Improved rice for uplands, lowlands and in-between

RIU

Validated RNRRS Output.

Thousands of farmers in Nepal now have a choice of rice varieties to suit their particular needs, whether they farm in the uplands, lowlands or on the slopes in between. In conventional plant-breeding, new varieties developed on experimental stations can take up to 18 years to become widely used. This means that varieties suitable for a range of climates, environments and purposes just aren't available. Now that farmers are involved, the process of improving varieties is much quicker. Plus farmers' choices give them not only higher yields but other qualities they value—perhaps good quality straw, grain that cooks well, drought tolerance, or early ripening so as to allow a follow-on cash crop. Thousands of farmers are already growing the improved rice varieties and they have major potential to improve livelihoods.

Project Ref: **PSP02:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

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Geographical regions included:

Nepal,

Target Audiences for this content:

Crop farmers,

Document Contents:

Description

PSP02

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Participatory varietal selection in rice - Improved rice varieties for rainfed upland (BG 1442, Sarwati), medium land (Pant Dhan 10, Rampur Masuli) and lowlands (Swarna) for the *terai* region of Nepal

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Plant Sciences Research Programme

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RiUP activities.

R6748, R7542

CAZS-Natural Resources, UK
Local Initiatives for Biodiversity Research and Development (LI-BIRD), Nepal

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

We developed and formalised a **participatory crop improvement (PCI)** approach. It employed **participatory varietal selection (PVS)** to overcome the limitations of traditional, on-station testing systems by testing new varieties with farmers. Farmers were given a choice of already existing but non-recommended varieties several of which were greatly liked by farmers (Table 1) for the rice cropping systems of the *terai.* In addition to other advantageous traits, these varieties yield 16-54% more than the best locally available alternatives (Table 2).

Table 1. Summary of varieties with their adaptation and important traits identified by PVS from 1996.

Variety name	***Seasonal adaptation***	***Special traits***
BG 1442	*Chaite* and main	High yield, wide adaptation, short duration
Sarwati	Main	High quality, short duration
Pant Dhan 10	Main	High yield, wide adaptation, disease resistant

Rampur Masuli	Main	Better eating quality
Swarna	Main	High yield, better in long-standing water conditions, fertilizer responsive

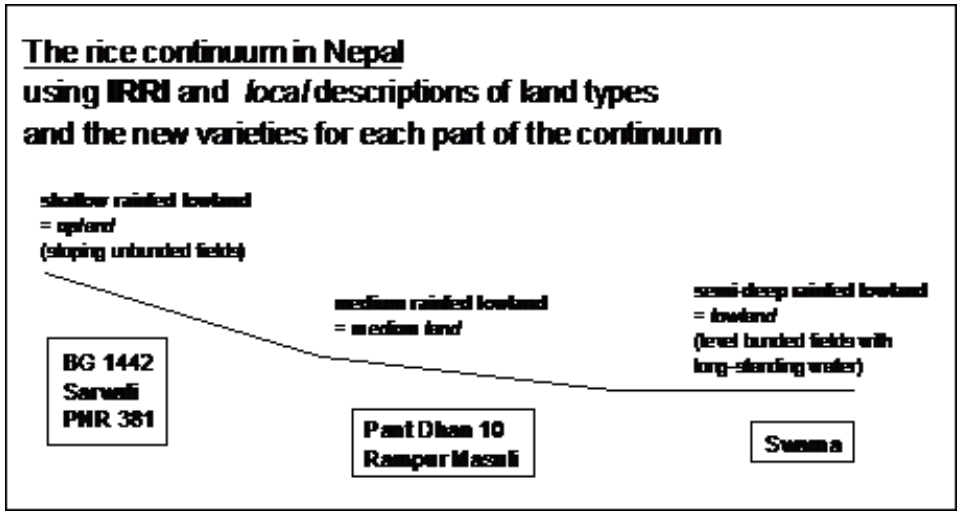

Fig. 1. The rice continuum in Nepal and the adaptation of the rice varieties

Rice is the most important commodity in Nepalese agriculture and its economy as it is grown on about 1.6 M ha producing 4.5 M t of rough rice with an average productivity of about 2.9 t ha^{-1} (MoAC, 2004). Rice contributes 20% to the agricultural gross domestic product (GDP) and 50% to the total calorie requirement of the Nepalese. Nepal imported >19,000 tons of milled rice in 2003 (IRRI, 2005) reflecting the slow pace of rice growth in the country. Rice straw meets about 35% of total digestible nutrients required for 8.6 million livestock (NRRP, 1997). It is estimated that of the 73% of the rice area in *terai*, 24% of the area is in the hills, of which >70% (1.1 M ha) is grown under rainfed conditions that suffers from drought and floods each year (CBS, 2003).

