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Discussion Paper

Paper no. 8 December 2005

The Evolution and Spread of Socially Responsible Technical and Institutional Changes in a Rice Innovation System in Nepal

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CAZS Natural Resources Discussion Paper No. 8

ISSN: 1363-8126

Published by CAZS Natural Resources, University of Wales.

ACRONYMS

AIC	Agricultural Inputs Corporation
AICRIP	All India Coordinated Rice Improvement Programme
APPSP	Agricultural Perspective Plan Support Project
AREP	Agricultural Research and Extension Project
ARPP	Agricultural Research and Production Project
ARS	Agricultural Research Station
ASC	Agricultural Service Centre
BRRI	Bangladesh Rice Research Institute
CAZS-NR	CAZS-Natural Resources
CBOs	Community Based Organizations
CBS	Central Bureau of Statistics
CBSPD	Community Based Seed Production and distribution
CDD	Crop Development Directorate
CEAPRED	Centre for Agricultural Policy, Research, Extension and Development
CGIAR	Consultative Group on International Agricultural Research
CIMMYT-SARO	International Maize and Wheat Improvement Centre, South Asia Regional Office
COB	Client-Oriented Breeding
CPT	Cropping Pattern Trial
CVT	Coordinated Varietal Trial
DADF	District Agricultural Development Fund
DADO	District Agricultural Development Office
DEF	District Extension Fund
DFID	Department for International Development (of the UK)
DISSPRO	District Level Seed Self-sufficiency Programme
DoA	Department of Agriculture
DoAB	Division of Agricultural Botany
FAMPAR	Farmer Managed Participatory Research
FAO	Food and Agricultural Organisation of the United Nations
FAT	Farmers' Acceptance Test
FFS	Farmers' Field School
FGD	Focus Group Discussion
FORWARD	Forum for Rural Welfare and Agricultural Reform for Development
FSR	Farming Systems Research
FSRDD	Farming Systems Research and Development Division
GDP	Gross Domestic Product
GOs	Government Organizations
HARP	Hill Agricultural Research Project
HICAST	Himalayan College of Agricultural Science and Technology
HMRP	Hill Maize Research Project
HPPS	High Potential Production Systems
IAAS	Institute of Agriculture and Animal Sciences
IARCs	International Advanced Research Centres
ICAR	Indian Council for Agricultural Research
ICIMOD	International Centre for Integrated Mountain Development
ICP	Integrated Cereal Project
IET	Initial Evaluation Trial
INGER	International Network for Genetic Evaluation of Rice
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management

IRD	Informal Research and Development
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
IRTP	International Rice Testing Program
JT	Junior Technician
JTA	Junior Technical Assistant
LAC	Lumle Agricultural Centre
LARC	Lumle Agricultural Research Centre
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
LIF	Local Initiative Fund
LoA	Letter of Agreement
MoAC	Ministry of Agriculture and Cooperatives
MoU	Memorandum of Understanding
NARC	Nepal Agricultural Research Council
NARDF	National Agricultural Research and Development Fund
NGO	Non-government Organisation
NPV	Net Present Value
NRIP	National Rice Improvement Programme
NRM	Natural Resource Management
NRRP	National Rice Research Programme
NSB	National Seed Board
NSC	National Seed Company
PAC	Pakhribas Agricultural Centre
PCI	Participatory Crop Improvement
POs	Private Organizations
PPB	Participatory Plant Breeding
PPVT	Pre-production Verification Trial
PRA	Participatory Rural Appraisal
PSP	Plant Sciences Research Programme
PTD	Participatory Technology Development
PVS	Participatory Varietal Selection
RCC	Reinforced concrete cement
R and D	Research and Development
RARS	Regional Agricultural Research Station
RRA	Rapid Rural Appraisal
RRC	Rice-fallow *Rabi* cropping
SEAN	Seed Entrepreneurs Association of Nepal
SERED	Socioeconomic Research and Extension Division
SSSP	Seed Sector Support Project
TOT	Transfer-of-Technology, Training-of-Trainers
UK	United Kingdom
UoW	University of Wales
VARRSC	Variety Approval, Release and Registration Sub-Committee
VDC	Village Development Committee

THE EVOLUTION AND SPREAD OF SOCIALLY RESPONSIBLE TECHNICAL AND INSTITUTIONAL CHANGES IN A RICE INNOVATION SYSTEM IN NEPAL

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SUMMARY

The Nepal rice improvement system comprises many formal and informal actors. In spite of over five decades of systematic rice research, the formal research system is still dependent on the introduction and promotion of rice varieties from International Rice Research Institute (IRRI) and other exotic sources. This is largely due to the lack of political commitment and lack of a sustained critical mass of researchers for rice research in the country. In addition, there has been a low investment in decentralised breeding and limited engagement with farmers in the selection process. Nevertheless, there is a long history of participatory technology development (PTD) in Nepal and farmers' innovations and their seed and social networks have contributed considerably to the rice improvement system. However, due to a lack of market perspectives in rice research, innovations of rice traders have not been positively utilised for promoting new rice varieties. Recently, the Department for International Development (DFID) Plant Sciences Research Programme (PSP) committed considerable resources to a decentralised participatory rice breeding programme that accelerated the process of developing rice varieties that are acceptable to clients. The participatory crop improvement (PCI) project was a process project that contributed to the development and spread of socially responsible, technical

and institutional innovations in the rice improvement system, e.g. improvement in food self-sufficiency, poverty reduction, social inclusion, policy influence and institutional innovations. Many of the outcomes of the project are a result of learning from the community and responding to the needs and aspirations of the clients. Developing understanding and working relationships with various stakeholders and signing letters of agreements (LoAs) with the key stakeholders for specific activities proved a suitable approach in terms of bringing about institutional changes. Collaborative activities with the stakeholders helped to develop understanding, strengthen networks and identify the common action points. The project was successful in influencing policy of national and international research and development agencies, both government and non-government. Sustained commitment to policy discussion with government line agencies through a joint Working Group resulted in a revision of the variety release procedures giving due recognition to participatory data and allowing non-government organisations (NGOs) and private organisations (POs) to engage in crop variety development and seed trade. Institutional innovations such as community-based seed production and distribution, informal networking with government and non-government agencies for participatory technology testing, verification and scaling up are sustainable approaches for agricultural and natural resource management and are relevant both for national and international organisations. However, more sustained institutional innovations are needed to provide benefits to the poverty-stricken farming community in rural Nepal in terms of livelihood and income security, poverty reduction, social inclusion and empowerment.

INTRODUCTION

The purpose of this article is to analyse the changes taking place in part of the overall rice innovation system in Nepal. These changes are being brought about by the actions of a number of major actors who make up the rapidly changing Nepal rice innovation system. For the purposes of this article an innovation system is made up of all the major private, civil society and public sector actors in the system, e.g. the different types of labourers and cultivators, the processing and marketing agents, consumers, plant breeders, extension workers, seed companies etc. The article concentrates on the plant breeding, and varietal aspects of the rice innovation system, but

also looks at relevant agronomy, marketing and consumption issues. The role of different actors in creating and promoting both technical and institutional innovations, networking mechanisms and broad changes in the rest of the system are described and reviewed.

A brief history of the national rice innovation system is reviewed with particular attention to the various major events that have been instrumental in bringing changes in the rice innovation system (Table 1). In addition, the variety development and release system is briefly described in relation to the source of germplasm utilised within the country.

The DFID-funded Hill Agricultural Research Project (HARP) contributed to the initiation of a competitive grant system in agricultural research in Nepal. The recent changes that have occurred in the rice innovation system can be associated with a specific project 'Participatory Crop Improvement (PCI)' which was a process-led project funded by the DFID Plant Sciences Research Programme (PSP) and implemented by Local Initiatives for Biodiversity, Research and Development (LI-BIRD) with support form CAZS-Natural Resources (CAZS-NR). An analysis of the project history reveals that many of the useful actions taken by project staff were not in the original project design. For example, at the start, the project was to concentrate on "high potential" regions. It soon became clear that within the high potential areas, there were many "food deficit" farmers because of small land holding and less productive lands and the project shifted its priorities to this group. Many other changes took place in the project as a result of acting on information that the project "planned" to collect, as well as actions that were taken following "unexpected" results.

The article ends with reflections on i) lessons that have been leant during the last 5-10 years, ii) examples of new positive (socially responsible) innovations that are now taking place in the overall system, and iii) suggestions of feasible ways forward which are relevant to the likely future political, social and funding contexts of Nepal.

METHODOLOGY

The analysis of the rice innovation system in Nepal involved reviewing the relevant documents, brainstorming with key people and the authors and circulation of a draft of this discussions paper for comments amongst other major actors. The draft discussion paper was sent to six lead reviewers from four

different organisations. Of these, two lead reviewers were from IRRI, two from Nepal Agricultural Research Council (NARC), including an ex-staff of NARC and currently an independent consultant. One lead reviewer was from the Ministry of Agriculture, Cooperatives (MoAC) and an NGO. In addition to the lead reviewers the document was also sent 24 other professionals representing 17 organisations including MoAC. A hard copy of the document was provided for review; however, in few cases electronic version of the document was circulated. The reviewers were allowed over three months to review the document and only 27% of the reviewers sent feedback.

FINDINGS

Socially responsible innovations

Socially responsible innovations can be defined as the processes and activities that involve stakeholders in a learning process whereby their needs and aspirations are incorporated into the innovation system so that the product and services are made relevant to them. Socially responsible innovations in one way or the other should address the issues of reducing poverty, improving food security, improving social inclusion and empowerment, reducing cost, strengthening farmers' production systems and contributing positively to the environment.

