Policy and Strategy for Increasing Income and Food Security through Improved Crop Management of Chickpea in Rice Fallows in Asia

Nepal Agricultural Research Council

International Crops Research Institute for the Semi-Arid Tropics

NRI
Natural Resources Institute

DFID
Department for International Development

Citation: S Pande, PC Stevenson, RK Neupane and D Grzywacz (eds.). 2005. Policy and strategy for increasing income and food security through improved crop management of chickpea in rice fallows in Asia. Summary of a NARC-ICRISAT-NRI Workshop, 17-18 November 2004, Kathmandu, Nepal. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 252 pp. ISBN 92-9066-479-7. Order code CPE 156.

Policy and Strategy for Increasing Income and Food Security through Improved Crop Management of Chickpea in Rice Fallows in Asia

Summary of a NARC-ICRISAT-NRI Workshop
17-18 November 2004, Kathmandu, Nepal

Funded by DFID-CPP

Edited by

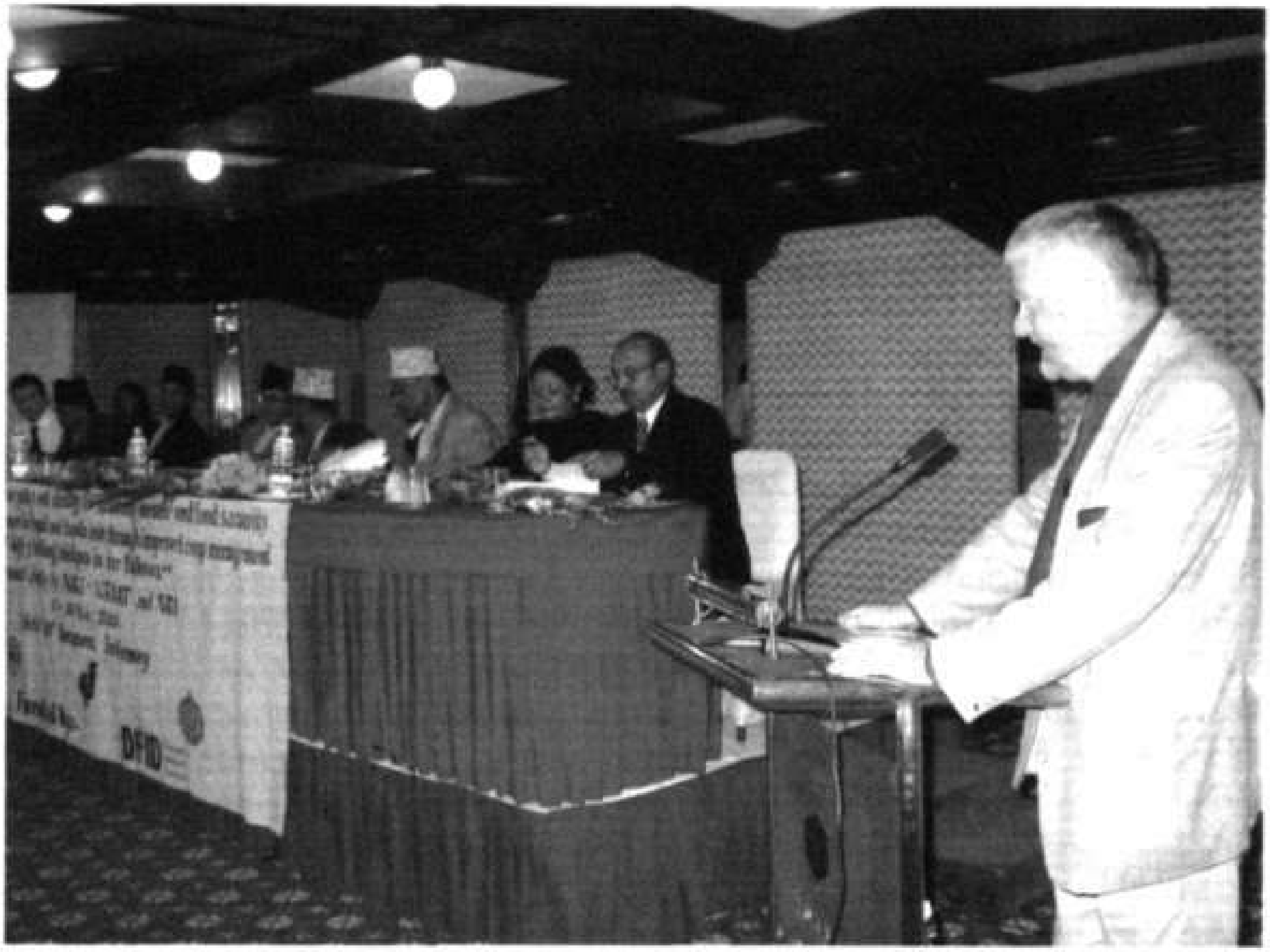
S Pande, PC Stevenson, RK Neupane and D Grzywacz

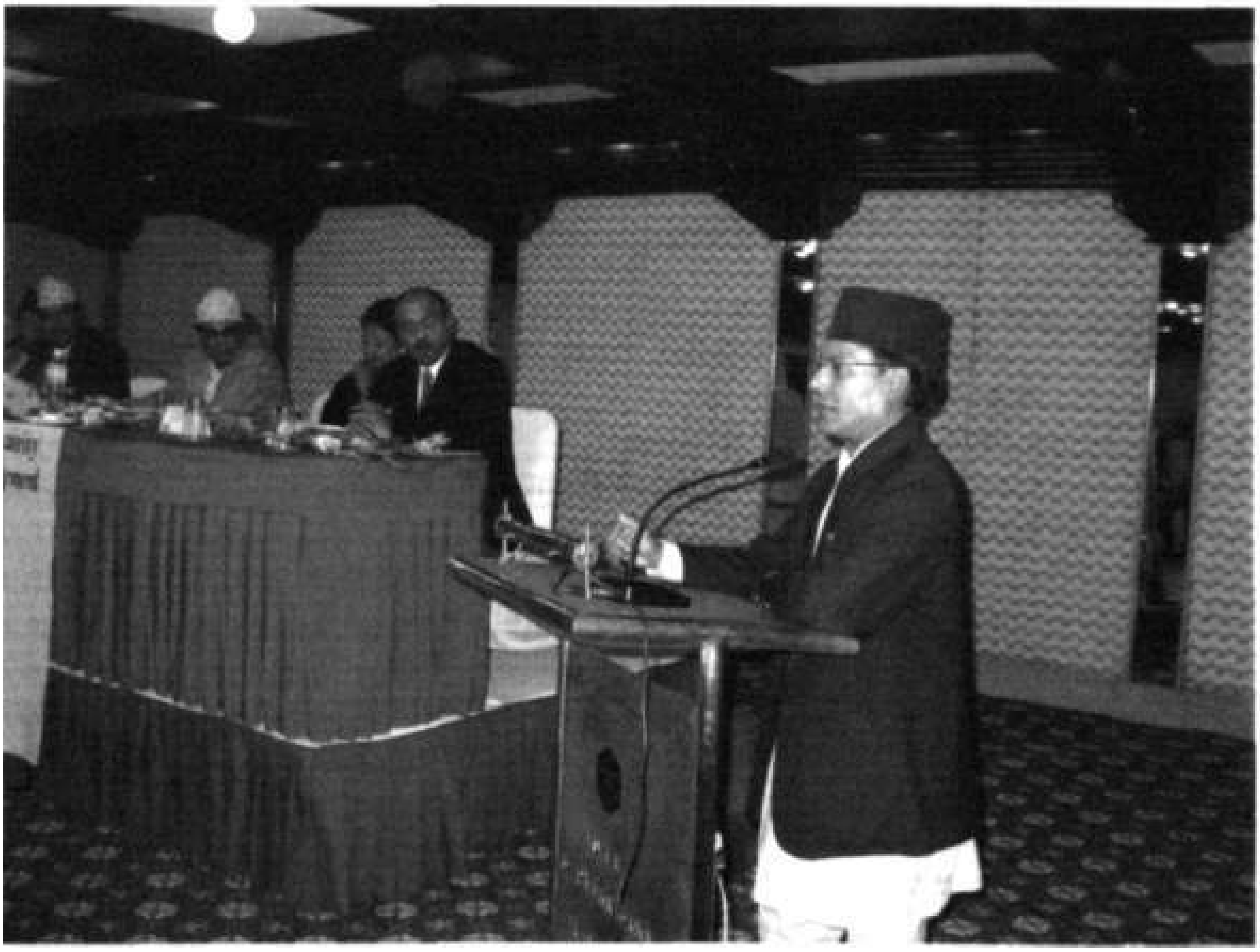
Nepal Agricultural Research Council

International Crops Research Institute for the Semi-Arid Tropics

Natural Resources Institute

Department for International Development





Acronyms and Abbreviations

ADB	Agriculture Development Bank
ADO	Agriculture Development Officer
AERP	Agriculture Research and Extension Project
AGLOR	Asian Grain Legumes On-Farm Research
AICCRP	All India Coordinated Crops Research Project
APP	Agricultural Perspective Plan
APPSP	Agricultural Perspective Plan Support Programme
AVRDC	Asian Vegetable Research and Development Centre
B. Aman	Boro Aman
B. Aus	Boro Aus
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BGM	Botrytis Grey Mold
BHU	Banaras Hindu University
BINA	Bangladesh Institute of Nuclear Agriculture
BRRI	Bangladesh Rice Research Institute
BSMRAU	Bangabandhu Saikh Mujibur Rahman Agricultural University
CAAM	Center For Alternative Agricultural Media
CAN	Computer Association of Nepal
CAZS	Center for Arid Zone Studies
CBO	Community-Based Organization
CDP	Crop Diversification Project
CGIAR	Consultative Group for International Agricultural Research
CHT	Chinese hand tractor
CIMMYT	International Maize and Wheat Research Centre
CLAN	Cereals and Legumes Asia Network
CLIMA	Collaborative Research Center for Legumes in Mediterranean Agriculture
COB	Client-Oriented Breeding
CPDD	Communication, Publication and Documentation Division
CPP	Crop Protection Programme
DADC	District Agriculture Development Committee
DADF	District Agricultural Development Fund
DADO	District Agriculture Development Office
DADS	District Agriculture Development Strategy
DAE	Department of Agricultural Extension
DDC	District Development Committee
DEF	District Extension Fund
DFID	Department for International Development (UK)

DOA	Department of Agriculture
DOLS	Department of Livestock Services
FAMPAR	Farmer managed participatory research
FFS	Farmers' Field School
FFT	Farmers' Field Trial
FORWARD	Forum for Rural Welfare and Agricultural Reform for Development
FPR	Farmer Participatory Research
GIS	Geographical Information Systems
GM	Genetically Modified
GO	Governmental Organization
GPS	Global Positioning System
GVT	Gramin Vikash Trust
HNPV	Helicoverpa Nuclear Polyhedrosis Virus
HMGN	His Majesty's Government of Nepal
IAAS	Institute of Agriculture and Animal Sciences
IARCs	International Agricultural Research Centers
ICAR	Indian Council of Agricultural Research
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICM	Integrated Crop Management
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IGP	Indo-Gangetic Plains
INGO	International Non-Governmental Organization
IPM	Integrated Pest Management
IRD	Informal Research and Development
IRRI	International Rice Research institute
LBMDPP	Lentils, Blackgram, Mungbean Development Pilot Project
LI-BIRD	Local initiatives for Biodiversity in Research and Development
LIF	Local Initiative Fund
LRPs	Local Resource Persons
MoAG	Ministry of Agriculture and Cooperatives
MOU	Memorandum of Understanding
MSP	Minimum Support Price
NARC	Nepal Agricultural Research Council
NARDF	National Agricultural Research and Development Fund
NARS	National Agricultural Research System
NGLRP	National Grain Legume Research Programme
NGO	Non-Governmental Organization
NPV	Nuclear Polyhedrosis Virus
NRI	Natural Resources Institute
NRRP	National Rice Research Program

NSB	National Seed Board
NSC	National Seed Corporation
OECD	Organization for Economic Cooperation and Development
OFRD	On-Farm Research Division
PCI	Participatory Crop Improvement
PGR	Plant Genetic Resources
PPB	Participatory Plant Breeding
PRA	Participatory Rural Appraisal
PRC	Pulses Research Centre
PRSP	Poverty Reduction Strategy Paper
PSRP	Plant Sciences Research Programme
PTD	Participatory Technology Development
PVS	Participatory Variety Selection
RARS	Regional Agricultural Research Station
RCTs	Resource Conservation Technologies
RRC	Rainfed Rabi Cropping
RTWG	Regional Technical Working Group
RWC	Rice Wheat Consortium
SAARC	South Asian Association for Regional Cooperation
SAFTA	South Asian Free Trade Association
SCRI	Scottish Research Institute
SMEs	Small and Medium Entrepreneurs
SQCC	Seed Quality Control Centre
T. Aman	Transplanted Aman (Aman Rice)
T. Aus	Transplanted Aus
TOT	Transfer of Technology
TTM	Technology Transfer Mission
USDA	United States Department of Agriculture
VDC	Village Development Committee
WTO	World Trade Organization

Contents

Objectives

The objectives of this meeting were to raise awareness and inform key government policymakers in Nepal of the positive impact integrated crop management (ICM) of chickpea has on the livelihoods of the rural poor in Nepal and South Asia and how wide scale adoption of chickpea can directly address a key facet of His Majesty's Government of Nepal's (HMGN) 10th Plan. Accelerating income and employment growth in Nepal's rural economy has been identified as the primary target for in-country development upto 2007 by the National Planning Commission in the Poverty Reduction Strategy Paper of the 10th Plan.

This meeting will also enable researchers and extension workers in similar or associated projects to present their work. Subsequent discussions will enable the development of a strategy for wide-scale adoption of chickpea with its concomitant ICM. It will also help government and non-government organizations work with farmers, community based organizations and the private sector to redress the decline of chickpea production in Nepal. It will identify hurdles to successful implementation and how they can be overcome. The lessons learned from the pilot project and the work of others have also been identified through consultation with participants at this meeting and are documented as a separate paper in these proceedings.

This workshop should encourage key policymakers to embed the adoption of ICM with chickpea into the national agricultural strategy and apply similar principles to other winter crops for diversification in rice-based cropping systems.

Welcome address

SL Maske[1]

Respected Chairman, Honorable Minister, Honorable Assistant Minister; Secretary and Joint Secretary, Ministry of Agriculture and Cooperatives; Director General ICRISAT, Dr Philip C Stevenson, NRI; Dr Suresh Pande, ICRISAT; distinguished guests, ladies and gentlemen...

On behalf of Executive Director, Nepal Agricultural Research Council (NARC) and its staff, a warm welcome to all participants from various countries to this workshop on *Policy and strategy for increasing income and food security for poor farmers in Nepal and South Asia through improved crop management of high yielding chickpea in rice fallows.* I hope you had a comfortable journey traveling to Kathmandu and that you have a pleasant stay with us.

When ICRISAT-NRI requested us to organize this workshop, although the request came very late, we were delighted to host it; we have a longstanding relationship with ICRISAT and the United Kingdom.

As you can see, we have a busy schedule in the next two days and our objectives are to exchange information, hold discussions and plan activities for the future. It would also be appropriate to discuss common problems and the reasons for decline in the area and production of chickpea in Nepal.

I am confident that fruitful deliberations will lead to a meaningful outcome. Ladies and gentlemen, on behalf of NARC staff and myself, I once again welcome all of you. I hope you will enjoy Kathmandu outside the workshop deliberations as well.

Thank you.

[1]Crops and Horticulture, Nepal Agricultural Research Council, Nepal.

Welcome address from ICRISAT: Legumes and cereals in development and the need for effective policy change to help alleviate poverty in South Asia

JDH Keatinge[1]

Your Excellency, Mr Horn Nath Dahal, Minister of Agriculture and Cooperatives, Government of Nepal; Your Excellency, Mr Umakanth Chaudhary, Assistant Minister of Agriculture and Cooperatives, Government of Nepal; Dr HK Upadhaya, Member of the National Planning Commission, Government of Nepal; Mr Chairman, Mr Minister and Gentlemen on the dais ...

I am resolved to target my opening remarks specifically to you, the senior politicians present, as while I am more than satisfied with the scientific dimensions of the project associated with this workshop, I am much less happy with the policy environment in which it is attempting to bring about development in South Asia.

The new Science Council of the Consultative Group for International Agricultural Research (CGIAR) has recently formulated a new series of agricultural research priorities (http://www.cgiar.org/pdf/agm04/agm04_cgiar_draft_priorities.pdf). In this document, the Science Council is recommending to International Agricultural Research Institutes such as ICRISAT, CIMMYT and IRRI, all of whom are involved in this project, to give much greater attention to crop diversification, high value commodities and market-driven approaches to research. All of these priorities, happily, have been foreseen several years before and adopted by the researchers in this project. I commend this approach to you strongly as ICRISAT believes that crop-livestock systems diversification and market facilitation are necessary priority research thrusts if we are going to be able to help farmers to be able to produce and sell agricultural produce sufficiently to remove themselves from poverty.

Yes, food productivity per unit area must increase in the light of rapidly climbing populations in South Asia but this cannot be achieved without also paying due regard to good environmental practices. Such practices are being recommended by this project in fostering integrated pest, disease and nutrient management and also by encouraging use of improved crop intensification through using legumes in rotation with rice in what are presently rice fallow lands.

[1]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.

This brings me to my major issue. I ask you to tell me whether or not the agricultural policies of the Government of Nepal are providing a supportive policy environment for these desirable agricultural interventions. I have some doubts as to whether the present policy environment is truly supportive. For example, very large quantities of rice straw are being produced in the farming systems of the Nepalese Terai and surrounding regions in South Asia. This is often being burned which negatively affects the environment and is not being used for a truly productive purpose such as an animal feed. Why is this so? Clearly, plant breeders for rice have given this factor insufficient attention to date and thus feed quality is very low. It could be much increased in palatability and digestibility by good breeding and with the addition of small quantities of legume straw (chickpea, lentils, mungbean etc.). However, such legume straws are not yet available in sufficient quantity in local farming systems as the Nepal Agricultural Research Council (NARC), its supporting institutes and the extension services have placed legumes in a much lower national priority category than rice or wheat. In support of this contention, then, I ask you to count the number of cereal scientists in these institutions and total-up their associated budget versus their equivalents in the area of pulse crop research. It will be a strong mismatch, I fear. A policy change, therefore, in support of a stronger pulses research and development cadre is a policy intervention that I am pleading with you to make as soon as possible.

This is not a problem only associated with Nepal. Rather, this is a clear hangover from the 1960s and 1970s in South Asia when the Green Revolution was in full spate. Unfortunately, this outdated positive policy environment for irrigated cereal production remains common in South Asia. For example, today in India, minimum support prices for rice and wheat and a very cereal dominated research and development cadre continue to exist even when there is a considerable surplus of rice and wheat in India's grain storage facilities and the large import bills for pulses and oilseeds continue to rise. This is clearly not a logical state of affairs in 2004. I note that this is not only the fault of the governments of South Asia: I observe in the recent External Program and Management Review of IRRI (http://www.cgiar.org/pdf/agm04/agm04_irri_epmr.pdf) that legume issues were hardly referred to at all. Yet, this workshop will adequately demonstrate their substantial importance in the overall profitability of potential rice/legume systems in Bangladesh, Pakistan, Nepal and northern India. Legumes can no longer be afforded a second-class policy environment, otherwise farmers with the potential to grow these crops may linger unnecessarily in poverty for the foreseeable future.

Finally, Mr Minister, once you review the present policies of the Government of Nepal in the light of the findings of today's workshop, let me make a plea for you also to give urgent thought to the need for appropriate legislation for the potential testing and release of new genetically modified chickpeas, pigeonpeas and groundnuts which will soon be available as international public goods to NARC scientists from ICRISAT. These will have been through all the rigorous testing and safety procedures adopted by the Indian Government. The disease resistance and much stronger IPM qualities of the new varieties are likely to be of substantial benefit to the farmers of the Terai. It is important that these farmers are not out-competed by their near neighbors in local markets once these varieties are available for release in India and Bangladesh in the very near future. Researchers can only go so far in demonstrating important development potential as this workshop will show; after that the politicians must also join hands and create a fertile policy environment and good governance in which the potent legume seeds of development can flourish for the ultimate benefit of the many disadvantaged, malnourished and poor agricultural families in South Asia.

Welcome address from NRI

PC Stevenson[1]

On behalf of the Natural Resources Institute (NRI), I would like to welcome all of you to this meeting on *Policy and strategy for increasing income and food security for poor farmers in Nepal through improved crop management of chickpea in rice fallows in Asia.* I would particularly like to welcome our guests of honor: Mr Horn Nath Dahal, Minister for Agriculture and Cooperatives; Mr Umakanta Chaudhari, Assistant Minister for Agriculture and Cooperatives; Dr HK Upadhyaya, Honorable Member of the National Planning Commission; Mr Bhairab Raj Kaini, Joint Secretary, Ministry of Agriculture and Cooperatives (MoAC); Mr SS Shrestha, Director General, Department of Agriculture and Mr DS Pathik, Executive Director, Nepal Agricultural Research Council.

I would like to thank all the participants of this meeting for making, in many cases, a considerable effort to get here. As a frequent visitor to Nepal, I would like to thank our hosts, the Nepal Agricultural Research Council (NARC), without whom none of our successes of the last few years could have been achieved.

I would also like to thank Dr William Dar, Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) represented today by Dr Dyno Keatinge, Deputy Director General of ICRISAT, for giving his continued support and endorsement. And finally, I would also like to extend my personal thanks to Dr Suresh Pande who has gone to great lengths to organize this meeting on behalf of the project and also for his enormous contribution to the success of integrated crop management of chickpea in Nepal over the past few years.

What we wanted to achieve in 2000

Four years ago, I stood here in Kathmandu and addressed a very similar audience and many of the faces today are the same as those in September 2000. I spoke from a platform of hope and ambition and while I was cautiously optimistic, there was no way of really knowing how the subsequent three seasons would pan out. I had secured some funds from the Crop Protection Programme (CPP) of DFID, and we hoped to use these funds to build on the success of earlier work by Dr S Pande and ICRISAT collaborators under former ADB funds. I highlighted how we hoped to bring strategic research from all areas of agricultural science - entomology, pathology, agronomy and socioeconomics

[1]Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent, ME4 4TB, UK.

-together in a multidisciplinary adaptive phase to show real impact for farmers and their livelihoods.

I want to use this meeting as an opportunity to raise awareness about the astounding successes of the previous project. Briefly, we wanted to expand the remit of the earlier work, and expand its geographic focus. We were able to determine constraints and issues for farmers through rural appraisals and subsequently we developed an Integrated Crop Management (ICM) strategy for dramatically improving chickpea production and fed this back to farmers through farmer schools and active demonstrations. Farmers were on average able to double their yields. This was validated through promotion to 3500 farmers in 14 of the 20 districts in the Nepal Terai between 2001 and 2004. The potential outcome is that this system could be extended to many more households in Nepal and much larger numbers in Bangladesh and India as well as to farmers in Pakistan and Afghanistan. Ultimately, we managed wide scale distribution of the ICM technologies and reports from field scouts suggest that many more learned of the benefits via local knowledge dissemination. This achievement would never have been possible but for the tireless cooperation and efforts of NARC. But how many could we reach if the mantle was taken up by MoAC as a major extension initiative - 30,000 or even 300,000?

Nepal's poverty focus

I hope that this meeting will stimulate policymakers in Nepal and other stakeholders into action, and I hope ultimately we can persuade the MoAC as well as non-government agencies in Nepal to help us scale-up the extension of this proven technology countrywide.

Acceleration of income and employment growth in the rural economy of Nepal was identified by Nepal's National Planning Commission through the Poverty Reduction Strategy Paper (PRSP 10^{th} Plan) as the primary target for in-country development up to 2007 (Anon 2003). This was also ratified by DFID in the Country Assistance Plan (September, 2003). The recognition of poverty foci and identification of specific targets by which to address poverty reduction is essential in guiding development workers. Specifically, the report indicated that strategies and approaches that can impact rapid changes on the wealth and employment of the rural poor need to be identified. Our project on the ICM of chickpea in Nepal is a robust, cost-effective and efficient approach for increasing chickpea production. We have shown that it has directly increased the wealth of participating farmers and that this in turn increased employment. Therefore, the ICM of chickpea directly addresses one of the major facets of Nepal's poverty reduction strategy and thus provides a model project for the government to pursue and I hope that this is recognized during discussions over the next two days and beyond.

What we want to achieve in 2005

Ultimately we want to raise awareness of the previous project's successes and in doing so stimulate policymakers and other stakeholders into action and persuade the Ministry of Agriculture and Cooperatives and NGOs to take up the mantle and scale-up extension and so increase production of chickpea countrywide. But to do this we need to develop a strategy for up-scaling and that is what we hope to achieve here.

Project outputs

1. Lessons from previous phase of chickpea ICM *identified and documented*

A major objective of this meeting I believe should be to identify and synthesize lessons from the preceding projects. We need to ensure that subsequent uptake and scaling-up is effective, optimized and sustainable. Therefore, I want to stress the importance of this aspect of the meeting, and would like each of us to focus some time in presentations and discussions on some of the lessons learned from the previous project or other relevant experiences that could help us determine the best way forward. I must stress that this is to identify good as well as bad lessons and also to draw on lessons learned from other related projects and experiences about which we will hear something over the coming two days. A quick look at the list of participants and their titles indicates a great deal of experience, knowledge and potential here in the room.

2. Raising awareness among policymakers and implementers on the value of chickpea rehabilitation

We have raised awareness of the impact of ICM on chickpea among farmers during the last project phase but now we need to raise awareness of the project outputs to NGOs, Community Based Organizations (CBOs), Small and Medium Enterprises, and Government Organizations. Now, we want to strengthen national capacity in Nepal to provide farmers with the information and support needed to embed the practice of producing high yielding chickpea (or even other appropriate Rabi crops) in rice fallows throughout Nepal, and to influence similar institutions in Bangladesh and India - thereby improving the livelihoods of rice and chickpea farmers in these regions.

3. Strategy for wider promotion of chickpea rehabilitation developed with key policymakers in Nepal-policy document written

Ultimately, these proceedings will be published by ICRISAT and we are very grateful to them for that. We also plan a policy document as an additional output of this meeting and this will detail a strategy for ICM adoption of chickpea (determined by us over the coming two days) country-wide. The target for this document will be senior government policy setters in Nepal and elsewhere eg, Bangladesh, India, Pakistan, Afghanistan, NGOs, private sector stakeholders, NARS and extension organizations as well as for international donor organizations and research institutes.

4. Advise target institutions (NARC/DOA) on approaches to sourcing funds to promote chickpea rehabilitation

The key objective ofthe present project phase is to obtain the Nepal government's adoption into the MoAC agricultural program to ensure the optimum uptake and impact on farmers' livelihoods. The role ofthe government is very important in ensuring that benefits will be gained from chickpea rehabilitation across the country. However, the project will be more likely to succeed through assisting extension programs to present funding proposals to international funding bodies. Government extension agencies and NGOs exercise a significant degree of autonomy in terms of carrying out activities on independent projects for which money is raised externally and this was illustrated by NARC extension during the preceding project.

Summary

Evidence from the previous CPP project phase is that adoption of high yielding chickpea varieties along with its concomitant ICM can increase the income and food security of poor farmers and have real positive impact on their livelihoods. This also led to many other benefits including increases in employment and so directly addresses the PRSP 10th Plan. It is also envisaged that this success can be translated to other crops that are considered more desirable or appropriate in different regions of Nepal by farmers, and so enhance crop diversification.

The 10th Plan also identifies the private sector, NGOs and CBOs as major stakeholders to carry out economic enhancement activities, infrastructure development and service delivery wherever possible. Hence, we have invited representatives from these groups to provide their insights and contribute to the development of a countrywide strategy.

This meeting is an opportunity for policymakers, stakeholders (farmers, private sector, CBOs and NGOs and their representatives) and project partners from the previous phase to develop routes to successful uptake of the ICM of chickpea. I also hope that the meeting will go on to ensure sustainability of the chickpea ICM adoption strategy and implement the adoption of ICM for chickpea production across the country.

References

Anon. 2003. The Tenth Plan (Poverty Reduction Strategy Paper) (2002-2007). His Majesty's Government (Nepal), National Planning commission, Kathmandu, Nepal, May2003.http://www.npc.gov.np/tenthplan/docs_inenglish.htm.

Keynote address from NARC: Approaches in improving pulses production in Nepal

DS Pathik[1]

Honorable Chairman, Minister, Assistant Minister, Secretary (MoAC), Director General ICRISAT, Joint Secretary, MoAC; Dr Phillip Stevenson (NRI), Dr Suresh Pande (ICRISAT), distinguished participants, ladies and gentlemen...

Let me first extend a cordial welcome to all participating scientists. I feel privileged for this opportunity to deliver the keynote address at this workshop on *Policy and strategy for increasing income and food security for poor farmers in Nepal and South Asia through improved crop management of high yield in chickpea in rice fallows.*

As I understand it, the main objectives of the workshop are to:

- Review the progress of on-farm IPM research on chickpea in Nepal and South Asia.
- Discover the reasons for decreasing production of chickpea and formulate concrete solutions through the sharing of experiences and technology among stakeholders.
- Discuss the contribution of Improved Crop Management on the security of chickpea farmers.
- Suggest ways to improve effective exchange of genetic materials, technology and information among South Asian countries.
- Enhance linkages with national, regional and international institutions and NGOs interested in chickpea research and development.
- Provide modalities for the scaling-up of proven chickpea ICM technologies for the benefit of resource-poor farmers of Nepal and South Asia.

Chickpea is one of the major legumes grown in Nepal. It is principally grown in the Terai and inner Terai in rainfed areas after rice and maize. It is also grown in a limited scale in some valleys and river basins in the hills. It is traditionally grown either as a sole crop or as a mixed crop with mustard and/or linseed on marginal lands with poor management.

Chickpea occupies the fifth position in terms of area (9738 ha) and production (7654 MT) in grain legumes. The national average yield is 0.83 t/ha (MoAC 2003). There has been a decreasing trend in area and production in the last decade. Compared to 1992/93 figures, a decrease in area by 59.6% and in production by 43.6% has been recorded, although the national average yield

---

[1]Nepal Agricultural Research Council, Singhdurbar Plaza, Kathmandu, Nepal.

has increased by 47.2% during the same period. The increase in productivity is attributed to the adoption of improved practices of production.

The declining trend in the area of chickpea is related to several biotic, abiotic, socioeconomic and institutional constraints faced by farmers. Botrytis gray mold, wilts and pod borers are the major biotic constraints. Among abiotic constraints are pre- and post-sowing moisture stress, foggy weather, poor soil fertility, and boron deficiency (in some pockets), and poor agronomic practices.

Socioeconomic and institutional constraints include inadequate extension services, poor technical knowledge among farmers about production technology, competition from other profitable/less risky crops, non-availability of seeds of improved varieties in adequate quantity and low priority accorded by the government.

Some of the challenges we are addressing during the 10th Plan period are:

- Agriculture for survival
- Low increment in crop production
- Unavailability of high quality seed
- Agriculture mainly dependent on rainfall
- Low cropping intensity
- High cost of production
- No systematized marketing
- High risk in crop production
- Fragmentation of agricultural research and development
- Globalization (WTO, SAFTA)

NARC will adopt the following strategies to address the challenges in sustainable manner:

- Focus on research and extension services directly in priority areas
- Adopt a partnership approach in technology development and dissemination
- Prepare a socially responsible research agenda
- Develop low cost technology
- Move toward commercialization of agriculture
- Encourage IPM technologies to reduce the use of pesticides and environmental hazards
- Move toward institutional rationalization
- Ensure diversification of funding sources

NARC-ICRISAT collaboration

Informal technical collaboration between Nepal and ICRISAT started in the late 1970s. The first high level ICRISAT mission in Nepal was headed by the then Director General Dr LD Swindale in 1987, and was followed by the signing of a Memorandum of Understanding (MOU) for cooperation between the Ministry of Agriculture, His Majesty's Government of Nepal and ICRISAT in Kathmandu on 24 December 1987. Since then, there has been a regular exchange visits by scientists and policy level dignitaries from both sides.

The NARC-ICRISAT collaboration has been fruitful in germplasm exchange, manpower development and strengthening research capabilities of national scientists engaged in on-station and on-farm research.

Let me note here briefly some of the gains from collaboration between NARC and ICRISAT.

Varietal improvement

- Six varieties of chickpea viz, Dhanush, Trishul, Sita (ICCC 4), Radha, (JG 74), Koselee (ICCV 6), and Kalika (ICCL 82108) have been released in Nepal, of which four have been derived from materials supplied by ICRISAT.
- Selections of crosses K850 X Dhanush and Sita X Dhanush are at the pre-release stage.
- Identification of BGM tolerant chickpea varieties (ICCL 87332, Avarodhi).
- Identification of chickpea lines less susceptible to pod borer.
- Validation of chickpea ICM technology through large-scale farmer participatory trials.

Manpower development

More than 90 Nepalese scientists and technical staff have been trained in on-farm adaptive research methodologies, statistical design and analysis of experiments, and chickpea and pigeonpea production through in-country training programs. Fifty six Nepalese scientists have participated in various training programs at ICRISAT center, while Nepal received 83 visits of ICRISAT scientists in connection with the collaborative project. This has resulted in capacity building of national scientists.