The conventional system of crop improvement in rice has been unable to provide varietal options to the farmers for different maturity classes suitable for rainfed upland, medium land and lowland domains. This is evident from the fact that farmers in Nepal are growing either very old rice varieties or varieties introduced informally from the Indian border. Baseline data (Rana et al., 2004) collected in Chitwan showed a great lack of varietal diversity with some old varieties, such as Mansuli, occupying nearly 80% of the rice area in Chitwan and Nawalparasi districts (Fig. 2). The most popular cultivars, such as CH 45 in the *Chaite* season and Masuli in the main season are over 25 years old and vulnerable to pests and diseases. Varietal diversity in *Chaite* rice is very narrow (Witcombe et al, 2001). In main-season rice, though more varieties are grown, the diversity is low when weighted by the area occupied by each variety (Witcombe et al., 2001).

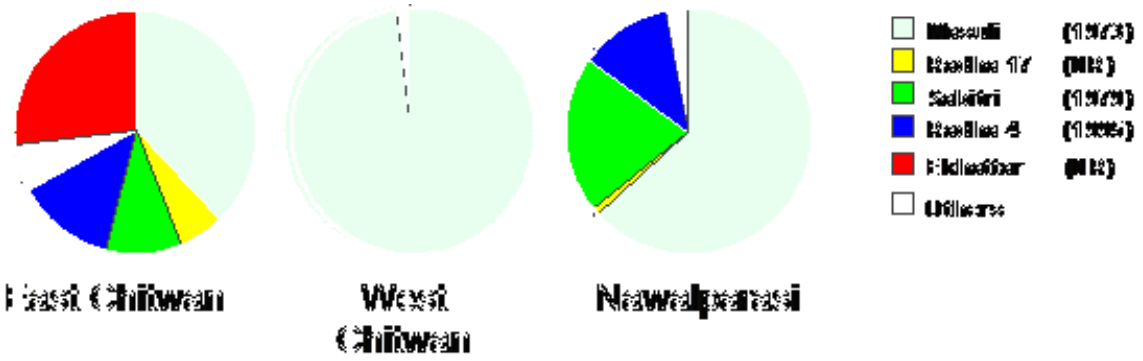

Fig. 2. Varietal diversity in two districts (Chitwan and Nawalparasi) of Nepal *terai*, from a survey in 1997 (Year of release of variety in parentheses; NR = not released).

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
x	*x*	*x*	*x*		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

Rice, which is the most important commodity in Nepalese agriculture, is the main commodity upon which the output is focussed. PVS as a technique can be applied to all crops.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
x	*x*	*x*		*x*			

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
x	*x*	*x*	*x*	*x*		

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**). Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.*

Other interventions that are synergistic with the new rice varieties are in the areas of crop protection and improved crop agronomy. Since farmers evaluate material for all traits including fodder quantity and quality then clustering with improved livestock nutrition would be synergistic.

It can be combined with testing, verification and scaling up of many other rice varieties (COB rice varieties PSP dossier 13), quality seed production (PSP dossier 36) and improved agronomic practices such as seed priming (PSP dossier 25) and interventions related to crop protection. The new rice varieties that are of earlier duration can facilitate the growing of a following (second) crop (PSP dossier 35).

It can be combined with outputs from other RNRRS themes:
CPP, Cost effective weed management packages for lowland rice in Bangladesh, R8412, R8234, R7471
CPP, Extension and promotion of rodent technologies in rice based systems, R8424, R8164
CPP, Good seed initiative, R8480
CPP, Linking demand with supply of agricultural information, R8429, R8281
CPP, Managing rice pests in Bangladesh by improving extension service information management for policy and planning, R8447
CPP, Rice sheath blight complex, R7778
CPP, Weed management in irrigated rice, R8409, R8233, R7377
NRSP, Participatory Technology Development, R7412

Validation

B. Validation of the research output(s)

***10. How** were the output(s) validated and **who** validated them?*
*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

How validated: Varieties were tested with farmers in PVS trials (see PSP dossier 33). In PVS, validation is always by the first end users of a new variety – farmers - in on-farm participatory trials. They used participatory evaluation (employing many techniques e.g., matrix ranking, focus group discussion, surveys) of many traits

considered important by farmers.

Validation of yield increases was done jointly by farmers, researchers from implementing organizations in on-farm trials and by government organisations in on-station trials. Wider dissemination tested the acceptability of these varieties on a much larger scale and area. The impact of these varieties on yield increment, overall food security and livelihoods was done by independent organizations (Rawal et al., 2006; Gauchan et al., 2006). None of the varieties found acceptable in PVS trials proved unpopular when scaled up. **See also outcome assessments Question 20.**

Increases in grain productivity were achieved of up to 54% over the local cultivars (see Table 2) well over 1 t of additional grain per hectare. There was improvement in traits other than grain yield such as earlier maturity, better lodging resistance, higher straw yield, increased drought tolerance. Better grain and cooking quality resulted and a higher market price.