History of rice innovations in Nepal

Rice (*Oryza sativa* L.) is the most important commodity in Nepalese agriculture and in its economy as it is grown in about 1.55 m ha (50% of the total cultivated area during the spring and summer) producing 4.3 m tons of rough rice with an average productivity of 2.77 t ha^{-1}. The share of rice is 20% of the agricultural gross domestic product (GDP) and it contributes nearly 50% to the total calorie requirement of the Nepalese people. Nepal, a net exporter of rice until 1980, imported over 19,000 tons of milled rice in 2003 (IRRI, 2005a), which indicates the slow pace of rice growth in the country. Rice straw is the main source of animal feed during the dry season as it meets about 32-37% of total digestible nutrients required for 8.6 million livestock (NRRP, 1997). The terai region occupies 73% of the rice area while 24% of the area is in the hills and just 3% in the high hills >1,500 m (NRRP, 1997).

Formal rice research in Nepal started in 1951 with the collection of 930 rice germplasms from across 54 districts and their evaluation at Parwanipur and Khumaltar (Mallik, 1981, Bhattarai, 1969).

Parwanipur station was considered representative site for the entire terai[1] including river basins (sub tropical region) and low hills while the majority of the rice varietal development and testing for most of the mid hills (warm temperate region) and shuttle breeding for Jumla valley (2500 m) was done at the Khumaltar station (NARC, 1997). Exchange of germplasm with the International Rice Research Institute (IRRI) started in 1968. In 1972 Nepal began to test IRRI's yield nurseries to meet specific system needs through the International Rice Testing Program (IRTP) and subsequently through the International Network for Genetic Evaluation of Rice (INGER) after its establishment in 1975. Introduction and testing of exotic rice varieties was the main method of rice breeding and germplasm from IRRI and other sources were the main contributors. This method is still very important in the formal rice breeding system in Nepal and accounts for nearly 80% of all the releases (Fig. 1). Of the exotic germplasm, introductions from IRRI contributed for 33%, India 18%, Taiwan 8% and China and Sri Lanka 6% each. However, Masuli (Mayang Ebos 80*2 /Taichung 65), the only introduction from Malaysia, has been the most popular and widely grown rice variety in Nepal.

The Bangladesh Rice Research Institute (BRRI) initiated their breeding work in 1970 (almost the same time as Nepal) and 80% of all the releases in Bangladesh are bred in the country resulting in the elimination of rice imports since 1990 and achieving rice self-sufficiency (Baffes and Gautam, 2001, Saleque et al., 2004).

In India, 620 rice varieties were released between 1965 and 2000 and international germplasm largely from IRRI constituted only about 4% of total released varieties. The actual number of adopted varieties was 221 of which, rice varieties from IRRI and other exotic sources were planted to 17% of India's total rice area contributing to over 19% of India's total rice production between 1998-2000 (Janaiah and Hossain, 2004). This indicated that merely counting the number of releases is less relevant and what is more important is the type of germplasm as only a few varieties come out as the real winners.

A systematic rice research system started after the inception of the National Rice Improvement Programme (NRIP) in 1972

[1]Terai is the flat plain area in the southern part of Nepal, stretching from east to west across country at altitudes <100 m to 200 m with major agricultural land and considered favourable for rice.

(Sharma and Anderson, 1985), crossing and breeding of rice in the country was initiated in the same year. Later NRIP was named as National Rice Research Programme (NRRP) in 1972. The informal flow of germplasm across the open border with India through farmers' seed and social networks has been another important source of rice germplasm particularly for Nepal terai.

Farmers Field Trials (FFTs) and Minikits approaches were adopted as a part variety evaluation and promotion strategy after the establishment of NRIP. District Agricultural Development Offices (DADOs) within the Department of Agriculture (DoA) played an important role in the dissemination of technologies through the Minikit programme, mostly in accessible areas. Block production programmes conducted by DoA during 1980s also contributed to the spread of modern rice varieties, but the concept did not last long as it was driven by subsidies.

The Lumle Agricultural Centre (LAC) also started rice improvement work in 1985 by evaluating indigenous and exotic rice germplasm (Sthapit, 1987), decentralised variety testing and subsequently collaborative breeding through to participatory plant breeding (PPB) by 1993. PPB has recently been redefined as client-oriented breeding (COB) to remove the artificial dichotomy (Witcombe et al., 2005) that was created in the last decade (Biggs and Gauchan, 2001) in Nepal.

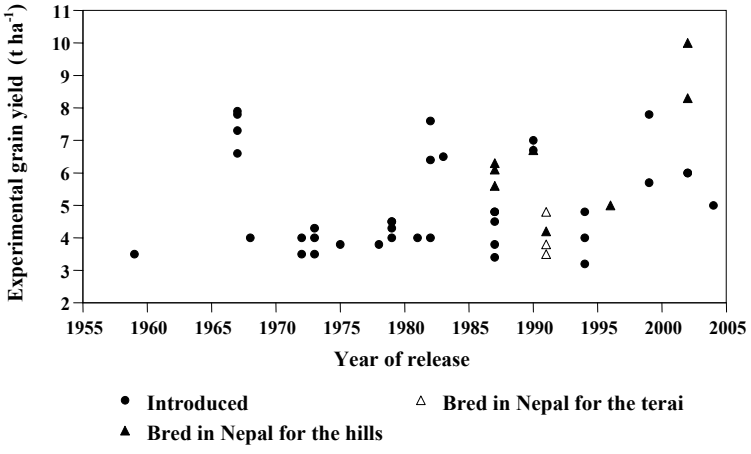

Fig. 1. Rice varieties released in Nepal up to 2004. Out of the 49 varieties released, 11 varieties have been bred in the country, 8 for the hilly areas, 2 for main season rice in the terai and 1 for *Chaite* (rice seeded in nursery in January-February and harvested in June-July) rice system.

Variety development and release system in Nepal

Plant breeding is expensive. Crop breeding, varietal testing and the release system in Nepal are slow and phase-wise. With few exceptions, a single generation of segregating material is handled per year meaning that at least six years is required from the time of making the crosses to the stage of making selections in the segregating generations. The first set of trials start in the seventh year, e.g. disease nursery, cold tolerant nursery etc. At least three years are spent in the multilocational trials; one year for the initial evaluation trial (IET) and two years testing is mandatory in the coordinated varietal trial (CVT). Two more years are spent in FFTs and at least two more years in generating data from farmers acceptance tests (FATs) or pre-production, verification trials (PPVTs) (Sthapit, 1995). Without considering the administrative delays of variety release, it takes at least 12 to 13 years to propose a variety to the variety approval, release and registration sub-committee (VARRSC) of the national seed board (NSB) for release. A longer breeding cycle entails an economic cost as farmers lose opportunities to grow better varieties earlier. Earlier completion of the breeding cycle leads to greater benefits to society and it could be an effective strategy to compensate for the difficulty of obtaining large yield gains that are harder to realize in unfavourable environments (Pandey and Rajatasereekul, 1999).

The package of practices

Historically the agricultural research and extension system in Nepal is dominated by the conventional crops-oriented top-down transfer of technology (ToT) approach with dominance of small-plot researcher-designed and researcher-managed trials with limited dissemination pathways (Gauchan, et al., 2003). This is partly due to the long-term connection of NARC with the International Agricultural Research Centres (IARCs), particularly the Consultative Group on International Agricultural Research (CGIAR) centres (Biggs and Matsaert, 2004). This paradigm was heavily guided by the ‘package of practices’. In the Research Station trials ‘low input’ varietal screening has never been a practice as they usually employ the ‘package of practice’ approach designed for a well-managed crop with a high yield. However, farmers in marginal areas invariably apply lower inputs to better match their limited capacity to procure resources, to reduce risks, and to maximise the long-term benefit

cost ratios by avoiding or reducing negative returns from purchased inputs in drought years. The promotion of a recommended 'package of practice' can be counter-productive in such circumstances (Joshi and Witcombe, 1996, Witcombe et al., 2005).

The 'package of practices' were predominant in on-station, on-farm trials and even in farming systems research (FSR) and also linked to extension strategy that forced block production of dominant varieties with incent-ives of subsidised agricultural inputs and credits. NARC and LAC established FSR sites at various ecological regions to verify and promote technologies. The trial design, input levels and final decision on the selection of a variety or technology even in FSR sites was mostly done by the researchers and the set of activities and approaches used were also more or less the same as that of on-station trials, e.g. cropping pattern trials (CPTs), FFTs, although, PPVTs and Minikits had relatively more farmer orientation. The farmers participated in land preparation, intercultural operations, harvest-ing and subsequent operations, but only had limited participation in the technology evaluation and decision making process.

Actor linkage in rice innovation system

In the past, there was a preoccupation with the simple representation of the "public sector" as being the major actor in the innovation system (Gauchan *et al.*, 2003). Rice research and development was primarily a public sector responsibility until late 1980s. Participation of private sector, NGOs and Community-based organisations (CBOs) in research and extension was minimal. However, the formal institutional architecture of the Nepal rice improvement system did not recognise the informal research and development (IR and D) that was taking place in the terai and other parts of Nepal as part of rice innovation system (Fig. 2). For example, the informal flow of germplasm across the open border with India through farmers' seed and social networks has always been one of the important sources of technology.

