, in the study area the varieties that farmers grow are old. In the main season of 1997, the variety Masuli, which was first introduced in 1973, occupied over 90% of the rice area in study villages in West Chitwan (Rana *et al.*, 2004). Therefore, not all farmers in HPPSs are benefiting fully from modern varieties. More client-oriented research methods such as participatory varietal selection (PVS) and client-oriented breeding (COB) can help farmers grow more modern varieties by exposing farmers to new and potentially better cultivars.

In PVS, farmers are given a wide range of novel cultivars which may be pre-released varieties or have already been released elsewhere, to test for themselves in their own fields (Witcombe *et al.*, 1996, Witcombe *et al.*, 2001). However, there are different approaches to PVS that require differing levels of resource inputs. Two methods used in the participatory crop improvement (PCI) project were; Farmer Managed Participatory Research (FAMPAR) trials or PVS, and Informal Research and Development (IRD). A similar method that was also used by the District Agricultural Development Offices (DADOs) which was referred to as Minikits. FAMPAR, or PVS, uses a somewhat formal trials system (mother and baby trials) with quite elaborate methods of participatory evaluation. In IRD, large numbers of seed packets are widely distributed to farmers in distant villages with very limited technical support and monitoring by researchers (Joshi and Witcombe, 2002). IRD mainly satisfies extension needs, whereas PVS methods satisfy both the needs of research and extension, but requires more resources (Subedi *et al.*, 2003).

This assessment seeks to understand whether, and if so how, the impacts of FAMPAR and IRD varied using several criteria. These included which varieties were adopted, the extent of adoption by area, by households, by land type and the importance of the varieties in the farmer-to-farmer seed distribution network.

## **MATERIALS AND METHODS**

### ***Study area and period***

This study was conducted in the rice growing areas of Chitwan and Nawalparasi in Nepal, and was targeted at main season rice growers. There were 42 villages from Chitwan (Fig. 1, Tables 1 and 2) and 16 villages from Nawalparasi (Fig. 2, Tables 1 and 2) and these were selected purposively from where LI-BIRD had conducted the research from 1997 (FAMPAR or IRD) along with villages that were close to or 'proximal to' those villages, and from where DADO had distributed Minikits from 2000. Three of the community-based organisations (CBO) from Nawalparasi also distributed IRDs in several villages and some of these were also included in the study. One village from Makwanpur and one village from Nawalparasi were surveyed as control villages. The villages that were surveyed are listed in Table 2 and Annex 1 according to the research method used. There were six village types:

- FAMPAR
- Proximal-to-FAMPAR
- IRD
- Proximal-to-IRD

- Scaling up by DADO
- Control

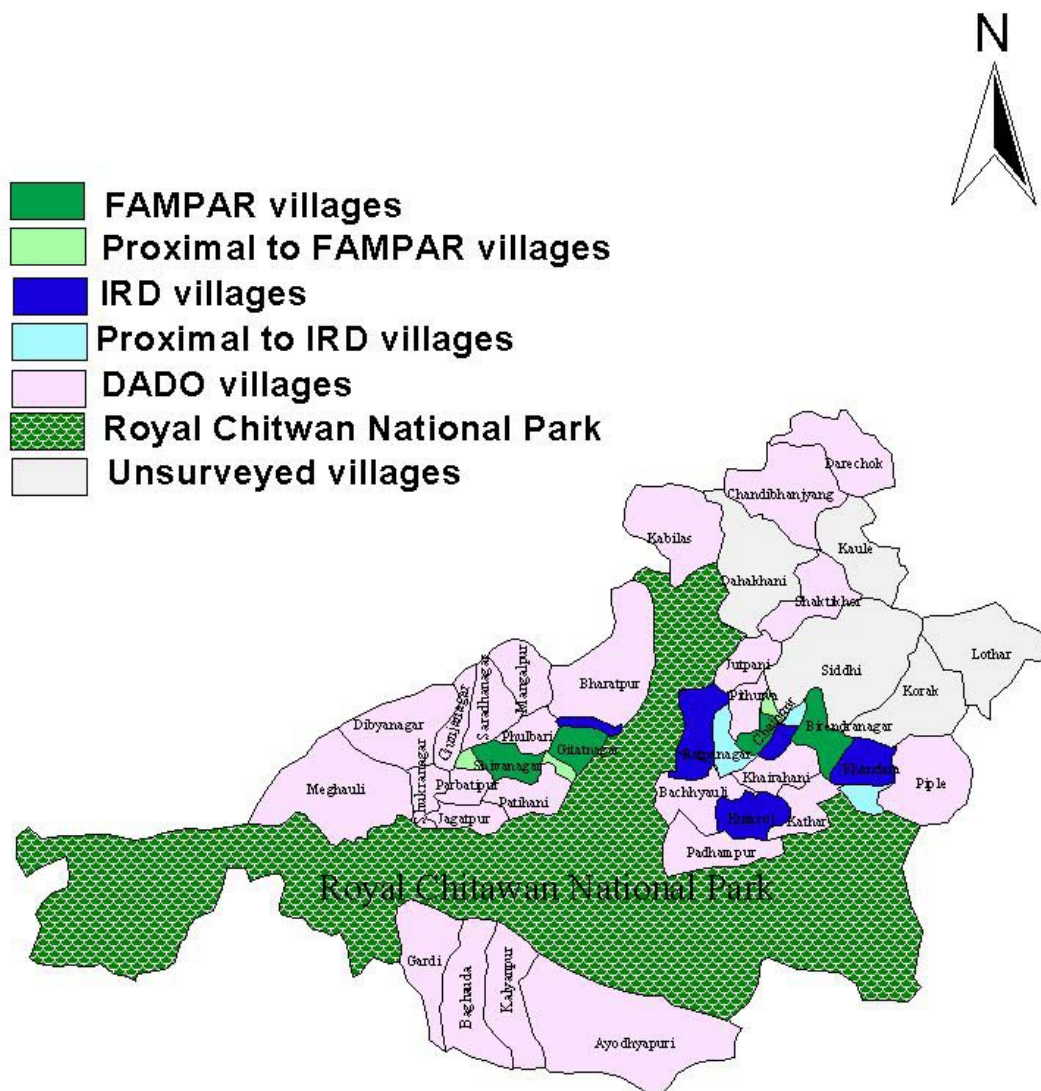
Although, much of the land can be characterised as belonging to HPPSs there is much diversity within these two districts. The survey was carried out in October and November 2002, and information was collected from farmers for the present (2002) and the preceding year (2001).