I trust that with the vast experience and knowledge of the participants, this two-day workshop will be able to come up with an effective and practical solution for production constraints faced by Nepalese and South Asian farmers. Hopefully, this workshop will bring practical recommendations for scaling-up/wider dissemination of chickpea ICM technology in this region. I wish to express thanks to ICRISAT and NRI for providing an opportunity to host this workshop in Kathmandu. I wish you an enjoyable and productive workshop.

Thank you.

References

Ministry of Agriculture and Cooperatives (MoAC). 2003. *Statistical Information on Nepalese Agriculture.* Agricultural Statistics Division. Ministry of Agriculture and Cooperatives. Singhdurbar, Kathmandu, Nepal.

Keynote address from DOA: Improving production of pulses through extension programs: Constraints and opportunities

SS Shrestha[1]

Honorable Chairman, Honorable Minister *of* Agriculture and Cooperatives, distinguished guests, delegates, ladies and gentlemen...

It gives me pleasure to be here this morning and share my views on the importance and role of chickpea in improving the income and food security of poor and marginal farmers in Nepal and South Asia. The workshop is very timely and relevant to us as we are committed to implementing a national strategy on food security and improving the livelihood of poor farmers. On this occasion, I would like to re-emphasize that grain legumes are important for maintaining soil fertility, enhancing soil organic matter and nitrogen status of soils through biological nitrogen fixation. They have special significance for human nutrition, as pulses are important constituents of daily diet of the Nepalese, which is expressed in our popular meal *dal bhat* meaning rice and pulses. Besides, they are components of livestock feed and fodder.

As far as chickpea is concerned, it used to occupy more than 30000 ha in the 1980s as compared to 9000 ha only. The sharp decline in area under the crop in recent years, besides various biotic constraints, is related to better options in terms of varieties and technologies in winter crops (cereals, oilseeds and vegetables) available to the farmers and an increase in irrigation facilities in area previously occupied by chickpea. However, more than 300000 ha-area with potential for chickpea-still remains fallow in winter.

As we know, Improved Crop Management (ICM) technologies with potential to double current yield levels are available. It is time for these technologies be up-scaled through the participation of the department of agriculture and other stakeholders. The Joint Action Plan by NARC and DOA is an important step that will result in its incorporation in the National Plan.

We must remember that due to the changed international scenario and the entrance of Nepal in WTO, quality and competitiveness of products must be accorded the highest priority. I hope the outcome of the workshop will result in practical recommendations to up-scale chickpea in rice fallows through effective dissemination of Improved Crop Management technologies.

Thank you.

[1]Department of Agriculture, Harihar Bhawan Pukhowk, Lalitpur, Nepal.

Integrated Crop Management of chickpea in Nepal: Past, present and future

S Pande[1], RK Neupane[2], PC Stevenson[3], D Grazywacz[3], VA Bourai[4], JN Rao[1] and GK Kishore[1]

Abstract

Chickpea until recently was a major winter pulse crop in Nepal normally grown on residual moisture after harvest of rice. A severe botrytis gray mold disease (BGM) epidemic in 1997/98 devastated the crop in Nepal and the damage was two-fold. Not only did farmers lose their crop, they did not cultivate chickpea in the following season due to lack of seed and disillusionment with the crop. A collaborative program between the Nepal Agricultural Research Council (NARC), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Natural Resources Institute (NRI) was launched on the Integrated Crop Management (ICM). The focus was on Integrated Pest Management (IPM) to fight diseases (BGM and wilt) and insect-pests (pod borer) to rehabilitate chickpea in the rainfed rice and maize based cropping systems in Nepal. The components of ICM technology included high yielding chickpea variety, Avarodhi (tolerant to BGM), treating seed with fungicide (Bavistin), wider row spacing, and applying need-based sprays of fungicide (Bavistin) to control BGM, and need based application of insecticide, Monocrotophos® or Endosulfan® (Thiodan) and biocide (Nuclear Polyhedrosis Virus NPV) for the management of pod borer. In the 1998/99 seasons, ICM technology was evaluated in 110 farmers' fields, and large yield responses were obtained. The following season saw a five-fold increase in adoption of chickpea using the ICM package. This number multiplied to 1100 farmers in 2000/01, 7000 farmers in 2001/02, 15,000 farmers in 2002/03 and 21,000 farmers in 2003/04. The overall mean grain yield obtained by adopting ICM (2.5 t/ha) was

[1]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[2]Nepal Agricultural Research Council, Singhdurbar Plaza, Kathmandu, Nepal.
[3]Natural Resources Institute, University of Greenwich, Chatham Marine, Kent ME 4 4TB, UK.
[4]Sri Guru Ram Rai Post Graduate College, Dehradun, Uttranchal, India.

124.5% greater than yield from non-ICM farmers. The increase in net income for chickpea cultivation attributable to ICM was two to six-fold. Further on-farm ICM of chickpea resulted in: 1) increase in family income by 80-100%, 2) increase in protein consumption by 40%, 3) increase in brick and mortar houses by 22%, 4) increase in labor use by 20%, 5) increase in household expenditures by 45%, and 6) increase in livestock ownership by 30%). Chickpea performance for profit and wealth was $216 per farmer that resulted in increase in overall wealth of 3500 project farmers by $750,000. In addition to these contributions, a farmer-friendly BGM disease forecasting system was developed and village level farmer-owned seed systems and IPM schools were initiated to sustain chickpea in Nepal. The ICM technology used so successfully in Nepal also holds great potential for chickpea in BGM-prone areas in India and Bangladesh.

Introduction

Chickpea (*Cicer arietinum* L.) is the most important leguminous crop for vegetarian diets in Nepal, as it is a rich source of proteins and essential amino-acids. It is remunerative and has high water use efficiency. It fixes atmospheric nitrogen, improves soil fertility and maintains the sustainability of cropping systems. During the past three decades, average yields of chickpea have declined or remained static (600-700 kg/ha); the crop has been virtually eliminated from rice- and maize-based cropping systems in the country. Biotic, abiotic and socioeconomic constraints are responsible for low yields of chickpea (Pandey et al. 2000). The major biotic constraints are seed/soil-borne diseases [wilt caused by *Fusarium oxysporum* and root rots caused by *Rhizoctonia solani* and *R. bataticola*], foliar diseases [botrytis gray mold (BGM) caused by *Botrytis cinerea*] and pod borer (*Helicoverpa armigera).* Drought, poor soil fertility and mineral deficiency are among the location-specific abiotic constraints. Together these biotic and abiotic stresses cause losses to the chickpea crop. Inadequate incentives by the government along with the poor minimum support price (MSP) system are the main socioeconomic constraints to chickpea production.

In this paper, we discuss past initiatives on collaborative research and development on chickpea in Nepal; processes and approaches in establishing on-farm farmers' participatory research (FPR) on Integrated Crop Management (ICM), quantification and prioritization of constraints for economical chickpea production, the present status of ICM, and future research needs.

The specific objectives of ICM of chickpea in Nepal were to:

- Identify constraints and opportunities for chickpea production by using participatory rural appraisal (PRA).

- Develop and validate ICM packages including IPM components that are appropriate and affordable to poor farmers.
- Scale-up and rehabilitate chickpea through ICM in rice- and maize-based cropping systems especially in rainfed fallow lands.

Past initiatives: Research and development on chickpea, 1978-1997

Technical collaboration on chickpea research and development (R&D) between ICRISAT and NARC was started in late 1970 with the exchange of germplasm and trait specific trials/nurseries. These included germplasm such as international chickpea screening nursery-desi-duration long (ICSN-DL); international chickpea screening nursery desi-duration medium (ICSN-DM); international botrytis gray mold nursery (IGMN) and international wilt and root-rot screening nurseries (IWRRN) and breeding lines selected by NARC scientists during their visits and participation in the annual chickpea scientists meet at ICRISAT. Further, some emphasis was laid on transfer of technology in the early 1990s and the Asian Grain Legumes On-Farm Research (AGLOR) was initiated in 1991 with support from the United Nations Development Programme (UNDP/ICRISAT). Technical collaboration with ICRISAT continued through the Cereals and Legumes Asia Network (CLAN). In addition to CLAN activities from 1994 to 1997, ICRISAT further expanded R&D activities on chickpea through the ADB project, *Legumes-based technologies for enhanced productivity of rice-wheat system in the Indo-Gangetic Plains.* The present DFID-funded project on *IPM of chickpea in Nepal* was linked with the ADB project in 1997 and this is presently ongoing.

In general, in the past three decades, attempts to overcome biotic constraints of chickpea production in Asia and in Nepal mainly focused on the use of chemical pesticides and/or host-plant resistance. These single factor management strategies to combat biotic and/or abiotic constraints were studied in isolation to each other. As a result, the yield losses caused by pest/disease epidemics along with poor agronomy, remained alarming and significant.

There is a greater opportunity to combine best-bet technologies that combat insect-pests and diseases with improved agronomical practices and emerge with an ICM package. The ICM of chickpea provides greater scope and need for its validation, scale-up and scale-out with the involvement of farmers for farmers.

Present successes: Processes and approaches of FPR and ICM, 1998-2004

Participatory rural appraisal (PRA)

Before on-farm FPR on ICM was established, and constraints for economical chickpea production quantified and prioritized, informal and formal surveys, and group meetings were organized in 20 villages across the country to be acquainted with the farmers' experiences on chickpea production and marketing.

During the formal survey intended to diagnose production constraints of chickpea, a multi-stage stratified random sampling technique was employed to select chickpea producers. At the first stage, five eco-regions of the Terai - Eastern, Central, Western, Mid-Western and Far-Western - were stratified based on administrative boundaries. At the second stage, 16 districts were randomly selected depending upon the extent of chickpea area across all five regions. In the third stage, villages were selected randomly from the selected districts. Finally, chickpea producers were selected randomly from each village amounting to 500 producers. The distribution of the selection was based on the probability proportionate criteria.

The target villages in the districts of Banke, Bardia, Rupendehi, Nawalparasi, Sarlahi, Mohottari, Bara, Parsa, Sirha, Saptari, Sunsari Morang and Jhapa were selected by formal and informal visits, and meetings with village heads and farmers. In each selected village, a meeting was held with farmers and IPM was explained. Participation was then solicited on a voluntary basis. Additionally, IPM orientation camps and schools were held thrice during the crop season (Pande et al. 2001).

Collection of data: Data was collected in a questionnaire that was specifically structured in Nepali, through personal interviews with producers. Questions were raised on general information about producing chickpea, land use patterns, enterprise choices, economics and benefits of chickpea vis-a vis other competitive crops, and constraints of chickpea production. Information was also sought on marketing and consumption of chickpea. Data was analyzed in different modules: the status of chickpea in sample farms, the economics of its production, the benefits of its production and its constraints.

Formation of Integrated Crop Management trials

Integrated Crop Management is a holistic approach that coordinates available crop and pest management technologies in an economically and ecologically sound manner. One major component of ICM is a high yielding, disease-tolerant (especially BGM/wilt) chickpea cultivar. High levels of disease resistance to these diseases, however, are yet to be identified. Other major components include seed treatment with fungicide (carbendazim), improved agronomical practices such as seed treatment with *Rhizobium,* seed priming (soaking the seeds for 8 hours in water before sowing), wider row spacing, and applying need-based sprays of carbendazim/chlorthalonil for BGM management and need-based insecticides such as Monocrotophos®/Endosulfan® (Thiodan) and biocide, Nuclear Polyhedrosis Virus (NPV).

On-farm trials consisted of two treatments: ICM and non-ICM. The non-ICM package consisted of a local cultivar with none of the inputs given to the ICM package.

For pest management, the trial consisted of two treatments: IPM and non-IPM. The IPM package included improved cultivar Avarodhi; seed treatment (2 g/kg seed) with a mixture of commercial fungicides; Thiarm + Bavistin in 1:1 ratio; application of Rhizobium inoculum (210 g/ha); di-ammonium phosphate (100 kg/ha), boron (whenever needed @ 500 g/ha) and need- or weather-based foliar spray with chemical pesticides (fungicide and insecticides) to control BGM and *Helicoverpa* pod borer. The non-IPM package consisted of a local cultivar with none of the IPM inputs. Fungicide, Bavistin (Carbendazim) 1 g/liter of water and 250 liter fungicide solution/ha to control BGM and insecticide, Thiodan (Endosulfan) 3 ml/liter of water and 250 liters insecticide solution/ha were used to manage pod borer.

Results

Findings from participatory rural appraisal (PRA)

Chickpea yields are very low (<0.5 t/ha) in Nepal. Diseases and pests are the main reasons for poor yields. The five Bs, ie, Boron deficiency, Bhilt (wilt), Botrytis gray mold (BGM), Borer and Bruchids, are the major constraints for its production. Of these, BGM [*Botrytis cinerea* (Pers. ex Fr.)], Fusarium wilt [*Fusarium oxysporum* f. sp. *ciceri* (Schlecht.)] among diseases, and pod borer [*Helicoverpa armigera* (Hub.)] among insects are economically significant. Weather conditions usually favor BGM development during the vegetative and reproductive growth stages of the crop and this can cause severe damage, and even result in total crop failure (Pande et al. 1998).

The salient findings from PRA can be summarized as follows:

- Chickpea can be grown more efficiently in Nepal because of the availability of large area of rice fallow lands (390,000 ha), demand and market.
- IPM is a new concept and about 75% farmers have no knowledge of its components, while 25% are aware of pest control by a thumb rule judgment.

- Chickpea in Nepal is declining at a very alarming rate because of the severe incidence of diseases and insect pests. Other contributing factors are:
    - Non-availability of quality seed
    - Non-availability of suitable pest-resistant varieties
    - Inadequate improved agronomical practices
    - Adulterated pesticides and bio-pesticides
    - Poor promotion of IPM packages
    - Seed loss in storage
    - Insufficient training and incentives

Findings from ICM trials

The results of on-farm ICM trials over several years with emphasis on IPM were:

- The incidence of wilt and root rot was less than 10% in ICM plots while it was about 70% in non-ICM plots.
- BGM was substantially controlled in ICM plots while the disease aborted upto 100% flowers and killed upto 80% plants in non-ICM plots.
- Pod borer damage was significantly less (> 5% damaged pods) in ICM plots than in non-ICM plots (30-50%).
- Two- to six-fold increase in grain yield (upto 4 t/ha) was obtained in ICM plots over the non-ICM plots (Fig. 1).
- Two- to five-fold increase in net income (Fig. 2).

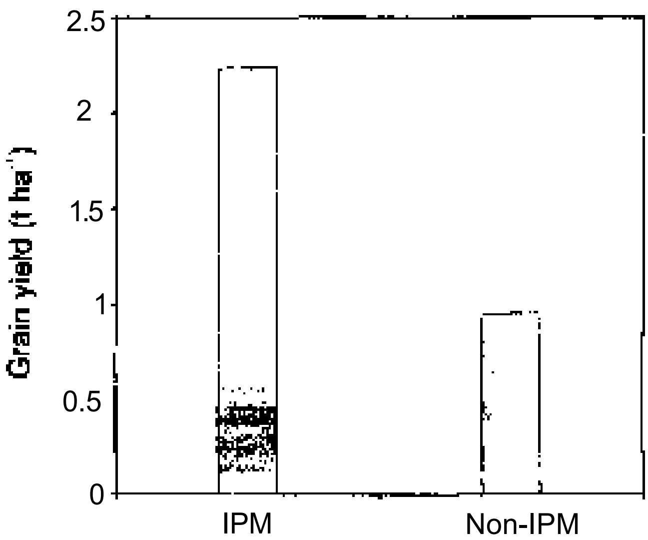


Fig. 1. Grain yield of chickpea in ICM and non-ICM on-farm trials, Nepal.

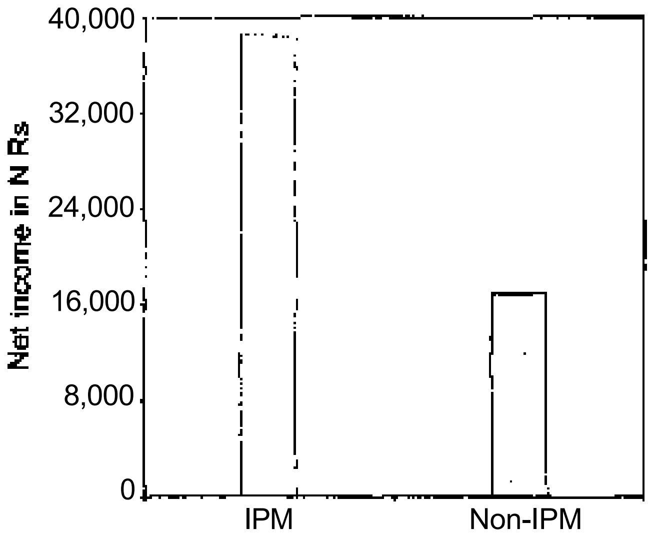


Fig. 2. Net income from ICM and non-ICM on-farm trials, Nepal.

Adoption and impact of ICM

In the 1998/99 season, the new chickpea line Avarodhi bred by ICAR was sown in the fields of 110 farmers. The following season saw a five-fold increase in chickpea adoption. The good news kept spreading, and by 2000/01, 1100 farmers were sowing chickpea. The best news was that IPM technology was firmly adopted by 21000 farmers during 2003/2004 season (Fig. 3). The Nepali farmers are happy that their chickpea fields are flourishing once more. The adoption of ICM has had a measurable impact on the livelihood of resource-poor farmers and has resulted in increase in the overall wealth of 3500 project farmers by $750,000. A summary:

- Increase in family income by 80-100%
- Increase in protein consumption by 40%
- Increase in brick and mortar houses by 22%
- Increase in labor use by 20%
- Increase in household expenditures by 45%
- Increase in livestock ownership by 30%
- Chickpea's total contribution to profit and wealth was $216 per farmer

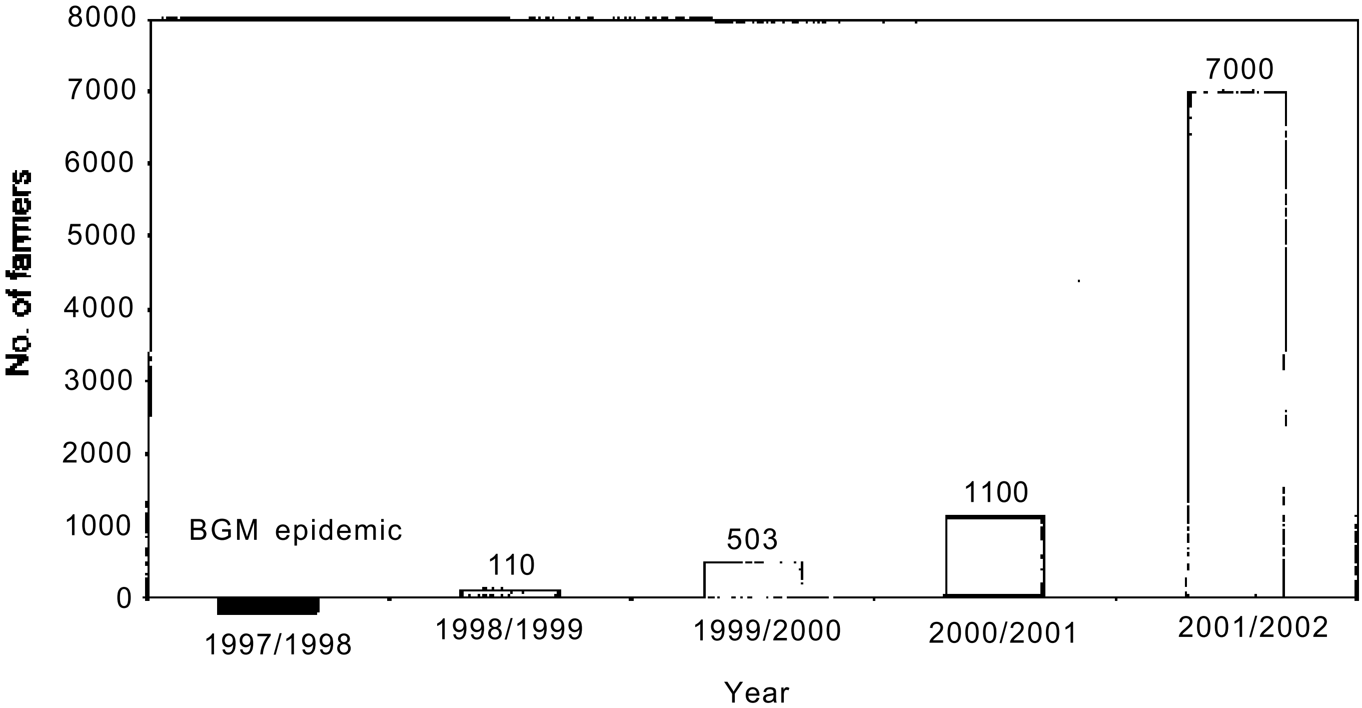


Fig. 3. Adoption and expansion of ICM of chickpea in Nepal, 1997/98 to 2001/02.

Future needs

In spite of the rational combination of the various management options available, the severity of disease/pest outbreaks remains significantly high. Therefore, effective, economical and eco-friendly components of IPM still need to be developed. Among promising approaches are broad-spectrum antagonistic biocontrol agents and the introduction of antifungal or insecticidal genes into commonly cultivated chickpea. These are being vigorously investigated in national as well as international research institutions. *Trichoderma* and *Pseudomonas* spp. proved effective in the control of BGM and wilt. A combination of fungicide tolerant T. *viride* and reduced fungicide was found effective in the management of BGM.

Transgenic crops offer hope to combat diseases wherein genetic resistance does not occur. The introduction of polygalacturonase inhibiting proteins (PGIP) and chitinase into chickpea can provide resistance against BGM/AB; this research is in progress at ICRISAT and its collaborating Institute, Scottish Crops Research Institute (SCRI), UK. Research efforts to identify molecular markers associated with resistance to BGM, AB and pod borer are in progress, which rapidly enhance resistance screening in breeding programs. Additionally, disease/pest resistance was identified in few wild accessions of C. *bigujum,* C. *judaicum* and C. *reticulatum.* Since adequate levels of resistance to AB, BGM and pod borer have not been identified in the cultivated *Cicer* spp., attempts are on to transfer the resistance from wild *Cicer* spp. into cultivated varieties through wide hybridization and embryo rescue techniques. Meanwhile, ICM technologies with available management options remain the best alternative currently available for higher production and economically sustainable yields.

Conclusion

All participating farmers expressly preferred the IPM package. IPM technologies included sowing of an improved BGM tolerant variety, treating seed with fungicide, wider row spacing and need-based sprays of fungicide and insecticide. The seed yield increase attributable to IPM was two- to six-fold and resulted in higher net incomes. IPM technologies, used so successfully in Nepal, also hold great potential for India and Bangladesh, which face similar problems.

Acknowledgements

This research was supported by Asian development Bank (ADB), RETA 5711; Department for International Development (DFID)/ Natural Resource Institute (NRI), R 7885; and Asian Development Bank/ Rice Wheat Consortium (RWC), RETA 5945.

References

Pandey SP, Yadav CR, Sah K, Pande S and Joshi PK. 2000. Legumes in Nepal. Pages 71-97 *in* Legumes in the rice-wheat cropping systems of the Indo-Gangetic Plain - Constraints and opportunities (Johnsen C, Duxbury, JM, Virmani SM, Gowda CLL, Pande S and Joshi PK, eds.). Patancheru, 502 324, Andhra Pradesh, India: International

Crops Research Institute for the Semi-Arid Tropics; Ithaca, New York, USA, Cornell University. 230 pp.

Pande S, Johansen C and Narayana Rao J. 1998. Management of botrytis gray mold of chickpea - Review. Pages 23-40 in Recent advances in research and management of botrytis gray mold of chickpea. Summary proceedings of the 4th Working Group Meeting to discuss collaborative research on Botrytis Gray Mold of chickpea, 23-26 February 1998, Joydebpur, Gazipur, Bangladesh (Pande S, Bakr MA and Johansen C, eds.). Patancheru, 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi Arid Tropics.

Pande S, Narayana Rao J, Upadhyaya HD and Lenne JM. 2001. Farmers' participatory integrated management of foliar diseases of groundnut. International Journal of Pest Management 47 (2) 121-126.

Opening remarks

BR Kaini[1]

Respected Chairman, Honorable Assistant Minister, distinguished participants, ladies and gentlemen...

Nepal has suffered rapid depletion of soil fertility due to intensive cultivation of cereal after cereal. Grain legumes play a significant role in Nepalese agriculture and are an essential component of the cropping system. During 2003/04, legumes were grown in 314000 ha with a total production of 262000 MT. Within one decade, chickpea area and production has decreased by 59.59% and 43.58% respectively. During the same period, productivity increased by 47%. Fusarium wilt and BGM diseases, and pod borer are the biggest constraints to chickpea production. These problems can be managed through ICM approaches, which will also help reduce environmental pollution.

About 0.3 million hectare land lies fallow after rice. Because of the high risks involved, farmers hesitate to grow chickpea. The development and promotion of low cost technology is needed to overcome these problems. Partnerships between INGOs, NGOs and community-based organizations also need to be strengthened.

I hope this scientific gathering will pay attention to this issue, share their experiences and will also focus on poverty alleviation through increasing the coverage of high yielding chickpea varieties in rice fallow cropping systems.

[1]Ministry of Agriculture and Cooperatives, Singhdurbar Plaza, Kathmandu, Nepal.

Opening remarks

U Chaudhary[1]

Honorable Chairman, Honorable Minister of Agriculture and Cooperatives, distinguished foreign scientists and guests, delegates, ladies and gentlemen...

This workshop on *Policy and strategy for increasing income and food security for poor farmers in Nepal and South Asia through improved crop management of high yielding chickpea in rice fallows* has special significance for Nepal, by being both timely and relevant.

Although chickpea is a traditional crop in this country, the area under it is declining. All technologies for chickpea should be developed with farmers as the focal point. These technologies should be economically beneficial, easily accessible and affordable. Although several production technologies in chickpea have been developed from past research, only a few have been adopted by farmers. Adoption of technologies has been limited for various reasons. Hence, for effective transfer of technologies, a suitable system needs to be developed wherein researchers, extensions workers, NGOs/INGOs/CBOs may have conducive functional relationships and effective coordination.

Distinguished delegates, I hope that this august gathering of national and international scientists will fulfill the objectives of this workshop through discussion and interaction, and hope that they may come up with suggestions and recommendations to improve the income and food security of poor farmers of Nepal and South Asia.

[1]Ministry of Agriculture and Cooperatives, Singhdurbar Plaza, Kathmandu, Nepal.

Remarks by the Chief Guest

HN Dahal[1]

Honorable Chairman, Honorable Assistant Minister for Agriculture and Cooperatives, distinguished foreign scientists and guests, delegates, ladies and gentlemen...

Nepal is a predominantly agricultural country with 66% of its population dependent on agriculture for their livelihoods. As the backbone of the economy, the agriculture sector has been accorded top priority by the government. In this context, the long-term agriculture perspective plan (APP) has prioritized commercialization and industrialization of the sector to reduce poverty. The production of legumes has considerably enhanced farm incomes and chickpea has accordingly been rated high among priority agricultural commodities in Nepal, as elsewhere. Pulses are the main source of vegetable protein in the daily diet of the majority of the Nepalese people. Besides, improvement in soil fertility due the inclusion of pulses in the cropping system has been validated by various studies.

Chickpea is an important winter pulse in the Terai and inner Terai of Nepal. However, marginal and resource-poor farmers have not reaped the benefits of chickpea cultivation as expected. The main reasons for this are low national priority to chickpea, inadequate technical know how among farmers, and poor supply/coordination of inputs and technical services.

These challenges can be addressed through coordination among various stakeholders involved in R&D. Already, the process of relevant policy reforms in agriculture strategy has been initiated. For these policies to materialize, effective functional relationships among national and international research and educational institutes are crucial, now more than ever.

For the overall development of agricultural technologies, we need to be able to validate and modify modern agricultural technologies on-farm to suit various socioeconomic and environmental conditions of farmers. Government bodies, NGOs and civil societies must take the lead in these endeavors. The current executive role of the government sector must change into that of a facilitator for program execution, continuation, promotion and effectiveness. In the context of Nepal having newly entered WTO, the international open and competitive market system will exert considerable influences on agricultural development in the days ahead. Therefore, our agriculture should be based on quality, profit and competitiveness.

[1]Ministry of Agriculture and Cooperatives, Singhdurbar Plaza, Kathmandu, Nepal.

The national policy is to seek the active participation of women, other socially excluded and marginalized groups in planning, execution, monitoring and evaluation of development projects for the overall development of the country. In line with this, the involvement of concerned farmers/stakeholders in different stages of agricultural program planning and execution has already been initiated. For easy access of modern agricultural technologies, mechanisms to gather resources and inputs from marginal and poor farmers, and other administrative and technical mechanisms have been streamlined gradually.

I hope this workshop will help identify potential solutions to these challenges, and will conclude with critical and constructive suggestions for the overall development and expansion of agriculture. I request the distinguished participants to consider ways to improve the income and food security of resource-poor farmers and also put forward suggestions for the development and expansion of chickpea cultivation in the South Asian region. I also request you to recommend ways to create awareness among stakeholders for the promotion of IPM tools for the protection of the environment and its balanced development. I assure you that we are politically committed to implementing eco-friendly agricultural technologies (such as neem products for pest control) for a balanced development of agriculture.

Lastly, I would like to express my good wishes to the organizers and participants of the workshop.

Chairperson's remarks

HK Upadhyaya[1]

Honorable Chief Guest, the Minister of Agriculture and Cooperatives; Executive Director, NARC; DG DOA, Joint Secretaries MoAC, Deputy Director General, ICRISAT; distinguished foreign and national delegates, ladies and gentlemen...

Speakers before me have already elaborated on chickpea, its importance and role in improving the incomes and food security of the poor and marginal farmers of the region. I do not intend to repeat it here.

As you all know, ensuring food security and improvement in the livelihoods of poor farmers is the need of the day not only for Nepal but also for the whole of South and Southeast Asia. I was very impressed by the chickpea technologies that were tested in farmers' fields that have shown potential for doubling present yields. Area under chickpea is low when compared to other crops, and as such, it may contribute very little in terms of livelihood improvement at the national level. However, at the local or regional level, these technologies, if properly disseminated, would help achieve sustained increases in the incomes of poor and marginal farmers. There is an urgent need to set up channels through which research products or technologies may reach farmers and help improve their livelihoods. I hope this forum will find and suggest ways to up-scale chickpea technologies for the benefit of the resource-poor farmers of Nepal.

We need to create an environment that makes it possible for farmers to adopt new technologies to improve farming, which would ultimately boost the economy. Farmers' access to new technology that is cost effective as well as environment-friendly is an important factor to be considered. In this context, the use of IPM of chickpea is very timely and relevant. Let me say that it is not the number of technologies or varieties recommended that counts, but the impact of those technologies on farmers' livelihoods. We now need to talk about technologies that can generate incomes, that can get quicker results and can sustain marginal and small farming systems that we operate.

I think the agriculture research and extension system in Nepal faces a challenge. The challenge is to prove that we have the technology that can impact livelihoods of farmers, and to bring these technologies to the level where the real users, the farmers, can use it. Therefore, it is an issue of availability of technologies and making these technologies available to the farmers. In this context, it was a great pleasure to learn of the development

[1]National Planning Commission, Kathmandu, Nepal.

and recommendation of cost effective improved chickpea technologies through the joint efforts of NARC, ICRISAT and NRI. Now the challenge is to scale-up these technologies to potential production pockets through the active involvement of extension services, NGOs, CBOs, farmers groups, other service providers and stakeholders.

I hope the workshop will discuss and recommend relevant policy issues essential for the wider dissemination of technologies. I assure you that we at the policy level are committed to reforming policy issues related to the dissemination of agricultural technologies in Nepal.

Vote of thanks

S Pande[1]

This workshop has brought together 75 participants drawn from various agriculture research, development and extension agencies of Nepal: non-government organizations (NGOs), International Agriculture Research Centers (IARCs) such as ICRISAT, CIMMYT, IRRI, RWC and NRI. It is a unique gathering where committed and dedicated policymakers and their representatives have spent valuable time and shared their views on the importance, need and scope of reviving and expanding chickpea in rice and wheat-based cropping systems in Nepal.

On behalf of the partners of the project, and especially on behalf of more than 20000 participating farmers, I thank you all for guiding the proceedings of this workshop. I further take this opportunity to thank all participating farmers who have sown chickpea in their rice and maize fallow lands following Integrated Crop Management (ICM). I believe that chickpea cultivation gave them the confidence to grow a second crop in the rainfed single crop (rice/ maize) system.