With the acceleration of globalisation, market liberalisation and privatisation processes in Nepal since the early 1990s, new actors such as International non-government organisations (INGOs), NGOs, CBOs and private sectors are emerging to meet farmers' needs and taking part in the rice innovation system. The roles of old actors (public institutions) are

also changing. New directions demand the formation of new institutional partnerships which is the best way forward in using scarce resources for research (Biggs and Gauchan, 2001). The NGO participation in the research and development process was instrumental in disseminating new opportunities at the grassroots level and also sensitising government for providing more emphasis on the resource-poor farmers.

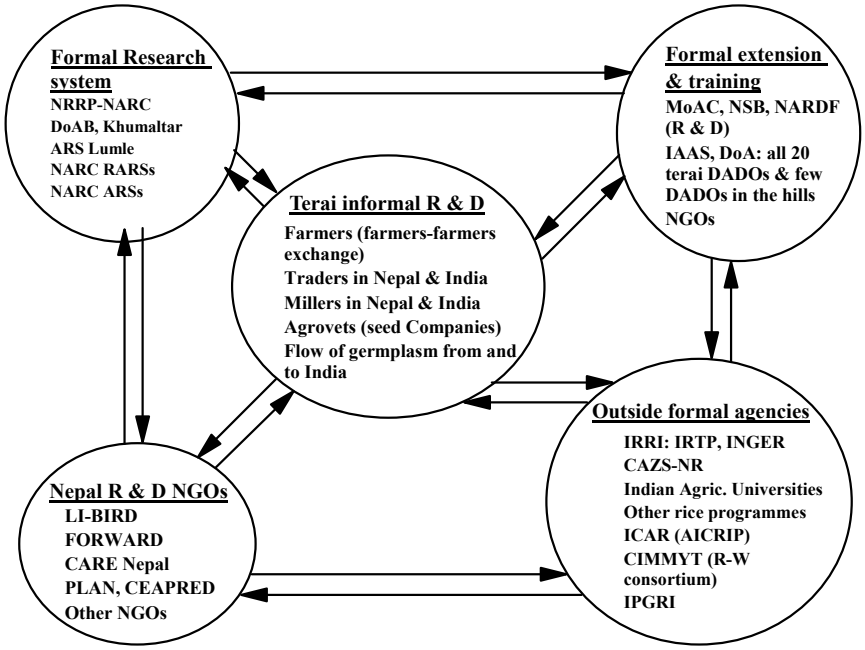

Fig. 2. Multiple actors in the rice innovation system in Nepal. In addition to the linkages shown in the figure, there are similar bi-directional linkages between formal extension and Nepal R and D NGOs as well as between formal R and D system and outside formal agencies

Diagnostic studies, germplasm exploration and exploitation and use of traditional wisdom

There is a long history of participatory technology development (PTD) in Nepal (Table 1). Some of the earliest works in low-income public-sector agricultural research organisations took place here (Kayastha et al., 1989). This started with the cropping systems project and grew to its height in the mid-1980s with the initiation of fully functioning FSR (Biggs and Gauchan, 2001). Farming Systems Research and Development Division (FSRDD), Socio-economic Research and Development Division (SEREDD) and semi government autonomous organizations e.g. LAC and PAC

made extensive use of exploratory surveys during 1980s through joint treks of multidisciplinary teams locally known as *Samuhik Bhramans* in vernacular. These *Samuhik Bhramans* were very useful in diagnosing farmers' needs and priorities and in collecting a wealth of information on various issues and the problems facing farmers. However, there are few innovations in Nepalese rice system in which local rice germplasm and traditional wisdom has been utilized e.g., only about 10% of the rice varieties released from 1959-2002 have Nepalese landrace as one of the parents. In these five varieties, only three landraces, Chhomrong Dhan, Jerneli and Pokhreli Masino were utilized and Pokhereli Masino was used in three of them (Joshi and Witcombe, 2002). This number is too little even comparing 2542 Nepalese rice germplasm that are in IRRI collection (IRRI, 2005b), although, the total number of rice germplasm in Nepal may be more than this. Of these varieties, Khumal 4 (IR 28/Pokhareli Masino) released in 1987 is still popular in the valleys and mid hills of Nepal. Enhancement of Chhomrong *Dhan* from local population by LAC led to the formal release of this landrace and it contributed to the portfolio of cold tolerant rice varieties in Nepal and elsewhere. Chhomrong *Dhan* is also popular in Bhutan (M. Ghimire, *pers. com.).* Spread of Pokhreli Masino from farmer-to-farmer networks was again a farmer innovation, which covered several eastern hilly districts of Nepal (Green, 1987).

Several organisations and projects identified, studied, and characterised many rice landraces in Nepal in the past but because of lack of systematic use either in germpalsm enhancement or in breeding programme, many landraces are now unavailable. The wealth of genetic resources and farmers' wisdom collected over the last several decades has been highly under-utilized.

Decentralised rice breeding in Nepal

While technically the formal representation of rice research puts NRRP in a dominant coordinating role, there has been decentralization in rice breeding and development work. NRRP took the lead for the sub-tropical area (terai) including low hills and river basins, Division of Agricultural Botany (DoAB) concentrated on Kathmandu valley, similar environments and also worked as a shuttle breeding station for Jumla valley. LAC was also given the responsibility of working for high altitude rice in 1987 (Table 1). The Regional Agricultural Research Stations (RARSs) and Agricultural Research Stations (ARSs) of the

Nepal Agricultural Research Council (NARC) spread in different parts of the country also collaborate for multilocational on-station trials and on-farm studies.

Development of Palung 2 (BG 94-2/Pokhreli Masino) for the mid hills is a kind of decentralised breeding. One of the parents of this cross was a landrace (Pokhereli Masino) and another important element in this cross was screening of segregating materials in the farmer's field of Palung valley (the target environment), though under breeder managed condition. The variety was preferred in several locations but later it became susceptible to blast and was dropped by the farmers.

Farmers' innovations

Nepal shares over 1700 km of open border with India with cross border socio-cultural interactions and this is vital for the flow of germplasm across the border with policy implications. Farmers are always looking for new options to maximise and diversify their farming system and they do not wait for the researchers (Brammer, 1980, Biggs, 1980). There are examples from other countries, such as Bangladesh, where farmers made their own selections from the population of IR 8 to suit their specific situations (Brammer, 1980). Many crop varieties are introduced informally through farmers' seed and social networks (Subedi et al., 2003). Rice is perhaps the best example of the informal flow of materials across the border between India and Nepal. Unlikely the widely held assumptions in 1980s that poverty and ignorance limits peoples' participation and hence innovations (Yadav and Rawal, 1981), there is evidence of farmers' innovations in the terai rice improvement system. Several rice varieties introduced from India through farmers' network are now widely grown in Nepal terai, e.g. Sarjoo 52, Mala, Indrasan, Malaysia, Phillips, China 4, Sona Masuli, Swarna, and Samba Masuli.

Table 1. Timeline of major events in the evolution and spread of some socially responsible technical and institutional innovations in the formal rice improvement system in Nepal[‡]

1950	1960	1970	1980	1990	2000	2010

Phase I: 1950-1970: (i) Initiation of formal research-collection and evaluation of indigenous rice landraces at Parwanipur and Khumaltar (1951) (ii) Introduction of exotic germplasm (mid 1950s) and first release of an exotic introduction (1959) (iii) Release of four exotic rice varieties for Kathmandu valley (1967).

Phase II: 1970-1980: (i) Establishment of National Rice Improvement Programme (NRIP) Parwanipur (1972) later known as National Rice Research Programme (NRRP) (ii) Release of six introduced varieties for terai including Masuli (1968-1973) (iii) Cropping systems research project - opening of six testing sites (1977) (iv) Integrated Cereals Project (ICP) and, release of six introduced varieties for terai including Sabitri (1975-1979).

Phase III: 1980-1990: (i)) Initiation of utilisation of local landraces and indigenous knowledge, e.g. Pokhereli Masino, Jerneli and Chhomrong Dhan (ii) Decentralised breeding of Palung 2 (1985) (iii) Establishment of Farming Systems Research and Development Division (FSRDD) and Socioeconomic Research and Extension Division (SERED) (1985) (iv) Agricultural Research and Production Project (ARPP) initiated and several on-farm testing sites established (1986) (v) Adopting multidisciplinary and interdisciplinary FSR approaches, opening of FSR sites (vi) *Samuhik Bhramans*–extensive use of Rapid Rural Appraisal (RRAs) by FSRDD, LAC, PAC (after 1985) (vii) LAC got mandate for developing cold tolerant rice breeding (1987). (viii) Outreach research at LAC and PAC (after 1989).

Phase IV: 1990-1995: (i) Informal Research and Development (IRD) developed and institutionalised (1990) (ii) Useful learning from CAZS-NR, University of Wales on COB and PVS (iii) COB and PVS on cold tolerant rice breeding initiated by LARC (1992) (iv) Use of PVS in outreach research by LARC (after 1992) (v) Closing down of FSRDD and SERED after the autonomy of NARC (vi) Start of Outreach research by NARC (1992) and establishment of Outreach Division in NARC (1994) (vii) Linkage between research and Agro entrepreneurs (1994) (viii) Evolution of LI-BIRD with major concentration on COB of rice (1995) (ix) Use of participatory rural appraisal (PRAs).