### ***Sampling***

LI-BIRD had project records of all of the farmers and villages involved in the PCI activities. Lists of farmers involved in the Minikit, were obtained from the District Agriculture Development Office (DADO) Chitwan. Various sampling methods were used for sampling, and different sampling sizes were used for the methods of PVS (Table 1). For the DADO villages where Minikits had been distributed, 20% of all the households given Minikits were selected at random.

### ***Data collection***

Primary data were collected from sample farmers using pre-tested, structured questionnaires. The initial testing was conducted in 5 households situated adjacent to the survey area. The outcome of the trial surveys was reviewed and appropriate changes incorporated into the questionnaire. An interview schedule was finalised. For the DADO villages in Chitwan, Junior Technicians (JTs) and Junior Technical Assistants (JTAs) from their respective Agricultural Service Centres (ASCs) conducted the survey. For other villages, students from various colleges



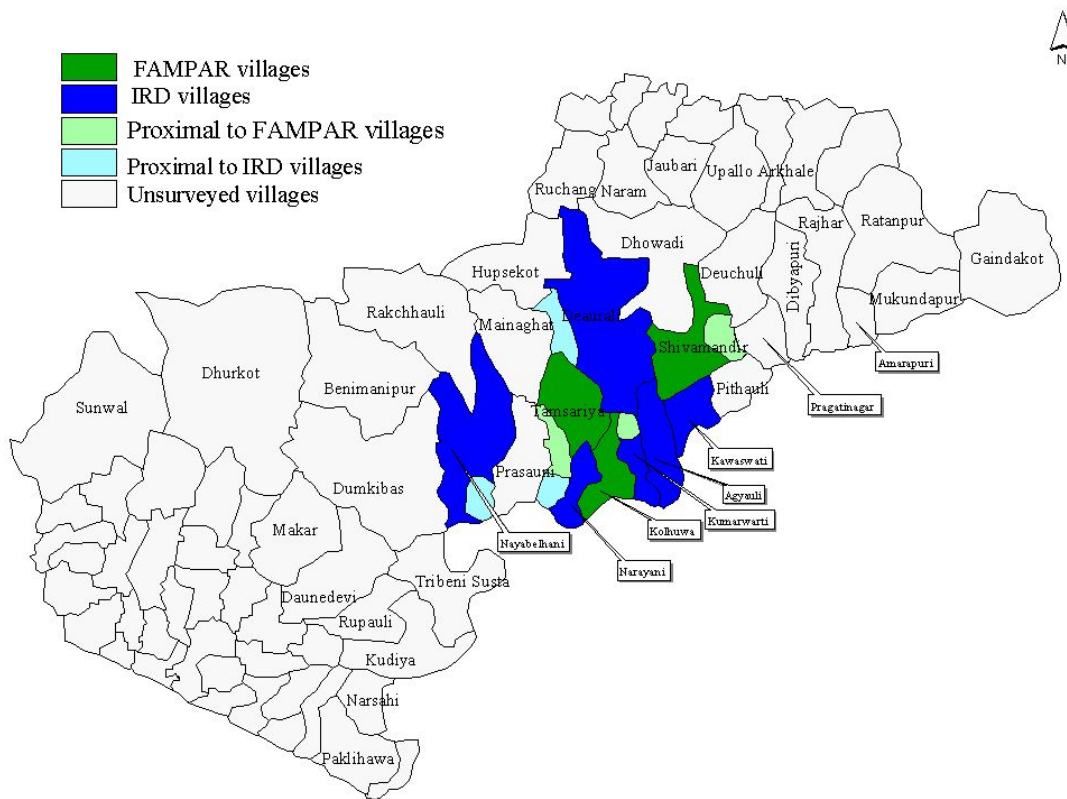
**Figure 1.** Classification of the method of PVS used in the various Village Development Committees (VDC) in the Chitwan district. Each area represents a VDC and each contains several villages. Hence, in some VDCs several methods of PVS were used. VDCs labelled as FAMPAR and IRD also have the ‘proximal’ villages within them. Non-surveyed VDCs are indicated.

of Nepal were employed to collect the information. Daily monitoring was done by a joint team from LI-BIRD and DADO, Chitwan, throughout the survey period. Information on total rice area and the area devoted to various varieties at the household level was recorded for 2001 and 2002. The study was done in October/November 2002. The data on varietal adoption, quantity of seed transacted and the recipients of

each transaction were recorded together with the names of the rice varieties. Information obtained through observation, informal group discussion and key informants was also collected.

**Data analysis**

Analysis was done by LI-BIRD, DADO, Chitwan and CAZS-NR. The data collected from the field were coded, entered onto the computer and



**Figure 2.** Classification of the method of PVS used in the various Village Development Committees (VDCs) in the Nawalparasi district. Each polygon represents a VDC and each contains several villages. In some VDCs, several methods of PVS were used. VDCs labelled as FAMPAR and IRD also have the ‘proximal’ villages within them. Non-surveyed VDCs are indicated.

analysed using MS-Excel. The analysis was done by mode of intervention, by land type and by category of variety. Five major categories of varieties were agreed for the purpose of this study those were: released, farmers' varieties, PVS varieties, varieties bred by COB and Agrovet varieties.

**RESULTS**

***Rice Varietal Inventory***

A total of 98 varieties were recorded from the study (Table 3).

*Released varieties:* Varieties released by the national seed board (NSB) have been included in this category. This includes popular varieties such as Masuli, Sabitri and Radha 4 and all other varieties released from 1959 to 2000. There were 11 other released varieties grown by the farmers (Table 3).

*Farmers’ varieties:* Two types of varieties have been included in this category, e.g. landraces and modern varieties. Modern varieties in this category are those that have been adopted



**Table 1.** The method of sampling, number of villages surveyed (in total and by district), and the number of households included in the sample, according to the method of PVS

	Chitwan DADO scaled up villages				FAMPAR	Proximal to FAMPAR	IRD	Proximal to IRD	Control villages
	Hilly area	Eastern Chitwan	Western Chitwan	Madi valley					
Date of first intervention	1999	1999	1999	1999	1997	1997	1997	1998	NA <sup>b</sup>
Method of sampling	Purposive <sup>c</sup>	Purposive <sup>c</sup>	Purposive <sup>c</sup>	Purposive <sup>c</sup>					
Villages in Chitwan	3	10	10	4	3	3	6	3	1 <sup>d</sup>
Villages in Nawalparasi	na	na	na	na	4	3	6	3	1
Total villages surveyed	3	10	10	4	7	6	12	6	2
Total households surveyed	1190 of 5950				All of 1017 25 per village		All of 620 25 per village		50 per village

<sup>a</sup> FAMPAR = Farmer Managed Participatory Research, IRD = Informal Research and Development. <sup>b</sup> NA = not applicable. <sup>c</sup> Randomly selected from the purposive sampling, however, data of Jutepani were merged with Ratnanagar and that of Shivanagar with Mangalpur during the analysis as number of household surveyed in these villages were <5. <sup>d</sup> One village was sampled in Makwanpur as a control village, which is adjoining with Chitwan. na: indicates not applicable.