Table 2. Examples of yield increases

Variety	Years evaluated	Yield advantage over best locally available alternative (%)	Reference
BG 1442	2002 and 2005	16	Devkota et al., 2006
	2002	31	Devkota et al., 2006
Sarwati	200-2002	14	Thagunna, 2002; Rahaman and Yadav, 2002
Pant Dhan 10	2001-2002	54	Yadav et al, 2002
Rampur Masuli	2001-2002	35	DADO Bara, 2002
Swarna	2001-2002	50	Yadav et al, 2002

Validation was done by researchers independent of the implementing organizations, by farmers and farmers' groups working with researchers, and to a large extent by governmental officials. The institutions involved were LI-BIRD, CAZS-NR, the National Rice Research Programme (NRRP) of the Nepal Agricultural Research Council (NARC), several other NARC stations, District Agriculture Development Offices (DADOs) from the terai (21 districts) and the midhill (10 districts), 10 community based seed producer (CBSP) groups, several CBOs and Agrovets and individual farmers from various parts of the country. (**See also uptake and promotion pathways Question 16**).

The target groups of male and female farmers were from all social groups representing resource-rich, resource-medium and poor farmers. Wealth categories (usually three) were determined through local informants using key proxies for wealth such as landholding size. Evaluation of PVS trials included participating farmers (with a representative proportion of women) and their neighbours, relatives and friends (this always included some women).

*11. **Where and when** have the output(s) been validated? Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the*

options provided in questions 7 and 8 respectively, above ***(max 300 words)****.*

The performance of these varieties was validated across diverse farming systems ranging from marginal rainfed to high potential production systems involving thousands of farmers from various districts of Nepal. Validation over wide areas was done by a number of DADOs from terai and midhill districts of Nepal (Fig. 3), by NGOs and INGOs (Fig. 5 Question 16). In addition, several CBSP groups from several terai districts (Fig 6 Question 16), several Agrovets (Fig. 7 Question 16), individual farmers (Fig. 4 Question 13) NRRP, and other NARC research stations of Nepal have validated these outputs. Details of validation by geographic location and by variety are shown in Table 3.

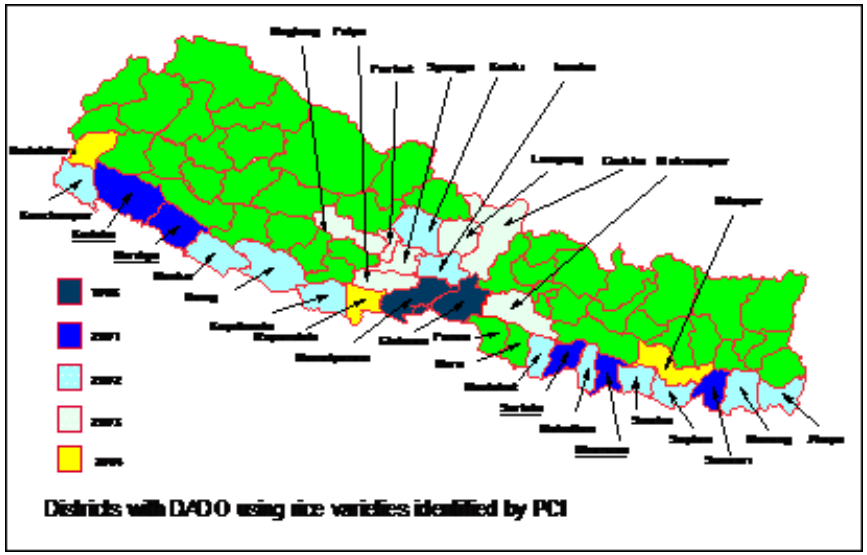

Fig. 3 Validation and promotion of outputs from 1998 to 2004 in various districts of Nepal by DADOs using PVS, IRD, Minikits and seed production programmes

Table 3. Geographical location and year of validation of these varieties

Variety tested	Maturity (days)	Altitude up to (m)	Geographical area of validation	Years of validation
BG 1442	120-125	1400	Several districts of terai and mid-hill region of Nepal	1998-2004
Sarwati	120-125	1200	Several districts of Central and Western terai,	1998-2004
Pant Dhan 10	135-140	900	Several districts of Central and Western terai and High Barind Tract of Bangladesh	1999-2004
Rampur Masuli	135-140	900	Several districts of terai region of Nepal	1997-2001

Swarna	150-160	900	Several districts of terai region of Nepal	1997-2002

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

Thousands of farmers are currently growing these rice varieties in Nepal for the significant benefits they bring. The short-duration varieties for shallow rainfed bunded conditions give farmers sufficient time to cultivate an additional crop of vegetable, oilseed or cash crop after the rice harvest. Hence, BG 1442 and Sarwati are popular with vegetable growers.

Pant Dhan 10 and Rampur Masuli are grown in medium land for their high yield and better grain quality. Most of the lowland in Nepal has high fertility, long-standing water conditions and is suitable for single or double rice cultivation only. For that situation, farmers prefer to grow a high yielding and long maturity variety such as Swarna.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

Large amount of seed of these varieties has been produced and marketed in many districts of Nepal by DADOs of *terai*, inner *terai* and mid-hill districts by NGOs such as LI-BIRD, FORWARD, SUPPORT Foundation and several CBSP groups from different districts. This has resulted in their widespread use (Figures 4a and 4b).