Phase V: 1995-todate: (i) Release of M-3 the first variety bred using COB (1996) (ii) Initiation of PCI project in high potential production systems (HPPS) (1997) by LI-BIRD and CAZS-NR (iii) Start of community integrated pest management (IPM) Farmers Field School (FFS) (1998) (iv) Joint PPB programme with NARC for *in situ* crop conservation (1999) (v) Scaling up and out of process and outputs of PCI to GOs and NGOs, e.g. CARE, PLAN, FORWARD, etc (1998 on wards) (vi) Uptake of resource conservation technologies (RCTs) (late 1990s) (vii) Initiation of informal scaling up of PCI process and outputs (after 1998) Signing LoA with DADO Chitwan (2000) (viii) LoA with CBOs in Nawalparasi (2000) (ix) Stakeholders meeting and formation of Working Groups for (a) fund raising and (b) revision of variety releasing procedures 2001 (x) Establishment of NARDF for awarding competitive grants for R and D to public and private sector (xi) Agricultural Research and Extension Project (AREP) funded by the World Bank provided funds to scale up PCI outputs in four districts (2001) and subsequently got scaled up to the parts of over 29 districts in the terai and hills (after 2002) (xi)Signing LoAs with NRRP for COB on rice (2002) (xii) Initiation of winter rice activities by NARC (2002) (xiii) Identification and release of cold tolerant varieties for Jumla valley (2002) (xiv) Establishment of IRRI liaison office in Kathmandu (2004) (xv) Final approval of revised variety release procedure by MoAC (2005)

[‡]AREP = Agricultural Extension and Research Project, ARPP = Agricultural Research and Production project, CBOs = Community based organisation COB = Client-oriented Breeding, DADO = District Agricultural Development Office, FFS = Farmers' Field School, FORWARD = Forum for Rural Welfare and Agricultural Reform for Development, FSR = Farming Systems Research, FSRDD = Farming Systems Research and Development Division, GO = Government Organisation, HPPS = High Potential Production systems, ICP = Integrated Cereal Project, IPM = Integrated Pest Management, IRD = Informal Research and Development, IRRI = International Rice Research Institute, LAC = Lumle Agricultural Centre, LARC = Lumle Agricultural Research Centre, LoA = Letter of Agreement, MoU = Memorandum of Understanding, LI-BIRD = Local Initiatives for Biodiversity, Research and Development, MoAC = Ministry of Agriculture and Cooperatives, NARC = Nepal Agricultural Research Council, NARDF = National Agricultural Research and Development Fund, NGO = Non-government Organisation, NRIP = National Rice Improvement Programme, NRRP = National Rice Research Programme, PAC = Pakhribas Agricultural Centre, PCI = Participatory Crop Improvement, PVS = Participatory Varietal Selection, RCT = Resource Conservation Technology, SERED = Socioeconomic Research and Extension Division.

Some of the modern rice varieties now in the farmers system were included in multilocational trials or even in the FFTs by the formal system but never released. Currently such varieties also occupy a considerable area, e.g. Aus Masuli (also known as Jhapali Masuli, Kanchhi Masuli, Bans Dhan, Banspate), Radha 17 (Rato Masuli, Makhamali), and Ekhattar. Of the rice varieties promoted through farmer-to-farmer network, Kanchhi Masuli, Radha 17, Swarna, Sona Mansuli and Sarjoo 52 cover quite a considerable area of rice in the terai. Monitoring of rice varieties in 15 terai districts revealed that Kanchhi Masuli and Radha 17 were prevalent in 10 districts each, while Swarna was reported from six districts, Sarjoo 52 from 5 districts and Sona Masuli from 4 districts. But none of these varieties have been formally released by the national system thereby limiting access of these germplasms in wider areas.

Masuli is still the most popular variety as it was reported from all the 15 districts monitored while other released varieties e.g. Sabitri were reported from 9 districts, Radha 4 from 8, Rampur Masuli 6 and Janaki from just 5 districts. Interestingly many of the released varieties e.g. Barkhe 2, Bindeswori, Khajura 2, Radha 7, Radhakrishna 9, Radha 11, Radha 12, etc were not reported even by a single farmer from any district (Joshi et al., 2002). Farmer innovations could be considered socially responsible innovations as these are time tested useful varieties; seed is disseminated from farmer-to-farmer network and the related information through word of mouth, which is much more powerful than information flowing from the formal channel. Power of this system also lies in identifying what is useful to them and what is not as the system was not growing several of the officially released varieties but instead growing many of the non-released varieties. The PCI project helped legitimise informal research and development (R and D) in the terai e.g., the germplasm coming from informal sources including farmers' innovations were included in the participatory varietal selection (PVS) trials of PCI project and this enabled the formal system to accept and capitalise on the reality of the open border with India in terms of rice innovations - a major institutional innovation.

Traders' Innovation

Rice traders in Nepal have also played important roles in rice innovation systems; either positively or negatively. Trading rice under the brand name of Masuli has major implication for plant breeding. This has hampered the efforts of the plant

breeders. Nepali consumers have very strong preference for fine- and Mansuli-type (formal name Masuli) rice varieties (golden husk colour, creamy medium fine grain with good cooking and eating quality) as they have a reputation of being a well established name for daily diet of people, particularly for the middle social strata. To make the marketing of new varieties easier traders have simply mis-labelled other varieties under the brand name of Mansuli for their personal benefits. For example, Khumal-4 a popular rice variety in Kathmandu valley is sold under the name Jira Masino or local Mansuli. However, rice traders have partly by deceiving consumers, assisted to popularise some of the new rice varieties, which have appealing traits for consumers and farmers. One of them is Sona Mansuli, an Indian variety popular in central Terai (Bara, Parsa districts) that has golden husk, higher percent of head rice recovery, medium grain and fairly good taste.

NRRP have been partly responding to traders' innovation by including Masuli in breeding programme, e.g. there are two rice varieties released by NRRP have Masuli in their parentage, e.g. Radha 7 and Radha Krishna 9. However, there is a major weakness in terms of naming rice varieties while proposed for release. For example a formal name given to a variety at release is neither related to its traits nor the growing season. And there is no mechanism of providing related information to the farmers and consumers at the grassroots level as to which entry was released on with new name.

COB (PPB) on rice managed by LI-BIRD, CAZS-NR and NRRP made more efforts to respond to the preference for Masuli by including Masuli in the crossing programme, putting strong selection pressure on golden husk, creamy grain with good grain and eating qualities and also by conducting extensive organoleptic evaluation (taste preferences) involving multi-stakeholders in the process. There are now a number of rice lines from COB having Masuli as one of the parents with very high promise in terms of field performance and farmers preferences.

Informal research and development (IRD): quick and cost effective approach of product marketing

The informal research and development (IRD) approach tested and promoted at LAC during early 1990s is fully participatory as the entire process of evaluating, decision making and disseminating rests with the farmers and researchers and/or development workers (Joshi and Sthapit, 1990). It is designed for

reaching difficult terrains, remote areas beyond the reach of formal research and extension services. It focuses on poverty as preferential distribution is to the poorest farmers in the poorest areas. IRD is a socially responsible research and extension approach as it addresses social inclusion, poverty, marginalized and remote areas. The approach has been very rapid and effective in increasing adoption, enhancing on-farm varietal diversity by providing the benefits of new genetic materials five to six years in advance of the formal system and it is substantially more cost effective and practicable as it overcomes the slow and hierarchical process of variety testing in formal system (Joshi et al., 1997, Joshi and Witcombe, 2002).

Client oriented breeding (COB)

Decentralisation of breeding and involvement of farmers in variety testing and promotion started after mid 1980s. These methods have been tried in marginal areas (Maurya, et al., 1988, Sperling et al., 1993, Joshi and Witcombe, 1996, IDRC, 1996, Debrah et al., 1996, Sthapit et al., 1996, Thiele et al., 1997, Joshi et al, 1997). LAC envisioned decentralised testing of rice varieties across ecological sites following the opening of FSR sites in late 1980s but trials in the farmers' field at these sites also lacked farmers' participation in terms of crop management and decision-making. Orientation towards effective farmer participation came only after the association of LAC with CAZS-NR, University of Wales Bangor in 1991. CAZS-NR brought the concept of evaluating varieties or breeding lines in the farmers' fields under their input level with their real participation and decision-making role. There was useful learning from CAZS-NR in terms of COB and PVS methodologies (Table 1). Development of Machhapuchhre 3 and Machhapuchhre 9 could be considered as the inception of COB. Of these two, Machhapuchhre 3 was formally released by VARRSC of NSB Nepal in 1996 (Joshi et al., 1997). Both the varieties are spreading from farmer-to-farmer networks, through NGOs and government organisations (GOs) networks. Their adoption had steadily increased and their spread commenced five to six years earlier than would have been the case in a conventional system. The farmers at Marangche village reported that 'the introduction of Machhapuchhre lines has increased food self-sufficiency by an additional four months. 'Before their introduction they had enough food for six months, now they can live without buying food from outside the village for ten months' (Joshi et al., 2001).

These varieties are also popular in Bhutan (M. Ghimire, *pers. com.).*

Participatory Crop Improvement (PCI) and Client-Oriented Breeding (COB)

A participatory crop improvement (PCI) project was initiated in late 1996 with the purpose of developing and promoting the strategies for the introduction of new crop varieties and improved agronomic practices in high potential production systems (HPPS) of Nepal terai in Chitwan and Nawalparasi districts. The project aimed to demonstrate, in a convincing manner, in a range of socio-economic environments that participatory methods are effective in HPPSs to increase cultivar diversity and variety replacement rates, and to improve agronomic practices. Rice varieties from various sources were included in to the PVS trials, e.g. NRRP, Indian Universities and even farmers' popular varieties, e.g. Ekhattar and Lahure were also included into the PVS trials and scaling up.