I express my deep gratitude to Mr Horn Nath Dahal, Minister for Agriculture and Cooperatives; Mr Uma Kant Chaudhari, Assistant Minister for Agriculture and Cooperatives; Dr HK Upadhyaya, Honorable Member of the Planning Commission; Mr Bhairab Raj Kaini, Joint Secretary, Ministry of Agriculture and Cooperatives, Mr SS Shrestha, Director General, Department of Agriculture; and Mr DS Pathik, Executive Director, Nepal Agricultural Research Council, for their consistent encouragement and guidance in implementing the project on *Integrated Crop Management in Chickpea in Nepal.*

I would like to thank Dr William Dar, Director General, International Crops Research Institute for the Semi-Arid Tropics, and Dr Dyno Keatinge, Deputy Director General, ICRISAT, for continued support to different phases of this project. In fact, the first phase of project *Integrated Pest Management in Chickpea in Nepal* was inaugurated in November 2000 by Dr Dar, and today as we seek further support on policy and strategy for chickpea cultivation in Nepal, we have the honor of having Dr Keatinge among us to steer deliberations at this workshop.

I would like to thank all participants of this meeting for making considerable efforts to reach Kathmandu. Nepal is my ancestral home, and as a frequent visitor to Nepal, I would like to thank our hosts, NARC without whose involvement and support, none of our successes of the last 10 years could have been achieved. Finally, I would register special thanks to Mr RK Neupane of NARC and Mr JN Rao of ICRISAT for their untiring efforts in the implementation of different activities of the project.

[1]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.

Session 1: Introductory Papers

Prospects of chickpea in rice-based cropping systems in Bangladesh

M J Uddin[1], M O Ali[1] and M M Rahman[2]

Abstract

Chickpea (Cicer arietinum L.), the major grain legume in Bangladesh, is traditionally cultivated under rainfed conditions during the winter season. Since most poor and medium farmers want to ensure food security for the family, rice cultivation receives top priority and chickpea is relegated to marginal lands. The area and production of chickpea has decreased over the last decade because chickpea's productivity is low as well as unstable compared to rice. Chickpea is mainly groum on relatively heavier soils under the aus rice/jute-fallow-chickpea and T. Aman rice-chickpea cropping patterns. Adaptive trials of chickpea varieties indicated that Barichola 2, Barichola 3 and Barichola 5 produced better yields in the Barind tract of Bangladesh. In this tract, there is room for including chickpea varieties as a sandwich crop in T. Aman rice fallows if the fields could be vacated by early November by using short duration rice varieties. Chickpea cultivar Barichola 5 which has early maturity, BGM (Botrytis gray mold) tolerance and resistance to fusarium wilt, made it possible to bring over 10000 ha of rice fallows under chickpea cultivation in recent years in the tract. Being a deep-rooted legume, chickpea utilized residual soil moisture after the harvesting of T. Aman and produced reasonable seed yield. Seed priming ensures better and faster seedling establishment, allowing some escape from terminal drought and heat stress. Seed priming produced 47% higher grain yield as compared to non-primed seeds (1.63 t/ha vs 1.11 t/ha) and higher number of pods/sq m, plant height and 1000-grain weight. Barichola 3 and Barichola 5 produced the highest yield of 1510 and 1411 kg/ha with irrigation after 40 days of seed germination in the Barind. It may be possible to establish chickpea as a vegetable and fodder crop within the fallow period in the T. Aman-Boro rice cropping system. Incorporating chickpea into the rice-based cropping system will rejuvenate the fatigued soil and ensure that at least the protein needs of the poor are met.

[1]Pulses Research Centre, Bangladesh Agricultural Research Institute, Ishurdi, Pabna, Bangladesh.
[2]Bangladesh Agricultural Research Institute, Gazipur, Bangladesh.

Introduction

Among food crops, legume grains occupy the second largest area (5.2%) after rice in Bangladesh. Since they contain the highest protein, they also play a significant role in Bangladeshi diets. Proteins in grain legumes are rich in lysine and cereal-based diets of the people when supplemented by grain legume improved in overall nutritional value. They are also a good source of calcium, iron and vitamins (B and C). Some are reported to reduce cholesterol and blood sugar levels.

The per capita consumption of pulses in Bangladesh stands at about 12.5 g/day. Bangladesh's population, as per World Bank projections, will cross 153 million by 2010 and 173 million by 2020 (BARC 1994). If the present rate of per capita consumption of about 12.5 g/day were to be maintained in 2010, the demand for pulses would be about 748 thousand tons. This means an additional requirement of 177 thousand tons to meet future demand. This demand can be met either by importing the total quantity or by increasing production.

Chickpea (*Cicer arietinum* L.) is one of the major grain legumes in Bangladesh. The crop is traditionally cultivated under rainfed conditions during the winter season (November-March) usually without any monetary inputs. The productivity of the crop is low compared to rice. Its inherently low yield, susceptibility to diseases and insect pests and sensitivity to microclimate changes contribute to its yield instability. Since most poor and medium farmers want to ensure food security for their families, rice cultivation receives top priority. With the expansion of irrigation facilities, farmers prefer rice-rice or rice-wheat/maize cropping systems and chickpea has been relegated to marginal lands.

The area and production of chickpea has decreased over the last decade. During 1992-93, there was a total area of about 99543 ha under chickpea with a total production of 70000 t (0.70 t/ha). However, the area has gradually decreased and in 2001-02, the figures stood at 27491 ha yielding about 224931 (0.82 t/ha) (DAE 2002). The productivity of chickpea has increased by about 17% while area decreased by 39%. This productivity is far below the potential (5.0 t/ha) or even actually achieved yields at research stations and farmer-managed on-farm trials (2.5 to 3.0 t/ha). The 17% higher productivity has been possible because of collaboration and contribution from BARI (Bangladesh Agricultural Research Institute) in association with ICRISAT since the late 1980s. Among the eight chickpea varieties released by BARI, seven were from ICRISAT source materials (Table 1).

Table 1. List of pulse varieties released by PRC, BARI in Bangladesh.

Variety	ICRISAT source line	Year of release	Yield (t/ha)	Days to mature	1000-seed weight (g)	Reaction to disease
Nabin	-	1987	1.4-1.8	120-125	110-120	Tolerant to wilt
Barichola 2	ICCL-83228	1993	1.5-1.9	125-130	130-140	Moderately resistant to wilt
Barichola 3	ICCL-83105	1993	1.7-2.0	125-130	170-180	Moderately resistant to wilt
Barichola 4	ICCL-85222	1996	1.9-2.2	120-125	130-140	Moderately resistant to wilt
Barichola 5	RBH-228	1996	1.7-2.0	120-125	110-120	Resistant to wilt
Barichola 6	ICCL-83149	1996	1.8-2.1	125-130	140-150	Moderately resistant to wilt
Barichola 7	ICCV-3274	1998	1.5-1.6	125-130	150-160	Resistant to wilt
Barichola 8	ICCL-88003	1998	1.3-1.4	125-130	250-260	Tolerant to wilt

Reasons for decline of chickpea area and production

The productivity of chickpea is low as well as unstable compared to rice. The major reasons are:

- Unlike cereal crops chickpea is more sensitive to climatic factors such as excess soil moisture, humidity and rainfall, terminal heat stress and soil factors (B, S, Zn and P deficiency) and Bangladesh's climate is very unpredictable. Consequently, the productivity of chickpea is also unstable. Understandably, with the expansion of irrigation facilities, farmers are shifting towards rice, wheat, maize or other profitable crops.
- Genetically, chickpea has lower yield potential than cereals.
- The crop is sensitive to high inputs like irrigation and fertilizer, and often shows negative response to these factors.
- It has greater disease and pest problems compared to cereals. Out of 13 diseases recorded so far, four diseases, viz, Botrytis gray mold (BGM), wilt, root rot and collar rot are major (Table 2). BGM and collar rot can cause up to 90% and 84% yield loss respectively (Bakr and Ahmed 1991). BGM

Table 2. Diseases of chickpea, their causal organisms and status in Bangladesh.

Disease	Causal organisms	Status
Botrytis gray mold	*Botrytis cinerea*	Major
Wilt	*Fusarium oxysporum, f.* sp. *ciceris*	Major
Collar rot	*Sclerotium rolfsii*	Major
Dry root rot	*Macrophomina phaseolina* (sclerotial state *Rhizoctionia bataticola)*	Major
Alternaria blight	*Alternaria alternata*	Minor
Rust	*Uromyces ciceris-arietini*	Minor
Root-knot	*Meloidogyne javanica, M. incognita*	Minor

infestation is less in the Barind tract. *Helicoverpa armigera* (pod borer) is the most important major insect pest for chickpea (Karim and Rahman 1991) causing upto 90% pod damage in the crop (Rahman 1989) (Table 3). Chickpea seeds are also severely damaged by bruchids. Two species of this pest, *Callosobruchus chinensis* and C. *maculatus* have been reported to infest seed.

- Farmers consider chickpea a minor crop and do not usually weed it; weeds compete with crops and cause substantial yield losses. There are several common weeds that affect chickpea, and these are more or less evenly distributed throughout Bangladesh (Table 4).
- The winter season in Bangladesh is very short (less than 100 days) within which winter pulses complete their life cycle. Therefore, high yielding long duration varieties that work well in other countries cannot be grown here.
- The adaptability of chickpea is generally centered in its place of origin and high yielding varieties of other countries do not suit this climate.

Table 3. Insect pests of chickpea, nature of damage caused and their status in Bangladesh.

Insect pest	Nature of damage	Status
Helicoverpa armigera Hubner	Bore into pods, feed on seeds and foliage	Major
Agrotis ipsilon Hufnagel	Cut the young plants	Major
Callosobruchus chinensis L. C. *maculatus* Fab.	Damage seed in storage	Major
Alcidodes collaris Pascoe	Bore into pods and feed on seeds	Minor
Aphis craccivora Koch	Suck sap from foliar parts	Minor
Pachynerus chinensis	Bore into pods and feed on seeds	Minor

Table 4. Common weeds of chickpea in Bangladesh.

Local names	Scientific names	Status
Mutha	*Cyperus rotundus*	Major
Bathua	*Chenopodium album* (L)	Major
Durba	*Cynodon dactylon* (L) Pers	Major
Bindi	*Convolvulus arvensis* (L)	Minor
Dondokalos	*Leucus aspera,* Sreng	Major
Foshka begun	*Physalis heterophylla*	Major
Boon moshure	*Vicia sativa*	Minor
Moshure chana	*Vicia hirsuta* (L) S.F. Gray	Major
Phulkaghash	*Panicum paludosum* (Roxb.)	Minor
Chhotoshama	*Echinochloa colonum* L. (Link)	Minor
Thistle	*Sonchus cleraceus*	Major

- Farmers pay little attention to proper land preparation, fertilization, timely sowing, weeding and plant protection, all of which results in very poor yields.
- Socioeconomic constraints such as low profit, cultivation without inputs, lack of cash and credit, lack of support price and marketing are some other reasons for low productivity.

Chickpea cropping systems

Chickpea is grown mainly in relatively heavier soils under the aus rice/jute-fallow-chickpea (Apr/May-Aug) (Aug-Oct) (Nov-Apr) cropping patterns, where it is sown in November and covers about 60% area. About 35-40% of chickpea is grown in the T. Aman rice-chickpea cropping pattern where it is sown in December as a late sown crop.

In Bangladesh, different cropping patterns (Table 5) followed involving chickpea are:
Chickpea-Aus + B. Aman,
Chickpea-B. Aus-Fallow,
Chickpea-Jute/T. Aus-Rabi crops,
Chickpea-Jute-Fallow/T. Aman and
Chickpea-Mixed + B. Aman.

Apart from these systems, chickpea is cultivated as a mixed crop with linseed, barley and mustard and as an intercrop with sugarcane. Genetically modified-T. Aman-chickpea against fallow-T. Aman-fallow may be a new cropping pattern for the Barind tract with its highlands and clay loam soil.

Table 5. Major cropping patterns involving chickpea in Bangladesh.

Cropping patterns	Land type	Remarks
Aus/Jute-Fallow-chickpea (April/May-Aug) (Aug-Oct) (Nov-Apr)	Highlands Clay loam soils	Optimum sowing pattern
Aus + B. Aman rice-chickpea (May-Nov) (Dec-Apr 2nd week)	Medium lowlands clay soil	Late sowing
T. Aman rice-chickpea (July-Nov) (Dec-Apr 2nd week)	Medium lowlands clay soil	Late sowing

Chickpea in rice fallows

Chickpea is considered ideal in sequence cropping, relay cropping and intercropping. Moreover, there is room for including chickpea varieties as a sandwich crop in T. Aman rice fallows in the event that fields are vacated by early November by using short duration rice varieties. Almost 88000 hectares in the Barind tract was unexploited except for T Aman two decades ago. The expansion of chickpea in rice fallows in this area over the past years is a noteworthy achievement. Being a deep-rooted legume, chickpea utilized residual soil moisture after harvesting of T Aman and produced reasonably good yield. Early maturity, BGM tolerance and resistance to fusarium wilt were found to be the most important traits in chickpea cultivars Barichola 5, which made it possible to bring over 10000 ha of rice fallow land under chickpea cultivation in recent years.

Chickpea and soil health

Sustainability of rice-based cropping systems has become a critical issue for agriculture in Bangladesh. Groundwater tables are going down due to excessive withdrawals for rice. The quality of water also is deteriorating with the accumulation of different salts, chlorides, iron, sodium and arsenic, thereby creating public health hazards. Organic matter content in the soil also has gone down significantly (<1% in 6.10 million ha and only 1-2% in 2.15 m. ha). Different nutrient elements such as nitrogen, boron and sulphur have become scarce in the soil. This is due to the rice-rice monoculture, under which more is taken up and less is added to the soil, ultimately making the soil sick (Pillai 1998).

Transplanted rice is grown submerged in puddled soil. This puddling however creates a hardpan below the ploughed soil layer, ie, a plough pan about 10 to 25 cm thick. This plough pan restricts the root system from both water and nutrient extraction from deeper soil layers (Badaruddin and Razzaque 1995).

The inclusion of chickpea in rice-wheat, rice-rice or rice-maize cropping systems adds to its sustainability by ensuring both nitrogen economy and improved soil health. Soil aggregation, soil structure, permeability, fertility and infiltration rate may improve with the inclusion of chickpea in rice-based cropping systems. The taproot system of chickpea makes soil porous, breaking the hard pan created by rice-based cropping systems. Chickpea also plays an important role for the sustainability of rice-based systems through biological nitrogen fixation in the soil. About 103 kg/ha nitrogen is fixed by chickpea every year.

Economic returns

The economics for chickpea production is an important issue not only in Bangladesh, but throughout Southeast Asia, where food legumes compete for a place in mainly cereal-based cropping systems. Although data is limited, it is clear that high production costs of cereals can be reduced by growing chickpea between systems. Considering inputs applied, chickpea is one of the most profitable pulses/legumes to grow.

Prospects for chickpea

Prospects for chickpea production in Bangladesh are bright. Additional production can be achieved by: (i) increased productivity through the adoption of improved varieties and cultural practices and (ii) utilizing fallow lands by introducing new cropping patterns. Newly released varieties of chickpea have produced higher yields compared to existing varieties at research stations as well as on farmers' fields.

Cultivation of chickpea in dryland areas

Most of the traditional chickpea area is concentrated in the Gangetic flood plains. Yield stability is very low because of losses caused by various diseases, mainly BGM, which is aided by high humidity and rainfall during the growing season. On the other hand, most of the 0.8 million ha land in the highland Barind region in north-western Bangladesh remains fallow in the winter months (November/December) after harvest of local transplanted aman rice. Experiments indicate that yields of more than 1 t/ha can be harvested, if chickpea is planted by early November. In this case, the local long-duration rice cultivars need to be replaced by short duration varieties like BR-14 and BR-32. The relatively less humid climate in the Barind area is not favorable for BGM infestation. If rain does not occur in October, there will be scarcity of soil moisture for chickpea germination. Adaptive trials of chickpea varieties indicated that Barichola 2, Barichola 3 and Barichola 5 produced better yields in the Barind region. Chickpea area may potentially be extended upto about 40000 ha or 5% of the total Barind area.

Seed priming

There have been reports of seed priming hastening germination, enhancing crop establishment, promoting seedling vigour and increasing yields of chickpea in western India (Harris et al. 1999). Similar on-farm trials with primed and non-primed chickpea seeds were conducted at 30 locations in the highland Barind tract. A higher grain yield (1.63 t/ha) was obtained from primed seed compared to non-primed seeds (1.11 t/ha), ie, 47% yield increase and other yield contributing characters such as number of pods/sq m, plant height and 1000-grain weight were higher with seed priming (Musa et al. 1999). The effect of seed priming on grain yield and its components appear to have its origin in better and faster seedling establishment, finally allowing some escape from terminal drought and heat stress.

Water management

A study on nutrient cycling and soil water status in the rice-chickpea cropping system in the Barind indicated that P was much below the critical level (10 PPM) and the response of P (30 kg/ha) was prominent. The growth of chickpea root depends both on soil moisture and available P. Periodic irrigation produced more roots on the upper surface which utilize more P and non-irrigation produced more roots from layers at 60-120 cm to extract soil moisture from deeper layers. Irrigation has a profound effect on chickpea yield. Irrigation trials with chickpea conducted in the Barind (2000-2001) indicated that Barichola 3 and Barichola 5 produced the highest yield of 1510 and 1411 kg/ha after being irrigated 40 days after germination (Table 6).

Table 6. Effect of irrigation on chickpea varieties in the Barind tract.

		Yield (kg/ha)		
Chickpea varieties	Treatment	2000-2001	1999-2000	1998-1999
Barichola 3	I_0	1083	1440	1090
	I_1	1416	1640	1140
	I_2	1510	1440	1110
Barichola 5	I_3	1483	1320	1040
	I_0	1027	1360	1110
	I_1	1333	1740	1250
	I_2	1411	1490	1130
	I_3	1355	1190	1050

I_0 = No irrigation

I_1 = Irrigation after 20 days of germination

I_2 = Irrigation after 40 days of germination

I_3 = Irrigation after 20 and 40 days of germination

Relay cropping of chickpea

Relay cropping of chickpea in rice fields could be an important factor that influences yield. Since it is too late to establish chickpea after T. Aman rice is harvested, relay cropping, or broadcasting of chickpea before rice has been harvested has proved effective. It is best to do this when the stubble height of the preceding rice crop is at 30 cm. Chickpea grain yields of 1323 kg/ha were obtained with this method.

Chickpea as vegetables and fodder

After T. Aman rice is harvested, a small percentage of land is used to cultivate short duration mustard, but most of the land remains fallow. Chickpea shak (vegetable) is generally favored by farmers and commands a high market price (Table 7), and so it may be possible to establish chickpea cultivation as a vegetable and fodder crop within the fallow period in the T. Aman-Boro rice cropping system.

Table 7. Agroeconomic performance of chickpea as vegetable and fodder.

Type of pulses	Vegetable weight (kg/ha)	Fodder weight (kg/ha)	Total variable cost (Taka/ha)	Gross returns (Taka/ha)	Net returns (Taka/ha)	BCR*
Chickpea	1773	7300	8066	24926	16860	3.09

* Benefit cost ratio

Prices

Urea	=	6 Tk/kg
Tri-Super-Phosphate (TSP)	=	15 Tk/kg
Murret of Potash (MP)	=	9 Tk/kg
Labor	=	50 Tk/head/day

Returns for pulses

Grain legume	As vegetable	As fodder
Lathyrus	8 Tk/kg	1 Tk/kg
Chickpea	12 Tk/kg	0.5 Tk/kg
Field pea	10 Tk/kg	0.75 Tk/kg

Chickpea to correct nutritional deficiencies of livestock

Chickpea is an abundant source of protein, calcium and vitamins, and corrects these deficiencies in livestock. For dairy cows, beef cattle and other animals, protein of satisfactory quality is always assured whenever chickpea forages are included in roughages. It furnishes calcium so liberally that the calcium requirement of dairy cows, even those of high productive capacity, is fully met if ample chickpea hay or straw is fed. Well-cured chickpea hay has much more carotene, and consequently much higher Vitamin A value than other non-legume grasses. Field cured chickpea hay is the richest source of Vitamin D.

Future priorities and research strategies

A few research thrusts need to be strengthened and taken up immediately to promote chickpea in Bangladesh.

- New germplasm should be collected on a priority basis and evaluated accordingly.
- The breeding program on chickpea should be pinpointed at specific objectives. Screening should be done under appropriate conditions to develop resistant varieties against particular stresses. Wilt and BGM-resistant varieties with high yield and early maturity should be developed.
- Maintenance of varietal purity and production of sufficient quantities of breeder seed should deserve special attention from the breeder. Apart from Bangladesh's own hybridization program, segregating populations from ICRISAT may be screened in the local environment.
- Cultural management packages such as optimum sowing time, plant population and seed rate need to be verified in new areas following the green manure-T. Aman rice-chickpea as against the fallow-T. Aman rice-fallow cropping pattern in the Barind tract.
- To overcome failure of germination due to moisture stress, seed priming (overnight soaking of seeds in water) demonstrations in farmers' fields need to be introduced.
- Foliar application of phosphatic and boron fertilizers, drip irrigation, lime palleting may help expand chickpea into non-traditional areas, minimizing yield gaps between research and farmers' fields.
- Varietal screening for host plant resistance against some pests such as chickpea pod borer *(Helicoverpa armigera* L) should be taken up under controlled conditions with rearing the insect.
- The use of pheromone traps and biological control of pod borer using NPV needs to be strengthened.

- Seed villages may need to be developed in chickpea growing areas to supply high yielding variety (HYV) seed to farmers.
- Chickpea growing farmers need to be trained with using these high tech-packs. They must also be supplied with seed preserving materials.
- In Bangladesh, there is an increasing shortage of agricultural labor. To overcome this, chemical control measures of weed in chickpea fields must be ensured. To do this, agronomists and breeders need to visit the field during the cropping season to develop and standardize the production package region-wise.
- Agronomists and soil scientists must explore areas involving new cropping patterns such as chickpea after T Aman rice and study the effect of bio-fertilizer in those areas.

Conclusion

It is very essential to make chickpea an integral component of cereal based cropping systems in Bangladesh. Chickpea must be incorporated to complement these systems and not to compete with any of the other components. This policy will rejuvenate fatigued soil and ensure national food security of the Bangladeshi poor at least for protein concerns.

References

Badaruddin M and Razzaque MA. 1995. Background research for rice-wheat research: Trend of productivity and objectives. *In* Proceedings of the workshop on sustainability of Rice-Wheat systems in Bangladesh. (Razzaque MA, Badaruddin M and Meissner CA, eds.). Bangladesh Agricultural Research Institute, Bangladesh Rice Research Institute and Bangladesh-Australia Wheat Improvement Project. 9 pp.

Bakr MA and Ahmed F. 1991. Botrytis gray mold of chickpea in Bangladesh. Summary proceedings of the BARI/ICRISAT Working Group Meeting on Botrytis gray mold of chickpea, 4-8 March 1991, Joydebpur, Bangladesh.

BARC. 1994. Strategic plan for national agricultural research systems to the year 2010 and beyond. Bangladesh Agricultural Research Council, Dhaka.

Harris D, Joshi A, Khan PA, Gothkar P and Odhi PS. 1999. On-farm seed priming in semi-arid agriculture: Development and evaluation in maize, rice and chickpea in India using participatory methods. Exponential Agriculture 35:15-29.

Karim MA and Rahman MM. 1991. Status of insect and vertebrate pest management research on pulses. *In* Proceedings of the 2nd National Workshop on Pulses, 6-8 June 1989. Joydebpur, Bangladesh: BARI; and Patancheru, Andhra Pradesh, India: ICRISAT. 135-138 pp.

Musa AM, Johasen C, Kumar J and Harris D. 1999. Response of chickpea to seed priming in the high Barind tract of Bangladesh. ICPN. 6:20-21.

Pillai KG. 1998. Problems and prospects for sustainable intensification of rice production in Bangladesh. Dhaka, Bangladesh: DAE.

Rahman MM. 1989. Control measures for important insect pests of major pulses. Pages 139-146 *in* Advances in pulses research in Bangladesh. Proceedings of the 2nd National Workshop on Pulses. 6-8 June 1989. Joydebpur, Bangladesh: BARI and Patancheru, Andhra Pradesh, 502 324, India: ICRISAT.

Lessons learnt from participatory dissemination and uptake pathways of IPM of chickpea and lentils in Bangladesh

MA Bakr[1], MA Afzal[1] and MS Aktar[1]

Abstract

Bangladesh has been suffering an acute shortage of pulses to feed its large population. To meet the demand for pulses, the country will have to increase production of pulses many times over. The share of cultivable land for pulses however is not very much: not more than 4%. To boost the production of pulses, the government launched a technology transfer mission (TTM) under a special project called the Lentils Blackgram and Mungbean Development Pilot Project (LBMDPP) embracing three major pulses: lentils, blackgram and mungbean. Four organizations were involved in TTM. The mission acted in a participatory capacity, coordinating research and liasing between partners. It brought together participating as well non-participating farmers by creating awareness of available ICM technologies, which includes IPM. A seed exchange program mediated by the mission was also launched to generate awareness of improved varieties. Farmers who implemented the technology particularly well were commended.

The mission achieved an increased area of 86000 ha for the three pulses with corresponding production increases of 84000 metric tons through LBMDPP The project was instrumental in changing legume cultivation patterns in some areas of Bangladesh. It also ushered in possiblities for utera cultivation of lentils and other pulses using improved varieties. The new varieties of pulses have generally been accepted by farmers.

Introduction

Bangladesh has been facing an acute shortage of pulses. A substantial amount of research has gone into evolving improved varieties and technologies of different pulses. Since 1996-97, efforts have been made under a special pilot

[1]Pulses Research Station, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh.

project called the Lentils Blackgram and Mungbean Development Pilot Project (LBMDPP) to disseminate pulses technology that involved ICM and IPM. The results have been encouraging. Efforts to develop and disseminate an integrated chickpea disease management package were also made through the Scientists' Working Group on Management of Botrytis Gray Mold (BGM) under CLAN.

What follows is a brief outline of the method of technology dissemination, experiences and problems encountered.

Background

Farmers in Bangladesh tended to cultivate old and traditional varieties of pulses, particularly chickpea, lentils, blackgram and mungbean; they applied no fertilizers and pesticides. Research on these crops by BARI, BINA and BSMRAU has succeeded in developing 12 varieties each of chickpea and mungbean, and five varieties of lentils. In developing these varieties, Bangladesh has collaborated with IARCs such as ICRISAT, ICARDA and AVRDC. Research was also carried out on the management of insect pests and diseases of these crops, which yielded some useful technologies of integrated management of major diseases and pests. The integrated management included genetic resistance, chemical control as well as agronomic management. However, the message about ICM did not reach grass root levels. Efforts to disseminate the technologies were made through the Department of Agricultural Extension (DAE). Particular attempts to disseminate chickpea varieties and technologies were also made in non-traditional areas like the Barind tract through OFRD with support from ICRISAT. Several NGOs have joined this effort.

In spite of all this, technology dissemination did not achieve the desired momentum in pulses with the exception of chickpea. At this point, a pilot project called the Lentils Blackgram and Mungbean Development Pilot Project (LBMDPP) was launched by the government. This has increased yield of pulses, and succeeded in disseminating ICM messages to farmers.

Facilitating uptake pathways

In disseminating pulses technology, TTM sought to bring together concerned research and development partners. It banded together five organizations: the Bangladesh Institute of Nuclear Agriculture (BINA), Bangabandhu Shaikh Mujibur Rahman Agricultural University (BSMRAU), Department of Agricultural Extension (DAE), Bangladesh Agricultural Development Corporation (BADC) and other NGOs, while resting major executive responsibility with Bangladesh Agricultural Research Institute (BARI). The project used the manpower and logistics of the organizations involved for technology dissemination.

The mission ensured the participation of all partners at every step - planning, execution and evaluation - by organizing a broad-based policy-planning workshop that included key personnel of partner organizations and farmer representatives. Secondly it organized regional workshops for planning and execution. In the third step, an execution plan was chalked out and projected to grass root level extension workers, block supervisors (BS) as well as the participating farmers through orientation trainings. The trainings elaborated on the technology package and implementation methodology.

In TTM, the modus operandi was to demonstrate the technology package in farmers' fields by following cluster demonstration. Each cluster was of 1.25 ha, with each consisting several demonstration plots of 0.133 ha each. Inputs required for each demonstration were supplied from the project in the form of mini-kits and were handed over directly to participating farmers. The block supervisors from DAE and SA initially supervised the demonstrations. Further activities were monitored by the mission at least two further times, one at the pre-flowering stage and the second at maturity. The first monitoring was informal and done by the project scientist. The second was a formal mobile workshop where senior members from all partner organizations participated. The mobile group evaluated the demonstration and identified constraints to successful transfer of technology. The group also selected the best farmer for an award. Organizing farmers' rallies or field days was another important step in technology dissemination.

Utilizing uptake pathways

Many steps were taken to increase farmers' awareness of improved ICM technologies. Progressive farmers from each of the blocks selected was given formal training on the technologies imparted. The technologies were also described in attractive leaflets written in easily readable local language. Demonstrations were set in visible, easily accessible fields to expose the technologies to more farmers. Field days were generally organized at crop maturity to demonstrate the result and to discuss implementation methodologies. Farmers from nearby as well as distant places came to participate in the field days. They observed and learnt from the successful demonstration cluster. This means of technology transfer has proved quite successful.

Encouragement through rewards

Instituting awards for farmers with outstanding records at implementing new technologies, and commendations for supervisors for the best management of a demonstration block, helped keep motivation high.

Uptake through seed exchange

Participating farmers were required to sign an agreement that he or she would return to the project the same quantity of seed they had borrowed from harvesting their own crop. This seed was then distributed among a new group of farmers. All this, coupled with the seed exchange program served to create considerable awareness about new and improved varieties as well as new technologies.

IPM in chickpea and its dissemination

Botrytis gray mold (BGM) is the most damaging disease of chickpea in Bangladesh. Grain yield loss due to this disease may occasionally reach 100%. Management of this disease was sorely needed. With a single approach proving insufficient, multi-pronged approaches have been tried. These include: identification of sources of resistance; cultural management options like spaced planting, mixed cropping and intercropping with suitable companion crops; and chemical approaches by applying foliar fungicides like Ronilan® or Bavistin® which reduce disease incidence significantly. Seed treatment by soaking with Carbendazim (25%) and Thiram (50%) at 1:1 ratio followed by two foliar sprays with Carbendazim at 14-day intervals have proved protection against the disease. These options individually and in combination show promise in managing the disease.

The pod borer is another major problem in chickpea cultivation. Attempts to control the insect pest by spraying insecticide as well as by applying NPV (nuclear polyhedrosis virus) have been successful. Initially, farmers' participatory (FP) trials were conducted under the BGM Working Group for integrated management during 1990s, which laid the ground for managing BGM and the pod borer. The attempt suffered setbacks due to cessation of financing for the program from CLAN. After a loop fall of two years, a similar program of farmers' participatory technology dissemination is under way with collaborative financing from ACIAR since 2003-04.

One hundred FP evaluation trials were set in 19 blocks of 14 upzilas under five districts in the project area (ACIAR 2004). The salient results of the FP evaluation trials have been presented in Table 1. There is a significant increase in yield ranging from 9 to 53% in almost all demonstrations. The yield increase was non-significant in only four locations.

Table 1. Mean grain yields (kg/ha) for clusters (five, unless otherwise indicated) of on-farm evaluations of recommended ICM as compared with the normal practice (NP) for chickpea across five districts of Bangladesh, 2003-04.

District	Upzila	Block	Mean grain yield (kg/ha)		Yield range (kg/ha)		Yield increase	Prob-ability[2]
			ICM	NP	ICM	NP		
Jessore[3]	Monirampur	Jaljhara	1,110	726	1,050-1,140	600-750	53	<0.001
	Bagharpara	Agra	1,365	1,080	975-1,800	825-1,350	26	<0.01
	Bagharpara	Betalpara	891	717	675-1,200	480-1,050	24	<0.001
Magura	Shalikha	Boira[4]	1,163	1,069	975-1,350	900-1,350	9	n.s.
	Sadar	Ichakhada	1,301	1,003	1,163-1,538	934-1,215	30	< 0.001
	Mohammad-pur	Binotpur	1,533	1,332	1,425-1,590	1,125-1,425	15	<0.01
	Shalikha	Hazrahat[5]	806	712	675-900	600-750	13	<0.05
Jhenaidah	Sadar	Shadhuhati[6]	792	630	375-1,425	300-1,050	26	<0.05
	Koatchand-	Kushna	1,485	1,200	1,200-1,725	900-1,425	24	<0.001
	Kaligonj	Ragunathpur	1,419	1,140	1,035-1,785	825-1,470	24	n.s.
	Moheshpur	Mandirbaria	1,530	1,260	1,350-1,800	1,200-1,350	21	<0.05
Faridpur	Sadar	Bil Mohammad-pur[7]	975	829	600-1,350	525-1,050	18	n.s.
	Sadar	Domrakandi[8]	1,200	450	900-1,500	300-600	167	n.s.
	Madhukhali	Bagat[9]	1,610	1,373	1,500-1,680	1,350-1,389	17	<0.05
	Boalmari	Goshpur	678	554	570-780	480-608	22	<0.01
Rajbari	Sadar	Khan Khanapur-02	975	777	930-1,020	780-885	25	<0.001
	Sadar	Khan Khanapur-04	906	729	825-975	675-825	24	<0.001
	Pangsha	Kalikapur	906	624	720-1,050	420-780	45	<0.001
	Pangsha	Madapur	957	723	675-1,200	330-975	32	<0.01

1. Percentage increase of ICM over NP.
2. Probability (P) that means of ICM and NP arc from the same population according to a paired "t" test; ns = not significantly different at P = 0.05.
3. Site at Bahadurpur Block, Jessore Sadar abandoned due to grazing damage.
4. Mean values for four plots of ICCL 87322; the one plot with Barichola 5 yielded 1,050 kg/ha and its comparison plot (NP) yielded 900 kg/ha.
5. Mean of four evaluations as one evaluation was abandoned due to poor seed establishment resulting from limited seedbed moisture and severe collar rot.
6. When the two worst plots, which had poor establishment due to collar rot, were discarded, yield in ICM was 1,050 kg/ha and in NP was 840 kg/ha, but the difference was not statistically significant.
7. One evaluation discarded due to severe collar rot.
8. Results for two evaluations of Barichola 5. For the other three evaluations using ICCL 87322, mean yield was 355 kg/ha in ICM and 550 kg/ha in NP, with the difference between means not significant.