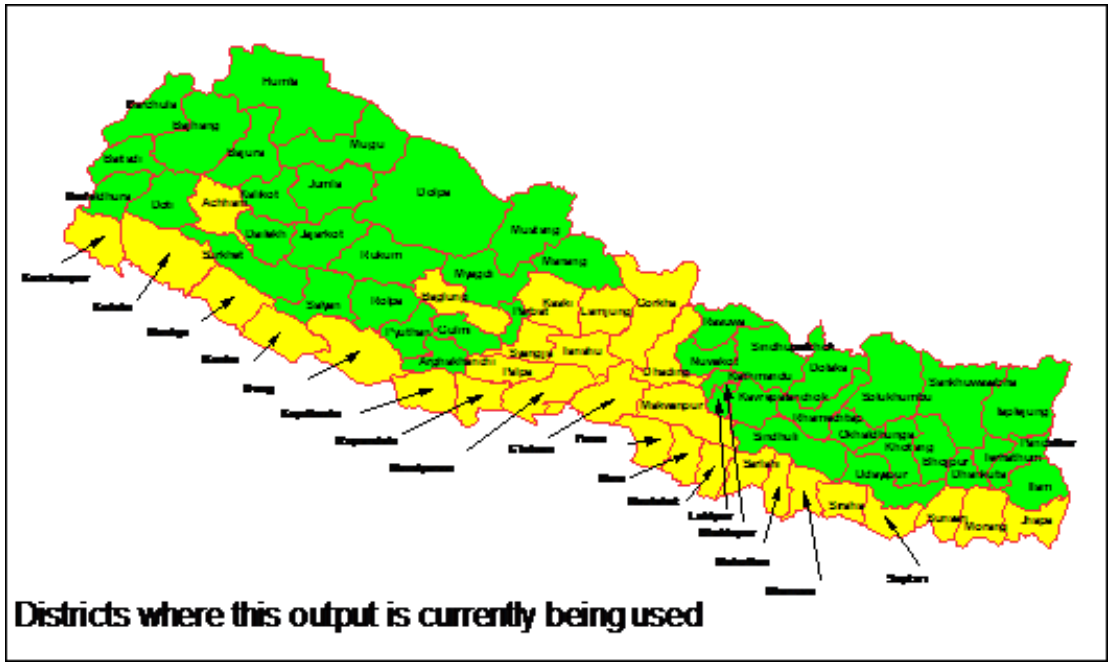

Fig. 4a. Districts of Nepal where PCI outputs are currently being used.

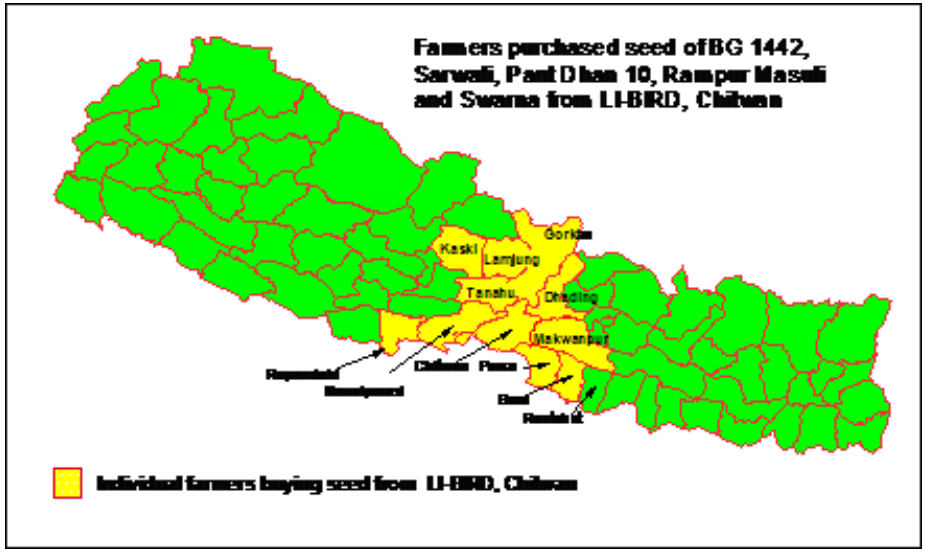

Fig. 4b Use of these varieties by individual farmers from seed purchased from LI-BIRD, Chitwan

14. What is the scale of current use? Indicating how quickly use was established and whether usage is still

*spreading **(max 250 words).***

The PSP research began in 1996 to increase the access of farmers to new crop varieties in Chitwan and Nawalparasi districts. The area under these varieties in the *terai*, inner *terai* and mid-hill districts of Nepal is increasing rapidly (Rawal et al, 2006) with huge potential to improve food security and overall livelihoods of the resource poor farmers (Joshi et al, 2006).