Scaling up could be defined as providing more quality benefits to more people, over a wide geographical area, more quickly, more equitably and more lastingly. Whereas scaling out can be referred to as horizontal scaling up as it involves spread across geographical boundaries to cover more people and communities while dissemination takes place within the same sector or stakeholder groups. Vertical scaling up on the other hand refers to going higher up in the ladder. It is institutional in nature that involves other sectors or stakeholder groups in the process of dissemination-from the level of grassroots organisations to policy makers, donors, development institutions and investors at international level (Gundel, et al., 2001, Gonaslaves, 2001). Majority of the scaling up through PCI was horizontal; however, there were a few successful innovations of vertical scaling up.

In 1998, a client oriented breeding (COB) project was also initiated as the PVS varieties could not provide enough choice to the farmers. For example Pusa Basmati 1 was evaluated in PVS trials, though its grain quality and taste was very much preferred but farmers were reluctant to grow this for two major reasons: difficulty in milling due to long awns and due to its short straw. Uptake of Radha 32 was very high following first year PVS trials but it was subsequently dropped due to its poor cooking and eating qualities. Both of these varieties were subsequently included as parents in to COB and now there are several lines from these two crosses that have been widely adopted in Nepal,

Bangladesh and India. This could be considered as socially responsible innovation system as the project responded to feedback from the clients.

Changes where projects played a role

The commonly held assumptions for high potential areas are that these are uniform in physical and socioeconomic environments, most grain in these areas is sold rather than consumed on farm, are served well by formal research and extension, which were totally refuted by this study. There was a vast diversity in agroecology; in types of land and soil, access to irrigation water, drainage patterns and interaction of these elements with other socioeconomic factors lead to greater diversity (Rana et al., 2004). Land holdings were small to medium, poverty prevailed even in these areas and majority of the farming households were food deficit (Fig. 3). Only about 25% of total grain produced in the area was available for the market and this mostly came from the richer farmers. Farmers were growing old varieties e.g. CH 45 (44 years) and Masuli (28 years) or un-recommended varieties e.g. Ekhattar, Kanchhi Masuli, Radha 17 and a large number of landraces. Sabitri released in 1979 was just becoming popular. Varietal diversity was low and varieties such as Masuli were covering more than 90% area in some of the clusters therefore farmers' livelihoods were vulnerable to major outbreaks of diseases and pests because of genetic homogeneity. The adoption of main season rice varieties identified by the project through PVS or bred using client-oriented breeding (COB) was 18% in 58 villages of Chitwan and Nawalparasi within two to six years of intervention (Devkota et al., 2005). Reducing vulnerability due to genetic homogeneity by increasing varietal diversity was considerable contribution of the PCI project.

Change of programme priority after baseline study

An eye opener to the project in its first year came from a farmers' livelihood analysis involving nearly 1500 households in 8 villages of Chitwan and Nawalparasi. Socioeconomic factors, e.g. land holding size, sources of income, food sufficiency levels and volume of rice that was available for market in the HPPS of Nepal were studied (Rana et al., 2004).

The farmers' livelihood analysis was instrumental in targeting food deficit households. The IRD approach was used to reach the food deficit households. The target households were identified using the criterion such as type of the house, i.e. households mostly with huts or clay-tiled roofing

were chosen for this purpose as opposed to reinforced concrete cement (RCC) roofing. Learning and responding to the information from the project livelihood analysis was instrumental in providing the right direction to the project activities. It is important to note that normally in Nepal baseline studies (Bench mark study) are conducted to provide a "benchmark" against which a project is evaluated rather than a survey to direct the project as was done here.

Influencing formal extension system

Initially, LI-BIRD consulted District Agricultural Development Office (DADO) Chitwan for preliminary situation analysis, site selection and local level support and DADO were positive and supportive. Project regularly organized monitoring tours inviting professionals from several DADO offices, NARC, Department of Agriculture (DOA), other lines agencies and NGOs. This forum was important in creating and building up the linkages and disseminating information. As the PCI activities were intensified, a demand for new varieties and technologies was created among farmers. DADO Chitwan proactively responded to those demands by spending their core funds to buy large quantities of seeds of new farmer preferred but unreleased varieties from LI-BIRD (after 1998) for verifying with a large number of farmers. Normally, extension system promotes only released or recommended varieties. This was an innovative and bold step taken by a formal sector organization in response to the demand by the farming community.

After an informal collaboration for over a year, a formal letter of agreement (LoA) was signed between the authorities of DADO Chitwan (a district level government line agency) and LI-BIRD facilitated by CAZS-NR for three years with a clear agreed roles and responsibilities. The financial support for this partnership came from DFID PSP. The role of DADO Chitwan was to implement the joint activities through their district level network and LI-BIRD was to provide technologies, technical support and agreed funds. Another proactive role played by DADO Chitwan was to institutionalize the processes of this collaboration. Not only the joint activities were presented to regional annual planning meetings to be included in to the final programme of the district but the efforts were also made to reflect the financial contribution for these activities in the *Rato Kitab* (the official government Red Book of authorised budgets). It is note worthy that influencing formal extension policy and

institutionalization of the partnership with the government line agency was not envisioned as one of the outputs in the original project log frame. This was clearly a result of new learning and responding to the lessons learnt and to the clients' needs.

This formal partnership may be one of the first examples of its kind in Nepal. This collaboration is also noteworthy in that the interest for collaboration actually came from the government side (DADO Chitwan) rather than LI-BIRD the NGO. Although, there was a lack of government policy (during that period) to support this type of local level initiatives, however, the then Regional Director of Agriculture for Central Region was positive and supportive for this development and gave a go ahead signal to DADO Chitwan. This was another contributing factor that allowed this GO-NGO collaboration to take place and to be effective. This example was one of the important cases to motivate the Ministry of Agriculture and Cooperatives (MoAC), DoA, Agricultural Research and Extension Project (AREP) and other projects to formulate policies for decentralization of agricultural extension function. DADO Chitwan and LI-BIRD Professionals involved in this partnership were invited to several brainstorming sessions and discussion fora to share their practical experiences of managing this emerging partnership in Chitwan (Devkota, 2000, Subedi, 2000). Later, a policy was formulated by the MoAC that allowed all the DADO offices to collaborate with other service providers and agencies for generating extra funds, making agricultural service delivery timely and efficient. PCI and COB (PPB) have been recognized as pluralistic extension approaches and DoA appreciated partnership with NGO/INGO as a means of verification and dissemination of new crop varieties directly with the farmers communities (Bhandari, 2002).

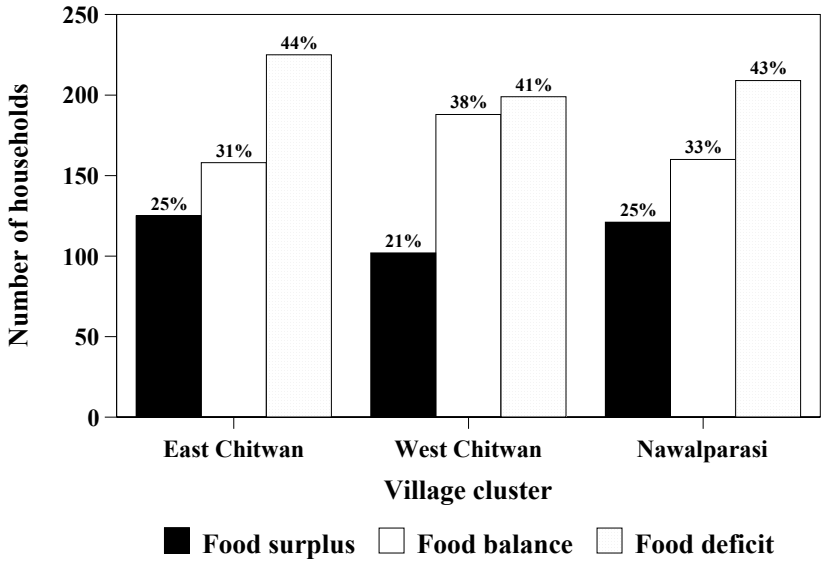

Fig. 3. Distribution of households according to food sufficiency level, e.g. food-deficit, food balance, or food surplus. Two villages from east Chitwan cluster, 3 villages from west Chitwan cluster, and 3 villages from Nawalparasi cluster. (Source: Rana et al., 2004).

Stakeholders meeting for scaling up and policy review

Stakeholders meetings were jointly organized by CAZS-NR and LI-BIRD in February 2001 with two main objectives (i) to scale up the findings of PCI project to wider areas involving multiple stakeholders and (ii) to work on the revision of variety release procedures so as to include data generated by participatory trials and other forms of experimentation and make the provisions flexible so that NGOs and private organization (POs) can participate more fully in crop improvement research in Nepal.

By the end of the Stakeholders meeting two separate Working Groups were set up; one to look in to the aspect of fund raising for scaling up of the process and outputs of PCI project to four additional districts. The second Working Group was formed to work on variety release procedures.

A six-member fund raising Working Group comprised of representatives from NARC, DoA, NSB, AREP (the World Bank funded project), DFID Nepal and LI-BIRD (Joshi et al., 2003) was created. The resources generated from the AREP were used by LI-BIRD and DADO collaboration to scale up the process and farmer preferred rice varieties from PCI project to Dhanusha, Sarlahi, Bardiya and

Kailali districts in 2001. Scaling up of process and outputs from PCI to other districts of Nepal was not envisioned as one of the outputs in the project log frame.