**Table 2.** List of surveyed villages

Method	East Chitwan	West Chitwan	Nawalparasi
FAMPAR	Chainpur, Six Group (2) <sup>a</sup>	Gitanagar, Radhapur (2)	Chormara, Abhiyun, Koilapani (3)
Proximal to FAMPAR	Gaindeale (Chainpur) 1	Shivanagar (Radhapur), Ganganagar (Gitanagar) 2	Bishnunagar (Koilapani), Dhoki (Awiwon), Ranitar (Chormara) (3)
IRD	Krishnamandir, Bhandara, Kharkhutte, Debauli, Chainpur (5)	Parasnagar, (1)	Bhadhara, Belhani Amaltari, Agyauli, Julbetar, Taruwa (6)
Proximal to IRD	Bhandara (Bhandara), Jamunapur/Girauna (Krishnamandir), Ladhari (Chainpur) 3	-	Guehenary (Julbetar), Hardiya (Bhadara), Jwainthar (Belhani) (3)
Scaling up by DADO	Ratnagar, Dibyanagar, Bhandara, Piple, Pithuwa, Khairhani, Chainpur, Kumroj, Kathar, Jutpani (10),	Gunjanagar, Shukranagar, Jagatpur, Phulbari, Meghauri, Saradhanagar, Mangalpur, Parbatipur, Patihani, Shivanagar (10)	
Scaling up by DADO <sup>b</sup>	<b>Madi:</b> Gardi, Kalyanpur, Bagauda, Ayodhyapuri (4)	<b>Hilly area:</b> Kabilas, Kuringhat, Shaktikhor (3)	
Control villages	Makwanpur (Manahari) (1)		Rudauli (1)

<sup>a</sup> Figures in the parenthesis indicates number of villages.

after being tested with the farmers at some point as part of the on-farm evaluation by DADO or NARC but never released. For example Aus Masuli (Kanchhi Masuli), Ekhattar, Radha 17 or those varieties that came from India from farmer-to-farmer networks e.g. Sarjoo 52, Mala, Malaysia, Sambha Masuli. However, none of these varieties are officially recommended therefore lack regular seed replacement and many may have lost their original identity in the farmers fields (Table 3).

*Farmers' varieties:* Two types of varieties have been included in this category, e.g. landraces and modern varieties. Modern varieties in this category are those that have been adopted after being tested with the farmers at some point as a part of on-farm evaluation by DADO or NARC but never released. For example Aus Masuli (Kanchhi Masuli), Ekhattar, Radha 17 or those varieties that came from India from farmer-to-farmer network e.g. Sarjoo 52, Mala, Malaysia, Sambha Masuli. However, none of these varieties are officially recommended and so lack regular seed replacement and many may have lost their original identity (Table 3).

*PVS varieties:* This category has three sub categories; popular PVS varieties, rice varieties introduced from NARC and tested in PVS trials and other rice varieties mostly introduced from Indian Universities and evaluated in PVS.

*Varieties bred by client-oriented breeding (COB):* This category contains only those varieties that have been bred using client-oriented breeding by a LI-BIRD-CAZS Natural Resources (CAZS-NR) collaboration with the active participation of the farmers in Nepal.

*Agrovet varieties:* Hybrid rice varieties marketed by private sector seed companies (these companies are commonly known as Agrovetts in Nepal) were included in this group.

#### ***The adoption trend by area***

By far the most widely grown varieties were Masuli and Sabitri accounting for 50% of the total area in the surveyed villages (Table 4). Nearly 24% of the area was under farmers' varieties; modern varieties promoted by farmer-to-farmer seed system and landraces. Cultivars disseminated by PVS and COB methods accounted for nearly 18% of the rice area in 2002. Although the percentage area coverage by COB varieties was quite low owing to the limited supply of seeds as all of these are still in their early stage of the development, however, the rate of increase for this category of varieties from 2001 to 2002 was quite remarkable (Table 4).

Masuli, Radha 4 and modern varieties promoted by farmers system suffered the greatest decline in area coverage after the project intervention. The area of Masuli and Radha 4 declined by around 65 ha in 2002, which was far more than the decline in modern rice varieties promoted by farmers' seed systems and other released but less popular varieties (Fig. 3).

Some rice varieties were less influenced by the introduction of new rice varieties. For example Sabitri, other released varieties and landraces showed more or less similar adoption trends from 2001 and 2002. Pant Dhan 10 was also in this category (Table 4). This is understandable as Sabitri and Pant Dhan 10 have their own specific growing environments and are well accepted varieties.

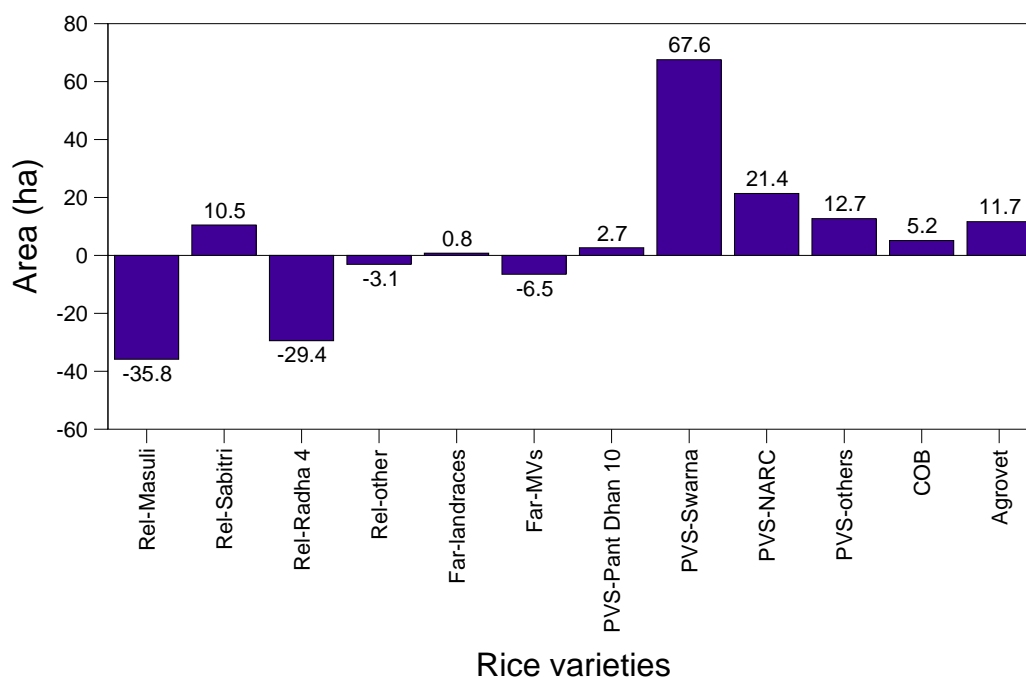
**Table 3.** Inventory of rice varieties recorded during the study