Community-based seed producer groups have begun to produce and market substantial quantity of seeds and this is increasing every year (Table 4) in several *terai* and mid-hill districts of Nepal. There are functional seed producers groups at least in nine districts producing and supplying a significant amount of rice seeds (see also PSP Dossiers 36 and 1). LI-BIRD and FORWARD are strengthening CBSP groups in these and several other districts in the *terai* and hills.

Even though the current use of seed of these varieties is quite high, it is still on a very small scale compared to actual needs. It is a reasonable assumption that these varieties are better alternatives to others on at least 30% of the total of 1.1 M ha of rice in the *terai* and 10% of the total of 0.3 M ha of rice in the hills of Nepal. If only 10% of this area is sown to purchased, quality seed each year then sufficient seed to transplant 0.03 M ha of rice is needed. This amounts to 1,500 t of rice seed each year at a rate of 50 kg ha^{-1}. Considering the seed supply figures of 2005/06 through CBSP, currently <7 % of 0.03 M ha is being supplied through this approach (Table 4).

Table 4. Amount of seed of these varieties produced and distributed (t) since 2000-2005 through individual farmers and community based seed production (CBSP) groups

Variety	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	
	Individual farmers	Individual farmers	Individual farmers	CBSP	CBSP	CBSP	Total
Swarna		2.5	3	1.5	1	0.8	8.6
Rampur Masuli		1.8	2.2	1.7	1.2	1.4	8.3
BG 1442		2.3	15	35	40	90	120.2
Sarwati		0.7	5.5	2.5	3.2	1.5	1.3
Pant Dhan 10		0.5	24	4.2	2.8	2.6	3.4
Total	6.0†	7.8	49.7	44.9	48.2	96.3	141.8

†Breakdown by variety not available

*15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key factors of success? **(max 350 words).***

The rice varietal promotion in Nepal is coordinated by NRRP; varieties introduced or bred in Nepal are evaluated by the NRRP/NARC system for yield and other agronomic performances, proposed for release to the National Seed Board. Once released the varieties are then widely disseminated by the Department of Agriculture and its network, other NGOs, CBOs and seed companies. However, in this approach, there are many delays and actual adoption takes place 5-6 years after a variety is released. Considering a variety development phase of 12 years,

it would need at least 18 years before any appreciable adoption of any variety takes place.

We have found that when working with this linear research and extension system it is extensionists (who deal normally with Minikit trials) who have assisted the most, i.e. the District Agricultural Development Offices (DADOs). NGOs that are oriented towards NRM also conducted PVS trials using these varieties. Thus several DADOs and NGOs have helped promote these varieties through the PVS approach.

NGOs have been working with community-based organisations, community-based seed producers groups, self-help groups, Agrovets and other private sector organisations. Adoption of multi-partnership and multi-stakeholders approaches for on-farm experimentation, testing, validation and scaling up of these varieties is the key for success by a wider scale of impact.

Current Promotion

D. Current promotion/uptake pathways

*16. **Where** is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion **(max 200 words).***

Various stakeholders currently involved in the promotion of these varieties in Nepal are shown in Figures 5 to7. These stakeholders include various organisations from grassroots civil societies, private companies through to governmental organisations involved both in the research and development. Pant Dhan 10 and PNR 381 are also currently being promoted in Bangladesh by PROVA, DAE and other NGOs etc

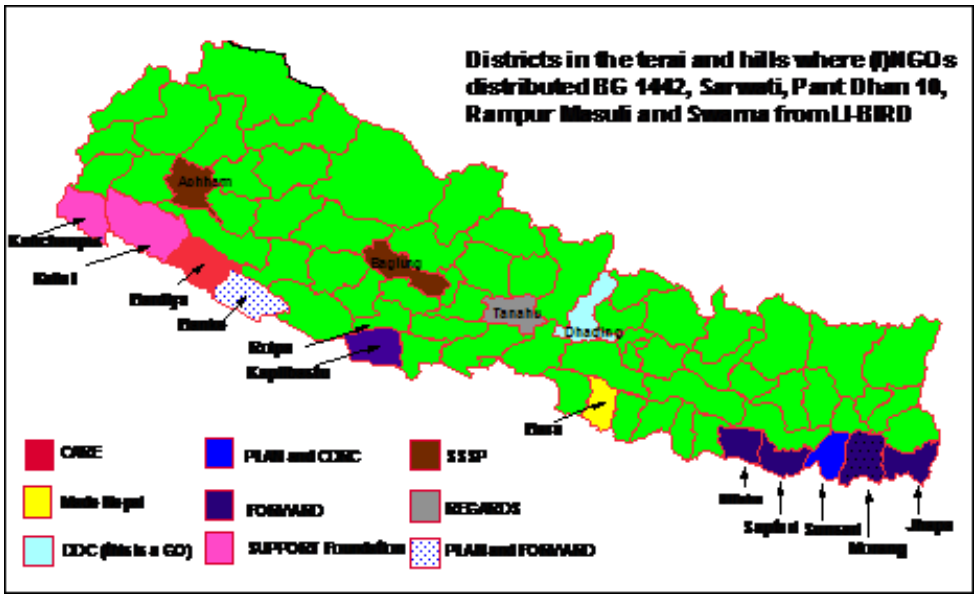

Fig. 5 Promotion and validation of outputs by NGOs and special projects in districts of Nepal