Consolidating and expanding to more organizations

Several rounds of brainstorming and workshops were organized in 2002 by DoA, LI-BIRD and CAZS-NR with DADOs to scale up the process and outputs of PCI project across all the terai districts. There was a consensus on the advantages of participatory approaches for variety testing and scaling up. It was agreed that PVS Mother trial (multi entry, single replicate PVS trial conducted under farmers level of input and management) and Baby trials (PVS with comparison of one or two new varieties with the existing ones conducted under farmers input and management) on rice be conducted in all the terai districts. The scaling up of outputs from PCI to all the terai districts of Nepal was not envisioned in the original project log frame.

Spill over to low hills and river basins

There was no systematic effort by the project to scale up PCI outputs in the hilly areas; however the project saw a spontaneous spill over to nine hilly districts. Seeds spread from farmer-to-farmer networks and NGOs. The DADO offices from different hill districts placed a demand for the seeds of rice varieties with LI-BIRD based on informal information flow through DADO networks, FM radios and other sources.

NGO-NGO collaboration:

The Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) an NGO has collaborated with LI-BIRD since 2002 for PVS and scaling up of rice varieties identified by PCI or bred by COB in parts of six districts (Khanal et al., 2004). This is a unique type of collaboration where one NGO is complementing the other for research and development initiatives. LI-BIRD, a research NGO is also collaborating with other International non-government organisation (INGOs), e.g. CARE, PLAN International and many other local NGOs.

Empowerment of Community based organizations (CBOs) and the farmers

Another important form of collaboration that emerged almost the same time was an NGO (LI-BIRD)-Community-based organization (CBO) collaboration participatory scaling up of PCI identified crop varieties through the empowerment of CBOs in natural resource management. LI-BIRD signed three separate LoAs with three CBOs in Nawalparasi, one of which was formed by DADO

office while the other two were self organized (Joshi et. al., 2003). This was probably the most dynamic type of collaboration due to institutional flexibility of both the organizations.

CBOs were fully responsible in decision making and in the execution of the activities while LI-BIRD played a facilitating role in providing technologies and financial support, capacity building, technical and institutional backstopping. These CBOs scaled up outcomes of PCI and produced excellent outcomes in crop and varietal diversification, capacity building of the farmers on various aspects of varietal selection and crop management in the villages.

LI-BIRD signed another LoA with Jaskelo Yuba Club - a local Club in Chitwan to facilitate in the various aspects of COB, e.g. identification of collaborators for breeding trials, seed production and marketing, facilitating visitors to the COB and other activities and focus group discussions (FGDs) and ranking exercises. The group has been instrumental in organizing the organoleptic assessment for COB lines and also the rice lines obtained from NRRP. Few of the Club members have skills in different aspects of COB and at times work as the resource persons for training farmers in other projects. One of the members of the Club Devraj Sapkota developed a rice variety from a bulk from the project and gave the name DR Dhan, which is becoming popular in Chitwan and other areas particularly in *Chaite* rice and in upland areas of main season. He was awarded by LI-BIRD for this innovation.

Farmer participation was an integral part of project activities, e.g. selection of segregating or uniform rice lines in the standing condition, ranking, FGD, post harvest evaluation including organoleptic assessment. It is now a policy to advance only those lines that have been endorsed by the farmers through ranking, post harvest evaluations and organoleptic assessment. Women farmers participated and played key role in all of the post harvest evaluations and organoleptic assessment. Involvement of women, other farmers, other stakeholders in all the decision making process contributed for the empowerment of communities.

Linkage with other projects

PCI project also had useful linkages with AREP project and they were first to adopt seed varieties and approaches from PCI in four districts, e.g. Dhanusha, Sarlahi, Bardiya and Kailali in 2001. Seed Sector Support Project (SSSP) also tested several of the *Chaite* and main season rice lines from the

project in various hilly districts of Nepal. Rice varieties e.g. Pant Dhan 10, PNR 381, Sarwati, Swarna, BG1442, Rampur Masuli, IAASR32, Judi 141F, Judi 572, Sugandha 1, Barkhe 1027 evaluated in AREP been preferred and adopted by the farmers and spreading in other parts of the district. Study of adoption and spread of rice varieties identified by PCI in Sarlahi district revealed that more than 15% farmers were adopting these varieties after just one time exposure of seeds to the farmers in 2001 (Rawal et al., 2005). Similarly short duration varieties e.g. Judi 572, Sugandha1 and Barkhe 1027 have been spreading in SSSP project areas (D. Karki *pers. com*.).

Collaboration with Nepal Agricultural Research Council (NARC)

The PCI project also included few rice varieties from NRRP as early as 1997 for testing in PVS trials. Rice scientists from NRRP also participated in the crop monitoring visits and other discussion fora. Later on a LoA was signed between LI-BIRD and NRRP in 2002 which fostered closer interaction between two organizations. Disease screening of COB rice lines is done by NRRP while LI-BIRD are supporting NRRP in screening rice lines for quality traits including cooking, eating qualities, market acceptance etc. This is an excellent development in terms of strengthening overall rice innovation system in Nepal.

NARC is increasingly changing from FFT to PVS approach. NARC are collaborating with CIMMYT in wheat and maize PVS and with IPGRI and LI-BIRD for rice COB (Sthapit et al., 2001). The final plenary session of the summer crops workshop organized by NARC at Khumaltar Lalitpur in June 2004 put forward a recommendation for the institutionalization of the PVS approaches into the national system (NARC, 2004).

Spill over to Consultative Group on International Agricultural Research (CGIAR) centres

The global project on *in situ* conservation of crop genetic resources, which started in 1997, adopted client-oriented breeding (COB) as a technical strategy for the conservation of crop genetic resources *in situ*. This project was managed by International Plant Genetic Resources Institute (IPGRI) and implemented by NARC jointly with LI-BIRD, CBOs, and DoA. This project was influenced by previous participatory research on PVS, COB (PPB), PCI in Nepal, India and elsewhere (Joshi and Witcombe, 1996, Witcombe and Joshi, 1996, Witcombe et al., 1996; Sperling et al., 1993 and Sthapit et al, 1996). This project was built upon the past

experiences and also refined some of the processes to make the COB more rigorous. A few members of the PCI team not only worked as the thematic leader for the COB component of *in situ* crop conservation project but also provided logistics for creating diversity and advancing generations of the crosses made by the project for the Kaski site. On the other hand, the PCI team capitalised on the good will that has been already created between LI-BIRD and NARC to sign the LoAs for collaborative participatory research on rice and maize. The *in situ* crop conservation project also contributed in developing closer linkage of PCI with NARC and brought together non traditional partners, e.g. GO (both research and development), NGO and farmers at a community level which generally does not happen. There was almost a collegial type of relation established between the partners involved in the project. Working with various stakeholders with different interests and orientations was really helpful in understanding their institutional contexts, strengths and constraints and making use of all these elements for achieving the common goal.

The PCI project was also instrumental in influencing other CG centres particularly CIMMYT South Asia Regional Office (SARO) in adopting participatory approaches particularly PVS both on wheat and maize. The Manager for DFID PSP, CAZS-NR, University of Wales (UoW), Bangor, who was also one of the members of Board of Trustees for CIMMYT, during his visits to Nepal had regular interaction with CIMMYT Scientists, this led to the development in 2001 of a multi-partner and multi-country project on wheat "Participatory research to increase the productivity and sustainability of wheat cropping systems in the eastern sub-continent of South Asia".

The project was implemented in Bangladesh, India and Nepal and CAZS-NR are one of the partners for providing technical backstopping to the concept and approaches of participatory research on wheat. The project identified and promoted farmer-preferred technologies, trained critical mass of scientists in these countries and was able to change the pre-occupations and mindsets of the researchers and research managers regarding the crop breeding research. As a result of this project, new farmer preferred wheat varieties and other technologies e.g. seed priming, resource conservation technologies (RCTs) have been disseminated across countries directly involving farmers in the process (CIMMYT, 2004).

The PVS approach was also adopted by another project within CIMMYT-SARO-Hill Maize Research Project (HMRP) funded by Swiss Agency for Development and Cooperation (SDC). The initial phase of the project was dominated by a researcher-led on station testing and verification activities. However after the recruitment of an agronomist with overseas training from UoW in participatory research, the entire orientation of the project was changed in the second phase adopting a more participatory approach involving several NGOs, grassroots organizations and government line agencies focussing on marginalised, socially excluded *Dalits*[2] in its activities. PVS and community-based seed production and distribution (CBSPD) has been initiated in several of the hill districts. In 2004, more women and disadvantaged ethnic communities participated in the project activities than previously. Nearly 12,000 farmers (32% women) benefited directly from the project, of which 70% were from food deficit category. Based on ethnic composition 33% of them were *Dalits* (HMRP, 2005). While CIMMYT and many international plant breeding institutes have on occasions given lip service to COB, significant moves towards it such as this have not been often been in the past.

Influence on National Agricultural Research and Development Fund (NARDF)

Hill Agricultural Research Project (HARP) funded by DFID introduced the concept of competitive grant system for agricultural research in Nepal. Based up on the experiences from HARP, the National Agricultural Research and Development Fund (NARDF) was constituted by a government order in 2001 to administer short to medium-term projects mostly on adaptive and action research, scaling up, market promotion. Analysis of NARDF awarding and administered competitive grants revealed that out of 15 projects awarded in 2003, seven (nearly 50%) were along the participatory approaches while three (20%) were actually on PVS (NARDF, 2004). This is very encouraging to see that participatory approaches are beginning to gain recognition in action by the government line agencies.