Experiences in technology dissemination

Changes in farmers' perceptions

Pulses cultivation in Bangladesh has through some qualitative, quantitative and cultural changes. There has been a change in the farmers' perception of lentils cultivation practices. Lentils as a rabi (or postrainy season) crop was being cultivated after broadcast Aman paddy as a relay crop or cultivated after the early harvest of T. Aman paddy generally without the application of fertilizer in either situation. Farmers felt that fertilizers were unneccessary for the cultivation of legumes. Minimal tillage was done if the crop was being cultivated after T. Aman paddy. Farmers did not apply plant protection measures.

With the development of improved lentils varieties and their distribution among farmers through the LBM development pilot project, the crop is now being cultivated using improved practices. Farmers apply fertilizers using appropriate tillage operations. They apply fertilizers even in the case of relay cropping. They plant lentils in rows and use fungicides and insecticides to protect from diseases and insect pests.

Achievements in grain yield and area expansion

Pulses in Bangladesh are considered after major crops like wheat, rice, oilseed crops and vegetables. On the face of it, there seems to be no suitable land that could be spared for major legumes like lentils, chickpea and mungbean. Even in such a situation, TTM has managed to expand area under lentils to 26000 ha, with a production increase of 28000 metric tones during' 1997-2002. During this period, it has also been estimated that about 40% of the total lentils area has been occupied by improved varieties. This was possible with the production and distribution of improved variety seed amounting to 27 tons to farmers (LBMDPP 2004).

Improvement in farmers' livelihoods and nutritional security

A sizable population in Bangladesh lives below the poverty level. Malnutrition is common due to the lack of balanced diets. Increased production of lentils by low-income farmers has increased their nutritional status by increasing plant protein in their diets. About 10600 farmers participated in improved technology demonstrations of lentils (Fig. 1). They received seeds of improved varieties along with fertilizers and technological support, which increased yield per unit area of land, thereby increasing their inflows. A socioeconomic study conducted towards understanding these efforts have shown that the farmers' incomes increased by 46% by adopting new technologies in lentils

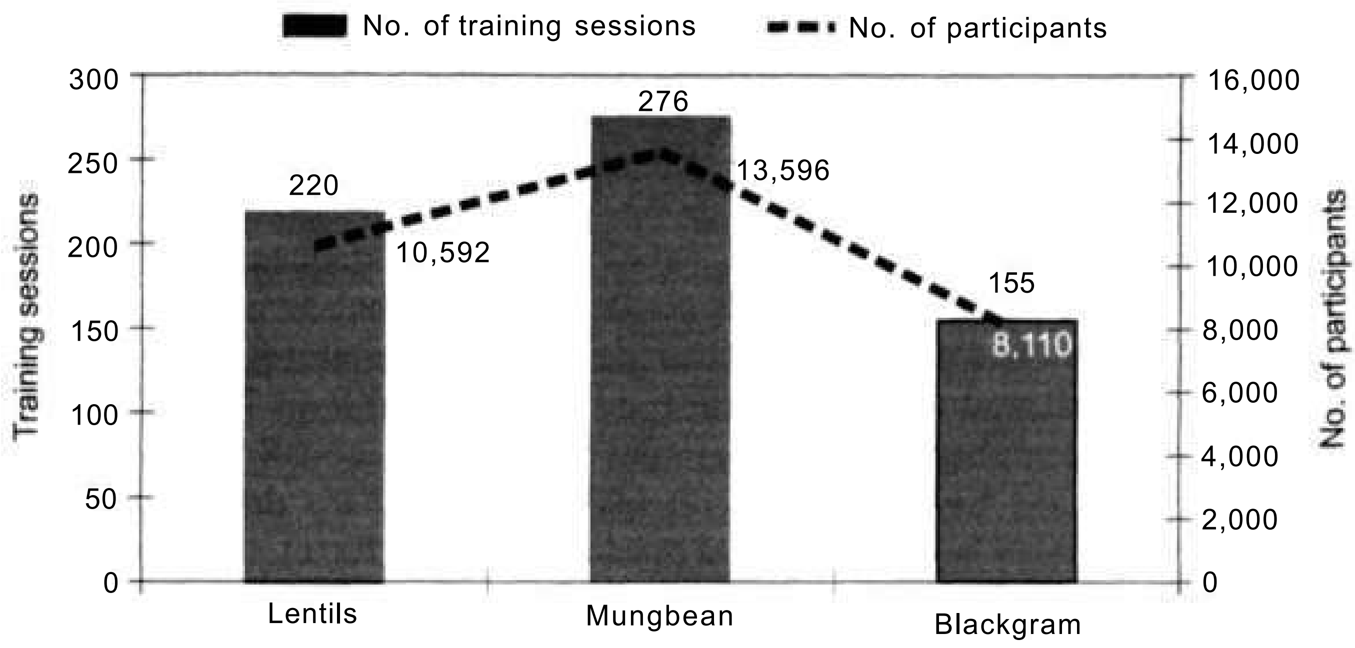


Fig. 1. Farmers' participation in training programs on pulses technology.

when calculated on full cost basis, while the increase was 26% on cash cost basis. The consumption status of the lentils produced by small and medium farmers has not been studied in an organized manner but sporadic interviews with concerned farmers revealed that consumption has definitely increased. Formal studies to this end are in progress.

Lentils

Lentils are the most popular among food legumes. Area under lentils seems to have stabilized around 170000-200000 ha. Further expansion of lentil cultivation as a sole crop seems difficult; however, lentils have potential to be grown as an intercrop with several upland crops. Prospects of expanding lentils with sugarcane appear bright. Currently, lentils are planted on 180000 ha producing nearly 140000 tons annually. Over 72% of total lentils are produced in the mid-western regions such as the greater districts of Jessore, Faridpur and Kushtia. There is not very much scope to expand area under lentils in non-traditional areas, therefore major thrusts to increased production must be placed on vertical yield increase. By replacing traditional or low yielding varieties with the newer ones in these districts, yield can be increased by at least 30%.

Intercropping lentils with sugarcane in the districts of Rajshahi, Natore, Faridpur, Rajbari, Kushtia, Chuadanga, Jhenaidah, Jessore and Narail offers an excellent opportunity to improve farmers' livelihoods and sustain the sugar industry. It is estimated that 20000-30000 ha could be brought under lentils as an intercrop in the sugar mill zones. Lentils can also be relay cropped before the harvest of Aman rice on the medium highlands in Norail, Magura, Madaripur, Faridpur and Barisal districts. Progressive farmers in Noakhali, Comilla and Barisal have been practicing relay cropping of lentils. This helps avoid late planting of lentils because of the late harvest of Aman rice in certain agroecological conditions.

Chickpea

Among legumes, chickpea suffered the most with the adoption of Green Revolution technologies. Currently, chickpea commands around 3% of the area covered by legume pulses, producing around 12,000 tons annually. Widespread prevalence of BGM has been the principal cause of sharp decline in area although other causes have affected its production (BBS 2001). Chickpea was affected most in the lowlands or traditional chickpea growing districts, while BGM is as rampant in the non-traditional Barind area, where the weather is dry during the growing season. Attempts are underway to rehabilitate chickpea production by replacing old varieties with modern ones, and adopting improved technologies.

Lentils cultivation: A socioeconomic profile

Yield from improved varieties of lentils was high compared to crops under farmers' own management. Average yield of Barimasur varieties was 1073 kg/ ha in demonstration plots, which constituted about 25% higher yield than the local variety under almost the same management (Table 2).

Gross return, gross margin and benefit: cost ratio of Barimasur's cultivation were higher in the demonstration plot as compared to those under farmers' own management. The cost of cultivation per hectare was Tk 10800 in the demonstration plot and Tk 10339 in plots under their own management.

Table 2. Economic performance of improved varieties of lentils.

Indicators	Demonstration	Farmers' management	Change (%)
Yield (kg/ha)	1073	857	25.20
Gross Return (Tk/ha)	22754	18179	25.17
Gross Cost (Tk/ha)	10800	10339	4.46
Gross Margin (Tk/ha)	11954	7840	52.47
Benefit : Cost Ratio	2.10	1.76	19.32

Constraints to technology transfer

1. Resistence to new technologies

In course of technology transfer and dissemination of information through LBMDPP, participating farmers were made aware of the details of the technology package and its ramifications. They had also been trained with ICM and apprised of improved varieties and their characteristics. When it came to practical application however, about 10-15% did not adopt the total package, feeling, on the whole, that line sowing of pulses was troublesome and not very useful.

2. Time of sowing

Pulses are very sensitive to sowing time. Particularly during the rabi season, pulses suffer serious setbacks due to delays in sowing. About 5-10% farmers did not sow their seed within the optimum sowing periods, resulting in sub-optimal yields and lack of profits.

3. Fertilizer and seed rate

The participating farmers were informed of standard and proper seed rates for each of the concerned pulses. They were supplied seed and fertilizers for a one-bigha (13.2% of a hectare) plot. In some cases however, the inputs were not used for the prescribed area; about 10-15% of the farmers distributed the inputs for the whole area at their disposal, irrespective of whether it was more or less than one bigha. This resulted in either densely or sparsely populated plant stand, with either high or low dose of fertilizers instead of a healthy, optimal plant stand.

4. Seeding method

The technology package recommended making furrows and line sowing by placing seed in the moist, which enhances germination and results in a good plant stand. In about 15-20% cases, farmers found it troublesome and fell back on their favored method, ie, seeding by broadcast, which does not ensure deep placement of seed, and in turn, germination, resulting in uneven plant stands.

5. Improper soil moisture and irrigation

Soil moisture stress is a limiting factor to successful cultivation of pulses. Moisture stress is encountered during the pre-sowing stage, causing poor germination and resulting in poor plant stand. Moisture stress is also observed during the later stages of crop growth. Farmers were advised to conserve soil moisture at proper levels for good germination, and they failed to do this in at least 5-10% of the cases for chickpea.

6. Weeding

Weed if not controlled competes with the crop and impairs productivity and yield. At least 10-15% of the farmers felt that weeding was not required for pulses. They found it troublesome, laborious and involving further expense, particularly when they had not practiced line sowing.

Conclusion

Food legumes in Bangladesh will continue to be in short supply due to the country's incremental rate of population and secondly, due to the small share of cultivable land for pulses. However, recent promotional activities through LBMDPP in traditional areas and the joint efforts of ICRISAT and BARI in the non-traditional Barind area have proved that substantial increase is possible in area and production of pulses.

For complete success in expanding chickpea area and productivity, there are a few cruicial factors. Firstly, the technology should be viable. Secondly, the message transfer mechanism should be appropriate and suitable. Thirdly, message degradation must be prevented.

In this respect, LBMDPP's methodology may be put forward as a model while attempting any fresh program for legume promotion. This method of participatory technology dissemination has brought about a momentum in the process. It is however important to note that a program such as LBMDPP needs to be kept in motion for some more time.

Reference

BBS (Bangladesh Bureau of Statistics). 2001. Statistical Year Book of Bangladesh for 1999. Dhaka, Bangladesh: Statistics Division, Ministry of Planning, and Government of the People's Republic of Bangladesh.

ACIAR. 2004. Annual Report of Australian Centre for International Agricultural Research on the project on Integrated Management of Botrytis Grey Mould of Chickpea in Bangladesh and Australia (CSI-2001-039) for the year 2003-04.

LBMDPP. 2004. Annual Report of Lentils, Blackgram and Mungbean Development Pilot Project for the year 2003-04.

Lessons learned from farmers' participatory BGM management in India

HS Tripathi[1]

Chickpea (*Cicer arietinum* L.) is an important grain legume in the Indian sub-continent, West Asia, northern and eastern Africa, and Central and South America. It is a versatile crop among grain legumes and ranks first among the pulses in both area and production. The average yield of the crop in India is only 740 kg/ha, which is low (Table 1). There are several reasons for low productivity. Diseases and insects seriously hamper chickpea production. Of the foliar diseases, BGM ranks second after Ascochyta blight (Table 2) in the order of importance world-wise (Reddy et al. 1990; Grewal 1988).

BGM *(Botrytis cinerea* Pers. ex. Fr.) is a serious disease in the Terai region of northeast India (Bihar, Uttaranchal, Uttar Pradesh and West Bengal). Fertile lands and frequent rains during crop growth are responsible for a dense canopy, creating a microenvironment highly favorable to the growth and development of the pathogen.

BGM resistant cultivars are presently not available, and so experiments are on to manage this disease through agronomic practices, bio agents and fungicidal sprays. None of the individual methods has proved highly effective, although fungicidal sprays showed some promise.

The spread and severity of BGM is facilitated by high relative humidity in the crop canopy. Tall, erect genotypes of chickpea have less disease severity (ICCL 87322) than bushy and spreading genotypes (H 208). Two to three foliar sprays of vinclozolin (Ronilan® @ 0.2%) or carbendazim (Bavistin® @ 0.1%), suppressed the disease. Inter-row spacing 30 x 10 cm and 60 x 5 cm with erect and compact growth habit and bushy and spreading type increased the yield significantly in wider spacing. Delayed sowing (late November/early December) helps reduce disease severity without affecting grain yield (Table 3).

Keeping in view that no single approach is successful against BGM, development of an Integrated Disease Management (IDM) strategy, became essential for the management of this disease. Various combinations of agronomic practices, choice of genotypes with different growth habits and judicious use of fungicides and biocontrol agents for foliar sprays were evaluated (Table 4 and 5).

[1]Department of Plant Pathology, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar 263145, Uttaranchal, India.

Table 1. Area, production and productivity of chickpea in India, 1999/2000 to 2001/2002.

	Area (000' ha)			Production (000' t)			Yield (kg/ha)		
State	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002
Andhra Pradesh	163.0	201.0	285.0	95.1	229.0	363.0	583.0	1139.0	1274.0
Assam	2.0	2.7	2.5	1.0	1.0	1.3	500.0	481.0	520.0
Bihar	97.8	76.2	68.2	95.4	78.7	67.0	975.0	1033.0	987.0
Chattisgarh	-	140.1	157.0	-	72.1	112.0	-	515.0	714.0
Gujarat	81.9	17.0	49.1	41.9	9.0	27.2	512.0	529.0	554.0
Haryana	100.0	125.0	145.0	58.0	80.0	124.0	580.0	640.0	855.0
Himachal Pradesh	2.0	1.3	2.2	3.0	1.5	2.8	1500.0	1154.0	1273.0
Jammu and Kashmir	0.2	0.2	0.2	0.1	0.1	0.2	-	-	-
Karnataka	319.4	369.5	480.0	175.0	239.4	291.0	549.0	648.0	606.0
Madhya Pradesh	2571.9	1978.4	2222.0	2535.1	1620.0	2196.8	986.0	819.0	989.0
Maharashtra	932.0	676.0	756.0	600.0	351.0	450.0	644.0	519.0	595.0
Meghalaya	2.0	0.5	0.5	1.5	0.5	0.3	450.0	600.0	600.0
Nagaland	1.0	1.0	1.0	1.2	0.8	1.0	1200.0	800.0	1000.0
Orissa	34.0	21.0	28.9	20.0	10.0	15.2	588.0	476.0	526.0
Punjab	6.0	7.7	7.1	6.1	7.0	6.2	968.0	948.0	873.0
Rajasthan	275.0	672.6	969.6	677.9	396.6	735.5	695.0	590.0	759.0
Tamil Nadu	7.8	5.7	6.0	4.9	3.7	3.9	628.0	649.0	619.0
Tripura	0.5	0.5	0.5	0.2	0.2	0.2	-	-	-
Uttar Pradesh	822.3	833.0	863.0	779.0	702.7	824.4	948.0	844.0	960.0
Uttaranchal	-	1.1	1.2	-	1.0	1.0	-	909.0	833.0
West Bengal	26.6	54.7	50.8	22.0	50.2	43.2	827.0	918.0	850.0
Dadra and Nagar Haveli	0.2	0.2	0.1	0.1	0.2	0.1			
Delhi	0.1	0.1	0.2	-	-	-			
All India	**6146J**	**5185 J**	**6096.8**	**5118.1**	**3855.4**	**5271.0**	**833.0**	**744.0**	**865.0**

Source: AICCRP 2003.

Table 2. Major diseases of chickpea.

Disease	Pathogen	Estimated annual loss (%)
Ascochyta blight	*Ascochyta rabiae*	20-40
Botrytis grey mold	*Botrytis cinerea*	25-35
Fusarium wilt	*Fusarium oxysporum f.sp. ciceri*	10-15
Dry root rot	*Rhizoctonia bataticola*	5-20
Stunt	Pea leaf roll virus	< 1
Phytophthora root rot	*P. megasperma*	NA
Stemphylium blight	*S. sarciniforme*	5-15
Alternaria blight	*A. alternate*	5-10
Rust	*Uromyces ciceris arietini*	NA

Table 3. Effects of dates of sowing and growth habit of chickpea genotypes on BGM severity and grain yield, Pantnagar, 1992-93.

	DS I[1]		DS II		DS III		DS IV	
Cultivars	Disease rating[2]	Plot yield (kg)	Disease rating	Plot yield (kg)	Disease rating	Plot yield (kg)	Disease rating	Plot yield (kg)
H 208	7.33	0.9	6.7	1.1	4.7	1.0	3.7	1.0
Pant G-114	6.3	0.9	5.7	1.0	3.3	0.9	3.3	1.3
K 850	6.0	1.0	6.0	1.1	4.3	0.9	3.3	1.3
ICCL 88510	5.3	1.2	5.0	1.0	4.0	0.7	2.3	1.2
ICCL 87322	4.7	1.2	4.7	1.1	3.3	0.9	2.3	1.1

SE	Disease rating	Plot yield (kg)
Cultivar	± 0.169**	±0.086
Sowing	±0.152**	±0.077**
Cultivar x sowing	±0.339	±0.173
CY (%)	12.6	31.6

[1] Dates of sowing, DS 1 = 31 October 1992, DS II = 14 November 1992, DS III = 29 November 1992, DS IV=14 December 1992.

[2] Disease rating on 1 - 9 point stale.

[3] Average of three replications.

** Significant at 1%.

Table 4. The effect of row spacing and fungicide sprays on BGM severity and grain yield in chickpea, Pantnagar, 1993-94.

Treatment	Cultivars	Spacing	Disease rating (1-9 scale)	Yield kg/ha
Sprayed[2]	ICCL 87322	30 x 10	4.3	1390
		60 x 10	3.3	1491
		45: 15:45	4.3	1400
		60 : 40 : 60	3.3	1475
	H 208	30 x 10	5.7	1140
		60 x 10	4.7	1270
		45:15:45	4.9	1160
		60 : 40 : 60	4.9	1190
No spray	ICCL 87322	30 x 10	5.7	1180
		60 x 10	4.3	1180
		45: 15:45	4.3	1180
		60 : 40 : 60	4.0	1240
	H 208	30 x 10	8.0	360
		60 x 10	6.3	450
		45:15:45	6.3	490
		60 : 40 : 60	6.0	490
SE				
Cultivars			±0.134*	±84.1
Spacings			±0.185*	±122.6
Sprayings			±0.134*	±84.1
Spacing x Sprayings		±0.240	±178.2	
Cultivar x Spacing		±0.230	±178.2	
Cultivar x Spraying		±0.176**	±128.4**	
Cultivar x Spraying x Spacing		±0.358	±244.7	
CV (%)			12.2	45.2

* & ** Significant at 1% and 5%

1 Average of three replications

2 Fungicide ronilan (0.2%)

In case of traditional bushy and spreading genotypes (H 208), detopping of the foliage by one-third of its height after 60 days of planting and one spray of Carbendazim@ 0.1% at the flower initiation stage significantly reduced disease severity. In the case of genotypes with tall, erect and compact growth (ICCL 87322), intercropping with wheat and one spray of Carbendazim (0.1 %) suppressed BGM effectively in farmers' fields.

Detopping of foliage in the case of bushy genotypes checked excessive foliage and increased the duration and intensity of sunlight to the lower portion

Table 5. The effect of *Trichoderma viride* on BGM severity and grain yield in chickpea, Pantnagar, 1994-95.

Treatment	Disease rating (1-9 scale)	Yield (kg/ha)
1. Control (No spray)	5.8	1200
2. Three sprays of Trichoderma (107-108 spores/ml) at 20 d interval	4.5	1700
3. Three sprays of Ronilan (0.2%) at 20 d interval	4.0	1800
4. First spray with Trichoderma (10^7-10^8 spore/ml) + Ronilan 0.1%, second spray with Trichoderma (10^7-10^8 spores/ml), third spray with Trichoderma (10^7-10^8 spores/ml) + Ronilan 0.1%	4.6	1600
SE	±0.204	±0.079
CV (%)	9.1	10.1

of the crop canopy, thus creating a microenvironment less favourable for BGM. Spray of vinclozolin directly suppressed growth of the pathogen.

Field trials conducted at Pantnagar, India, indicated that BGM in chickpea can be managed by sowing a tall, erect genotype at wider spacing with judicious use of fungicide or an effective biocontrol agent. These components along with manipulation of sowing dates have been developed into a management strategy suitable to be transferred to farmers. During 2001-02 and 2002-03, demonstrations were conducted in farmers' fields for the management of BGM, using tolerant cultivars (PG 186 and ICCL 87322) with or without spray of chemicals. It was observed that invariably, tolerant cultivars protected with chemicals yielded more than unprotected crops (Tables 6, 7 and 8).

Table 6. Management of BGM in farmers' fields during 2002-03.

Treatment	BGM score (1-9 scale)	Grain yield (kg/ha)	Net return (Rs/ha)
Protected	2.0	1630	13040
Unprotected	5.0	1400	11200
% increase	-	14.28	16.43

Sowing: 22 November 2002

Preceding crop: Rice

Cultivar: PG-186 (Tolerant)

Treatment: Two prophylatic sprays of vinclozolin @ 0.2%, two sprays of endosulfan (5) 0.1% to prevent the crop from pod borer damage

Harvesting: 21 April 2003

Table 7. Management of BGM in farmers' fields during 2003-04.

Treatment	BGM score (1-9 scale)	Grain yield (kg/ha)	Net return (Rs/ha)
Protected	3.0	1750	15130
Unprotected	5.0	1500	12178
% increase	-	16.66	24.24

Sowing: 20 November 2003
Preceding crop: Rice
Cultivar: ICCL 87322 (Tolerant)
Treatment: Two prophylatic sprays of carbendazim @ 0.1% at 15 days interval; Two sprays of endosulfan @ 0.1 % to prevent the crop from pod borer damage
Harvesting: 20 April 2004

Table 8. Production potential of BGM tolerant cultivars ICCL 87322[1] and PG 186[1] during 2003-04.

	BGM score (1-9 scale)		Grain yield (kg/ha)		Net return (Rs/ha)	
Cultivar	ICCL 87322	PG 186	ICCL 87322	PG 186	ICCL 87322	PG 186
Tolerant[1]	2.0	2.0	1850	1872	15673	15859
Avarodhi*	5.5	5.0	1566	1656	13217	13976
% increase	-	-	17.9	13.0	18.6	13.5

* Check cultivar
Sowing: 25 November 2003
Preceding crop: Rice
Treatment: Seed treatment with Carboxin + Thiram (2 : 2) @ 4 g/kg; Pre-emergence application of Pendamethalen @ 1 kg a.i./ha; Two sprays of endosulfan @ 0.1 % at 15 days interval; Two sprays of carbendazim @ 0.1 % at 15 days interval
Harvesting: 20 April 2004

Disease rating scale

The following rating scale (1-9) was used to record data and observations on disease severity on individual plants or fields, in the experiments reported in Tables 1-8.

Disease rating	Observation	Description
1	No disease visible	Highly resistant
3	Lesions were seen after careful search	Resistant
5	Lesions clear but not damaging	Moderately resistant
7	Lesions common, damaging but no plant death	Susceptible
9	Death of the plant	Highly susceptible

References

Grewal JS. 1988. Diseases of pulse crops: An overview. Indian Phytopathology, 36:1 -14.

Reddy MV, Singh O, Bharti MP, Sah RP and Joshi S. 1990. Botrytis grey mould: epiphytotics of chickpea in Nepal. International Chickpea Newsletter, 19:15.

Promotion of rainfed rabi cropping in rice fallows of eastern India, Bangladesh, and Nepal: An overview

JVDK Kumar Rao[1], D Harris[2], KD Joshi[3], N Khanal[4], C Johansen[5] and AM Musa[6]

Abstract

South Asia is one of the major rice producing regions of the world. Using satellite imagery and GIS, it was estimated that about 30% of the total kharif rice area of 50.4 million ha, ie, about 14.3 million ha remains fallow in the rabi (postrainy) season. Their spatial distribution in South Asia has been documented. These rice fallows represent an enormous underutilized resource. DFID's Plant Sciences Research Program supported several projects (R7540, R8098, R8221, R8269) to improve the livelihoods of the farmers in study areas of Bangladesh, eastern India and Nepal, by making better use of their land by growing short-duration legume crops with minimal inputs in the rabi season on residual moisture after kharif rice has been harvested. This overview covers briefly the progress made so far in promoting rainfed rabi cropping (RRC) eg, chickpea, in rice fallows of Bangladesh, eastern India and Nepal.

Introduction

South Asia is one of the major rice producing regions of the world with about 50 million ha under this crop. Much of this area has a single crop per year, usually rainy season rice, and no crop is grown after the rains mainly due to lack of irrigation. Despite growing demands for food production because of increasing populations in South Asia, there is little scope for expansion of cropping into new areas and therefore an increase in cropping intensity along

[1]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[2]Center for Arid Zone Studies, University of Wales, Bangor, Gwynedd LL57 2UW, UK.
[3]International Maize and Wheat Research Centre, South Asia Regional Office, Kathmandu, Nepal.
[4]Forum for Rural Welfare and Agricultural Reform for Development, Bharatpur, Chitwan.
[5]Apartment 2B, Palmdale, Plot 6, Road 104, Gulshan - 2, Dhaka 1212, Bangladesh.
[6]People's Resource Oriented Voluntary Association, Rajshahi 6000, Bangladesh.

Table 1. Estimates of area under rice during the kharif season of 1999, and rice fallows during the rabi season of 1999/2000 based on satellite image analysis.

Country	Kharif rice area (million ha)	Rabi fallows (million ha)	Rabi fallows as % of rice area	Percentage of total rice fallows in South Asia
Nepal	1.45	0.39	26.9	2.7
Bangladesh	6.36	2.11	33.2	14.8
Pakistan	2.45	0.14	5.7	1.0
India	40.18	11.65	29.0	81.5
Total	50.44	14.29	28.3	

with raising of yields, needs to take place on existing agricultural lands. Rice fallows present considerable scope for crop intensification and diversification if appropriate technologies are applied. Using satellite imagery and GIS, it was estimated that about 30% of the total area under kharif rice (of 50.4 million ha), ie, nearly 14.3 million ha remains fallow in South Asia (Table 1). Their spatial distribution (Fig. 1) has also been documented (Subbarao et al. 2001).

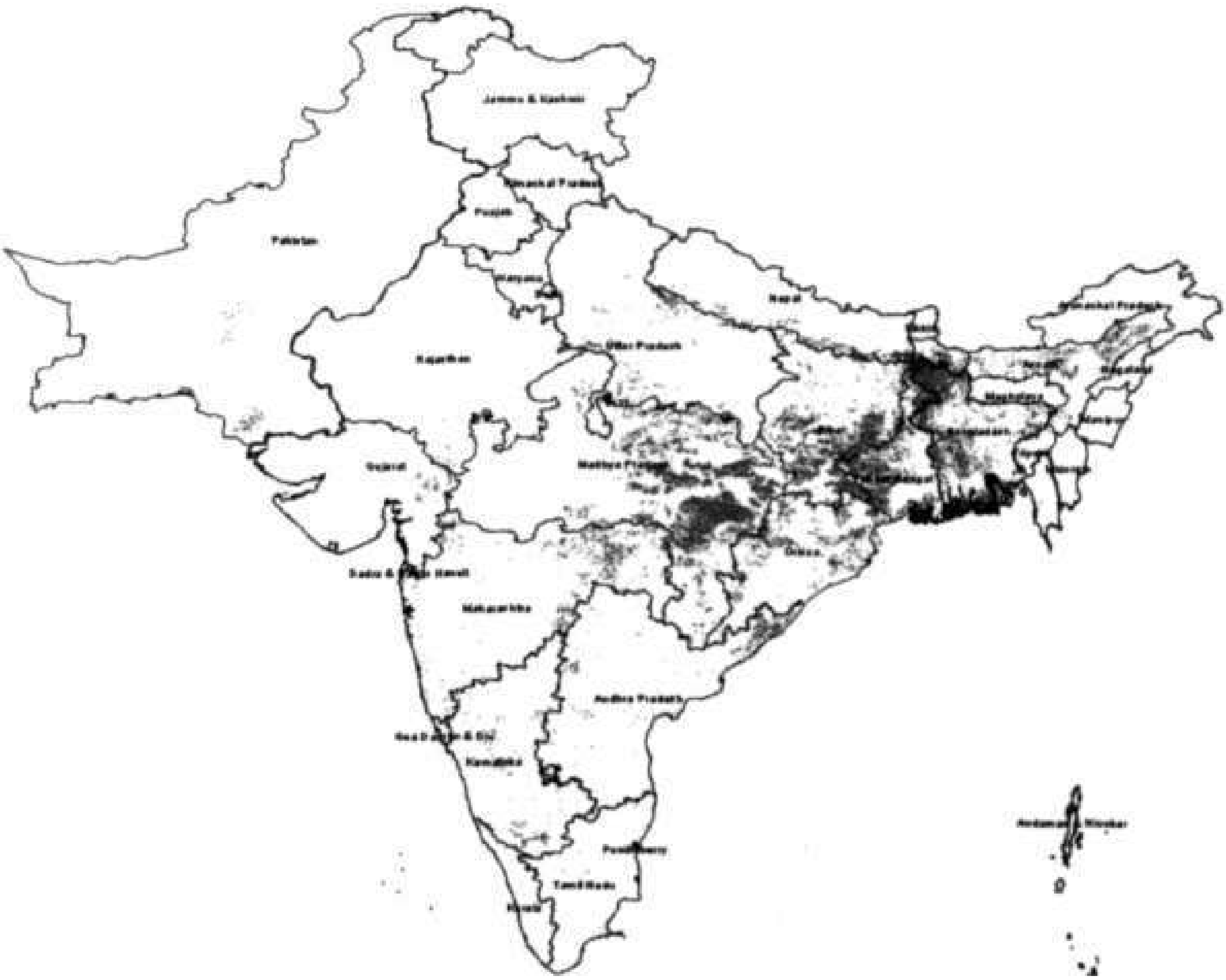


Fig. 1. Rice fallows in South Asia.

The study also attempted to relate the spatial and temporal distribution of rice fallows with various climatic and edaphic variables and socioeconomic information to assess the possibility of legume intensification for specified rice fallow situations. Accordingly, recommendations for better utilization of rice fallows through legume cultivation have been made. Crop diversification through the addition of new regenerative components such as legumes, and adoption of minimum tillage methods, seed priming and crop rotations can be particularly successful approaches to sustainable intensification (CSD 2000; Harris et al. 1999; Harris et al. 2000). This overview presents the progress made so far in promoting rainfed rabi cropping in rice fallows of Bangladesh, eastern India and Nepal carried out as part of the DFID/ Plant Sciences Research Program funded projects - R8098, R8221, R8269 and R7540 that were initiated around 2001. The main objective of these projects is to improve the livelihoods of farmers in the study areas by making better use of their land by growing short-duration crops with minimal inputs in the rabi season on residual moisture after kharif rice has been harvested.

The geographic focus of the project is as follows: High Barind Tract in northeast part of Bangladesh; Orissa, West Bengal, Chattisgarh, Jharkhand and eastern Madhya Pradesh in India; Jhapa, Morang, Saptari, Siraha and Kapilbastu districts in Nepal. The collaborating institutions in this project are presented in Table 2.

Table 2. Collaborating institutions in the RRC projects.