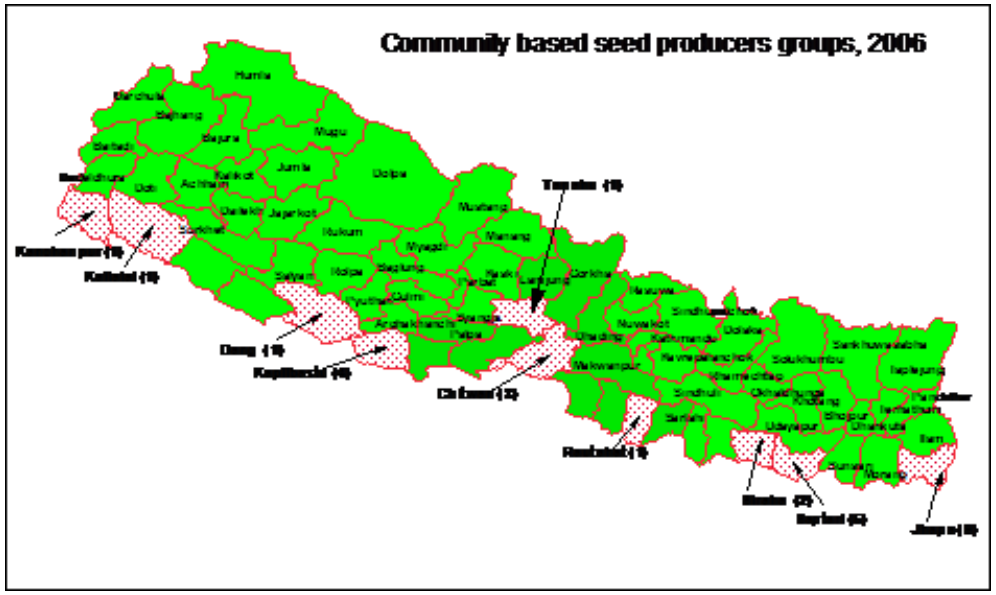

Fig. 6 Promotion and validation of outputs by community-based seed producer (CBSP) groups in various districts of Nepal

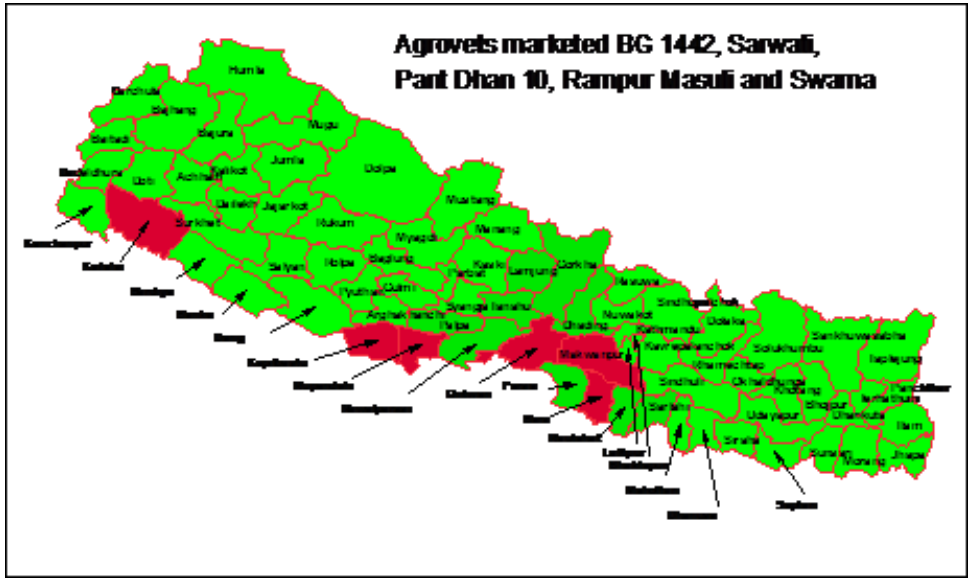

Fig. 7 Promotion of outputs by Agrovets in various districts of Nepal

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words)****.*

The formal sector seed channels in Nepal do not officially promote non-released varieties. The collaboration from the Department of Agriculture in promoting non-released varieties was a very innovative and bold step but still there is no official policy on this as the initiatives have been taken as a district level.

Changes in the seed regulatory frameworks that encourage participation of farmers have been made. For example, in a release proposal for rice variety Barkhe 3004, on-station and on-farm data from participatory trials, i. e. mother and baby trials were combined and they had equal status. Farmer participation in varietal testing by providing a wider choice of varieties and testing under farmer managed conditions is an integral part of the process. However, the release procedure is resource-consuming, complex and the diverse stakeholders in the release process can hold different worldviews on the value of releasing a great diversity of varieties that have not been 'officially' tested. Hence, it is impossible for all of these varieties to be released even though all are of value to the farming community. Official recommendation does help. BG 1442 was officially released as a result of the raised awareness of its value in NARC following the PVS programme, and is the only variety where seed production is increasing.