Category of rice varieties	Name of rice varieties	Number of varieties
<b>1. Released</b>		
1.1 Popular varieties	Masuli, Sabitri, Radha 4 (Bammorcha, Chuarasi, Mota, Gaire saila, Makar kaddu, Kilo, Dhikuri)	3
1.2 Other released varieties	CH 45 (Japani) Chaite 2, Chaite 4, Himali, Janaki, Laxmi, Makawanpur 1, Radha 7, Radhakrishna 9, Radha 11 (Rambilas), Taichung	11
<b>2. Farmers varieties</b>		
2.1 Landraces	Aapjhutte, Achhame Masino, Adhikhola, Anadi, Antare, Banarasi, Battsara, Bhadaiya, Bihari, Bijaya Dabbe Gauriya, Hajariya, Jernali, Jethobudho, Jhinuwa, Junge Dhan, Juwa, Kasmire, Makasi, Manabhog, Manamuri, Masino (Jhinuwa, Kanajira), Pahalman, Pokhrela Masino, Poteli, RB, Salagam, Sarala, Shova, Sita, Tamang Thapachini, Wasan	33
2.2 Modern varieties	Bhale Masuli, BPI 3-2, Govinda, Indrasan, IR 20, IT, Aus Masuli (Jhapali Masuli, Kanchhi Masuli, Bans Dhan, Banspate), Mala, Malaysia, OR 367, Pakhe Masuli (Dare Masuli, Hade Masuli, Gokul Masuli, Dinanath), Radha 17 (Makhamali, Rato Masuli), Sambha Masuli, Sarjoo 52, TW, 1008, 1017, 1072, 8000, 8848	20
<b>3. PVS varieties</b>		
3.1 Popular varieties	Pant Dhan 10 and Swarna	2
3.2 NARC PVS	BG1442, Radha 32, Radha 82, AS781-1 (Rampur Masuli) <sup>§</sup>	4
3.3 Other PVS	Barsha, Ekhattar, GR 4, IAAS 16, IAAS32, IR 64, Kalinga III, Lahure, Mahalaxmi, NDR 97, PNR 381, PR 103, Pusa 33, Pusa Basmati 1, Samanta, Sarwati, Urbashi	17
<b>4. COB</b>		
	Barkhe 1027, Barkhe 2001, Barkhe 3004, Judi 572, Judi 582, MT1, MT2, Sugandha 1	6
<b>5. Agrovat varieties</b>		
	Loknath 505 and Shankar	2
<b>Total</b>		<b>98</b>

<sup>§</sup>AS781-1 was subsequently released in 1999 by the National Seed Board as Rampur Masuli (also known as Chhote Masuli).

Landraces on the other hand have very specialised niches, where probably other varieties are less suitable and they also have niche market therefore stability in their area adoption is quite sensible. The category of varieties that showed increasing trend in adoption was mostly the varieties identified by

PVS or bred by COB or Agrovat varieties (Table 4).



**Figure 3.** Change in area (ha) of various categories of rice varieties over all surveyed villages from 2001 to 2002.

#### ***The adoption trend by households***

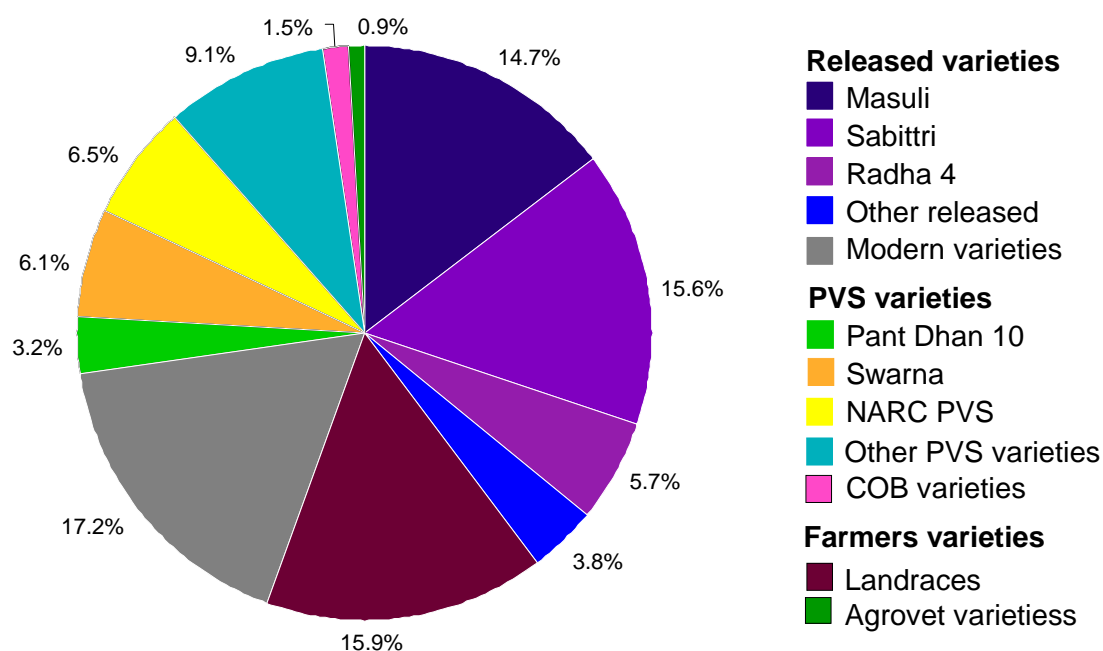
Masuli and Sabitri showed a greater decline as measured by household adoption percentage as only about 15% of the total households were growing Masuli in 2002 while this percentage was slightly more for Sabitri (Fig. 5). This was expected as the Masuli is becoming increasingly susceptible to diseases and many of the Masuli growers who were exposed to new varieties from PVS and COB dropped this variety. In case of Sabitri its poor performance in the low lying areas may have been the main cause for its decline. Both the area of adoption and household coverage remained more or less the same for Radha 4 (Table 4, Fig 5). One of the important indicators of success of the project is the increase in percentage of households growing new varieties promoted by the project. Over 26% of the surveyed households were growing varieties identified by PVS and bred by COB (Fig 5). With the exception of Pant Dhan 10, all the