Country	Collaborating institutions
Bangladesh	Bangladesh Agricultural Research Institute, Bangladesh Rice Research Institute, People's Resource Oriented Voluntary Association, Dept. of Agricultural Extension, Center for Arid Zone Studies (University of Wales)
India	Catholic Relief Services-India, Gramin Vikas Trust, Dept. of Agriculture, Center for Arid Zone Studies (University of Wales)
Nepal	Forum for Rural Welfare and Agricultural Reform for Development, National Grain Legume Research Programme, International Maize and Wheat Research Centre, Asian Vegetable Research and Development Centre, District Agricultural Development Office, Center for Arid Zone Studies (University of Wales)
USA	Cornell University
UK	Center for Arid Zone Studies (University of Wales)

Bangladesh

Rice fallows occupy an area of 2.11 million ha amounting to 33% of T. Aman rice area in the country. They are largely in the northwestern (Barind), northern and coastal parts of the country (Subbarao et al. 2001). Nearly 0.8 million ha in the Barind tract in northwestern Bangladesh remains fallow in winter after harvest of T. Aman rice (Raisuddin and Nur-E-Elahi 1984). The High Barind Tract comprises uplifted weathered alluvium of high clay content that is not subject to annual flooding by the major river systems. Technology that permits cultivation of rabi crops to follow rice has been developed (Kumar et al. 1994). Chickpea has proved to be particularly suitable for growing after rice in this system because of its strong rooting characteristics and the availability of new short-duration improved varieties, compared with traditional local landraces (Rahman et al. 2000). Unfortunately, the surface layers of the soil dry out rapidly, so crop establishment is the key objective. Two things are essential: 1) rapid tillage to cover the seed whilst causing minimal disturbance to the soil (and minimal loss of moisture); 2) on-farm seed priming, ie, soaking the seeds for 4-6 hours in water before surface-drying them to facilitate handling, then sowing. Over four seasons (1998/99-2001/02) grain yield responses to seed priming in many on-farm, operational-scale trials conducted across the High Barind Tract ranged from 22% to 48% with responses inversely proportional to winter rainfall (Johansen and Musa 2004). The combination of on-farm seed priming, rapid tillage and short-duration improved varieties of chickpea has proved outstandingly effective in rice fallow areas of this region (Musa et al. 2001). Farmers readily adopted the simple priming technology and at least 25% of the chickpea sown in 2001 was primed (Saha 2002). Improved varieties of chickpea such as Barichola 2, Barichola 5, and appropriate fertilizer practices for the crop were also introduced. An impact analysis conducted in 2002 quantified benefits to rural households of increased cultivation of chickpea (Saha 2002). Chickpea was found more profitable than irrigated rabi crops such as boro rice and wheat, due to low input costs.

Current emphasis is on dissemination of optimum chickpea cultivation technology across the Barind. This also includes appropriate methods of chickpea seed production, storage and dissemination so as to encourage village-level entrepreneurship in seed supply. As continued chickpea cultivation on the same land would lead to build-up *of* pests and diseases, efforts are underway to identify alternative rabi crops with which chickpea can be rotated. Work is in progress to alleviate nutrient deficiencies such as phosphorus, nitrogen and molybdenum, and to develop Integrated Pest Management (IPM) methods for management of pod borer in chickpea.

India

Satellite image analysis of India estimates that the rice area was 40.2 million ha during the 1999 kharif season and the total rice fallow area during the 1999/2000 rabi season was 11.7 million ha (Subbarao et al. 2001). Chattisgarh, Jharkhand, Orissa, West Bengal, eastern Madhya Pradesh and Assam account for most of the rice fallows in India.

Reasons for not practicing RRC

The reasons for farmers not choosing to sow a second crop after harvesting rice were examined in a combined survey (Joshi et al. 2002) and trials during the 2001-2002 season. The survey covering 18 villages in five states (Chattisgarh, Jharkhand, Orissa, West Bengal and eastern Madhya Pradesh) showed that farmers are generally not aware or do not pursue opportunities for rainfed rabi cropping. The main constraints noted were:

- Lack of information on rabi cropping.
- Various physical soil- and water-related issues, predominantly drought.
- High costs involved and poor availability of inputs, in particular the non-availability of seeds of short-duration chickpea varieties as tested in the preliminary trials.
- Poor market opportunities.
- The need to protect rabi crops from free-grazing animals.

Farmers who participated in preliminary chickpea trials of the technology developed in Bangladesh (Musa et al. 2001) were almost unanimous in wishing to grow chickpea again and were convinced of the main elements of the preliminary 'package'. The preliminary trials had demonstrated the potential for rainfed rabi cropping convincingly, and such exposure had generated enormous enthusiasm amongst farmers.

Ways to take RRC forward

In 2002, the DFID/Plant Sciences Research Programme supported a follow-on project on *Promotion of rainfed rabi cropping in eastern India and Nepal* (R8221). The project used chickpea as a model to: 1) adjust the simple package to the needs of Indian farmers, 2) increase seed production of varieties preferred by farmers, 3) test additional components of the technology according to farmers' needs, and 4) test contrasting methods to disseminate the concept. Subsequent research, both in India and in Bangladesh, has refined the package initially developed in Bangladesh (Harris and Kumar Rao 2004).

In summary, the technology package tested and approved by farmers in the study includes:

- Well-adapted, short-duration chickpea varieties such as the currently popular ICCV 2 and KAK 2.
- Sowing under rapid minimum tillage as soon as possible after harvesting rice.
- Seed priming for 4-6 hours with the addition of sodium molybdate to the priming water at a rate of 0.5 g/litre (per kg seed) and Rhizobium inoculum at the rate of 5 g/litre (per kg seed). Rhizobium inoculum should have about 109 viable rhizobia per g inoculum.
- Application of manure and single superphosphate to impoverished soils.

By the end of the 2003-04 rabi season the results were clear:

- The two short-duration varieties (ICCV 2 and KAK 2) were clearly superior to any of the varieties available to farmers in all five states and were consistently preferred. Both varieties flowered and matured earlier, before soil moisture became exhausted and often yielded when other varieties failed. Preliminary benefit : cost analyses are very promising (Table 3). Early pod formation enabled many farmers to compete successfully in the market to sell green pods for snacks, which is very profitable. The grain of these kabuli-type (bold-seeded) varieties also attracts a premium price.
- The simple on-farm storage techniques are farmer-friendly and highly effective in preserving valuable seed through the kharif season.
- A degree of social cohesion is required in any village to facilitate block-planting and cooperation in protecting the crop from grazing animals, pests and diseases. A group of at least 20 farmers is generally necessary for success, as is the provision of 200-300 kg seed.

The collaboration between scientists and farmers has been highly effective in identifying additional constraints and developing appropriate solutions. For instance, analysis of soils from all sites confirmed that most were acidic and therefore generally not ideal for growing legumes such as chickpea. However, trials during 2003-04 have identified a simple technique that farmers can use to

Table 3. Comparison of returns from a short-duration chickpea (ICCV 2) and a local variety.

Variety	Cost of seed (Rs/kg, estimated)	Sale price (Rs/kg)	Net returns (Rs/ha)
ICCV 2	45	25	21330
Local	22	15	9530

Source: CRS, Satna, MP, India.

boost the growth of chickpea (and other legumes), by supplying tiny amounts of molybdenum, an essential micronutrient lacking in these areas (Johansen et al. 2004; Kumar Rao et al. 2004). Additional studies are addressing other constraints such as protection from pests eg, pod borer, and diseases eg, collar rot.

A possible future

Through dialogue and experimentation with farmers, a consensus has evolved:

- Thousands of farmers who have been exposed to this technology are now convinced that a second crop can be grown without irrigation.
- An effective approach to dissemination has emerged. For new villages this includes:
    - Identification of interested and committed farmers and formation of growers' groups. The groups must agree to plant in a block to facilitate crop protection;
    - Provision of training on crop production technology to group representatives and village-level extension staff;
    - Provision of 200-300 kg seed of short-duration varieties. Currently only ICCV 2 and KAK 2 are available but additional varieties are being developed using farmer-participatory breeding approaches;
    - Provision of 'starter packs' (enough Rhizobium inoculum, sodium molybdate and single superphosphate for 200-300 kg seeds, ie, for about 2-3 hectares). Assembly and distribution of packs of Rhizobium and sodium molybdate represent an opportunity for small-scale business development in resource-poor communities.
    - Technical backstopping where necessary.

Nepal

Based on satellite image analysis, the total rice fallows estimated in Nepal are 392,000 ha, which amounts to 26% of the total rice area. A major portion of these fallows is located in the eastern and central Terai including Jhapa, Morang, Saptari, Siraha, Dhanusa and Kapilavastu districts.

Based on avenues indicated by the DFID-supported study and other experiences gained in Nepal, the rainfed rabi cropping (RRC) project was conceptualized with the aim to intensify the rice fallow system in the Terai through capitalizing on the low external input agricultural technologies. Some on-farm trials on winter crops and socioeconomic studies (Bourai et al. 2002) were carried out in the pilot phase from October 2001 to June 2002. Based on this understanding of the constraints and opportunities for crop diversification, the second phase of the project is in operation from July 2002 to March 2006. The project has been implemented in Jhapa, Morang, Saptari, Siraha and Kapilbastu districts of Nepal. The interventions primarily involve participatory varietal selection (PVS) and on-farm verification of rainfed technologies on wide range of crops including rice, chickpea, field pea, lentils, mungbean, soybean, pigeon pea, niger and buckwheat. To address the intricate problems and to enhance the sustainability of the system, the project has included other supportive activities such as development of local resource persons, strengthening community-based seed systems, establishment of agro-forestry nurseries and on-farm plantations and awareness of regenerative energy technologies.

Fallow lands

Broadly, the causes for fallow lands can be classified under technical and socioeconomic barriers:

- Low soil fertility
- Erratic or scanty rainfall during winter
- Lack of information on rainfed rabi cropping
- Lack of credit facilities and access to quality seeds, fertilizers and pesticides

The intervention approach

The project has adopted the livelihoods system approach (DFID 1999) to achieve lasting impacts of intervention through enhancing community capabilities and resources. Broadly, the approach includes the following interventions:

- Enhancing technical and managerial capabilities of farmers (human capital) through training, excursions, workshops, interactions and on-site coaching.
- Promoting collective activities (social capital) through self-help groups/ farmers cooperatives.
- Augmenting natural resource bases (natural capital) through crop diversification, nutrient recycling, Integrated Pest Management etc.
- Promoting mechanical devices (physical resource) such as tractors, power tillers, sprayers, zero tillage planters.
- Promoting micro-financial practices (financial capital) among the groups.

Some major activities and their achievements

- Group building and networking.
- Participatory varietal selection (PVS) of rice. Farmer preferred new varieties Sugandha 1, Pant Dhan 10, Barkhe 1027, Barkhe 2014, Judi 572 for higher yield and better qualities than farmers' predominant varieties. These varieties yield 10-15% more, mature 15 to 30 days earlier and thus facilitate early establishment of winter crops in the residual moisture.

- **PVS of chickpea.** Chickpea has been rehabilitated, despite the challenges of BGM, collar rot and pod borer. Varieties GNG 469, KPG 59, Tara, ICCC 37, and ICCV 2 were identified as promising with about 20% more yields than local varieties and preferred by the farmers. Jhapa local, though not particularly a higher yielding variety, was nevertheless preferred for its better adaptation and tolerance to abiotic stresses such as boron deficiency.
- **PVS of lentils.** Variety ILL 7723 has been preferred by farmers for its bolder grain size. Farmers have also adopted Khajura 1 and Simrik on the basis of their promising performance.
- **PVS of pea.** Variety E 6 has been preferred by farmers for its earliness; it matured within 85 days of sowing. A small seeded cultivar collected from Chitwan district has been preferred for its good adaptation in low fertility and moisture stress conditions.
- **PVS of mungbean.** Varieties VC 3960-88, VC 6372 (45-8-1), NM 92, and NM 94 have been preferred for most agronomic and postharvest traits including earliness, yield (25% higher than local), pod and grain size, grain color, smell and taste.
- **Adaptive demonstration on buckwheat.** A local landrace collected from Chitwan was preferred by farmers for its adaptation in low fertility and poor management conditions. The crop matures within 80 days of sowing. In a reasonably fertile soil, it is possible to grow mungbean after buckwheat, thus tripling the cropping intensity with rice-buckwheat-mungbean.
- **Adaptive demonstration on niger.** It can be successfully grown in low fertility conditions, provided planting is done immediately after the harvest of early maturing rice by the end of September. Some farmers have preferred this crop.
- **Integrated nutrient management on chickpea and field pea.** Supplementation of boron either as a basal application or foliar spray significantly increased yield (28%) of chickpea. Four sprays with cattle urine at 20%) concentration resulted in 11 and 27% increase in the yields of chickpea and field pea.
- **Seed priming on mungbean, chickpea and field pea.** Soaking seeds in sodium molybdate solution (containing 0.5 g sodium molybdate/liter of water) significantly increased nodulation and yield (23%) in mungbean. Preliminary results are promising in chickpea and field pea and need further verification.
- **Pod borer management in chickpea.** NPV has been found as effective as endosulfan in suppressing pod borer. Efforts are underway to recycle NPV at local levels.
- **Seed production.** Testing and seed production of crop varieties are ongoing.

Project impact

A cursory survey in the project area of Nepal two years after the project intervention showed that nearly two-thirds of the fallow area has been brought under winter and summer cultivation. Some farmers have entirely grown crop varieties introduced by the project.

Overall systems productivity in rice fallows has increased substantially with 20 to 30% more yield with new rice varieties and average production of 0.3 to 0.5 t/ha of winter or summer crops.

The challenges that remain

- BGM and pod borer in chickpea
- Terminal drought and westerly dry wind leading to premature senescence of winter crops
- Erratic and unpredictable rainfall
- Low soil fertility
- Free-grazing system
- Tenancy system
- 'Dependency syndrome' among community members

Lessons learned

- Rice fallows present a complex problem that demands a holistic approach and plurality of efforts. The multi-stakeholders approach is required to address the situation.
- Working from the agroecosystems perspective is essential to increase systems productivity and sustainability. The component crop approach of research and development by itself may not lead to sustainable outcome.
- Local empowerment is the key to lasting impact on the livelihoods of farmer communities.

References

Bourai VA, Joshi KD and Khanal N. 2002. Socio-economic constraints and opportunities in rainfed rabi cropping in rice fallow areas of Nepal. Patancheru, Andhra Pradesh, India: ICRISAT.

CSD. 2000. Ecological and socio-economic foundations for defining best practices for sustainable agriculture and rural development (SARD). Agriculture Dialogue Paper 3. United Nations Commission on Sustainable Development (CSD).

DFID. 1999. Sustainable Livelihoods Guidence Sheets. DFID, UK. Weblink:www.livelihoods.org/info/guidance_sheets_pdfs/section1.pdf.

Harris D, Joshi PA, Khan PA, Gothkar P and Sodhi PS. 1999. On-farm seed priming in semi-arid agriculture: Development and evaluation in maize, rice and chickpea in India using participatory methods. Experimental Agriculture 35: 15-29.

Harris D, Tripathi RS and Joshi A. 2000. On-farm seed priming to improve crop establishment and yield in dry direct-seeded rice. Paper presented at the IRRI-sponsored International Workshop on Dry-seeded Rice Technology, 25-28 January 2001, Bangkok.

Harris D and Kumar Rao JVDK. 2004. Rainfed *rabi* cropping in rice fallows - Chickpea in Eastern India. A development brief prepared by the Centre for Arid Zone Studies, University of Wales, UK; Catholic Relief Services, India; Gramin Vikas Trust, India; ICRISAT, India. 7 pp.

Johansen C and Musa AM. 2004. Rainfed cropping in the High Barind Tract. Paper presented at the Review and Planning meeting of the DFID/PSP Project R8221 on Promotion of rainfed *rabi* cropping in rice fallows of eastern India and Nepal, 7-9 June 2004, Bhubaneswar, Orissa, India.

Johansen C, Musa AM, Kumar Rao JVDK, Harris D, Ali MY and Lauren JG. 2004. Molybdenum response of chickpea in the High Barind Tract of Bangladesh and in Eastern India. Pages 52-54, *in* Book of Abstracts - Micronutrients in South and South East Asia (Tuladhar JK, Karki KB, Anderson P and Maskey SL, eds.). International Workshop on Agricultural strategies to reduce micronutrient problems in mountains and other marginal areas in South and south east Asia, Kathmandu, Nepal, 8-10 September 2004.

Joshi PK, Birthal PS and Bourai VA. 2002. Socio-economic constraints and opportunities in rainfed rabi cropping in rice fallow areas of India. Patancheru, Andhra Pradesh, India: ICRISAT.

Kumar J, Rahman MM, Musa AM and Islam S. 1994. Potential for expansion of chickpea in the Barind regions of Bangladesh. International Chickpea and Pigeonpea Newsletter 1:11-13.

Kumar Rao JVDK, Harris D, Johansen C and Musa AM. 2004. Low-cost provision of molybdenum (Mo) to chickpeas grown in acid soils. Abstracts *in* CD of IFA International Symposium on Micronutrients, 23-25 February 2004, New Delhi, India. International Fertilizer Industry Association; email: publications@fertilizer.org; website: www. fertilizer.org.

Musa AM, Harris D, Johansen C and Kumar J. 2001. Short duration chickpea to replace fallow after Aman rice: The role of on-farm seed priming in the High Barind Tract of Bangladesh. Experimental Agriculture 37 (4):509-521.

Rahman MM, Bakr MA, Mia MF, Idris KM, Gowda CLL, Kumar J, Deb UK, Malek MA and Sobhan A. 2000. Legumes in Bangladesh. Pages 5-34 *in* Legumes in rice and wheat cropping systems of the Indo-Gangetic plain: Constraints and opportunities. (Johansen C, Duxbury JM, Virmani SM,Gowda CLL, Pande S and Joshi PK, eds.). Patancheru, Andhra Pradesh, India: ICRISAT and Ithaca: Cornell University.

Raisuddin M and Nur-E-Elahi. 1984. Technologies for low rainfall Barind Tract. Pages 107-118 *in* Proceedings of the 1st BRRI - Extension multilocation working group meeting on rice-based cropping systems, Joydebpur, Bangladesh. Joydebpur, Bangladesh: BRRI.

Saha AK. 2002. Impact assessment study for the DFID-funded project R 7540, Promotion of chickpea following rainfed rice in the Barind Area of Bangladesh. Consultant's Report. Limited circulation.

Subbarao GV, Kumar Rao JVDK, Kumar J, Johansen C, Deb UK, Ahmed I, Krishna Rao MV, Venkataratnam L, Hebber KR, Sai MVSR and Harris D. 2001. Spatial distribution and quantification of rice-fallows in South Asia - Potential for legumes. Patancheru, Andhra Pradesh, India: ICRISAT. 316 pp.

Session II: Scaling-up and Uptake Pathways

Lessons learned from scaling up participatory variety selection: LI-BIRD experiences

KP Devkota[1], S Gyawali[1], MP Tripathi[1], KD Joshi[2] and JR Witcombe[3]

Abstract

Local Initiatives for Biodiversity, Research and Development (LI-BIRD) is a non-governmental organization based in Nepal. LI-BIRD has a participatory and partnership-based approach, and works with agencies within and outside the country for the development, promotion and scaling up of methodologies, technologies, processes and programmes, and aims at producing outputs suitable for addressing local and regional situations. This paper describes the uptake pathways and lessons learned from scaling-up of participatory variety selection and policy implications of participatory research by national research and extension agencies.

Introduction

Participatory variety selection (PVS) is one of the approaches adopted to make popular new varieties. PVS research provides feedback on farmer-preferred traits that can be included in participatory plant breeding (PPB). This increases the efficiency of formal breeding programs in developing and popularizing varieties appropriate for resource-poor farmers. The multilocational trial system can be replaced by radically modifying their design without significantly increasing farmer participation. Alternatively, the problems can be addressed by introducing a major component of participatory varietal testing. Redesigning the trials by decentralization or increased farmer participation is the most efficient solution. Decentralization and increased participation benefit testing in various ways. They:

- help trial sites to better represent the crop area,
- allow better representation of the environments in farmers' fields,
- increase the reliability of trials,

[1]Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Pokhara, Nepal.
[2]DFID Plant Sciences Research Programme, CIMMYT South Asia Regional Office, Kathmandu.
[3]Centre for Arid Zone Studies, University of Wales, Bangor, Gwynedd LL57 2UW, UK.

- allocate resources more efficiently between varieties in different years of testing,
- allow varieties to be selected for specific adaptations and
- allow trade-offs between traits.

Further, increased participation aids speedy adoption of new varieties.

Decentralization or greater participation can provide solutions mainly by allowing more replication, particularly replication that increases the number of test sites. Adding more researcher-managed test sites in a decentralized testing program is expensive. Adding farmers in a participatory testing program is cheaper because there are many farmers willing to collaborate with minimal costs involved (Witcombe 2001).

Uptake pathways for PVS

Situation analysis and need assessment. Community meetings are organized to identify farmers' problems and needs in relation to their current crop varieties. Farmers may want to improve or change their current varieties. A separate group of farmers with good knowledge and skills in seed selection and management may also be used for formulating and deciding PVS activities. Documentation of local knowledge is done at this stage.

Search for genetic materials. Three sources of genetic material are used to obtain seeds for participatory selection of desired crop varieties.

- **PVS with improved local landraces:** The improvement of local landraces is done through mass as well as pure-line selection. Since the mass-selection method does not require very specialized skills, farmers have been able to undertake this selection after a simple orientation. The improved local landraces are then given to a large number of farmers within the community as PVS materials for their own testing and selection.

- **PVS with reintroduced local landraces:** PVS also reintroduces landraces from genebanks to the community when local materials have been destroyed by disaster. Local varieties collected from different locations within and outside of the community are evaluated in the community to give farmers more choices.

- **PVS with modern crop varieties:** Modern crop varieties from research institutions and finished products from PPB are also given to farmers for testing under farmers' own management and household requirements.

On-farm experimentation. The crop varieties preferred by farmers under the PVS program are then put into varietal yield trials in the community for farmers to observe directly and make selections of their choices. Common varieties in the community are used as local checks in these trials. Farmer field days are organized just before harvesting to bring farmers in the community to the trial plots for a joint evaluation of tested varieties. Preference/matrix ranking is done at this stage. Desirable varieties (usually two to three varieties) are then selected for seed multiplication.

Wider dissemination

Seed multiplication. Varieties selected by farmers from yield trials are distributed to a group of farmers who are particularly knowledgeable and interested in seed production, to multiply large quantities of seeds for use by other farmers in the community. Seed multiplication fields are closely monitored and used as final checks for large-scale production.

Monitoring. Field visits and farmer field days are the most appropriate tools for participatory monitoring and evaluation of PVS activities. Breeders, field staff, extension workers and farmers participate in such activities. Data collection depends on farmers' objectives and includes common traits such as growth duration, plant height, tillering capacity, grain yield and quality, and tolerance to insects and diseases. Experience sharing, training, farmers' field days, field visits, Integrated Pest Management and ecological pest management are often included in the PVS process.

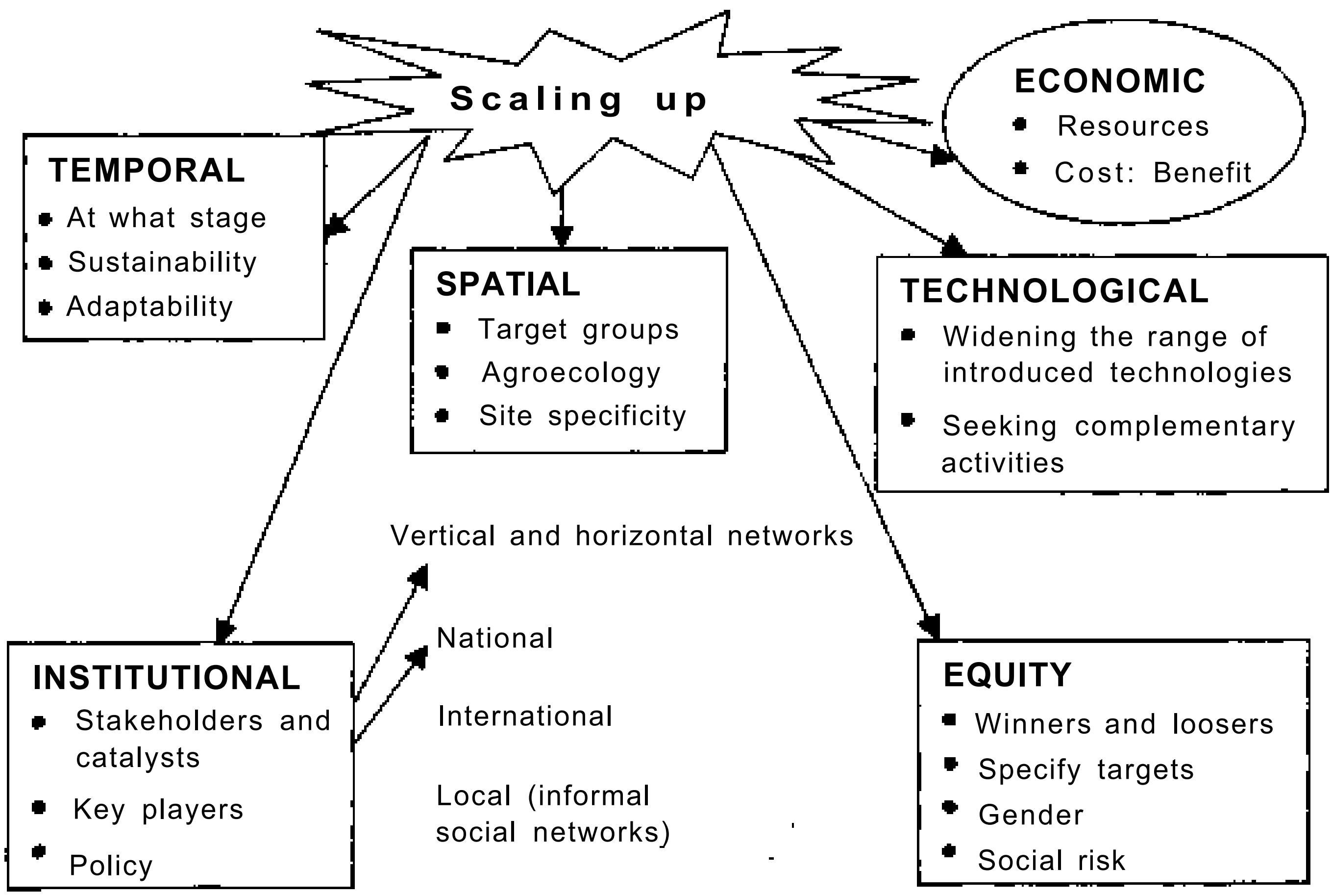


Fig. 1. Model for scaling-up of PVS-PPB activities.

Lessons learned

1. Strategic partnership

Scaling-up is a three-dimensional process. There are systems for sustainable collaboration and partnership, systems for adaptive learning and systems for extension of innovation. To do this, LI-BIRD is working in partnership with various partners with a participatory approach (Fig. 2). LI-BIRD has developed linkages with different District Agriculture Development Offices (DADOs) from the eastern Terai to the far-western Terai and mid-hill districts to test and spread PVS-PPB technologies effectively.

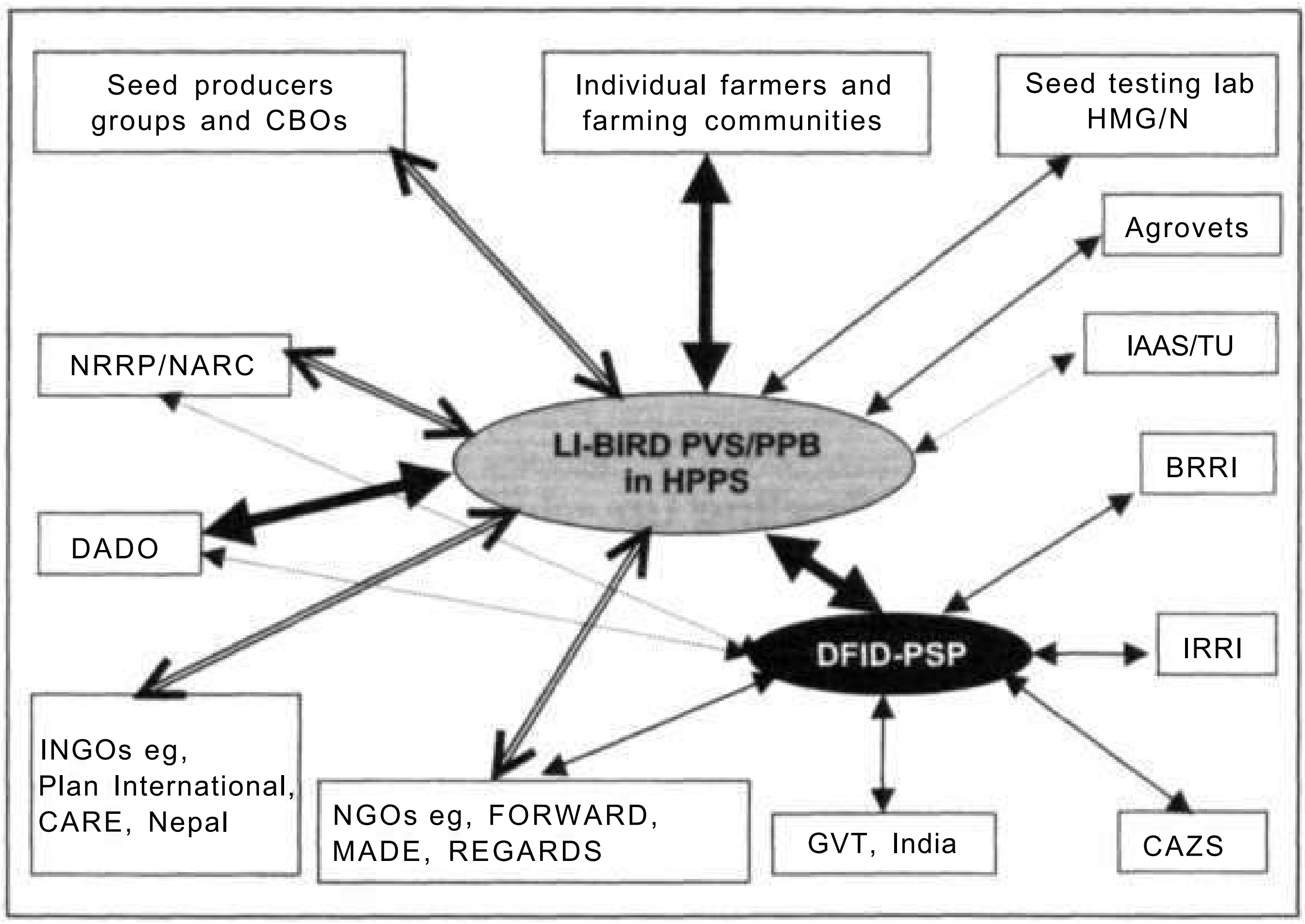


Fig. 2. Degree and mode of partnership adopted in PVS-PPB.

What is needed?

- Expand and strengthen links amongst institutions and organizations with complementary agendas, expertise, resources and reach (which is akin to the 3M model, ie, multi-sectoral, multidisciplinary and multi-stakeholders).
- Improve the efficiency and effectiveness of partnership mechanisms.

2. Learning from success and failures

LI-BIRD conducted PVS initially in two districts in 1997. After the success of PVS-PPB technology, this was scaled up to seven districts in 2001 to 19 districts in 2002. After the institutionalization of the participatory approach, this approach was further scaled up to 29 districts of Nepal in 2003 (Fig. 3).

Thus, we learnt that for successful scaling-up of PVS-PPB it is essential to *enhance analytical and systematic learning about the performance of PVS-PPB varieties and the process associated with scaling-up from the perspective of experiences.*

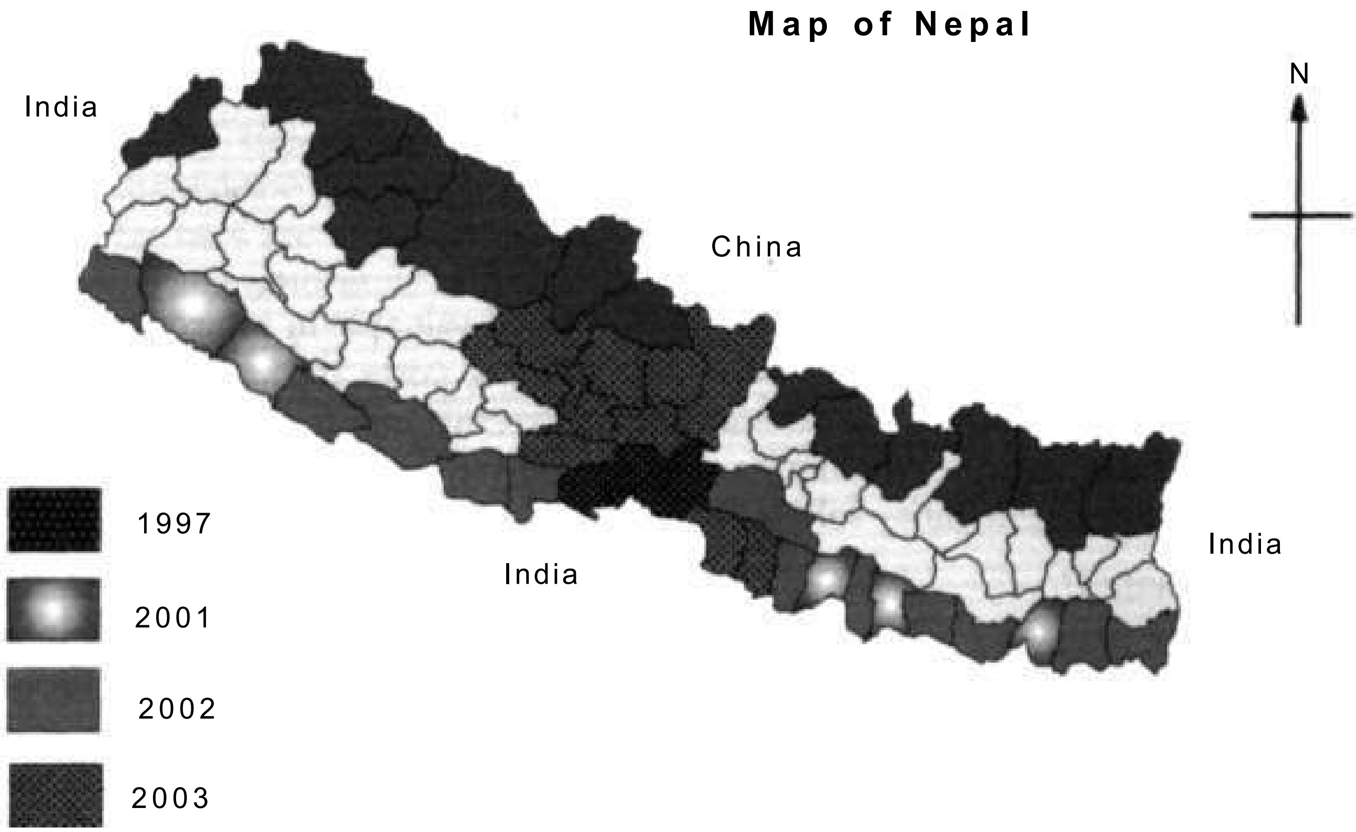


Fig. 3. Year-wise growth of PVS-PPB activity by districts in Nepal, 1997-2003.