Policy changes on seed regulatory issues

A seven-member group was set up representing NARC, National Seed Board (NSB), DoA, Seed Entrepreneurs Association of Nepal (SEAN), IPGRI, LI-BIRD and CAZS-NR to look in to the

[2] *Dalits* are occupational castes and are socially excluded and marginalized communities in Nepal.

options for releasing the crop varieties bred or identified using participatory methods by suggesting appropriate revisions in variety releasing procedures in line with a New Seed Policy of 1999. It was argued that changes in the current system to one in which farmers evaluate and multiply promising materials themselves to make the widespread use of modern varieties would contribute considerably to increasing food and income security (CAZS-NR, 2001). The group could not be effective for various reasons and was re-organized in September 2003 in the presence of the authorities from NARC and NSB (Joshi et al., 2003). CAZS-NR and LI-BIRD organized several rounds of stakeholders meetings, consultation and discussion fora to open up the debate on current variety releasing procedure adopted by NSB. Following several rounds of discussions there was an acceptance that the variety release and registration procedures should be made more flexible. A new seed policy was adopted by MoAC in 1999 that was particularly helpful in bringing the debate to a logical and fruitful conclusion. It states, "the function of variety development and promotion done only by public sector until now will also be open to NGOs and private sector" (MoAC, 1999). The revised variety release procedure was formally endorsed by the government in 2005 (MoAC, 2005). Recently two joint variety release proposals on mung bean and one on rice have been submitted to NSB (Khanal, et.al., 2005, Yadav et al., 2005 and Gyawali, et.al., 2005). This will be the first example of NGO-GO jointly submitting variety release proposals together with IARC. It is of note that regulatory reforms concerning variety release issues were not envisioned as outputs in the original PCI log frame.

Increasing availability of varietal choice for the terai

The choice of farmers accepted varieties for terai has increased after PCI and COB. Farmers choose varieties based on adaptation, maturity, grain quality and suitability to the cropping systems and in reality a range of PVS identified varieties were adopted. As a result of introduction of unrelated new varieties, the weighted average diversity increased substantially from 0.04 to 0.26 (Witcombe, et al., 2001). COB has been more rapid in variety development and scaling up as in less than seven years, COB varieties e.g. Judi 141F, Judi 567, Judi 572, Sugandha 1, Sugandha 2002, Barkhe 1027, Barkhe 2001, Barkhe 2014, Barkhe 3004 and Super 3004 have reached parts of 29 districts in the terai and the hills, have been widely accepted and increased the varietal choice

in all the four rice domains considerably. This is a great achievement for a seven year project to offer wide choice of greatly accepted varieties. This process provides environmental benefit to community as both theory and observation indicate that genetic heterogeneity is a possible solution to the vulnerability of monoculture crops to diseases and pests (Zhu et al., 2000). Crop diversification following the introduction of short duration rice varieties was another important change brought about by PCI and COB projects.

Contribution in improving food and livelihood security

The outcome and impact of PCI and COB have been assessed comprehensively and reported separately (Joshi et al., 2005). The project contributed considerably in reducing poverty and addressing food and livelihood security.

The adoption of project identified and promoted rice varieties was 18% for the main season rice in Chitwan and Nawalparasi districts (Devkota et al., 2005). The yield advantage of *Chaite* rice variety, e.g. BG 1442 over check variety was 22% (3.66 t ha^{-1} cf 2.99 t ha^{-1}) and over other varieties 40% (3.66 t ha^{-1} cf 2.53 t ha^{-1}). In addition to yield advantage, a price advantage of Rupees 0.5 to 1 kg^{-1} ($7-14 ton^{-1}) was also reported. For main season rice, the yield advantage from Barkhe 2014 in medium lands was 24% (4.2 t ha^{-1} cf 3.4 t ha^{-1}) and from Super 3004 in the lower lands 37% (3.7 t ha^{-1} cf 2.7 t ha^{-1}). These advantages from new varieties contributed both to food and income security of adopting farmers in the terai.

Swarna, one of the project identified varieties, is becoming popular in Agauli, Sherganj and Abhiyun villages of Nawalparasi where Masuli was grown in the past. The farmers in these villages told the researchers that Swarna yields 1.5 times to twice as much though it fetches slightly lower price compared to Masuli ($7-14 ton^{-1}). Swarna contributed to increasing food sufficiency from six months to one year (majority of cases), contribution to an increase in family income that was crucial for life saving health care (maternity care), schooling of the children, meeting household requirements, social obligations (marriage), farm improvements etc (Joshi et al., 2003). The project is directly contributing to millennium development goals of eradicating extreme poverty and hunger and indirectly contributing to other millennium development goals as it is promoting gender perspective in the research and development (goal number 3), enhancing varietal diversity contributing to environmental sustainability (goal number 7)

and also contributing to global partnership for development (goal number 8) (UN, 2000).

The internal rate of returns (IRR) and net present values (NPV) for PCI project could be calculated and those are high. The IRR for PCI project within the fifth year of trail was 43-126% while NPV ranged from £2 to £29 million by 2010 and £4 to £52 million by 2012 (Witcombe et al., 2003).

Addressing social inclusion, disadvantaged and marginalised communities

Outcome assessment was done with 350 randomly sampled households in seven villages for *Chaite* rice and 906 randomly sampled households in 16 villages of Nawalparasi for the main season rice where PCI outputs were scaled up. Results indicated that >75% of sampled beneficiaries for *Chaite* rice activities were indigenous people and disadvantaged communities, while this percentage was nearly 53% for main season rice (Table 2). This clearly shows that the project addressed the issue of social inclusion by targeting minority communities, disadvantaged and socially excluded communities (Table 2).

Table 2. Ethnic composition of surveyed households in the selected villages of Nawalparasi for *Chaite* and main season rice.

Ethnic group	Description of Group	Households receiving *Chaite* rice varieties from PCI[§]:			Households receiving main season rice varieties from PCI:		
		Total	Sampled	%	Total	Sampled	%
Brahmin, Chhetri	Advantaged	323	65	4.4	833	350	15.3
Newar	Advantaged	47	20	1.4	133	80	3.5
Tharu	Disadvantaged	850	254	17.2	850	344	15.0
Kumal, Damai, Kami, Miya, Darai, Bote, Mushhar[†]	Disadvantaged	202			294	115	5.0
Gurung, Magar, Tamang	Disadvantaged	56	11	0.7	184	17	0.7
Total		1478	350	23.7	2294	906	39.5

[§]*Chaite* rice varieties were scaled up to 7 villages while main season rice varieties to 16 villages in Nawalparasi. [†] No farmers from this category grew *Chaite* rice crop.

Community based seed production and distribution (CBSPD)

Although, it was not envisioned in the project design to work on CBSPD, the project facilitated several seed producers groups and currently LI-BIRD and FORWARD are working with 11 functional groups in parts of several districts from Jhapa to Kanchanpur, annually producing over 500 tons of rice seeds including varieties identified by PCI or bred by COB. The amount of seed dealt by these groups is

not very high but their importance lies in increasing the access and choice of new rice varieties to farmers directly in the villages. These groups are also working with other crops and mostly focus on crop and varieties that are in demand avoiding any mis-match between seed demand and supply. Many of these groups have already been linked or are in the process of being linked with Seed Companies, Agrovets[3] and other market channels and would continue producing and marketing seeds even after the termination of the project, unlike the project promoted seed programmes that hardly survive after the project. These seed producer groups are self organised and there is no project support other than technical backstopping and market networking. This is one of the most important institutional innovations through PCI that will enhance participatory scaling up and contribute to long-term sustainability of the approach.

District level seed self-sufficiency programme (DISSPRO) was initiated by Crop Development Directorate (CDD) of DoA to improve the access of farmers to improved seeds of preferred crop varieties locally. The idea was to identify resource centres in selected district for seed production. The programme provides logistical support, technical backstopping, source seed, subsidy and a matching fund of up to Rupees 65, 000 ($880) per group to strengthen the seed production activities (Bhandari, 2002). The programme basically focuses on production with out envisioning seed marketing.

Formal seed system meets <5% of total seed requirements in Nepal (although this 5% can be very important for innovation when it is seed of newly released varieties) and the rest is entirely met through farmers seed system (Baniya et al., 2000). Recently National Seed Company (NSC) has been reorganized from Agricultural Inputs Corporation (AIC) but they are yet to be fully operational and hence less likely for them to cater for higher percentage of seed requirements. But even with a fully-fledged operation, it would be impossible for NSC to cater for the entire seed demand for food crops in Nepal considering their scale of operation, production and distribution approaches, rigidity in action, lack of competitive price and seed quality, absence of business motives and failure to respond to the demands of the clients. Therefore future interv-entions on seed should focus on improving and strengthening the

[3] Private Companies supplying, e.g. seeds, agrochemicals, veterinary medicines and other agricultural inputs are referred to as Agrovets in Nepal.

CBSPD, which is vital to farmers' production systems.

Changes in the actors in Nepal rice innovation system

Innovation systems are dynamic. Contemporary internal and external policy environments play important roles in influencing the innovation systems and the actors involved in them. The project team for PCI programme played a proactive role in involving as many actors as possible from different sectors (Table 3).