other new varieties were grown by more farmers in 2002 than in the previous year (Table 4). Although area under Agrovet varieties was more, it is interesting to note that more households were growing COB varieties than hybrids (Fig. 5). One of the important outcomes of the project is that there was considerable increase in the choice of varieties for all the land types. New, high-yielding, disease-tolerant, better-adapted and farmer-preferred varieties were replacing old, disease-susceptible and obsolete ones. This process provides environmental benefits to the community as both theory and observations indicate that genetic heterogeneity is one possible solution to the increased vulnerability of monoculture crops to diseases and pests.

**Table 4.** Rice varietal diversity in the selected villages of Chitwan and Nawalparasi districts of Nepal after the adoption of new rice varieties identified through PVS or bred by COB across all the study villages in 2001 and 2002

Rice varieties	Year <sup>a</sup>	Number of adopting farmers			Area adoption (ha)			Adoption (%)		
		2001	2002	1997 <sup>b</sup>	2001	2002	T test <sup>c</sup> statistics	1997	2001	2002
<b>Popular released varieties</b>										
Masuli	1973	1212	1119	595.7	601.9	566.1	0.31	71.6	29.1±1.0	26.7±0.96
Sabitri	1979	1114	1189	70.2	469.4	480.0	0.70	8.4	22.7±0.92	22.6±0.91
Radha 4	1994	474	436	42.0	160.9	131.5	0.07	5.0	7.8±0.6	6.2±0.5
Other released varieties (11) <sup>d</sup>	1959-1996	240	290	18.7	52.7	49.6	0.29	2.3	2.5±0.3	2.3±0.3
<b>Farmers varieties</b>										
Landraces (33)	-	1131	1211	na	102.5	103.3	0.06	na	5.0±0.5	4.9±0.5
Modern varieties (20) <sup>e</sup>	-	1339	1310	105.8	401.2	394.7	0.67	12.7	19.4±0.9	18.6±0.8
<b>PVS varieties</b>										
Pant Dhan 10	1997-2002	282	244	-	33.9	36.6	0.59	-	1.6±0.3	1.7±0.3
Swarna	1997-2002	442	466	-	125.8	193.4	0.01*	-	6.1±0.5	9.1±0.6
NARC PVS varieties (4)	1997-2002	275	495	-	16.3	37.7	0.00**	-	0.8±0.2	1.8±0.3
Other PVS varieties (17)	1997-2002	744	697	-	92.2	104.9	0.88	-	4.5±0.5	4.9±0.5
<b>Varieties bred by COB (6)</b>	2001-2002	47	111	-	1.0	6.2	0.00**	-	0.1±0.07	0.3±0.12
<b>Agrovets varieties (2) <sup>f</sup></b>	2000-2002	32	70	-	7.4	19.1	0.00**	-	0.4±0.14	0.9±0.2
<b>Total</b>		7332	7638	832.4	2065.2	2123.1		100.0	100.0	100.0

<sup>a</sup> Year of release, evaluated in PCI project or promoted in the farmers field by private sector, e.g. hybrid varieties <sup>b</sup> From a baseline survey of 1478 households in 8 villages in 1997 in Chitwan and Nawalparasi districts, Nepal. <sup>c</sup> Probability for paired t test for area adoption in 2001 and 2002 of various rice varieties, \* = P < 0.05, \*\* = P < 0.01. <sup>d</sup> Figures in the parentheses are number of varieties. <sup>e</sup> Modern varieties promoted by farmers seed system, some pre-released varieties, e.g., Ekhattar, Radha 17, Kanchhi Masuli, IR 20, BPI 3-2, OR 367, Sarjoo 52, Mala, Malaysia, Sambha Masuli etc. <sup>f</sup> Agrovets is a private Company selling agrochemicals, veterinary medicine and seeds, rice varieties distributed by Agrovets were only hybrids. -: indicates no data are available.



**Figure 5.** Percentage adoption by households for various categories of rice varieties in the study area in 2002

#### ***Adoption trend in DADO Chitwan scaled up villages***

An adoption study in 27 villages of Chitwan represented nearly 40% of the total rice area covered in the entire study. West Chitwan had the highest rice area while east Chitwan and Madi valley have almost equal rice areas. The hilly areas of Chitwan had less than 5% of the total rice area covered during the study (Table 5). It is obvious that Masuli was only popular in west Chitwan, while Sabittri had more of a wider acceptance and was a leading variety in east Chitwan and Madi. Radha 4 is more common in Madi while farmers' modern varieties were more commonly grown in west Chitwan and Madi valley. Adoption of project varieties across all the 27 villages of Chitwan was slightly over 5%. Although no definitive

conclusions could be drawn from the adoption trends that emerged from different geographic regions of Chitwan, the adoption of PVS and COB was increasing in west Chitwan and hilly areas and the rate of increase in the hilly areas was more than two-fold (Table 5). This was because there was a lack of varietal choice for the hilly areas. Once farmers had access to varieties such as Pant Dhan 10, PNR 381, BG 1442, Sarwati and Sugandha 1, these were highly accepted. Moreover all of these varieties were also very well adapted to the hilly conditions and have several good traits e.g. early maturing and suited to limited water conditions, perform well even under medium fertility conditions and have very good grain qualities.

### ***Levels of adoption according to land type***

The villages were classified by land type to see if this was a factor in determining adoption levels. The distinction between upland and medium land is not sufficiently clear to consider them separately so they were combined. DADO villages, FAMPAR villages, and those proximal to them, were predominantly upland and medium lands whereas those villages under IRD, and those proximal-to-IRD, were predominantly lowland. By categorising villages by land type it was clear that adoption was much higher in lowland villages than those with uplands. This was mainly due to the reason that Swarna is mostly adapted to low-lying areas where rate of adoption for this variety was considerable. In the upland and medium lands Pant Dhan 10, PNR 381, BG 1442, Sarwati and Sugandha 1, COB varieties were better adapted. Among the project varieties Swarna had the highest adoption, followed by other PVS and other NARC PVS varieties (Table 4). These trends clearly explain why the adoption percentages were much higher in IRD and proximal to IRD villages than in the rest of villages.