3. Available germplasm

Farmers have their own adaptive and integrated *in situ* management systems for plant genetic resources (PGR) whereby the formal PPB adds the genetic resources through *ex situ* PGR management system. In Nepal, more than 90% of seed is supplied through the informal systems in terms of seed saved, seed exchange with friends, relatives or via merchants (Baniya et al. 2000). The major thrusts from LI-BIRD go to strengthen local plant genetic resource systems and establish the multidirectional flow of genetic materials within and across local and formal PGR systems. The breeding and non-breeding approaches have been employed to enhance the conservation process.

LI-BIRD has developed and promoted several new rice varieties from different sources like National Rice Research Programme (NRRP), Institute of Agriculture and Animal Science (IAAS) Nepal, different Indian universities, promising farmers landraces, International Rice Research Institute (IRRI) Philippines and output from its own PPB program to enhance livelihoods and conserve agro-biodiversity.

What is needed?

- Enhance timely availability of quality germplasm to meet farmers changing needs.
- Analyze and compare the processes and cost-effectiveness of different methods of supplying and producing germplasm (1kg vs 2kg IRD sets, mother baby trial, IRD vs FAMPAR and DADO etc).
- Build the capacities of development partners, farmers and farmers groups to produce and disseminate or diffuse quality germplasm.

4. Technology options

Farmer assessment of various experiments proved valuable in improving their livelihoods. This was achieved either by reducing costs through the use of cheaper local inputs, reducing dependence on external inputs or by introducing new germplasm into the production system. On-farm experimentation meant that they started to identify solutions to related problems.

What is needed?

- Identify existing technical options that are likely to be appropriate in a defined and characterized project area for farmer experimentation, adaptation and adoption.
- Define the social, economic and biophysical boundary conditions (recommendation domains) of new potential PVS-PPB innovations.

5. Farmer-centered research and extension approaches

What is needed?

- Conduct participatory research, in collaboration with development partners, to determine the adoption potential of PVS-PPB innovations.
- Build the capacity of farmers and communities through participatory research, so they may become agents of change and take over some functions of existing research and extension bodies.

6. Knowledge/information sharing

What is needed?

- Ensure informed, effective and appropriate decision making by a wide range of stakeholders in the scaling-up process through sharing of knowledge and information.

7. Strengthening capacities of local institutions and nodal farmers

The majority of farmers showed keen interest in experimenting, monitoring progress and assessing results. They organized themselves in groups to share and discuss the results and the process of conducting new experiments. A major attraction for both individuals and groups was having the opportunities to compare the different options and this creates learning moments. It strengthened the farmers' confidence in their own ability to find solutions. The more farmers are exposed to scientific activities, the more they are able to develop their innovative skills and knowledge.

What is needed?

- Create broad-based support and effective local institutions such as the community-based seed production system for scaling-up PVS-PPB technologies by empowering farmers and local communities.

8. Facilitation

LI-BIRD has established collaborations with national and international research, teaching organizations and extension systems for scaling up PVS-PPB technologies. Flow of genetic material was developed through PPB-PVS between DOA, NARC, 1/NGOs, universities and international research institutes such as CAZS, IRRI and BRRI. PPB products like Sugandha 1 and Judi 582 were found promising by BRRI. Gramin Vikash Trust (GVT) has already included Sugandha I in its variety release process in India.

What is needed?

- Mobilize existing and external expertise and resources to support the scaling-up process.
- Assist the coordination and integration of the scaling-up process within and between countries and regions.
- Ensure the sustainability and multiplier effect of scaling up through the empowerment of local institutions.

9. Policy options

Participatory approaches for technology generation, verification and dissemination have been adopted simultaneously to enhance Nepal's research and extension efficiencies at all levels. Among lessons learnt:

- Favorable policy climate is essential for the scaling-up, adoption and impact of PVS-PPB activities and methodologies by farmers, CBOs, GOs and I/NGOs.

10. Market options

What is needed?

- Build capacity of local institutes and develop strategic partnerships in marketing.
- Improve marketing information systems, define successful marketing strategies and product development plans, and help develop an enabling policy framework.

Policy implications of participatory research

Government bureaucracies should integrate participatory research and development approach in their regular program due to the following reasons:

- Government bureaucracies are more concerned with their continued survival than meaningful addressal of demand-driven, client-oriented problems.
- International aid communities have been instrumental in stimulating a growing interest in participatory approach on the part of governments in developing countries.
- Recognition of failure of past research and development approaches is why government agencies have included participatory research in planning.
- The successful application of participatory approaches by other organizations has been convincing.

Some key strategic elements for successful scaling-up

- Every research and development worker must always consider three dimensions of scaling-up, viz, systems for sustainable collaboration and partnership, systems for adaptive learning with the participatory approach and systems for extension of innovations.
- Funders and donors must give priority to projects and programs that focus more on ideas, leadership, appropriate strategies and participatory approaches.

- Research needs must be placed in the context of local, regional and national development agendas as this helps identify key entry points and major needs that must be addressed.
- Appropriate research objectives and outputs within the development process must be identified to ensure widespread uptake.
- Indicators of planning, monitoring and evaluation methods must be identified to measure the impact of scaling-up.
- Networks and partnerships must be built to increase local ownership and to clear pathways to scaling-up, capacity building, so that institutional systems may be sustained and replicated.
- Appropriate financing mechanisms must be developed to sustain capacity for expansion and replication.

Acknowledgements

This document is an output from the projects R 7542 and R 8071 funded by the United Kingdom's Department for International Development - Plant Science Programme (DFID-PSP) for the benefit of developing countries. The views expressed here are not necessarily those of DFID. The authors would like to thank all participating farmers, DADOs, NRRP/NARC partners and LI-BIRD staff for their contribution to these innovations.

Reference

Baniya BK, Subedi A, Rana RB, Poudel CL, Khatiwada SP, Rijal DK and Sthapit BR. 2000. Informal rice supply and storage systems in the mid-hills of Nepal. *In* A scientific basis of in-situ conservation of agro-biodiversity on farm: Nepal's contribution to the global project (Sthapit BR, Upadhaya MP and Subedi A, eds.j. 79-91 pp.

Witocmbe JR. 2001. Participatory Variety Selection in high potential production systems. Pages 19-27 *in* Proceedings of a Workshop - An exchange of experiences from South and Southeast Asia: International symposium on participatory plant breeding and participatory plant genetic resource enhancement. PRGA, IDRC, DFID, DDS, LI-BIRD, IPGRI, ICARDA.

Scaling-up of participatory variety selection in wheat in South Asia: The CIMMYT-NARS experience

G Ortiz-Ferrara[1], AK Joshi[2], A Mudwari[3], MR Bhatta[4], S Souffian[5] and JR Witcombe[6]

Traditionally, wheat researchers have not been encouraged to interact with farmers. However, participatory research methods are making them realize that farmers' input helps them target their efforts better, ensuring the development of relevant technologies that will help lift resource-poor farmers out of poverty.

At a meeting of three farmer groups in Lele, Lalitpur district, Nepal, the farmers, mostly women, talk about their experience with newly introduced wheat varieties, which they had previously chosen through participatory varietal selection (PVS). "We've gotten a 100% increase in yield-from one ton to two," says Mrs Saru Godar, head of one of the farmer groups, "mostly because the new wheats germinate better and are resistant to diseases like rusts and foliar blights."

Other women hasten to point out that two tons is very good on their tired soils, and that now they work half as much because the new wheat varieties are easier to harvest and thresh. They also note that the new wheats make savory chapati and roti (local flatbreads). As the session continues, the participants go on to discuss problems they are facing and possible solutions. For example, due to the soil type in this region, they have to break up clods of soil by hand after plowing, or the clods will limit nutrient absorption. "Our group is planning to buy a tractor and a power tiller to break the clods. This will allow the soil to absorb the compost we apply, and our yields could go up to perhaps three tons," says Mrs Maya Devi Silwal, leader of another group of farmers.

Listening attentively are Guillermo Ortiz-Ferrara, regional wheat breeder and Coordinator of CIMMYT's South Asia Regional Office (located in Nepal), and Binod Sharma, head of extension at the Agriculture Development Office (ADO) in Lalitpur district. They like what they hear. "PVS is a new approach

[1]CIMMYT-South Asia, Nepal.
[2]Banaras Hindu University, Varanasi (UP), India.
[3]Botany Division, NARC, Nepal.
[4]National Wheat Coordinator/Sr. Wheat Breeder, NARC, Nepal.
[5]Wheat Research Center, Nashipur, Bangladesh.
[6]Center for Arid Zones Studies, University of Wales, Bangor, UK.

for ADO, but we think it should be applied to other crops in other areas of Nepal. PVS empowers farmers and makes them want to participate more in this type of research," comments Sharma. "It's a team effort by researchers, extension agents, and farmers. With PVS there's less chance of failure and more accountability."

PVS is taking off in South Asia

This session is one of many farmer/extension/researcher interactions occurring in South Asia as part of a regional project on farmer participatory varietal selection coordinated by CIMMYT, and until recently, funded by DFID-UK. Now in its sixth year, the project aims to replace the old wheat varieties farmers are sowing with new, high yielding and disease-resistant wheats, mainly to prevent disease epidemics. Should these diseases gain a foothold in the region, they could prove disastrous to millions of farmers. The project, led by Ortiz-Ferrara, involves Bangladesh, India, Nepal, and Pakistan. In each country, work is conducted in partnership with the national agricultural research system (NARS). For the last two years, DFID-UK has been funding the project's activities. This has allowed the expansion of activities to other more remote areas of the country. It has also allowed the active participation of other stakeholders including farmers groups, NGOs, ARIs, public and private seed agencies, the RWC and other sister CGIAR Centers.

In Nepal

In Nepal, PVS activities are being conducted in three districts within Kathmandu Valley: Bhaktapur, Kathmandu and Lalitpur. In Lalitpur, extension services headed by Sharma are collaborating closely with Ortiz-Ferrara. A major partner in this project is the Nepal Agricultural Research Council (NARC). Other important collaborators include CEAPRED and LI-BIRD, two agricultural NGOs working in the area. The Center for Arid Zones Studies (CAZS) of the University of Bangor, UK, the Rice Wheat Consortium (RWC) as well as other CGIAR Centers such as ICRISAT are important partners and have provided valuable input in the project.

In the village *of* Siddsipur in Lalitpur, Bala Ram Maharjan leads a farmers' group made up mostly of men. The population here is of a different ethnicity than that of the neighboring villages: 99% belong to the Newari tribe. This is a male-dominated society, where women stay at home and men do most of the field work. Even so, the women do participate in PVS.

These farmers were motivated to take part in PVS when they saw the benefits being reaped by the initial group of participants, who harvested 150% more grain by sowing the new disease-resistant varieties BL1813 and BL1473 and by using the recommended cropping practices.

The Siddsipur farmers are very enterprising: they are planning to buy a Chinese hand tractor (CHT) (for which they already have half the money) and a power tiller to reduce the labor invested in tilling and planting. These machines have been demonstrated by RWC-CIMMYT staff and they do everything in one pass, compared to as many as 10-14 passes by farmers with draft animals. This could reduce farmers' production costs by 30-40%.

Researchers from CIMMYT play an important role in advocating for farmers' issues vis-a-vis the government. Specifically, Ortiz-Ferrara is trying to persuade the Ministry of Agriculture and other decision makers in Nepal to lift the ban on the Chinese hand tractor in Kathmandu Valley. The government used to subsidize CHT for agricultural uses, but people abused this by using the machine for things like transportation; hence, the ban. If the ban is not lifted, Siddsipur farmers will not be able to buy the CHT they so badly need.

In Varanasi, India

In Varanasi, Uttar Pradesh, India, the predominant farming system is the rice-wheat rotation system. Five years ago, a research team of Banaras Hindu University (BHU) comprising Dr AK Joshi, breeder, Dr Ramesh Chand, pathologist, and Dr VK Chandola, agriculturalist and water and machine specialist, started applying PVS as a way to convince farmers to try new varieties and agronomic practices.

Before PVS, the closest contact the team had had with farmers was through on-farm trials, in which farmers would test a particular technology as directed by the researchers. However, in PVS (a concept suggested to them by Ortiz-Ferrara) researchers have direct, two-way communication with farmers. They go into farmers' fields to hear what their problems are and, later, what they have to say about the new technologies developed by the researchers once they have tried them. Before PVS, many researchers were somewhat apprehensive about such interaction since farmers might take them to task if a given technology did not work. Breeders, for example, ended their involvement once a new variety was developed and left technology transfer to the extension agents.

In close collaboration with Ortiz-Ferrara, the team in Varanasi set up PVS trials in a few villages. Says Joshi, "We started building friendship bridges between us and the farmers, setting up linkages aimed at giving them options." The team asked the farmers to compare a technology package that included several new wheat cultivars and zero-tillage to their favorite variety, HUW234, and conventional tillage, their usual practice. Farmers had been growing HUW234, an old improved variety, for several decades. To make it possible for them to zero-till, the team obtained five specially adapted planting machines from the Indian Council for Agricultural Research (ICAR) and the Directorate of Wheat Research (DWR), two other important partners in the project.

Though early maturing and heat tolerant, HUW234 yields 2-3 t/ha, which is not as much as more modern wheats. Nevertheless, it is very popular among farmers, who really like its "bold" (large) grain. In many places, HUW234 has come to cover as much as 90% of the total wheat area, which puts the region at very high risk for a widespread wheat epidemic if HUW234's disease resistance breaks down. An epidemic of such proportions could provoke devastating production losses that would drastically affect millions of people's food security.

During the PVS trials, farmers easily identified two wheat varieties that they liked better than their old one: HUW468 and HUW 516, which produce large grain and are as early maturing as HUW234, but have the potential to produce far more (5-6 t/ha). As for zero-tillage, farmers discovered that they could plant wheat 20 days earlier because of the time they saved on field preparation, and reduce the number of passes with the plow to just one. The earlier they planted the better the wheat yields, given that as much as 38 kilograms of wheat grain per hectare can be lost for each day that sowing is delayed in this tightly rotated cropping system.

To further shorten the turn-around time between the rice harvest and wheat sowing, the researchers suggested switching to an earlier maturing rice variety and sowing it 15 days earlier than usual. By applying this combination of technologies, farmers were able to increase their yields considerably (30-50%) and at the same time reduce labor and production costs.

The information exchange through PVS facilitated farmers' adoption of the new technologies so greatly, it was an eye-opener for Joshi, Chand and Chandola. Based on feedback from farmers, they were able to propose more relevant solutions to local problems. The farmers, in turn, were more willing to try the proposed solutions and, as they observed the positive results in their own fields, came to trust the researchers more. As word of the benefits of PVS spread, the team was able to set up similar trials in other communities. Soon the researchers were working 365 days a year to keep up with farmers' demand for new technologies through PVS. Currently their goal is to bring a whole range of new varieties and zero-tillage to all areas of the vast region they cover.

"Farmers have gained much confidence in themselves working through PVS," says Chand. "As for us, instead of telling farmers to just take a technology, our message now is 'Take only what's good, what suits your needs.'"

The team likes to tell about Anil Singh, who lives in Karhat, a tiny village in Mirzapur district in eastern Uttar Pradesh that had been largely bypassed by modern agricultural technologies. In this extremely poor community, people on average harvested only two tons or less of wheat grain per hectare. Shortly after participating in a PVS exercise, where they selected wheat varieties that best suited their needs, Karhat farmers began sowing the new varieties and applying conservation techniques such as zero tillage and direct seeding. With the combined use of these technologies, farmers in the area are now getting yields of 4-5 t/ha.

Some of them, like Anil Singh, were trained by the team to produce wheat seed and are now doing very well supplying quality seed to other farmers and even private seed companies. In particular, Anil Singh's seed is of such high quality that private companies are willing to pay 10-15% more for it, which they later sell as their own. Singh has become a huge success only five years after he started applying the new technologies.

Chand, Chandola and Joshi become very enthusiastic when narrating their experiences. "We've had close to a 100% success rate with the technologies we promote thanks to PVS," says Chand. Adds Chandola, "We're involved in many projects, but none is as successful as this." Joshi finishes, "It's beyond imagination!"

The team gives high marks to Ortiz-Ferrara for introducing and promoting PVS. "Our entire institute has adopted the concept of establishing direct contact with farmers, in every crop, not just wheat," they say. "Today, farmers and researchers are together, members of the same club."

In Bangladesh

Currently the biggest concern for national wheat researchers in Bangladesh is that just one variety, Kanchan, released in 1972, occupies about 70% of the country's wheat area. This represents a risk to everyone who sows it, since the wheat crop would be left unprotected if Kanchan's genetic disease resistance fails. In fact, Kanchan has become susceptible to potentially serious diseases such as leaf rust and foliar blight, so the risk of a devastating epidemic is all too real-hence the urgency of replacing Kanchan.

A few years ago, researchers at the Wheat Research Center (WRC) lead by Dr S Souffian, set out to replace Kanchan with four new wheats (all of them CIMMYT-derived) that are high yielding and have good resistance to multiple diseases, but they knew that it would be difficult to get farmers to adopt them. They had heard about PVS through Ortiz-Ferrara, and it struck them as a very promising way to introduce the new varieties to farmers.

As was explained to them by Ortiz-Ferrara, in PVS researchers and extension agents work very closely with farmers, who are presented with an array of new technologies (varieties, farming practices, etc.) during field demonstrations. The trials also include the farmers' current wheats and practices for comparison. Participants in PVS come together during a field day to observe the results and express their views of the alternative technologies. Researchers gather this information in a quantitative way (through questionnaires) and make sure farmers are supplied with seed of their chosen varieties to sow in the next cropping cycle. Training in the use of new agronomic practices is also provided.

With Ortiz-Ferrara's technical help, and with funds provided by DFID-UK, the Bangladeshi team initiated PVS in four locations with farmers from eight villages. In the first year, farmers identified several varieties they preferred over their beloved Kanchan, for they were resistant to leaf and foliar blight, yielded 20-25% more and proved to be well adapted to their conditions. The researchers are now in the process of obtaining sufficient seed of these varieties to distribute to farmers in the coming season. Next year they plan to repeat the experience in other locations.

Regional collaboration

Bangladesh, along with India, Pakistan and Nepal, is part of the Rice-Wheat Consortium, a regional initiative coordinated by CIMMYT. The Bangladeshis emphasize that the four countries have excellent regional collaboration, for researchers routinely exchange germplasm and visit each other. "None of this would be possible without CIMMYT. Our governments allow us to visit each other because it's CIMMYT who's convening, and they know and trust CIMMYT," says Dr Souffian, Director of Bangladesh's WRC. "Furthermore, we don't usually exchange materials directly among ourselves; for the most part it's done through CIMMYT"

Since Ortiz-Ferrara came to the region eight years ago, he organized and initiated the Eastern Gangetic Plains Yield Trials (EGPYT) and the Eastern Gangetic Plains Screening Nurseries (EGPSN), a regional network for the exchange of germplasm and information. This network is jointly handled by NARC-Nepal and CIMMYT. "Through these nurseries we get materials that are better adapted to our conditions," says Dr Pandit, a senior wheat breeder at WRC.

The Bangladeshis are highly appreciative of CIMMYT's many contributions, but make special mention of the training courses imparted at CIMMYT Headquarters in Mexico. Adds Souffian,"Our scientists learn new ways of working and a different mindset during their stay in Mexico, and the increased confidence they acquire as a result of their training is noticeable when they return. We want to emphasize that it's absolutely essential that these courses continue to be available to our people."

The scaling-up process and outputs of participatory crop improvement in Nepal: Adoption and impact

KD Joshi[1], KP Devkota[2], S Gyawali[2], MP Tripathi[2] and JR Witcombe[3]

Abstract

Participatory crop improvement (PCI) for new varieties and crops and their scaling-up in Chitwan and Nawalparasi started in 1997. LI-BIRD, an NGO, implemented the project jointly with the Centre for Arid Zone Studies (CAZS), University of Wales, Bangor The United Kingdom's Department for International Development - Plant Sciences Research Programme (DFID-PSP) provided funding. Initially the project was implemented in a few villages of Chitwan and Nawalparasi. The project used a participatory approach in technology identification, verification and scaling-up using farmer level inputs on crop management. This appeared very appealing to many government line agencies, non-government organizations and policymakers. This paper describes some of the processes and outputs of the PCI project that have had significant impact both on the peoples' livelihoods and also in influencing the crop improvement approaches and regulatory reforms in Nepal.

Introduction

The participatory crop improvement concept includes participatory varietal selection (PVS), client oriented breeding (COB) or participatory plant breeding (PPB) and participatory agronomic interventions. The PVS approach involves mother and baby trials and informal research and development (IRD). The mother and baby trials are more of research tools meant to generate both quantitative and qualitative data while IRD is an extension approach widely used for participatory scaling-up. The participatory crop improvement (PCI)

[1]Centre for Arid Zone Studies, CIMMYT Regional Office, PO Box 5186, Kathmandu, Nepal.
[2]Local Initiatives for Biodiversity in Research and Development, PO Box 324, Pokhara, Nepal.
[3]Centre for Arid Zone Studies, University of Wales, Bangor, Gwynedd LL 57 2UW, UK.

project aimed to demonstrate that participatory methods are effective in high potential production systems (HPPSs) to increase cultivar diversity and variety replacement rates and to improve agronomic practices.

The process and approaches

Farmers' livelihood analysis

An extensive farmers' livelihood analysis (baseline survey) was conducted in 1997 before initiating project activities that covered nearly 1500 households in eight villages of Chitwan and Nawalparasi. This was important to have an in-depth understanding ofthe farming system, to identify collaborating farmers to serve as a baseline for monitoring changes after the intervention.

Programme implementation

PCI activities were implemented using three approaches:

(1) Farmer managed participatory research (FAMPAR); participatory varietal selection (PVS); mother and baby trials towards the later part of the study.

(2) Informal research and development (IRD)

(3) Participatory scaling-up

Although PCI activities were implemented in several crops, this paper shares experiences on rice, with examples from IRD and participatory scaling-up. Initially, project activities were implemented in 18 villages in Chitwan and Nawalparasi (Fig. 1). Regular crop monitoring visits were organized and important stakeholders, eg, representatives from District Agricultural

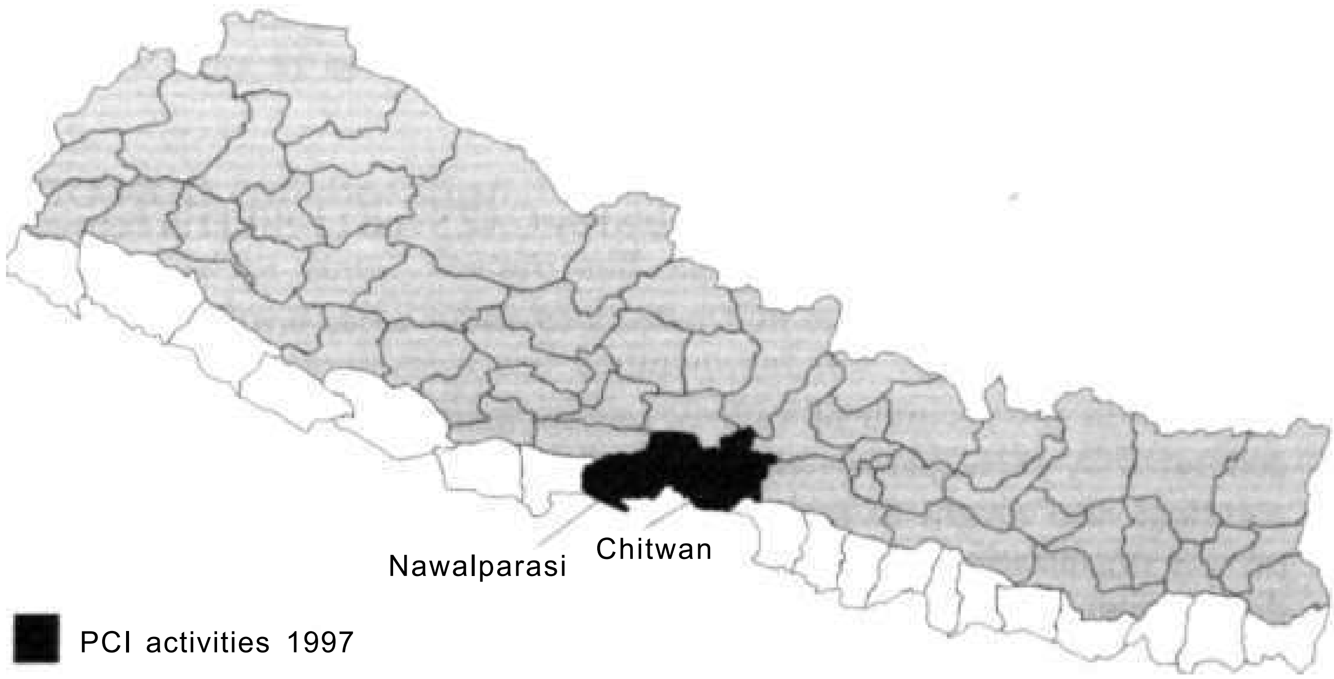


Fig. I. PCI activities started in 1997 in Chitwan and Nawalparasi districts.

Development Offices (DADOs) for Chitwan and Nawalparasi, Department of Agriculture (DoA), Nepal Agricultural Research Council (NARC), other non-government organizations (NGOs) and private organizations (POS) were invited. The PCI initiatives led to several innovations.

Government-non-government partnerships

As a result of visits and other informal interactions, DADO, Chitwan, bought and distributed farmer-preferred rice varieties identified by PCI (unreleased) using their own funds. After this informal collaboration for over a year, DADO, Chitwan, and LI-BIRD formally signed a letter of agreement (LoA) in 2000 initially for three years to scale up PCI technologies throughout the district with agreed roles and responsibilities (Joshi et al. 2003). This collaboration is also noteworthy in that the initiative actually came from the government rather than from LI-BIRD.

NGO-CBO partnerships

Another important form of collaboration emerged between LI-BIRD and other community-based organizations (CBO). Institutional flexibilities that existed in both types of organizations helped make the system very dynamic. LI-BIRD signed three separate LoAs with three CBOs in Nawalparasi, one of which was formed by the DADO office (Joshi et al. 2003). The purposes of these collaborations were also participatory scaling-up of PCI identified crop varieties. The financial support for all these collaborations came from the United Kingdom's Department for International Development - Plant Sciences Research Programme (DFID-PSP) through the Centre for Arid Zone Studies (CAZS).

Stakeholder meetings

Stakeholder meetings were jointly organized by CAZS and LI-BIRD in February 2001 with two main objectives:

1. To reach the findings of the PCI project to wider areas involving multiple partners,
2. To work on the revision of varietal release formats so as to include data generated by participatory trials and other forms of experimentation. The meetings also sought to make the provisions flexible so that NGOs and private organizations could participate in crop improvement research and development in Nepal.

By the end of the meeting, two separate working groups were setup: the fundraising group and the variety release procedure review group. The first was to look into aspects of fundraising for scaling-up PCI products and the other was to look into various aspects of variety releasing procedures and recommend appropriate suggestions to the National Seed Board (NSB) for revising the formats in line with the new Agricultural Policy.

The fundraising group was successful in generating resources from the Agriculture Research and Extension Project (AERP) funded by the World Bank after several rounds of negotiations with the DoA. This led to the scaling-up of PCI outputs to four more districts (Fig. 2).

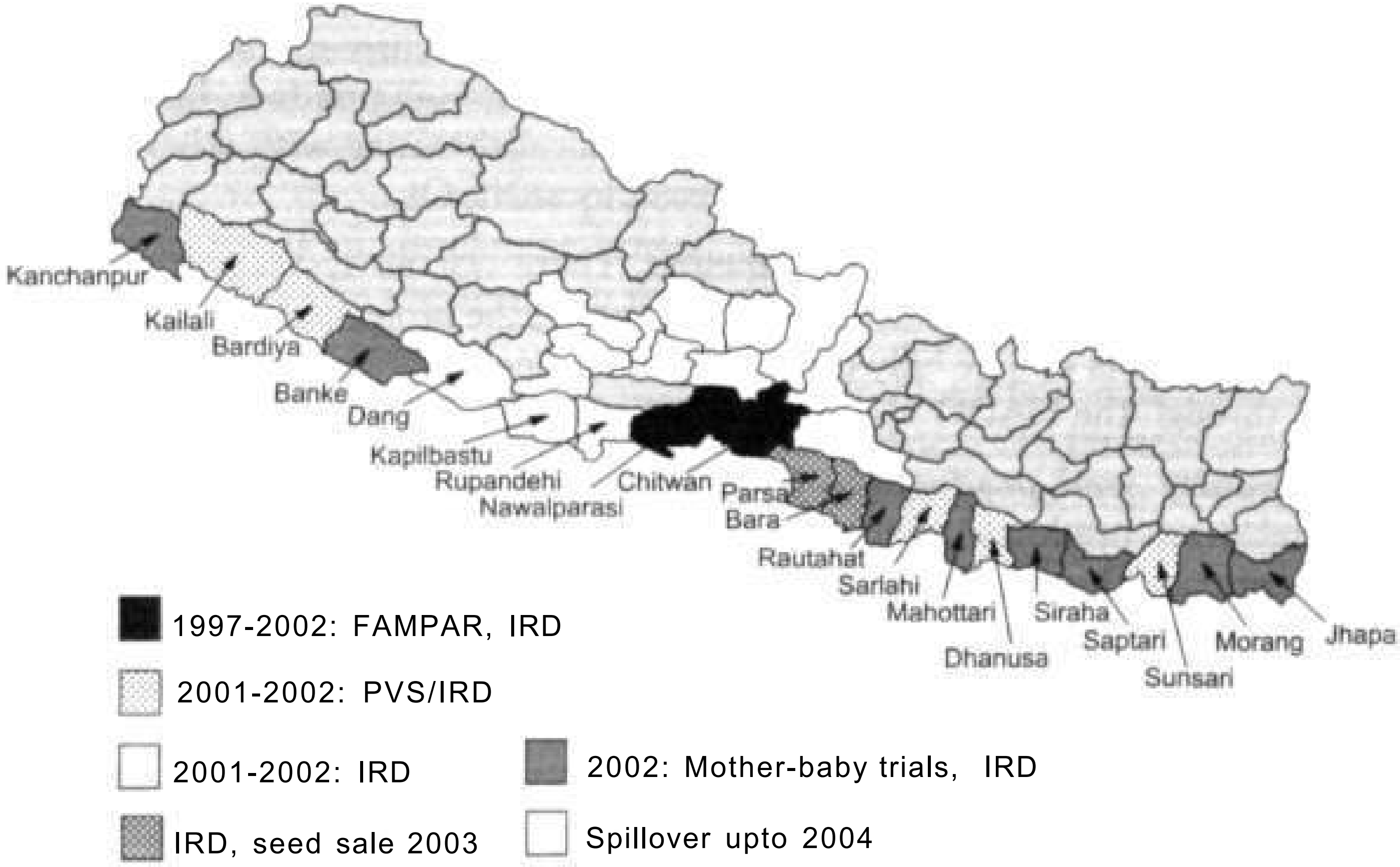


Fig. 2. Scaling-up of the process and outputs of PCI in Nepal, 2004.

NGO-NGO collaboration

The Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) is an NGO that has been collaborating with LI-BIRD since 2002 for participatory evaluation and scaling-up of rice varieties identified by PCI or bred by client oriented breeding (COB) outputs in six districts. This is a unique collaboration where one NGO complements the other for research and development initiatives.