The lack of clarity on the promotion of unreleased varieties has probably contributed to the inertia in the process of actually marketing them, as is evidenced by the still small proportion of the demand that is being met.

18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues ***(max 200 words).***

The major barrier to the widespread adoption of these varieties is that some of these are yet to be officially released. One of these varieties, i.e. BG 1442 was released in 2004 as a result of widespread promotion by the PCI projects and subsequent demand of the variety by the farmers. However, other outstanding varieties are still in the informal domain and they need to be released. The production and marketing of seeds using 'Truthful labelling' needs to be mainstreamed as this approach would reduce the need for official release and allow CBSP groups to be fully involved in the seed trade with reduced administrative hurdles.

There is a need for capacity building on community-based seed production and marketing and linking such groups not only with the private sector but with the government programmes for the internalisation of the approach by the system.

Lack of knowledge among the farmers is also hindering the widespread adoption of these varieties. In recent years, FM Radio stations have really emerged in Nepal and they are very interested to collaborate in the dissemination of technical information to the communities. Widespread use of FM Radio stations in strategic locations could be one of the most important ways forward in the faster promotion of the outputs.

Another important factor to remove the barriers to adoption are the changes in mindset of a 'transfer-of-technology' approach through the wide-scale training of GO staff and, to a lesser extent, NGO staff in the PVS

process.

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

Using Rogers (2003) diffusion of information as a framework for the lessons learnt:

1. The relative advantage of a technology compared to what it is replacing;
This is generally high (see Table 1)

2. The compatibility of the technology with existing systems and ways of doing things, which is closely related to culture;
The compatibility with farmers is high as they are used to experimentation in their own fields. However, in the case of the PVS process (rather than the new rice varieties) the compatibility is low for scientists and extensionists trained in the transfer of technology model.

3. The complexity of the technology in terms of what people need to learn to make it work;
The complexity is low for farmers as the varieties fit into their farming systems and do not require any significant changes. The process of PVS is of moderate complexity for scientists/extensionists who need to learn a range of new participatory techniques.

4. The observability of a technology in terms of how easy it is to demonstrate and observe performance;
The observability is high for most traits such as maturity and yield although post-harvest traits are more difficult.

5. The trialability of a technology in terms of how easy it is to test it before deciding to adopt.
The trialability is high if seed is available but impossible without seed.

Hence the training of scientists and extensionists and the production of seed become the most important factors in getting this research into use.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

There are several impact assessments that have been done both internally and externally or a combination. These are concerned with the impact of these varieties as well as those produced by client-oriented breeding.

1. DTZ Peida. (1998). An Evaluation Study of Participatory Crop Improvement in Nepal. A Final Report Prepared for Department for International Development, UK. Edinburgh, UK: DTZ Peida Planning, Economic and Development Consultants. This study analyses the impact of PVS in the high potential production in Nepal. It covers the impact of PVS in several crops.
2. Witcombe, J.R. Joshi, K.D., Gyawali, S., Devkota, K. and Subedi, A. (2003). An impact assessment of participatory crop improvement in the low-altitude regions of Nepal. PSP Annual Report 2002. Section 1: Introduction and General Overview. Research Outcomes. pp 11-18.
3. Joshi, K.D., Biggs, S., Devkota, K. and Gyawali, S. (2003). Delivering impacts from participatory crop improvement projects in Nepal. PSP Annual Report 2003. Section 1: Introduction and General Overview. Research Outcomes. pp 11-18.
4. Witcombe, J.R. Joshi, K.D., Gyawali, S., Devkota, K. and Subedi, A. (2004). Participatory crop improvement in the low-altitude regions of Nepal. Plant Sciences Research Programme. Highlights and impact. Participatory crop improvement. pp 21-50.
5. Gauchan, D. (2006). Assessment of the Outcomes of Rice-fallow Rainfed Rabi Cropping (RRC) Project in Nepal the terai. A report of the RRC outcome assessment in Kapilvastu, Saptari and Jhapa districts, Nepal. Bangor, UK: CAZS-Natural Resources, University of Wales, Bangor.
6. Joshi GR, Paudel PK, Rawal KB and Singh U. (2006). Assessment of adoption and spread of rice varieties bred by COB and identified by PCI. SUPPORT Foundation, PO Box: 24, Mahendranagar, Kanchanpur, Nepal.
7. Rawal, K.B., Bhatta, V.R., Joshi, G.R. and U., Singh (2006). Adoption and spread of rice varieties in Sarlahi and Kailali districts identified by participatory crop improvement (PCI) and bred by client-oriented breeding (COB). Kanchanpur, Nepal: SUPPORT Foundation.
8. Devkota K.P., Gyawali S., Subedi A., Witcombe J.A.D. & Joshi K.D. (2005) Adoption study of main season rice in Chitwan and Nawalparasi districts of Nepal from 2001 to 2002. Discussion paper no. 6. Wales, Bangor: CAZS-Natural Resources, University of Wales. Available at www.dfid-psp.org

Cost benefit analyses have been made (see PSP dossier 13).
The internal rate of returns (IRR) and net present values (NPV) was 43-126% while the NPV ranged from £2 to £29 million by 2010 and £4 to £52 million by 2012 (Witcombe et al., 2004).