Another strong evidence of land type influencing the level of adoption of rice varieties could be found in the changes in area of adoption by land types (Fig. 6). For example Swarna increased most in lowland villages where Sabitri declined most. The reason for decline of Sabitri in the low-lying areas was because it is prone to zinc deficiency, a problem that is most pronounced in flooded conditions. In upland villages PVS and COB varieties increased the most while farmers' varieties declined the most. The increase in area under the project varieties in the upland and medium

land villages is obvious as most of the products of COB or PVS varieties, other than Swarna are largely suitable for those domains. In fact these changes were mainly brought about by the introduction of several new rice varieties with differential maturity, different kind of adaptation and niche specificity. This indicates that in addition to the rice growing environments, adaptation of rice varieties also plays an equally important role in determining the level of adoption.

### ***Levels of adoption according to the method of variety evaluation and dissemination***

It is clear that the adoption levels were highly masked by the interaction of varieties with the land types and therefore it was difficult to disaggregate the independent effect of research methods from that of the rice growing environments. In spite of this confounding effect, the adoption rates are over 40% for some of the PVS methods, while none of the project identified varieties were adopted in control villages to any appreciable proportions (Fig. 7).

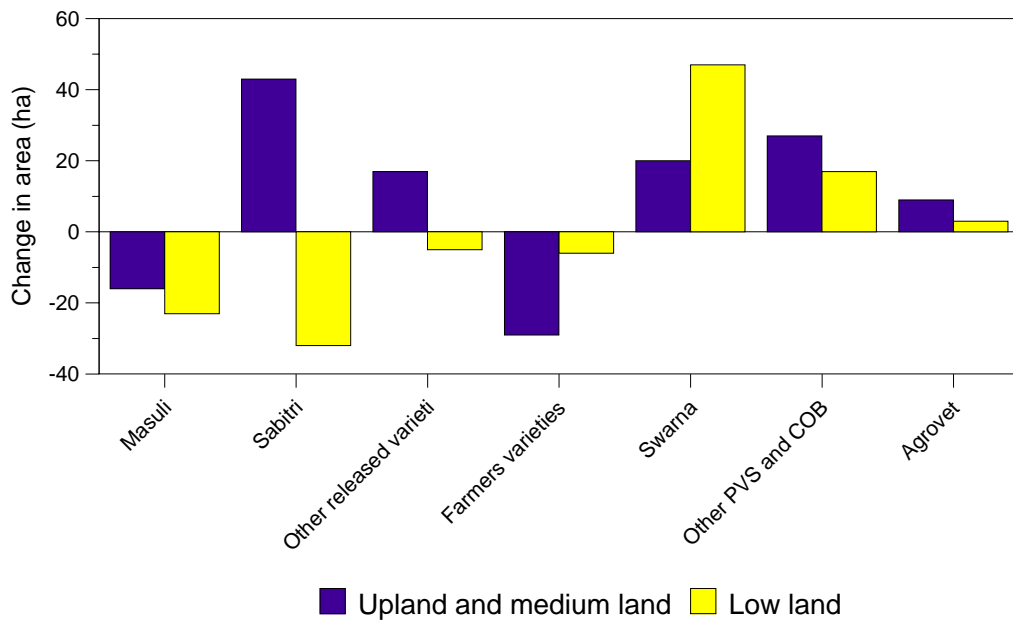
Adoption percentages were quite low for the villages where scaling up was done by DADO Chitwan but even in those villages some differences were evident between the different geographic regions. For example west Chitwan and hilly areas had higher rates of adoption than rest of Chitwan, which was again influenced by the type of the rice growing environments because these areas have relatively fewer facilities for irrigation.

**Table 5.** Adoption patterns (ha) of various rice varieties in 27 villages of Chitwan from different geographic regions after the adoption of new rice varieties identified through PVS or bred by COB