Linkages with more organizations

A workshop was jointly organized by DoA and LI-BIRD in January 2002 to share findings from the six collaborating DADOs. Representatives from seven

DADOs also participated and developed seven project concept notes for the scaling-up of PVS and PPB produced varieties. The possibility of incorporating the plan into the regular planning processes of DoA to attract regular funding was discussed. Some of the DADOs had already incorporated this in their regular plan indicating greater acceptance and uptake of the approach by the DoA.

A similar workshop was also organized in December 2002 to review the progress made in the 2002 rice season and also to plan for 2003. Representatives from 19 DADOs participated in the programme along with a few NGOs and INGOs.

Although the extent of activities differs greatly, currently activities have been extended to 20 Terai and 9 hilly districts. In these initiatives, LI-BIRD, in addition to working closely with DoA, is also collaborating with other NGOs, eg, CARE, PLAN International and several local NGOs.

Spillover to low hills and river basins. There was no systematic effort to scale up PCI outputs in the hilly areas. However, the project saw a spontaneous spillover to parts of nine hilly districts. PCI technologies are spreading to these areas through the DADO network, NGOs and informal farmer networks.

Community seed production. LI-BIRD and FORWARD are working with several seed producer groups in parts of several districts from Jhapa to Kanchanpur. There are now more than 11 functional seed producer groups producing over 150 tons of rice seed annually (including those varieties identified by PCI and recommended by NARC). This is one of the most important assets of participatory upscaling in terms of long-term sustainability.

Impact assessment in Chitwan and Nawalparasi

Studies in 58 villages of Chitwan and Nawalparasi indicated over 14% adoption of PCI varieties with 43-126% internal rates of return to investment on PVS (Witcombe et al. 2003) within the fifth year of the first PVS trials. Witcombe et al. (1999) in another study reported that the internal rate of return to the investment on PVS was between 47-70% after the fourth year of the first trials.

In the conventional systems, it typically takes about five to six years after release before appreciable adoption occurs (Morris et al. 1992). Rohrbach et al. (1999) while studying the Okashana 1 variety of pearl millet in Namibia reported 18 to 50% internal rate of return nearly eight years after release.

The cost effectiveness of participatory approaches is increased by the simultaneous testing and adoption of new technologies (Joshi et al. 2002). This overcomes the slow and hierarchical process of variety testing in the formal system (Witcombe et al. 1996, Joshi et al. 1997). When PVS methods are used, the time taken for benefits to show is reduced by almost half (Joshi et al. 1997).

Conclusion

Participatory approaches are simple, rapid and effective in providing a choice of technologies. They overcome the lag phase of conventional systems and are cost effective. Participatory scaling-up increases the chances of rapid adoption by improving the usual processes of the Transfer-of-Technology model.

Organoleptic and other physical quality screening by farmers before national disease nurseries, multilocational trials and variety release process increase the chances of acceptance of varieties promoted through participatory scaling-up. With this approach, there would be significant reduction in research time and costs.

Capacity building for farmers, support staff, researchers and development professionals in areas such as participatory research and scaling-up has been a regular activity throughout the project. These efforts are proving to be very fruitful in terms of developing critical mass for participatory research and scaling-up and make the approach much more sustainable. This needs further strengthening.

Community-based seed production and distribution is becoming increasingly reliable and has improved the access of new seed varieties to farmers directly in villages. This needs further strengthening and consolidation.

Policy discussion and decision is needed for integrating varieties identified by PVS and produced by PPB into the national system.

The PCI project is considered a success as it was based on the long-term knowledge and commitment of the Nepali staff and significant refinement of the approach due to overseas collaboration, particularly with Centre for Arid Zone Studies. The project really strengthened and scaled-up past efforts on participatory technology development (PTD) in Nepal by several organizations over time.

Acknowledgements

This document is an output from Natural Resources Systems Programme and Plant Sciences Research Programme (PSP) project R6748 and PSP projects R7542 and R8071, funded by the United Kingdom's Department for International Development (DFID). The views expressed are not necessarily those of DFID. The authors would like to thank all the participating farmers in several districts, DADO partners, NGO and INGO partners for their contribution in these innovations. The contributions of LI-BIRD staff who helped implement this research are also gratefully acknowledged.

References

Joshi KD, Subedi M, Rana RB, Kadayat KB and Sthapit BR. 1997. Enhancing on-farm varietal diversity through participatory varietal selection: A case study for *Chaite* rice in Nepal. Expl. Agric. 33:335-344.

Joshi KD and Witcombe JR. 2002. Participatory varietal selection in rice in Nepal in favourable agricultural environments-A comparison of two methods assessed by varietal adoption. Euphytica 127:445-458.

Joshi KD, Biggs S, Devkota KP, Gyawali S and Witcombe JR. 2003. Institutional innovations in the Nepal rice innovation system. *In* Proceedings of a Workshop on uptake pathways and scaling-up of agricultural technologies to enhance the livelihoods of Nepalese farmers. Kathmandu, Nepal: Hill Agriculture Research Fund (HARP).

Morris ML, Dubin JH and Pokharel T. 1992. Returns to Wheat research in Nepal. CIMMYT Economics Working Paper 92-04. Mexico: CIMMYT.

Rohrbach DD, Lechner WR, Ipinge SAand Monyo ES. 1999. Impact from investments in crop breeding: The case of Okashana 1 in Namibia. Andhra Pradesh, India: ICRISAT.

Witcombe JR, Joshi A, Joshi KD and Sthapit BR. 1996. Farmer participatory crop improvement I. Varietal selection and breeding methods and their impacts on biodiversity. Expl. Agric. 32:445-460.

Witcombe JR, Petre R, Jones S and Joshi A. 1999. Farmer participatory crop improvement. IV. The spread and impact of Kalinga III-A rice variety identified by participatory varietal selection. Expl. Agric. 35:471-487.

Witcombe JR, Joshi KD, Gyawali S and Subedi A. 2003. Participatory crop improvement in the low-altitude regions of Nepal; Impact Assessment Working Document: Version 5.3. Bangor, UK: CAZS.

Experiences of scaling-up: Nepal Agricultural Research Council

YN Ghimire[1], TP Pokharel[1], R Khadka[1] and D Gauchan[1]

Abstract

According to the preamble of the Nepal Agricultural Research Council (NARC) Act 1991, the objective of NARC is to conduct high-level studies and research on problems of the agriculture sector. However, the impact of NARC technologies depends on the scale of adoption by the farming communities and other stakeholders. Realizing this, NARC has modified the previous objective to include demand-driven technology generation and subsequently fitted it into uptake networks. This paper highlights some of NARC's present up-scaling programmes, experiences earned, NARC's strength in scaling-up, constraints and finally, policy and strategy needed for efficient scaling-up of agricultural technologies in the country.

Introduction

Chickpea is an important winter legume of Nepal and is mainly grown in the rice-based systems in the Terai region. It is considered poor man's meat and is grown in poor man's land ie, in rainfed areas. Research and development in chickpea in Nepal, therefore can address poverty reduction in the country. In spite of the more marginal benefit : cost ratio invovled in producing the crop, Nepalese farmers are very wary about it. The reason is the low risk bearing capacity of subsistence farmers. Area and yield trend of chickpea in Nepal from 1991/92 to 2002/03 has been given in Fig. 1.

If we can solve the problem of BGM disease and *Helicoverpa,* Nepalese farmers would benefit greatly from chickpea. In an attempt to do this, on-farm participatory research in grain legumes, particularly chickpea, was emphasized with the establishment of NGLRP at Rampur during the mid-1980s. Chickpea outreach research activity in NARC includes farmer field trials (FFTs), farmer acceptence tests (FATs), and Frontline demonstration by NGLRP and outreach research by NARC centers in their research sites in central, far western and western Terai districts of Nepal. Banke, Bardia, Sarlahi, Siraha are the main chickpea research areas in Nepal.

[1]Outreach Research Division, Nepal Agricultural Research Council, Kathmandu, Nepal.

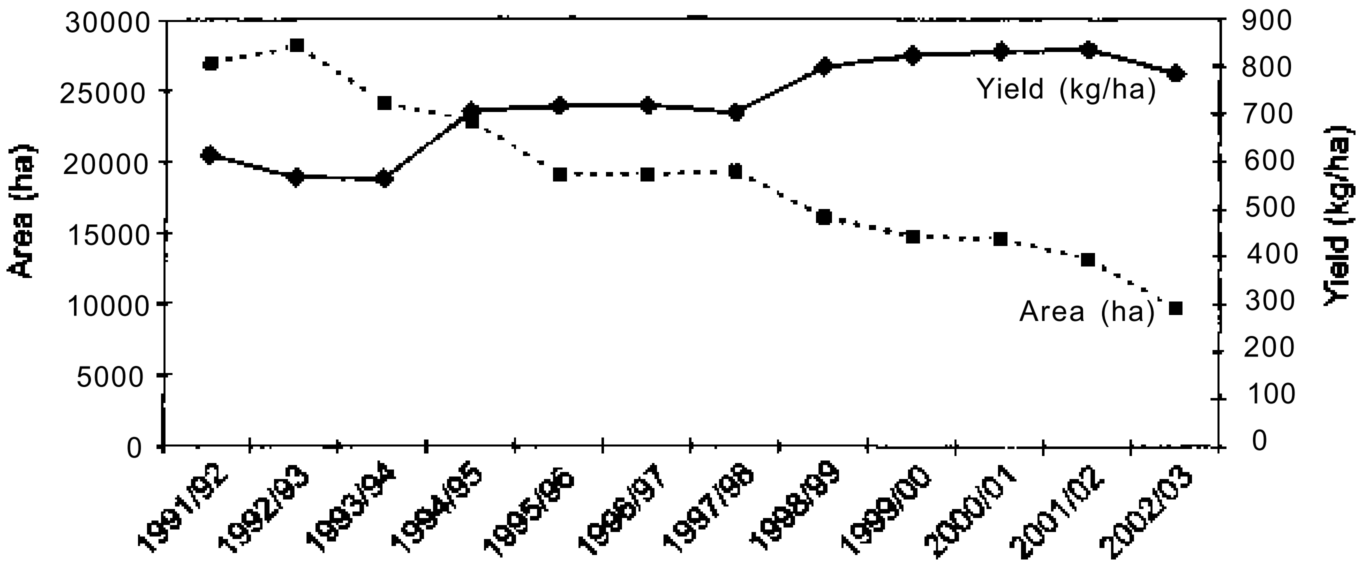


Fig. 1. Area and yield trends of chickpea in Nepal, 1991-2003.
Source: Statistical Information on Nepalese Agriculture 2003.

Research outputs differ for different types of research. Therefore, in order to study uptake pathways and scaling-up of agricultural technologies, research output may be classified into four categories: varietal development technologies, pest management technologies, agronomy and other crop management technologies, and finally resource conservation technologies (Ghimire et al. 2003).

Scaling-up of varietal development technologies

Since its establishment, NARC has been producing foundation seeds of released and pre-released varieties of crops from its regional and station offices. Generally, seed replacement at the annual rate of 20-25% is sufficient to maintain seed quality considering that seed needs to be replaced every four or five years. With the amount of foundation seed produced (provided full potential is exploited), the amount of C_2 (certified 2) seed that can be produced is seven times more than the total requirement in rice, 12 times more in maize, and 23% of the total requirement for wheat (Table 1), which is sufficient. For chickpea, 2.8 MT of foundation seed is sufficient for the current level of production. However, shortage of reliable seed (certified or improved) at sowing time is common in Nepal.

District level governmental organizations (GOs) and non-governmental organizations (NGOs) demand foundation seeds of different crops each year from different research stations. Some portion of it is used in seed production. However, significant part of such seed goes to minikit packets and distributed to the farmers of the respective districts for the production of food, not for seed. The problem here is that the production of foundation seed is not completing its seed production cycle for improved varieties. This under-exploitation of

Table 1. Potential of NARC foundation seed produced in 2000/2001.

Crops	NARC foundation seed (MT)	Cultivated area/ha	Potential C2 seed production (MT)	Requirement of seed (MT/year)
Rice	373	1550990	596800	77549
Maize	36	819010	202500	16380
Wheat	129	660040	18576	79204
Lentils	4.7	178706	1097	7148
Pigeonpea	1.4	24035	1968	481
Chickpea	2.8	14590	1120	729

Source: Calculations based on Annual Report, 2000/2001, NARC.

foundation seeds is causing shortage of improved seeds each year. Each year, NARC is strongly blamed for not producing sufficient seeds. However, it must be borne in mind that NARC is officially mandated to produce foundation seeds only. Moreover, even if NARC were given the responsibility of fulfilling the entire nation's needs for improved seed, NARC's present resources will be insufficient.

Frontline demonstration of prereleased technologies

Since the late 1980s, seed multiplication mechanisms were built into on-farm research projects of the National Agricultural Research System. The objective of frontline demonstrations is to enhance scaling-up of technologies through demonstrating the effect of the promising varieties, and to make seed immediately available to farmers. In cereals, frontline demonstrations are generally conducted in 0.20 ha and replicated five times.

Scaling-up by farmers' initiatives

Promising varieties from on-farm research are multiplied by innovative farmers. Although this process appears simple, it has contributed much in scaling-up many technologies. Initiative by farmers was the most influential factor for the scaling-up of Sambha Masuli and Radha-4 varieties of rice in Nepal.

Scaling-up built into the Participatory Variety Selection Program

Participatory Variety Selection (PVS) is a useful process for identifying and scaling-up new varieties of crop. PVS covers varietal development and the diffusion process of farmer-preferred varieties. The Center for Environmental and Agricultural Policy Research, Extension & Development, in collaboration with NARC, conducted PVS in the form of mother-baby trials in farmers' fields in 2002 in two Village Development Committees (VDCs) of Morang district. Four different varieties of wheat have been identified through this methodology for further seed multiplication program.

NARC in collaboration with CIMMYT also has been conducting PVS on wheat in different villages in Lalitpur, Bhaktapur, and Kathmandu using pluralistic participation. As a result, three-decade-old wheat varieties have been replaced significantly by BL 1473, a variety preferred by farmers. Empirical evidence will come only after detailed impact analysis. However, observation shows that this method of scaling-up is faster than other conventional approaches. Eleven tons of seed of BL 1473 and four tons of BL 1813 have been produced at the farmer level in the VDCs for the distribution. Similarly, National Wheat Research Program, Bhairahawa, has identified BL 1987 (for the Terai), BL 1813 (for the hills) from mother-baby trials and produced tons of seeds at the farmer level. Now, in partnership with LI-BIRD, BL 1923 and BL 1968 have been identified for scaling-up in Chitwan valley, and BL 1473 and BL 1923 for Pokhara valley.

Agronomy and other crop management technologies

Scaling-up output of agronomical research is more difficult than scaling-up of varietal development technologies. Examples of such technologies are new or modified cropping patterns, irrigation management, plant densities, spacing, seed rate, fertilizer use, most livestock management technologies, and soil conservation technologies. During on-farm testing, research and demonstration is sought in one activity. Farmer to farmer dissemination is facilitated through farmers' visits to the research site.

Pest management technologies

The approach used in scaling-up IPM technologies is slightly different from scaling-up other agricultural technologies in that the concept of farmer empowerment is put in practice more systematically and strongly in the latter. In IPM, farmers are made frontline researchers. IPM in farmers' field schools (FFSs) is aimed to improve farmers' understanding of pest problems, and to develop strategies for overcoming them through experimentation in their own fields.

The Entomology Division of NARC has conducted some FFS for scaling-up IPM of vegetable in Kathmandu from 1995/96 to 1996/97. It was seen that most farmers see DOA extension services as possible sources of subsidized inputs, rather than as a source of knowledge (Sharma 2003). NARC has also made similar observations regarding FFS. Farmers continue with the FFS approach till they get some material advantage from research scientists.

Table 2. Adoption of the IPM approach.

Districts	Number of farmers	
	At the beginning	At the end
Lalitpur	32	25
Kathmandu	26	11
Bhaktapur	23	19
Total	81	55

Source: Annual Report, 1999/2000, Entomology division.

The demand for pheromone traps for *S. litura* and *H. armigera* was very high in the study village. On the other hand, FFS has brought considerable awareness among farmers. In the study period, IPM in Nepal became active and stable for the farmers even out of the group. However, long-term sustainability could not be achieved (Entomology Division 1996/97).

Resource conservation technologies

With the involvement of CABI/CIMMYT/NARC, some resource conservation technologies are in the process of being scaled-up in different districts of Nepal. Examples include surface seeding of wheat, and the use of the Chinese seed drill in wheat. The approach employed was to mobilize groups of farmers. The group using the technology demonstrates its efficacy with great impact to farmers outside the group. This was successful in both the examples mentioned earlier. Recent studies have shown that areas under these technologies have been increasing in the Terai districts of Bara, Parsa, Dhanusha, Rauthat, Rupandehi, Kapilbastu and Nawalparashi; and in the hill districts Bhaktapur and Kabhrepalanchok. The methodologies used to upscale the technology included farmers' group formation; farmers training; intra and inter-site visit; and on-farm research in different places of the districts; and use of mass media to popularize the message among farmers. In training, farmers were also used as resource persons.

Natural resource related technologies

Natural resource management research such as agroforestry and pasture are essential to solve the production and livelihood problems of rural farmers and other clients. Scaling-up of such technologies is possible through the joint efforts of different stakeholders.

Strengths of NARC in uptake pathways and upscaling

1. NARC scientists work in collaboration with farmers on farmers' priority problem areas. They have a mutual understanding, which makes for congenial working environments.
2. NARC has technical capabilities in diverse fields.
3. NARC has the capacity to produce sufficient research material for scaling-up.
4. NARC has research stations in different parts of the country and caters to diverse needs of research clients in different agroecozones.
5. NARC has more than 50 on-farm research sites.

Constraints in uptake pathways and upscaling

1. Improved varieties are not available.
2. On-farm research is mostly conducted on small plots, which does not truly represent field conditions.
3. Limited frontline demonstration.
4. There is no support price for chickpea.
5. Scaling-up ofthe Chinese hand tractor constrained by small-scale subsistence production.

Along with above constraints, there are some constraints specific to up-scaling chickpea technologies:

1. Unavailability of quality seed. The National Seed Company (NSC) and agro vets do not deal with chickpea seed business. Farmers' seed producer groups have not come into this business.
2. High risk due to price variability and outbreak of BGM and *Helicoverpa.*
3. Requires deep integrated knowledge of ICM, which farmers do not have.
4. Expanding irrigation. Wheat, winter maize, vegetables are less risky and occupy what would have been chickpea area.
5. Low pH, low organic matter content in soil.
6. Low/no access to information.
7. Cereal dominated food habit of farmers.

Policy and strategy support needed

1. Ensuring the availability of quality seed
   - Use of foundation seed to produce improved seeds.
   - Strong mechanism for community seed production and distribution.
   - Frontline demonstration in all promising technologies.
   - PVS model for outreach research.
   - Due emphasis on chickpea R&D by formal institutions such as NARC, DOA and NSC.

- Participatory and partnership approach (NARC, DOA, I/NGOs, CBOs, private sector] for seed production and distribution.

2. Reducing vulnerability
    - Price variability needs market research.
    - BGM, *Helicoverpa* outbreaks: ICM training for potential farmers.
    - Reliable weather forecasting system.
    - Resistant high yielding varieties as in other crops.
3. To continue in the irrigated area: reduce seasonality risk.
4. Develop market for IPM chickpea; create promotion, awareness.
5. Provide crop insurance to combat BGM disease.

References

Entomology Division. 1996/97. Annual Report. Nepal Agricultural Research Council.

Ghimire YN, Pokharel TP and Khadka R. 2003. Lessons learned from the experiences of scaling-up programme of Nepal Agricultural Research Council. *In* Proceedings of the Workshop on uptake pathways and scaling-up of agricultural technologies to enhance livelihoods of Nepalese farmers. Organized by MoAC/NARC/NARDF/DFID-HARP, Kathmandu, Nepal, 23-24 September 2003. 137-144 pp.

NARC. 2000/2001. Annual Report.

Sharma KC. 2003. MoAC experience in social mobilization #8211, paper presented at the National Workshop on #8220; Social Mobilization in Agriculture #8221; organized by Nepal Agriculture Association (NAA), Lalitpur, Nepal, 2 June 2003.

The role of APPSP: Lessons learned

P Mainali[1]

Abstract

The Agriculture Perspective Plan Support Programme (APPSP) has renewed the importance of agriculture perspective planning (APP) by bringing its partners onto a platform for joint action. Furthermore, a District Agricultural Development Fund (DADF) was created, and necessary financial support for improving agricultural service delivery at the grass-roots level was established. DADF operation using local service providers and farmers' group is gradually demonstrating prospects for providing modality to work in conflict situation, and government commitment to pursue privatization and market liberalization has facilitated DADF operation. Finally, experiences to date reveal the existence of favorable macro-policies (PRSP and its orientation on poverty and social inclusion) assist on making APP implementation pro-poor and introduce reform on service delivery mechanism and process to ensure social inclusion and scale-up services delivery to the poorest of the poor.

Introduction

Nepal's Agricultural Perspective Plan (APP) was launched in 1995. It is the government's key policy on agricultural and rural development in the country. Both the 10th Plan and the Poverty Reduction Strategy Paper (PRSP) reiterate many of the aims and approaches of the APP, and give agricultural development and poverty reduction a high priority. In spite of the fact that the plan has laid down the guideline and focus for Government and concerned agencies' development agenda since APP's implementation in 1997, it has not resulted in expected improvements or created impact in the rural economy. Lapses in implementation are clearly visible at the district level due to weak reflection of APP's vision and strategies in district level planning and implementation, differences in understanding and poor coordination between various stakeholders. Apart from this, people have been facing problems with normal service delivery mechanisms on the ground: inaccessibility, flaws in intervention processes and approaches, gender, caste and ethnicity etc. As a result, only a small fraction of the poor benefited from current decentralization policies in the agricultural

[1]Agricultural Perspective Plan Support Programme, Ministry of Agriculture and Cooperatives, Singhdurbar, Kathmandu, Nepal.

and rural sector. The enactment of the Local Self Governance Act in 1999 increased the powers and authority of the District Development Committees (DDC) and Village Development Committees (VDC) vis-a-vis the centre. The guidelines issued by the MoAC to assist devolution of agricultural services to local elected bodies provided invaluable opportunities to move towards full district level APP implementation. His Majesty's Government of Nepal (HMGN) initiated the APP Support Programme (APPSP) with the support of DFID in August 2003 for a period of five years. This paper briefly provides the status on APPSP implementation, and identifies lessons learned for funding extension of agricultural services.

Implementation status

The APPSP expects to attack poverty and reduce vulnerability through agricultural reform and development in Nepal. The programme assists the Ministry of Agriculture and Cooperatives (MoAC) by implementing its commitment to integrate a stronger poverty focus into APP, include the excluded, outsource extension services, and shift the government's role from implementer to coordinator and facilitator. The programme is mandated to assist HMGN: implement APP; to put into action the agricultural component of the 10th Plan/PRSP; increase equity through pro-poor, locally determined inputs; decentralize agriculture and livestock extension services and promote demand-driven approaches.

The goal of the programme to achieve higher agricultural growth that benefits poor producers, agricultural workers and consumers by delivering appropriate agricultural support services to the rural poor through improved policy and institutional arrangements. The programme has been implemented in 20 districts representing various ecological belts and development regions of the country.

At the core, APPSP's goal is delivery of more effective services through the provision of additional resources and capacity enhancement at the district level. The programme supports the extension of appropriate agricultural technologies to the poor, marginalized, women, low-caste and ethnic group of farmers, paying particular attention to those in remote areas presently not well served by extension services. It supports local level service planning and partnerships, based on priorities identified in periodic district plans to encourage agriculture-based livelihood opportunities that are in line with the national agenda and in accordance with the needs of local farmers, and capacity and capability of local service providers.

The District Agricultural Development Fund (DADF) is the major operational tool of APPSP and consists of two sub-funds: a District Extension Fund (DEF) and Local Initiative Fund (LIF). DEF is intended to strengthen agricultural extension and boost local resources available. District-based NGOs, private companies; cooperatives and farmers groups compete for DEF funds to deliver agricultural extension, technologies, input supply mechanisms and small-scale agricultural infrastructure (eg, minor irrigation) to poor farmers, who have had limited access to such services in the past. LIF focuses on addressing the needs of weaker groups: the poor, marginalized, women, low caste and ethnic farmers, to start up activities that will enhance their production capacity and provide them with sustainable livelihoods. DADF, which is provided by DFID on grant basis, forms a part of the total agriculture sector budget that is allocated to DDC for implementing agriculture and livestock development activities. The DDC - through the DADC, and assisted by a special Technical Committee - manages these funds. Beneficiaries' participation in fund operation is particularly encouraged. Clear allocation criteria ensure that activities supported are pro-poor, inclusion-oriented and need-based, with focus on sustainable use and management of local resources. Approximately 8,50,000 families living in 1037 VDCs of 20 programme districts are expected to benefit directly or indirectly from DADF.

As of November 2004, the programme has completed district profiling and institutional assessment of all 20 districts as well as codified the by-laws and guidelines for operating DADF. These districts are: Okhaldhunga, Udayapur, Siraha, Ramechhap, Sindhuli, Rautahat, Arghakhanchi, Kapilbastu, Pyuthan, Salyan, Ralpa, Rukum, Jajarkat, Humla, Mugu, Bajhang, Bajura, Achham, Doti and Baitadi.

The implementation of DADF is included in the Immediate Action Plan (IAP) of HMGN. The establishment of DADF, formation of the technical committees, preparation of local guidelines for operating DADF and calling in of proposals has been carried out in all programme districts except Rolpa. Proposal evaluation has been completed in four (Humla, Pyuthan, Achham, Siraha and Udayapur) districts; 7 (2+5) DEF and 21 (8+13) LIF proposals were approved in two districts (Humla and Pyuthan) and the first instalment of funds (2 DEF and 8 LIF) were disbursed in Humla district.

Responses from service providers and farmers groups have been received in four districts in the first cycle. The number of proposals submitted has been high, indicating greater acceptance of DADF approaches and strategies by local service providers and farmers' groups. For instance, in Udayapur and Siraha, a total of 190 (57 DEF and 133 LIF) and 83 proposals (39 DEF and 44 LIF) have been received respectively.

The programme is also supporting the DDCs in Udaypur and Siraha districts to formulate their respective District Agriculture Development Strategy (DADS). A draft guideline has already been prepared. The DADS process in these two districts will be carefully documented and the initial draft will be revised to produce an interim guideline. This will be used to prepare

DADS in the 18 other districts. These guidelines help MoAC formulate DADS in all other districts in Nepal.

At the central level, the programme supports the implementation APP by strengthening MoAC's capacity, in partnership with other APP agencies, to formulate policy, plan, monitor lessons learned and to allocate resources accordingly. The programme is assisting policymakers use this enhanced capacity to design instruments that are pro-poor, in line with the PRSP/10th Plan. For this, there is a Policy Support Fund to enable APP agencies to commission independent analysis on key policy issues, strengthen policy responses, management and monitoring. Some of the initiatives at the central level include: the review of Pocket Package Strategy, preparation of the National Agricultural Extension Strategy; support to conduct five policy studies; and review APP and prepare an APP implementation plan.

Lessons learned

Lessons learned while implementing APPSP at the central and district level for a year:

- APPSP has renewed the importance of APP by bringing partners onto a platform (CADIC, DADC etc.) for joint action.
- The program establishes a framework for bringing district experiences into national level feedback.
- The program has potential for sustainability, scale-up and replication due to its perfect integration into the MoAC system utilizing existing organizational structures at the central (CADIC, M&E Division, MoAC, APMAU) and district (DDC, DADC, DADO, DLSO, district line agencies) levels.
- The program works in remote districts and frequent/adequate communication is a challenge.
- Opportunities have been offered to other programs to enable technologies and infrastructure/service capacity.
- Bringing coherence among APP partners under MoAC leadership is a challenge.
- Planning of decentralized participatory programs and policy feedback in the absence of elected bodies is difficult.
- The establishment and operation of DADF is feasible to provide necessary financial support to improve agricultural service delivery at the grass-roots level.
- Using local service providers and farmers' groups is emerging as a feasible model for working in conflict situations.
- The government's commitment to pursue privatization and market liberalization has helped DADF in the districts.

- Favorable macro-policies (PRSP and its orientation on poverty and social inclusion) have contributed on making APP pro-poor and ensured social inclusion at the grass-roots level.

Conclusion

Implementation of APPSP started with the realization that APP did not result in expected improvements and desired impact on poverty reduction in the rural economy. Lapses in APP's implementation were clearly visible at the district level due to weak reflection of APP's vision and strategies in district level planning and implementation. Differences in understanding and poor coordination between various stakeholders; exclusion of the poor and disadvantaged from normal service delivery due to inaccessibility, flaws in intervention processes and approaches as well as gender, caste and ethnicity further compounded the problem. Implementation of APPSP renewed the importance of APP by bringing its partners onto a platform for joint action.

The program has supported APP implementation both at the central and district level to establish the framework to bring district experiences into feedback at the national level. Early experiences with the program reveal that DADF is proving feasible in providing necessary financial support to improve agricultural service delivery at the grass-roots level. Using local service providers and farmers' groups in DADF operations is emerging a feasible model for working in conflict situations. The government's commitment to pursue privatization and market liberalization has helped DADF. Finally, the existence of favorable macro-policies (PRSP and its orientation on poverty and social inclusion) has been effective in making APP pro-poor and in ensuring social inclusion on service delivery.

Background literature

APPROSC/IMC. 1995. Nepal Agriculture Perspective Plan Main Document (Final Report). ADB TA 1854, Kathmandu.

APPSP. 2003. Inception Report of the APP Support Programme prepared for the MoAC and Department for International Development, Kathmandu.

APPSP. 2004. Annual Report (2003-2004) prepared for the MoAC and Department for International Development, Kathmandu.

HMGN/NPC. 2003. The Tenth Plan: Poverty Reduction Strategy Paper (2002-2007): Summary. Kathmandu.

Session III: Commodity Seed Production and Farmers' perceptions

Seed quality control mechanisms in Nepal

KK Lal[1]

It is a known fact that investment in fertilizers, water, plant protection chemicals and other inputs does not yield economical returns without the use of quality seed. Quality seed is the most basic, critical and cheapest input for enhancing agricultural productivity and increasing higher net monetary returns per unit area. Returns on investment significantly depend on varietal purity and physical quality of seed that is used in production of crops.

For centuries, farmers have used their own seed by selecting and saving part of their harvest. These practices are still followed by most farmers in Nepal. Although organized seed production in Nepal started in early seventies, spread of the concept of seed quality during the last two decades has been slow but satisfactory.

The Central Seed Science and Technology Division had responsibility for seed quality-related operations till October 1992. However, this mandate was transferred to the Department of Agriculture at the time of reorganization in the Ministry of Agriculture and in 1993, the Seed Development and Quality Control Service section was created under DoA to provide quality-monitoring services to public and private seed agencies. Later, this mandate was again transferred to the Seed Quality Control Center under the Ministry of Agriculture and Cooperatives.

Awareness about seed quality is increasing among seed entrepreneurs, seed growers and farmers. Also, planning and policymaking authorities in the country are convinced about the importance of an efficient seed quality control system in developing a viable seed production and distribution program. The Nepal Seed Act was enacted in 1988 and the National Seed Board (NSB) has been constituted to implement it and advise HMGN on all matters concerning the development of a viable seed industry.

The Board is assisted by three technical sub-committees in discharging its responsibilities:

1. Variety Approval, Release and Registration sub-committee

The main function of this sub-committee is to formulate and update rules for approval, release and registration of varieties, and consider new varieties for release. The subcommittee is also responsible to maintain a register of released crop varieties, their distinguishing characteristics and salient agronomic features and make this information widely known.

[1]Seed Quality Control Center, Department of Agriculture, Harihar Bhawan, Pulchowk, Lalitpur, Nepal.

2. Seed Planning and Monitoring sub-committee

This sub-committee is meant to assist NSB in planning seed production and trade by private and public sectors and institutions, with a view to ensure regular supply of quality seed to general farmers. It is also supposed to assist NSB in seed policy matters.

3. Seed Quality Standards, Establishment and Monitoring sub-committee

This sub-committee is mandated to:

- Develop, update and publish seed quality standards as approved by NSB;
- Publish the certification procedure and assume responsibility for providing assured seed testing and certification services;
- Institute regulations for preventing the sale of sub-standard seed and prescribe labeling requirements for the marketing of seed;
- Inspect processing and seed storage facilities of the private and public sector agencies to enforce improvement; and
- Carry out any other function related to seed quality monitoring.

Seed quality control

Quality control is an essential component of a viable and dependable seed development program. The responsibility of maintaining quality and providing assurance for seed offered for marketing lies with the producers and entrepreneurs. Most reputed international companies have their own internal quality control mechanism to maintain seed quality. In Nepal, seed entrepreneurs do not have trained persons to carry out internal quality control operations. Therefore, the Seed Quality Control Center of the MoAC, in addition to implementing a regular seed certification program, has the responsibility to provide guidance to seed entrepreneurs and seed producers in internal quality control techniques by organizing training program in different regions of Nepal.

Seed quality control system

Most countries have registrations made formal by legislations (Seed Act), which govern the quality of seed marketed. The standards are usually uniform worldwide except for some variations. However, each country has its own standards, which are approved by a competent agency. Nepal too has prescribed standards for different crops, which are notified in the Nepal gazette. Recently a technical committee approved and recommended standards for fodder crops, which must also be approved by NSB.