Table 3. Changes in the actors in Nepal rice innovation system from 1996 to 2004

Type of actors	Number of actors	
	1996	2004
Public sector organisations in Nepal	6	40
Public sector organisations outside Nepal	0	8
Civil societies in Nepal	4	9
Civil societies outside Nepal	1	5
IARCs, Universities, donors	7	10
Private organisation	3	10
Other projects	0	9
Total	21	91

There was a marked change in the actors involved in rice research and development in Nepal since 1996 to 2004. The greatest response came from the government organizations including NARC, DADOs (DoA) and NSB. The major actors in this category were the DADO officers from 29 districts who were looking for new ideas and new technologies to fulfill the ever increasing demand from the farmers and their groups. The increased inclusion of private sector organizations (POs) and civil societies in Nepal is another interesting achievement of the project. This was possible as many of the NGOs and CBOs have agriculture as one of the major activities and they are always willing to collaborate on this type of activities. In this innovation system they contributed to the spread and scaling-up of farmer-preferred technologies in different parts of the country. Traditionally POs and Agrovets mostly sell vegetable seeds but gradually they are being attracted towards food crop seeds including rice as the demand for these seeds is increasing as there are no suppliers after the privatization of AIC and newly established NSC is yet to function properly. The project was also able influence public sector and civil societies outside Nepal particularly in India and Bangladesh. The

Project was also successful in developing and maintaining functional relationship with International Advanced Research Centres (IARCs), universities and donor communities for smooth running of the project as well as for participatory scaling up.

Lessons leant

Yadav and Rawal (1981) argue that public institutions are more innovative and flexible than individuals and they advocated that this sector should be involved in institutional innovations. After 25 years the scenario has changed and so is the role of public sector institutions. Analysis of empirical data showed that the PCI project actively promoted new types of "networking" between old and new actors and evidence provided that many of these new mechanisms have been incorporated into and are changing the behaviour of the larger system. The project has led to significant improvements in a number of current rural livelihood, poverty reduction, gender, social inclusion and empowerment indicators, as well as having a sustained effect on changing the institutions and behaviour of different actors in the overall innovation system. For example, the working relationships between major non-government organisations (NGOs) and government extension and research agencies and revision in the working practices and the procedures of the varietal approval, release and registration of National Seed Board (NSB) are note worthy.

Several useful lessons leant from the project contributed to the success of some of the innovations that evolved in the Nepal rice improvement systems.

1. Project flexibility was the key to success. The Project team learnt and promoted effective mechanisms. The Project team mostly mobilized existing farmers groups rather than creating new groups and also worked with other groups e.g. forest users groups, farmers field schools, drinking water groups.
2. Participatory approaches or mechanisms of doing research and scaling up were developed within the system not in a separate "action research" project to be delivered to others. These are viable methods within the current socio-economic-institutional situation in Nepal.
3. The Project team offered options rather than promoting 'packages' to the clients and was firmly against any kind of authoritative style in technology evaluation and dissemination. It played an important role of bringing

all the major actors together in the farmers' fields for participatory technology development (PTD).

4. Rural livelihood outcomes or impacts were monitored regularly and used for further planning.
5. The Project team was instrumental in legitimising the partnership between the GO and NGO and NGO-NGO for agricultural research and development. These partnerships were built upon comparative advantages, mutual trust, shared responsibilities and accountabilities.
6. It also helped to streamline the informal flow of rice germplasm across the open border with India by including some of the rice varieties from the farmers' fields into participatory trials.
7. The Project contributed to an increase in varietal diversity, enhancing food security and improving different dimensions of farmers' livelihood strategies and helped reduce poverty and vulnerability.
8. The issue of social inclusion was addressed by targeting a large percentage of farmers from indigenous communities, *Dalits*, minority ethnicity and other marginalized and disadvantaged communities.
9. The biggest contribution of the project team was in institutional innovation for GO-NGO networking. However, this could only be done after successful technical innovations had been convincingly demonstrated. The project demonstrated the value of participatory approaches for crop improvement to DoA and DADOs, which lead to the signing of a formal LoA with DADO Chitwan for the scaling up of the process and the outcomes of PCI project in the district, and evidences from this case later helped in building informal network with 29 DADOs in the terai and hills of Nepal.
10. The project demonstrated that plant breeding is possible without Research Stations and other infrastructure. It reduced rice breeding and varietal development time by half which also raised the issue of efficiency of public sector crop improvement programmes.
11. The Project team also facilitated signing of another LoA with NRRP, NARC by capitalizing on the good working relation

between NARC and LI-BIRD developed after successful implementation of *in situ* crop conservation project jointly. This LoA streamlined disease screening of COB rice lines by NRRP, exchange of germplasm between LI-BIRD and NARC and to have participatory evaluation of physical qualities, cooking and taste for NARC rice lines through LI-BIRD's coordination with the farmers groups. Success of COB activities in PCI project greatly contributed in establishing credibility of COB approaches which helped for easy acceptance of COB by *in situ* crop conservation project.

12. The Project team contributed in revising the variety release procedures of Nepal to include data generated by participatory trials and other forms of experimentation and opened up the opportunities for POs and NGOs to participate in variety development and seed business.
13. Achieved diversified funding sources by networking with DADOs, NGOs, INGOs for scaling up the farmer-preferred technologies.
14. Participatory, need-based research and dissemination approaches have been found useful in identifying farmer-preferred and niche-specific technologies.
15. The Project was instrumental in developing and strengthening CBSPD programs in different terai districts which are vital for the sustainability of outputs PCI project.

WAY FORWARD

PCI has largely been a process-led project; some of the outcomes are due to its design, while others are the results of learning from the clients: farmers, traders, consumers, CBOs, NGOs, and formal sector organisations and responding to their needs and aspirations. The project may not have done full justice to poverty reduction, social inclusion, empowerment and institutional innovations, however, efforts were made to address these core issues and there is evidence that some of these have been better addressed than the others. These issues need to be focussed on in future interventions. Interaction with other partners or projects with strong background in these areas and integrating new learning in our actions will help better address these issues. Working with the occupational castes (*Dalits)* to integrate them

into agricultural development is another very important area for future activities. Addressing food security and poverty reduction issues of *Kamaiyas* (freed bonded labourers mainly from *Tharu* communities) and *Haliyas* (bonded labourers in hilly areas basically from *Dalit* community) is another important question. Linking our initiatives with DFID-funded Agricultural Perspective Plan Support Programme (APPSP), which has developed grassroots oriented programmes, e.g. District Agricultural Development Fund (DADF) comprising of District Extension Fund (DEF) and Local Initiatives Fund (LIF) (MoAC, 2004) may be one of the options of involving socially excluded, marginalised and disadvantaged communities in the scaling up of PCI process and outputs and providing benefits to them. However, government bureaucratic delays and lack of clarity on guidelines related to the payment of taxes by grassroots level civil societies, e.g. CBOs and NGOs participating in this type of initiatives may prove to be counter-productive to the programme.

Several innovations and approaches have been developed, evaluated and verified by the project over nearly one decade. These innovations have important implications for the rice improvement system of Nepal and elsewhere. In Nepal, many scientists within the NARC system have accepted such collaborations and new approaches. More time and more exposure to these ideas are needed to change the mindsets and attitudes of other people. We believe that these approaches are equally applicable to other sectors of Natural Resources Management (NRM) research and development at large for technology development, evaluation, scaling up and institutional changes. International Agricultural Research Centres (IARCs) including CGIAR centres may also find these innovations useful for redefining their changing roles in the years to come.

It is also necessary to initiate discussions with academic institutions, e.g. Institute of Agriculture and Animal Sciences (IAAS) and Himalayan College of Agricultural Sciences and Technology (HICAST) to change their academic curricula to incorporate issues such as systems thinking, participatory approaches, institutional innovations, social inclusion, poverty reduction and empowerment so that new generation of the NRM cadres are trained in a new thinking and different way of doing things rather than business-as-usual.

CONCLUSION

There are several elements within Nepal rice innovation system, which have potential to offer socially responsible technical and institutional innovations. For example farmers' innovations are vital in terms of making the rice innovation system more flexible, dynamic and farmer relevant. They have tremendous research and development capabilities, which have not been utilised by the formal rice improvement system. Traders also have innovative ideas and their strengths should be capitalised upon in the promotion of farmer's preferred varieties to benefit the farming communities. Flow of germplasm across the open border with India through farmers seed and social networks is another important element in Nepalese rice system, which needs to be recognised and made use of for the benefit of the broader clients. This project has already developed a method concerning the issue. Emerging research approaches, e.g. PVS and COB are very simple, rapid, cost effective and socially responsible methods of developing, evaluating and disseminating crop varieties and their integration into the formal system will contribute considerably to making the system more effective and responsive to the needs of the stakeholders. The PCI project team contributed in spreading technically and socially responsible rice innovations in Nepal as it was based on the long-term knowledge and commitment of the Nepali staff and significant refinement of the approaches due to overseas collaboration, particularly with CAZS-NR, University of Wales, Bangor. Of the various contributions of the Project team, we consider institutional changes at a higher level for varietal release mechanism, acceptance and sustained institutionalisation of participatory researches; GO-NGO partnership and legitimising the terai informal rice research and development system as the most important in terms of bringing more lasting effects in crop research and development in Nepal. Dealing with the human factor is most difficult as pre-occupations, mindsets and authoritative institutional infrastructures pose large hurdles in changing the institutional and policy environments. However, the learning from the past experiences, demonstrating evidences at the community level and farmers' innovations and initiatives together with other partners contributed in bringing the institutional changes.

ACKNOWLEDGEMENTS

This document is an output from projects (Plant Sciences Research Programme projects: R6748, R8269, R7542, R7122, R8071) funded by the UK Department for International Development (DFID) and administered by the CAZS-NR for the benefit of developing countries. The views expressed are not necessarily those of DFID. The authors would like to thank all the participating farmers in Nepal for their contribution in this research. LI-BIRD, FORWARD, DADO Chitwan and NRRP, NARC staff who, helped in the implementation of this research are also acknowledged.

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