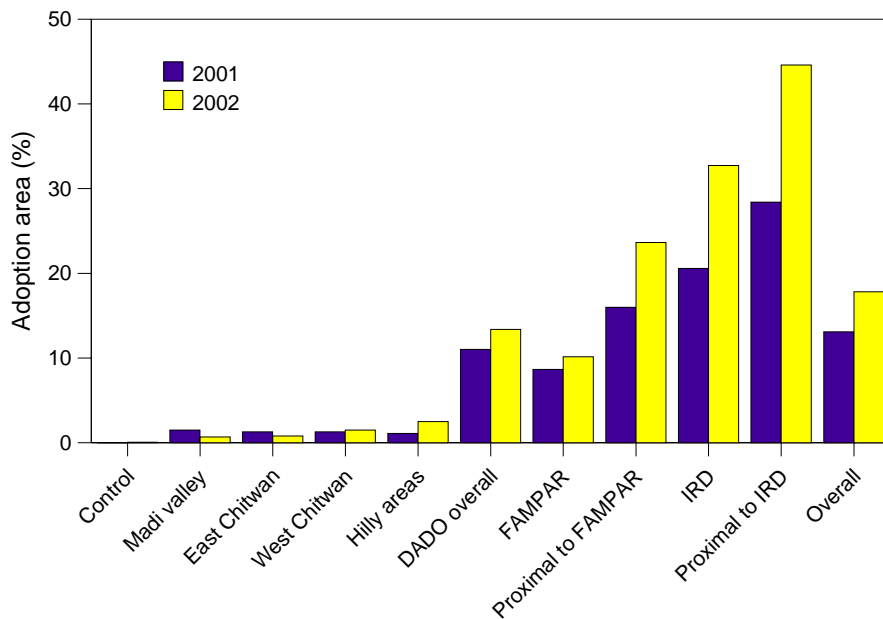
Rice variety	East Chitwan		West Chitwan		Hilly areas		Madi area		Overall adoption (%)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
<b>Popular released varieties</b>										
Masuli	11.9 (0.6) <sup>§</sup>	10.7 (0.5)	126.6 (6.1)	103.4 (4.9)	20.9 (1.0)	12.5 (0.6)	14.5 (0.7)	19.4 (0.9)	8.4	6.9
Sabitri	137.2 (6.6)	143.4 (6.8)	14.9 (0.7)	10.7 (0.5)	11.3 (0.5)	11.5 (0.5)	59.1 (2.9)	78.7 (3.7)	10.8	11.5
Radha 4	17.5 (0.8)	17.3 (0.8)	13.0 (0.6)	7.3 (0.3)	0.8 (0.0)	0.7 (0.0)	58.6 (2.8)	53.4 (2.5)	4.4	3.7
Other released varieties	0.9 (0.0)	0.1 (0)	3.9 (0.2)	4.4 (0.2)	1.1 (0.1)	0.7 (0.0)	0.4 (0.0)	0.2 (0.0)	0.3	0.3
<b>Farmers varieties</b>										
Farmers landraces	6.6 (0.3)	5.2 (0.2)	23.6 (1.1)	23.6 (1.1)	7.9 (0.4)	1.2 (0.1)	5.0 (0.2)	4.2 (0.2)	2.1	1.6
Farmers modern varieties	11.3 (0.5)	16.4 (0.8)	112.6 (5.5)	123.7 (5.8)	13.9 (0.7)	10.7 (0.5)	34.3 (1.7)	40.5 (1.9)	8.3	9.0
<b>PVS varieties</b>										
Swarna	6.5 (0.3)	1.5 (0.1)	9.1 (0.4)	7.6 (0.4)	2.2 (0.1)	6.7 (0.3)	3.6 (0.2)	2.6 (0.1)	1.0	0.9
Pant Dhan 10	5.8 (0.3)	5.1 (0.2)	4.4 (0.2)	2.7 (0.1)	6.0 (0.3)	9.4 (0.4)	4.0 (0.2)	1.2 (0.1)	1.0	0.9
NARC PVS varieties	7.2 (0.3)	8.1 (0.4)	7.6 (0.4)	11.7 (0.6)	2.4 (0.1)	4.0 (0.2)	1.9 (0.1)	2.1 (0.1)	0.9	1.2
Other PVS varieties	8.3 (0.4)	2.1 (0.1)	6.0 (0.3)	9.3 (0.4)	11.7 (0.6)	31.9 (1.5)	21.0 (1.0)	8.9 (0.4)	2.3	2.5
<b>Varieties bred by COB</b>	0.0 (0)	0.1 (0)	0.0 (0.0)	0.1 (0.0)	0.0 (0.0)	0.2 (0.0)	0.0 (0.0)	0.2 (0.0)	0.0	0.03
<b>Agrovet varieties</b>	1.0 (0)	2.5 (0.1)	3.0 (0.1)	5.4 (0.3)	0.2 (0.0)	0.2 (0.0)	0.0 (0.0)	0.6 (0.0)	0.2	0.4
<b>Total</b>	214.2 (10.4)	212.5 (10.0)	324.7 (15.7)	309.8 (14.6)	78.2 (3.8)	89.6 (4.2)	202.2 (9.8)	212.0 (10.0)	39.7	38.8

<sup>§</sup> Figures in the parenthesis are adoption percentage





**Figure 6.** The changes in area of rice varieties grown in lowland, upland and medium land villages from 2001 to 2002 (control villages are excluded as levels of adoption were almost non-existent)



**Figure 7.** Proportion of rice land under new varieties in villages in 2001 and 2002 according to the method of research used.

### *Farmer-to-farmer spread of seed*

From the survey data it was possible to compare the importance of the varieties in terms of the area they covered with their relative demand in the farmer-to-farmer seed network (Table 6). This gives an indication of the on-farm rice varietal replacement process which operates in the informal seed system. Three groups of rice varieties emerged from the study: (i) varieties that occupy a larger area now but their seed demand is greatly declining; (ii) varieties that have a medium range of area adoption and similar level of seed distribution and both have remained more or less unchanged and (iii) varieties that currently occupy a relatively small area but are in high demand and therefore have very high seed distribution.

Clearly, the old variety Masuli is in decline by many criteria including the seed distribution because, despite large land coverage (27%) it only contributed for 10% of seed transactions. Modern varieties promoted by farmers

seed system and the landraces together occupied nearly 24% of the area but just had around 9% of the total seed transactions. The second group of varieties occupy 36% of the area and accounted for slightly over 36% of the total seed transactions in the villages (Table 6). The varieties introduced by the project, such as Pant Dhan 10, Swarna and PVS varieties from NARC and COB varieties were most important in the seed distribution network. Although the area under these varieties may be low because of limited seed supply in the beginning, the rate of acceptance and uptake was quite remarkable. The area under these varieties was about 13% whereas they accounted for over 45% of total seed transactions indicating that they are becoming popular (Table 6). For example varieties bred by COB had quite a small percentage of area under adoption (Table 4) but nearly 2% of the total surveyed households were growing these varieties in the second year of evaluation, which shows their higher acceptance by the farmers.

**Table 6** Area of adoption and seed distribution through farmer-to-farmer seed supply systems for different main season rice varieties in 2002. Direction of change in area and seed distribution from 2001 to 2002 are shown as: increasing (↑), remaining the same (—) and decreasing (↓).

	Area (ha)	Direction of change in area	Seed distribution (kg)	Direction of change in seed distribution
Swarna	193.4	↑	4244	↑
NARC PVS varieties	37.7	↑	6202	↑
Other PVS varieties	105.0	↑	1202	—
Agrovet varieties	19.1	↑	148	↑
COB varieties	6.2	↑	416	↑
Sabitri	480.0	—	8068	—
Other released varieties (including Radha 4)	49.6	—	1032	—
Radha 4			3449	—
Phant Dhan 10	36.6	—	6197	↑
Masuli	566.1	↓	3122	↓
Modern varieties promoted by farmers	394.7	↓	3012	↓
Landraces	103.3	↓	207	↓

## DISCUSSION AND CONCLUSION

The survey was extensive and sampled a very large number of farmers and many villages of Chitwan and several villages in Nawalparasi. The adoption of rice varieties introduced by the project was substantial, accounting for 18% of the rice area in the surveyed villages. In a conventional system for introduced crop varieties, a research lag of eight years (i.e. eight years of research costs would be incurred prior to the release of the first variety) has been reported prior to the release of the first variety (Morris et al., 1994). In terms of methodology, adoption in DADO villages was around 10%. This somewhat lower figure is to be expected as the DADO activities began after the LI-BIRD PVS trials were first conducted.

The study clearly showed that rice varietal diversity has considerably increased in the study villages and this is happening by reducing area under old, obsolete and disease-susceptible varieties by new, better-adapted, higher-yielding and farmer-preferred varieties. This has an important implication in terms of improving productivity, strengthening food security and overall systems production potential.