Many interviews have been made with farmers on the impact of these varieties on their livelihoods. Below is one example from Witcombe et al., 2004.

Sun Maya Mahato of Agauli village, Chitwan. Owns about 1.3 ha land and has grown Swarna for the last four years. This year the variety occupies nearly 80% of her rice area. She reckons that Swarna yields nearly 1.5 to two times more than Masuli, the variety she grew before.
"*We had to buy two new Bhakari [1] to store extra grain from Swarna while in the past we never bought extra Bhakari. We never sold rice while growing Masuli, as it was just enough to meet the family needs. But Swarna gave us much more cash. We repaid a Rs. 50,000 loan from the additional income from Swarna. This year, we had to spend nearly Rs. 30,000 for the maternity care for my daughter-in-law, which also came from the sale of Swarna. Had the cash not been with us, we had to sell out part of our land or borrow money at a very high interest rate. We do not have any other significant sources of income. Though, we have two fishponds, we hardly earn about Rs. 2000 from the sale of fish*".

[1] Bhakari is a local storage structure used for storing food grains, which may be an earthen pot or made of bamboo or wood.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

The extent of adoption was assessed (Devkota et al., 2005, Rawal et al., 2006; Gauchan, 2006, Joshi et al., 2006) and there was significant adoption. For main season rice varieties it was 18% of the rice area in project villages within two to six years of intervention with a high number of adopting households. Since 2002, a significant amount of seed of several rice varieties has been distributed and sold in various districts of Nepal. Considering a seed rate of 50 kg ha^{-1} and at least a trebling in farmer-to-farmer seed distribution every year, at least several thousands of farmers are growing the varieties on thousands of hectares.

For the spring *Chaite* season rice the yield advantage was:

- 16-31% from BG 1442 over the check variety (Devkota 2006) and 40% over other varieties including a price advantage of Rupees 0.5 to 1 kg^{-1} ($7-14 t^{-1}).

For main season rice the yield advantage over the best available alternatives was:

- up to 54% from Pant Dhan 10 in medium lands (Yadav et al., 2002) and
- up to 50% from Swarna in the lower lands (Yadav et al., 2002) than the local.

The yield gains in all of these varieties clearly showed that the participating farmers significantly benefited from the use of these varieties (Table 2). The increased yield and quality of these new varieties contributed considerably to reducing poverty and addressing food and livelihood security, e.g. food sufficiency was increased from six months to one year in the majority of the studies. Increased family income was crucial for e.g., life-saving health care, children's' schooling, meeting household requirements, social obligations (marriage), and farm improvements and for food surplus households cash income increased from the sale of surplus grains (Joshi *et al.,*2003).

Results of the outcome assessment indicated that >75% of the sampled adopters for *Chaite* rice activities were indigenous people and from disadvantaged communities, while this percentage was nearly 53% for main season rice (Joshi et al., 2006). Rice varietal diversity increased considerably in the study villages through the reduction of area under old, obsolete and disease-susceptible varieties by new, better-adapted, early-maturing, higher-yielding varieties improving the overall system productivity and strengthening food security (Devkota et al, 2005).

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Direct and indirect benefits:

- The adoption of PVS process widely will reduce the national wastage of testing of varieties that

farmers would reject in the end. This would reduce the un-necessary use of inputs for such a testing.

- Increased productivity per unit area without the use of additional external inputs especially pesticides is environmentally beneficial.
- Increased productivity will reduce the pressure to increase the area under cultivation.
- Varietal diversification will help reduce crop loss due to pests and diseases and thereby reduce the use of pesticides. Introduction of new varieties always increased on-farm diversity as farmers adopted many cultivars for different niches.
- Cropping intensity and benefits will be enhanced if farmers are provided earlier maturing varieties.
- The better disease and pest resistance of the new varieties can reduce the use of water and soil polluting agro-chemicals. Reduced use of pesticides and insecticides reduces the risk to human life and help create a more balanced pest-predator cycle.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

Any adverse environmental impact is unlikely in the present case as the new varieties are scale neutral and do not require any special cultural, management and production inputs.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Earlier maturing varieties have increased the resilience of farmers by making available extra time for other operations, lower cost of production, reduced use of water and nutrients besides, in some cases, increasing cropping intensity (two crops a year in the place of one)

Varietal diversification is a means of coping with climate change because staggered deployment of varieties with different dates of maturity spreads out water demands and reduces the risks from natural disasters such as diseases, pests and natural calamities. Deployment of varieties that do well under low irrigation but respond to better conditions is possible with new varieties. This increases the capability of farmers to cope with natural risks.

Annex

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