One of the important findings from the study was the use of seed distribution pattern as an indicator of future varietal adoption levels. The evidence from seed distribution and the changes in adoption from 2001 to 2002 indicates that this high level of adoption is increasing substantially over time.

Client-oriented breeding has produced the varieties that satisfy the needs of the clients. The seed distribution data

showed that COB varieties were spreading even faster than the best PVS varieties.

The study indicated that matching right varieties to the right environment is crucial for high adoption while the participatory approaches considerably improve the efficiency of the process. Rice growing environments are very important in terms of determining the rate of adoption as particular varieties are best suited to specific conditions. The effect of research method on the other hand was masked by the interaction between rice growing lands and the adaptation of rice varieties.

IRD and FAMPAR methods were compared previously in a high potential production system (Joshi and Witcombe, 2002) for the years of 1997 and 1998 in the same area as this study. They concluded that both methods identified the same varieties most-preferred by farmers, but in IRD villages farmers tested varieties for more years before deciding to reject them; this was because they had less help in decision making in the absence of participatory techniques such as farm walks and focus group discussions. In IRD villages, more farmers disseminated seed to others as this provided an insurance against the loss of new germplasm. Farmers in FAMPAR villages could rely on project scientists to re-supply them with seed if necessary. The findings from the current study largely support earlier findings that the levels of adoption in IRD and proximal to IRD villages are highest due to the higher rate of seed distribution from farmer-to-farmer networks. Nevertheless, the predominant land type in these villages clearly had a larger influence than research method, as varieties such as Swarna were adapted to more low

lying land and thus were most widely adopted.

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## ANNEXES

**Annex 1.** Number of villages surveyed per method of evaluation and the village development committees (VDCs) or Municipalities to which they belong.

District	VDC	NUMBER OF VILLAGES SURVEYED						
		DADO	IRD	Prox.† to IRD	FAMPAR	Prox. to FAMPAR	Control	
Chitwan	Ayodhayapuri	1						
	Bagauda	1						
	Bhandara	1	1	1				
	Bharatpur <sup>§</sup>	1						
	Chainpur	1	1	1	2	1		
	Darechok	1						
	Dibyanagar	1						
	Debauli		1					
	Gardi	1						
	Gitanager		1		1	1		
	Gunjanager	1						
	Jagatpur	1						
	Kablias and Chandibhanjyang	2						
	Kathar	1	1					
	Kharihani	1						
	Kumroj	1						
	Madi Kalyanpur	1						
	Mangalpur	1						
	Parbatipur	1						
	Pathihani	1						
	Phulbari	1			1			
	Piple	1						
	Pithuwa	1						
	Ratnanagar <sup>§</sup>	1	1	1				
	Saradhanager	1						
	Shaktikhor	1						
	Shivanagar	1				1		
	Sukranager	1						
	Sub-total		27	6	3	4	3	
	Makawanpur	Manahari						1
Nawalparasi	Agyauli		1					
	Kumarawarti		1		1	1		
	Naya Belhani		1	1				
	Bhadara Debaulia						1	
	Narayani		1	1				
	Deurali		1	1				
	Kawaswati		1					
	Tamsariya				1	1		
Shivamandir				1	1			
Sub-total			6	3	3	3	1	
<b>TOTAL</b>		<b>27</b>	<b>12</b>	<b>6</b>	<b>7</b>	<b>6</b>	<b>2</b>	

†Prox. = proximal, § Municipality

**Annex 2.** Area of land (ha) under which different varieties were being grown in all the villages surveyed, categorised by research method in 2001 and in 2002 and the changes between the two years.

Category	Year	Masuli	Sabitri	Other released	Farmer	Agrovet	Pant Dhan 10	Swarna	PVS NARC §	Other PVS varieties
<b>FAMPAR</b>	<b>2001</b>	246.40	106.57	42.83	132.83	0.47	3.50	20.50	4.77	19.93
	<b>2002</b>	267.23	130.60	43.37	112.03	1.07	2.90	33.23	8.43	17.93
	<b>Change (%)</b>	8.46	22.55	1.25	-15.66	128.57	-17.14	62.11	76.92	-10.03
<b>IRD</b>	<b>2001</b>	73.93	92.77	31.50	98.17	2.17	5.47	47.07	6.97	17.87
	<b>2002</b>	55.33	76.93	25.67	93.43	2.30	8.40	80.17	14.87	19.40
	<b>Change (%)</b>	-25.16	-17.07	-18.52	-4.82	6.15	53.66	70.33	113.40	8.58
<b>Proximal to FAMPAR</b>	<b>2001</b>	70.60	9.40	3.27	20.20	0.67	0.23	12.90	1.47	5.10
	<b>2002</b>	61.43	6.97	3.17	17.57	2.70	0.07	22.70	1.43	4.23
	<b>Change (%)</b>	-12.98	-25.89	-3.06	-13.04	305.00	-71.43	75.97	-2.27	-16.99
<b>Proximal to IRD</b>	<b>2001</b>	19.10	32.57	4.93	26.80	0.53	4.53	24.03	3.60	1.07
	<b>2002</b>	15.20	16.20	6.03	25.33	3.30	6.87	38.33	7.13	0.80
	<b>Change (%)</b>	-20.42	-50.26	22.30	-5.47	518.75	51.47	59.50	98.15	-25.00
<b>DADO</b>	<b>2001</b>	173.83	222.53	166.07	162.27	4.23	20.13	21.37	19.03	29.83
	<b>2002</b>	145.97	244.30	182.60	156.90	8.70	18.37	18.40	25.83	52.83
	<b>Change (%)</b>	-16.03	9.78	9.96	-3.31	105.51	-8.77	-13.88	35.73	77.09
<b>Control</b>	<b>2001</b>	17.70	5.57	9.33	27.07	0.20	0.00	0.00	1.40	2.87
	<b>2002</b>	20.60	4.97	9.07	29.70	0.20	0.00	0.63	0.37	0.00
	<b>Change (%)</b>	16.38	-10.78	-2.86	9.73	0.00	0.00	0.00	-73.81	-100.00
<b>Overall</b>	<b>2001</b>	601.53	469.43	257.93	467.33	7.43	33.83	125.83	37.17	76.67
	<b>2002</b>	565.73	479.90	269.83	434.97	19.13	36.57	193.40	58.03	95.20
	<b>Change (%)</b>	-5.95	2.23	4.61	-6.93	157.40	8.08	53.70	56.14	24.17

§PVS varieties from NARC are: BG 1442, Rampur Masuli and Radha 82 (IR51672)