Two types of seed quality control systems are operational ie, certification and truthful labeling. In Sweden and Denmark, seed certification is compulsory, while in most of the countries it is voluntary. In Nepal, the seed certification is voluntary but truthful labeling of seed containers is compulsory.

Seed certification

Seed certification is a comprehensive quality control system, which is designed to maintain genetic purity and varietal identification of notified and registered crop varieties and propagating material during different stages of seed production, processing, packaging and marketing. This is accomplished through field inspection and laboratory testing by the staff of authorized seed certification agencies. In Nepal, the Seed Quality Control Center is the authorized certification agency. The Central seed-testing laboratory is in Kathmandu, while five regional laboratories are situated in different development regions.

Classes and source of seed

Three classes of seed, namely breeder, foundation and certified seed are recognized under seed certification in Nepal.

Seed certification sequence

This is the sequence adopted for carrying out seed certification in Nepal:

- Receipt and scrutiny of application
- Verification of seed source, class and other requirements of seed used for raising seed crop
- Field inspection to verify conformity to the prescribed field standard
- Supervision of postharvest stages including processing and packaging
- Seed sampling and analysis of sample in seed testing laboratory to verify conformity to the prescribed standards, and
- Supply of certificate and certification tags, tagging and sealing of containers.

Truthful labeling

Most countries in the world have a system of formal registrations to regulate the quality of seed marketed and this is normally implemented through Seed Acts. Seed certification in most countries including Nepal is voluntary, but according to the Nepal Seeds Act, 1988, labeling of seed containers of notified varieties offered for sale is compulsory. Under the truthful labeling scheme, the seed producer is responsible for maintaining prescribed seed quality standards through internal quality control techniques.

Future plans

1. Amendment of the Seed Act, 1988 will be finalized by adopting some appropriate means in the absence of Parliament.

Main features of the amendment

- Presently the act is enforced only in the three districts of the valley. The amendment will enforce it in all districts of the country.
- Some definitions have been changed to bring the Act into conformity with international practices.
- Licensing of non-governmental or private laboratories for the testing of seed.
- Registration of seed traders.
- Introduction of fees for services like crop inspection, seed sampling and seed testing.
- Establishment of quality declared seed schemes to complement other quality control schemes, monitored by the Seed Quality Control Center.

Chickpea cultivation: Farmers' perceptions

BK Aryal[1]

First, I would like to express my gratitude for giving me an opportunity to participate and present a paper as a representative farmer from Rajahar VDC, Nawalparasi district.

We, the farmers of Rajahar, have been actively involved in improved chickpea production, conduction and evaluation of IPM trials, training and tours of chickpea production demonstrations plots.

Before the start of the project, chickpea used to be grown as a mixed crop with lentils, wheat or field pea, mainly due to lack of technical knowledge on chickpea cultivation. After contact with scientists from ICRISAT and NARC, we have come to know that chickpea can also be grown successfully as a sole crop after rice. As a result of the project intervention, the rice-wheat cropping pattern is being gradually replaced by the rice-chickpea pattern. Farmers have become economically stronger by adopting the rice-chickpea pattern. This has had visible impact on improving living standards of the poor and landless farmers of the area.

In spite of being a profitable and successful crop, chickpea has some problems:

Pod borer: This is chickpea's biggest enemy. The pest has gradually developed resistance to locally available chemicals also. Although, we have gained knowledge and skills on the integrated management of pod borer, we need to constantly update our knowledge.

Root Rot/Wilts: Roots rots, yellowing and death of plants has also negatively affects chickpea production in the region.

Hailstorm damage: Chickpea is often damaged by hailstorm in our region. The maturity period of chickpea coincides with the occurrence of hailstorms in April. Early maturing chickpea varieties would be valuable in such situations.

Storage damage: The traditional practice of storing chickpea in earthen pots often results in poor germination and emergence.

In spite of these problems, we benefit from chickpea in many ways:

- It needs less moisture compared to other crops and is suited for rainfed farming.
- Rhinos do not seem to like chickpea and so, it is a safer option since the area is in the vicinity of the Chitwan National Park.

[1]Chhipeni, Rajahar Village Development Committee, Nawalparasi.

- Chickpea helps maintain the fertility status of soils and there is no need to incorporate dhaincha (*Sesbania aculata* L.) as a green manure for rice in fields rotated with chickpea. Yield of rice following chickpea has increased.

The rice-chickpea system would be the most profitable if problems associated with chickpea were addressed through appropriate technical knowledge, seed supply and intervention in terms of integrated management of diseases and pests. However, intensive knowledge on pod borer management and seed storage technology should be given to farmers.

We must give heartfelt thanks to scientists from ICRISAT and NARC for the valuable service they render us. We look forward to greater cooperation and help from these organizations to address problems faced by farmers, which would help raise living standards of resource-poor farmers. I request all concerned to continue to implement IPM trials and farmers' training to further entrench the rice-chickpea pattern.

Chickpea cultivation: Farmers' perceptions

KK Shrestha[1]

I am Krishna Kumari Shrestha from Lalbandi VDC, Sarlahi, and am very pleased to be here, representing farmers from Sarlahi.

From 2000, we have been provided with pulse minikits from the National Oilseeds Research Program/Grain Legume Research Program. In 2000, we received chickpea trial sets for the first time through the ICRISAT/NARC chickpea IPM project. Over the years, we participated in various activities: evaluation of IPM technology for chickpea, testing of improved varieties, fertilizer including rhizobium culture, seed treatment, techniques for the management of pod borer and BGM.

For the past three years, we have evaluated chickpea on-farm trial sets in Lalbandi VDC. These trial sets comprised improved chickpea varieties, and integrated disease and insect management techniques. The evaluation project was conducted in our fields in collaboration with ICRISAT, NORP and NGLRP scientists. In participatory variety evaluation, eight different varieties were evaluated in 150 sq m plots, whereas in the case of ICM trials, each trial was evaluated in 333 sq m plots. We also participated in spot training and farmers' field days organized at the podding stages of the crop. Details of trial sets in Lalbandi are given in Table 1.

Table 1. Number of chickpea trial sets evaluated at Lalbandi, 2003-2005.

Year	Ward no 1	Ward no 2	Ward no 3	Ward no 4	Ward no 6	Total
2003	10	65	125	135	30	365
2004	-	-	60	60	30	150
2005	-	25	50	65	25	165
Total	10	90	235	260	85	680

The chickpea IPM project was very important to us, as the crop has proved more profitable than tomato in our area. Farmers have moved from tomato to chickpea, feeling that chickpea was less risky and more profitable. We have been fortunate in acquiring technical knowledge and skills on improved chickpea production through participating in the project. Now, the area is self sufficient in chickpea seeds and many farmers have started production and sale of chickpea seeds to NGOs/CBOs and other farmers as well.

[1]Lalbandi Village Development Committee, Sarlahi district.

Chickpea cultivation: Farmers' perceptions

S Adhikary[1]

Bardibas and its adjoining areas have not had a very long history of chickpea production. In the past four years, however, there has a satisfactory rise in production, after the introduction of improved chickpea varieties and technologies. These have come to us through on-farm IPM trials by the Oilseeds Research Program, the Grain Legume Research Program and ICRISAT.

In these years, chickpea has established itself as a cash crop in the Bardibas area. Compared to other winter crops, chickpea has fewer obstacles, can be grown as a rainfed crop in the unirrigated areas and is more profitable. The contribution of the Oilseeds/Grain Legume Research Program and ICRISAT in popularizing chickpea in the area is highly appreciated by the farmers. Thanks to the successful rehabilitation of chickpea in the rice-based system, the standard of living of farmers in the area has improved substantially, and the credit goes to ICRISAT and NARC.

Although the fertility status of soils has improved substantially through chickpea cultivation, farmers in the area have not yet adopted the complete package of practices of improved chickpea cultivation encompassing optimum seed rate, sowing time, Rhizobium inoculum and other aspects. The project successfully created awareness among farmers, which led to adoption of improved varieties and disease and pest management techniques. We hope that regular training and monitoring by ICRISAT and NARC staff will ensure continuity to the limited successes so far in the use of ICM in chickpea.

[1]Bardibas Village Development Committee, Mahottary district.

Chickpea cultivation: Farmers' perceptions

B Khatri[1]

For the last 5-6 years, RARS, NARC, Nepalgunj, and ICRISAT scientists, Dr Suresh Pande and Dr Rao have contributed a lot to rehabilitating chickpea in our area. Before 1997, the area under chickpea was negligible; and we did not have access to chickpea seed.

With the chickpea program, a lot of information about seed rate, seed treatment, plant protection and improved varieties was provided by NARC and ICRISAT scientists through personal discussions, formal and informal training, conduction of on-farm trials/demonstrations, field visits and monitoring. Improved seeds were made available. Training on seed production and storage was also provided to the farmers.

In our region, chickpea area and production has increased ten-fold after the initiation of the chickpea program. Chickpea farmers are economically better off and the program has helped raise their income and living standards. The area is now self sufficient in chickpea seeds and we are able to supply chickpea seeds to local NGOs/CBOs and farmers. I assure you, we will continue to grow chickpea in rice-based systems as we have found it profitable. At the same time, I request that regular training and monitoring be continued to further disseminate improved chickpea technology.

[1]D Gaon, Bagashwory Village Development Committee, Banke district.

Session IV: DFID-funded and Related Projects

On-farm IPM of chickpea in Nepal: Dissemination, adoption and promotion. 1997-2005

RK Neupane[1], M Joshi[2], S Pande[3] and NK Yadav[4]

Abstract

Chickpea is an important winter grain legume grown in the rice and maize-based systems in the Terai and inner Terai regions of Nepal. In spite of several chickpea varieties and production technologies recommended to farmers in the past, farmer adoption has not been encouraging. To promote better adoption, Integrated Crop Management (ICM) technologies of chickpea were introduced in potential production pockets in the Terai/inner Terai region. On-farm ICM research was initiated jointly by NARC and ICR1SAT with DFID funds in 110 farmers 'fields in 1998/99. On the basis of encouraging results obtained in the first year, the project activities were extended to other districts subsequently. By 2004, ICM technologies were disseminated to 20 Terai districts. The ICM package consisted of high yielding disease-tolerant varieties, recommended dose of fertilizers, seed dressing with fungicides and need based foliar application of insecticides and fungicides. Results of the research indicate that ICM packages gave two to three-fold yield increase in chickpea, thereby reducing the unit cost of production and enhancing the incomes of poor and marginal farmers. Study on impact assessment of on-farm ICM research conducted in Banke, Bardia, Sarlahi and Mahottari districts reveals that adoption of the ICM package has substantially enhanced family income, increased dietary intake of chickpea among poor families and increased farmers' ability to spend on education, health and other household activities. A total of 12000 farmers from 20 Terai districts have been educated about ICM, and some of them are involved in seed production and seed business activities, providing more long-term sustainability. Scaling-up of ICM technology is suggested.

Keywords: *PVS, ICM/IPM, Chickpea, On-Farm Research.*

[1]Outreach Research Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.
[2]Nepal Agricultural Research Council, Singhdurbar Plaza, Kathmandu, Nepal.
[3]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[4]National Grain Legume Research Program, Rampur, Chitwan, Nepal.

Introduction

Grain legumes occupy approximately 10% of total cultivated land in Nepal. They are grown in 311,210 ha with the total production of 256,000 MT and average productivity of0.823t/ha (Anon 2003). Chickpea is an important winter grain legume grown in the Terai and inner Terai regions in rice and maize-based cropping systems. Apart from supplying cheap protein to the predominantly vegetarian population, it is a source of income to poor and marginal farmers. Research in the past has recommended six varieties of chickpea (NGLRP 2004). Suitable practices for cultivation have also been recommended.

In spite this, national average yield levels have shown rather slow increments over the period. Research results indicate that though the yield potential at the research station is about 3 t/ha, and yield obtained in farmers' field under well managed conditions is 1.5 t/ha, these have not been reflected in national productivity. The reason for this is non-adoption of recommendations due to a number of socioeconomic, biotic, abiotic and technological constraints. With these factors in mind, farmer participatory ICM in chickpea was initiated in different production pockets. This report deals with *Farmer participatory research initiatives-dissemination, adoption and promotion in chickpea* implemented in collaboration with different stakeholders with funding supports from ADB/ICRISAT, DFID/ICRISAT, IFAD/ICRISAT, and NARDF/NARC during 1997-2005.

Objective: Rehabilitation of chickpea in rice fallows through the promotion and dissemination of ICM technologies to potential production pockets in the Terai region of Nepal.

Materials and methods

Based on the availability of on-station proven varieties and technologies; and problems identified in farmers' fields through formal surveys, village level workshops, regional technical working group (RTWG) meetings, interaction with farmers/extension workers, focused group discussions and stakeholders' workshops, participatory varietal selection (PVS) was initiated in chickpea. The sites were selected on the basis of local importance of the crop and their potential.

ICM trials comprising of all the components were initiated in chickpea in 1998/99 in potential production pockets. Plot sizes were kept 333 sq m and the full package of crop production practices were compared with farmers' practices.

Orientation training, farmers' field days, joint monitoring of trials were also conducted in the research sites with the participation of farmers, local extension workers, NGOs and research scientists. Relevant data and farmers' reactions were collected through formal and informal surveys.

For the dissemination and promotion of ICM technologies, distribution of mini-kits, community level seed increase, training and distribution of leaflets/folders were carried out during the project period.

Participatory varietal selection (PVS)

In PVS, released and pre-released varieties were evaluated at Banke, Bardia, Mahottari, Sarlahi and Nawalparasi, Kapilbastu and Chitwan districts (Tablel).

Table 1. IPM trials conducted in chickpea, 1998-2004.

Year	No. of districts	No of trials	Districts	Involvement/ Linkage
1998/99	4	110	Banke, Bardia, Nawalparasi, Siraha	NARC - ICRISAT/ ADB
1999/00	6	503	Banke, Bardia, Nawalparasi, Siraha, Sarlahi	NARC-ICRISAT, DFID
2000/01	8	647	Banke, Bardia, Nawalparasi, Siraha, Sarlahi, Mahottari, Sirha, Sunsari	NARC-ICRISAT, DFID
2001/02	14	843	Banke, Bardia, Nawalparasi, Siraha, Sarlahi, Mahottari, Sunsari, Saptari, Parsa, Bara, Rupandehi	NARC-ICRISAT/ DFID and ADB
2002/03	17	1100	Banke, Bardia, Nawalparasi, Kapilvastu, Sarlahi, Mahottari, Sunsari, Chitwan	NARC-ICRISAT, DFID and RWC
2003/04	20	700	Banke, Bardia, Dang, Kanchanpur, Sirha, Saptari, Nawalparasi, Rupandehi, Kapilvastu, Chitwan, Bara, Parsa, Sarlahi, Mahottari, Sunsari, Saptari, Morang, Jhapa, Rautahat, Kailali	NARC-ICRISAT/ DFID, IFAD and NARDF
2004/05	20	700	Banke, Bardia, Dang, Kanchanpur, Siraha, Saptari, Nawalparasi, Rupandehi, Kapilvastu, Chitwan, Bara, Parsa, Sarlahi, Mahottari, Sunsari, Saptari, Morang, Jhapa, Rautahat, Kailali	NARC-ICRISAT/ DFID, IFAD and NARDF

Table 2. Chickpea grain yield (t/ha) in PVS at Sarlahi, Mahottari, Banke and Bardia, 2002/03.

Variety	Sarlahi and Mahottari	Banke and Bardia	Mean
Avarodhi	2.58	1.37	2.0
Tara	1.54	1.36	1.5
Koselee	1.63	1.39	1.5
Kalika	1.70	1.42	1.6
Sita	2.07	1.46	1.8
Chandra	1.59	1.64	1.6
Dhanush	1.75	1.32	1.5
Local	1.20	1.28	1.2
Mean	1.76	1.58	1.41
F test	*	*	*
LSD (0.05)	0.30	0.25	

Results to date indicate that variety Avarodhi was favored by farmers across the Terai (Table 2), while some farmers preferred Koselee as it fetches higher price in the market. Sita was a variety of choice in the mid-western Terai. Avarodhi performed better in spite of very low yield levels for all the varieties at Kapilvastu site due to higher disease and insect damage in new test site operated by FORWARD.

Integrated Crop Management

In the initial years, single components of production technologies were evaluated in different production pockets, and compared with the local practices or farmers practice. Almost all the components were found better than the existing farmers' practices. Therefore, all the components were packaged as Integrated Crop Management (ICM) technology and evaluated in farmers' fields over a wide range of environments. IPM technology consisted of improved varieties, seed dressing with Bavistin® @ 2 g/kg, basal fertilizer application @ 20:40:0 NPK kg/ha, Rhizobium inoculation, need-based foliar application of Thiodan® @ 2 ml/L water (2-3 times) for the management of pod borer and Bavistin® @ 2 g/L water 2-3 times for the management of BGM. The plot size was 333 sq m per treatment and the produce served as a source of seeds for the subsequent years. It has also demonstrated effectively to farmers and development workers and convinced them of the superiority of the selected variety.

The ICM package gave an overall yield increment of 134% over the control (Table 3), the range being 107-195%. Higher number of pods/plant, lower

Table 3. Comparative performance of the ICM package on chickpea yield, 1998/99-2003/04.

Crop	Seed yield (t/ha)		Percent yield increase over control	
	ICM	Non-ICM	Range	Mean
Chickpea	1.97	0.84	107-195	134

Source: Neupane et al. 2002 and NGLRP 2004.

disease and insect incidence were associated with ICM. In cases where farmers also applied plant protection measures the differences were only marginal. Economic analysis of application of IPM has indicated that it is highly profitable to apply plant protection measures for the control of pod borer and BGM.

Promotion

Over the years the promotion of chickpea ICM technologies has included distribution of mini-kits, community level seed increase, on-the-spot training on chickpea ICM, farmers' field days, workshops, distribution of ICM promotional tools, TV broadcasts, training of field staff and farm visits.

Training and capacity building

Training programs on chickpea ICM were organized through collaborating stations/agencies. Experts from the Department of Agriculture, NGOs and NARC stations participated as resource persons in the training programs organized on-farm. During 1997/98-2003/04, more than 12000 farmers from 20 Terai districts have been acquainted with improved management of chickpea, through trainings, exposure visits, distribution of literature and formal and informal contacts, through different implementing/collaborating agencies.

Farmers' field days

Farmers' field days were organized at the podding stage to familiarize farmers, extension personnel and NGO and research staff with chickpea ICM technologies and create interactions among them. These activities were helpful in getting all the stakeholders at one place, interacting and sharing on different aspects of the technologies. This has helped disseminate varieties and ICM technologies.

Impact assessment

A study on impact assessment of ICM technology was conducted at selected project sites. About 400 research participants and 100 non-participant farmers from Banke, Bardia, Sarlahi and Mahottari districts were selected for the study. Results indicated that participatory chickpea ICM significantly increased household income, and offered a diversity of crop varieties and choice. Adoption of ICM has enhanced the dietary intake of chickpea, increased farmers' ability to spend on education, health and other household activities.

1. Seed transaction

Farmers' access to improved seed and its dissemination was of considerable importance. Seeds were sold to areas as far as 35-40 km from Bardibas and Lalbandi, which serve as seed villages. In the mid western region, 83% of farmer respondents sold seed to other villages, traders and NGOs/CBOs, whereas in the central region, 73% farmers sold it to other villages. In the project area, seed sold per household was 127 kg in the mid-west and 279 kg in the central region. Additional employment generation @ 50 man-days per ha for additional chickpea growing has been recorded in the project sites.

2. Reduction in cost of production

The unit cost of production with ICM was 62% lower compared to farmers practices. Net income from IPM was 1056 kg/katha as compared to 310 kg/katha from farmers practices (Pande et al. 2003). Farmers were able to save money from chickpea sales and invest in repairs, education and health services. The consumption of chickpea in the project area increased compared to the base year.

3. *Community level seed production*

PVS and ICM activities have supported local seed systems. In the absence of organized seed distribution systems, the project sites acted as the seed resource centers, apart from farmer-to-farmer diffusion of seeds/technologies. Lalbandi, Bardibas, and D Gaon have become known as seed centers for chickpea.

4. Change in cropping pattern

At Lalbandi, Sarlahi, area under tomato is slowly being replaced by chickpea as a result of its profitability. The traditional maize-tomato pattern is being slowly replaced by maize-chickpea. The area under chickpea has increased and the village serves as a source of chickpea seeds. In the Bardibas area, where chickpea is sown in rice fallows, its area has increased considerably as farmers found this legume the best alternative to toria. Overall, the adoption of technologies is going up around the project sites.

Constraints and opportunities

Although the results from chickpea ICM research were highly encouraging and the impact assessment showed positive benefits of the technologies, the dissemination has been rather slow. This may be ascribed to non-availability of improved seeds, risky nature of the crop, inadequate extension services, and better options available to farmers.

Chickpea is a traditional crop, and consumed daily in a variety of ways. There are ample opportunities for expansion of its area and production because the demand for chickpea is increasing and 20,000 tons of chickpea would be needed to meet the demand of increased population by 2020. ICM technologies will help double current yield levels. Current estimates of rice fallows in the country are about 400 thousand hectares, which could be brought under chickpea, through the concerted efforts of research, extension, CBOs, NGOs and other stakeholders involved in scaling-up the technologies.

Conclusion

Participatory on-farm ICM research on chickpea has provided an opportunity for farmers to select varieties and technologies best suited to their condition. Dissemination of varieties was faster and effective through farmer-to-farmer exchange, the barter system and other local means. These efforts have helped in supporting local seed systems, created newer opportunities for seed transaction/sale and maintained chickpea varietal diversity in the localities. The technologies need to be scaled up through regular extension systems throughout the Terai districts of Nepal.

Acknowledgements

The authors would like to extend sincere gratitude to the Executive Director, Director, Crops and Horticulture Research; Director, Planning and Coordination, NARC; and Director Finance, NARC, for their keen interest and support to the program.

We also gratefully acknowledge the valuable contributions ofresearch scientists and cooperators from RARS-Nepalgunj, Tarhara, NORP-Nawalpur, farmer groups, LI-BIRD, FORWARD, SAATHI and DADOs from various districts. We acknowledge the contributions of ICRISAT, CPP-DFID and other donor agencies for funding towards implementing various on-farm activities in chickpea.

References

Anon. 2003. Statistical information on Nepalese Agriculture 2002/03. Agricultural Statistics Division, Ministry of Agriculture and Cooperatives, HMG, Kathmandu, Nepal.

NGLRP. 2004. Farmer participatory research into integrated management of grain legumes (Nepal component) IFADTAG-532 ICRISAT Project. Year 2 Progress Report -Pulses.

Pande S, Bourai VA, Stevenson PC and Neupane RK. 2003. Empowerment through enrichment: on-farm IPM of chickpea in Nepal. Information Bulletin No. 65. ICRISAT, NARC, NRI and CPP. Patancheru, Andhra Pradesh, India: ICRISAT.

The adoption of ICM technologies by poor farmers in Nepal

PC Stevenson[1], S Pande[2], RK Neupane[3], RN Chaudhary[3], VA Bourai[4], JN Rao[2] and D Grzywacz[1]

Introduction

Rural poverty remains pervasive throughout Nepal, the poorest country in South Asia and a predominantly agrarian nation, with 60% of its GNP derived from agriculture. The principal foods are cereals (rice, maize and wheat) with grain legumes grown as secondary crops during the winter, mostly in paddy fields using residual moisture for plant establishment. As the staple crop, rice is grown in 1.45 million hectares across the country but 400,000 ha remain fallow in winter (Subba Rao et al. 2001). The exploitation of this uncultivated land offers one route to resolving problems of food security in Nepal. Chickpea (*Cicer arietinum* L.), the 3rd most important pulse in Nepal after lentils *(Lens esculenta)* and pigeonpea (*Cajanus cajan*) provides a high yielding and high value crop option for poor farmers. Like all pulses, chickpea is a very important source of protein for poor rural families and equally so for the urban poor. It is also valuable because it is a highly versatile grain and is used for making biscuits, breads and sweets as well as a soup vegetable. It provides an excellent crop with which to tackle food security and alleviating malnutrition, and as a winter crop, it lends a strong focus on the agricultural role of women.

However, yields of chickpea have decreased in recent years primarily due to disease and insect pest problems and the reluctance of farmers to invest time and money in a crop that increasingly fails. This has resulted in a decline in grain legume consumption to about 25% of the level recommended by FAO ie, less than 10 kg/capita/annum (Pandey et al. 2000). Owing to severe crop failures, especially in the 1997/98 season, upto 90% of chickpea consumed in Nepal is now imported according to Johansen (2001). This frequent crop insecurity associated with the production of chickpea over the past twenty years has seen a decline in area sown under chickpea drop from more than 50,000 ha in 1980 to less than 10,000 ha in 2003 according to reports at this meeting. A decline in the production of leguminous crops could have a negative impact on the sustainability of the cereal-based systems because legumes enhance soil fertility through nitrogen fixation and as organic matter.

[1]Natural Resources Institute, University of Greenwich, Chatham, ME4 4TB, UK.
[2]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[3]Nepal Agricultural Research Council, PO Box 5459, Kathmandu, Nepal.
[4]Department of Economics, SGRR (PG) College, Dehradun, Uttaranchal, India.

While yields using traditional approaches are low (<0.8 t/ha), the scope for increasing chickpea is high through increasing efficiency, exploiting the large area of winter rice fallows and the simple fact that there is always demand in a country that has a 90% deficit of the crop. How long might it be before Nepal begins importing its chickpea from Australia or Canada?

Major project outputs - Phase 1

The overall aim of this project was to promote the adoption of an Integrated Crop Management (ICM) strategy for increased chickpea production and the outcomes of the project have been reported (Pande et al. 2003a, b & c; Stevenson 2004). Within the first phase, we aimed to achieve several specific goals, which are summarized below (Pande et al. 2003a & b).

1. Survey current farmer practices for chickpea production using participatory rural appraisal (PRA) - what are the problems?

The outcome of this phase are detailed by Pande et al. (2003a). The area of production was declining and farmers were achieving low yields. Farmers were also reportedly not optimizing production or managing constraints. One direct outcome of this was a severe outbreak of BGM in 1997/98, which severely affected farmer confidence in the crop. More specifically, farmers reported a lack of quality seed and of suitable progeny with ineffective or adulterated agrochemicals and a poor knowledge of how to use them. Seed losses in storage were also reported but by far the most important constraints according to farmers are the diseases Fusarium Wilt and BGM along with the pod borer. However, it was also clear that the scope for increasing production was considerable through increasing efficiency and exploiting the large area of winter rice fallows.

2. Develop and validate a new ICM package that was appropriate, effective and affordable.

The second output of the first phase was to develop the technology and present it in a way that was usable by farmers. The ICM package consisted of the following components:

1. Improved cultivars, Avarodhi or Tara, which are both resistant to Fusarium wilt, tolerant to BGM and high yielding. Importantly, these were selected by farmers themselves as preferred varieties in participatory selection trials.
2. Fungicidal treatment of seed (thirum+Bavistin (1:1 ratio) @ 2 g/kg seed).

3. Seed priming to increase germination and overall vigor.
4. The application of Rhizobium inoculum @3g/kgseed (where not previously applied).
5. Addition of diammonium phosphate (DAP) (a) 100 kg/ha.
6. Prophylactic BGM control (Bavistin @lg/liter of water; 17 liter of water/katha).
7. Pod borer control with Thiodan @3ml/liter of water (17 liter of water/katha).
8. Boron application in areas shown to be boron deficient (restricted to some farms in the central region).
9. Maintenance of an open canopy to reduce microclimatic humidity and thus reduce BGM by avoiding excessive fertilizer or irrigation.
10. Encouraging sun-drying seed prior to storage to reduce insect infestation and subsequent treatment with naphthalene, Azadirachtin, oil or chilli powder to maintain seeds insect free. Also keeping seed in sealed containers.

It is worth noting that 2 to 4 operations can be achieved in one single treatment.

3. Produce and disseminate promotional tools on ICM.

The ICM package was promoted through farmer schools, NARC extension services and NGO links established under the previous ICRISAT led crop diversification project, funded by the Asian Development Bank (ADB). A central facet of the project was to use the farmer participatory techniques previously developed by ICRISAT/NARS under previous grain legume projects so that farmers themselves should conduct all on-farm trials. The performance of the package based upon grain yields was monitored but simple tools were needed to provide farmers with a guide to ICM along with farmer schools.

The NARC/NRI/ICRISAT team developed promotion tools for the new chickpea ICM system. As well as posters and materials for showing farmers at field schools, the team produced information cards in Nepalese detailing all stages of chickpea growth, when they are affected by the principal target constraints of the project and how best to manage them (Plates 1 and 2). During the 2000-2001 season, promotion tools for new integrated technologies were distributed. These sheets were produced and used during the main promotion phases in years 2 and 3. They were disseminated to at least 2000 farmers in the target areas in year 3. They have now been updated.

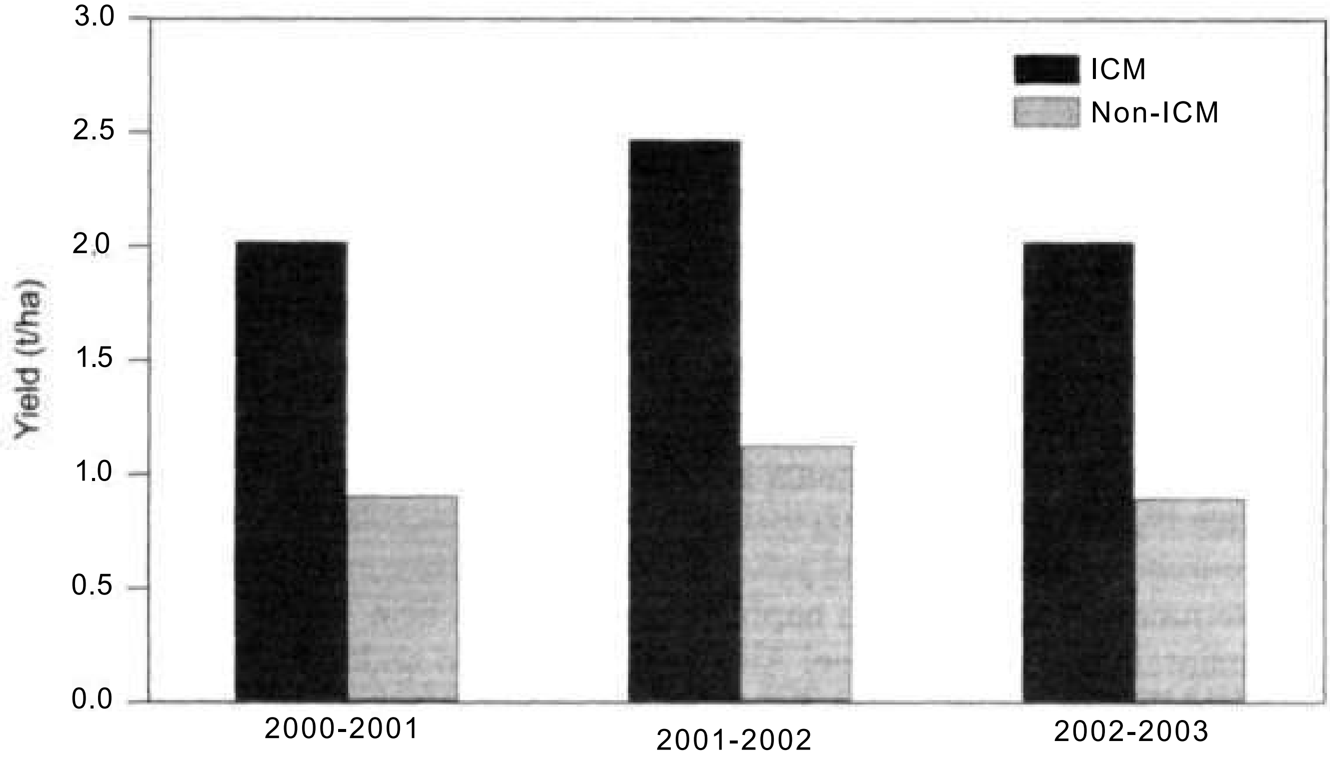


Fig. 1. Yield of chickpea with and without ICM, 2000-2003.

4. Rebuild confidence in farmers.

On-farm grain yields achieved by farmers throughout the project area have shown farmers that it is possible to grow chickpea profitably. Not only have yields doubled (Fig. 1) but because of the relatively low additional investment for the ICM technology above that already required for the traditional production, the actual unit cost per kg is almost halved when using the ICM package developed on this project (Table 1).

Table 1. The economics of chickpea production (NRs/ha) with and without ICM.

	Without ICM	With ICM	Change (%)
Total cost	14962	16454	9.97
Gross income	24120	35440	46.93
Net income	9158	18986	107
Unit cost of production (NRs/kg)	17.53	9.26	47.18

Major project outputs - Phase 2

Phase 2 of the project aimed to promote the knowledge widely, develop up-scaling strategies, evaluate impact and identify exit strategies.

1. Promote project technologies widely and increase numbers of farmers growing chickpea in the Terai and increase area under chickpea production.

In order to start the promotion process, farmer field schools were conducted with all farmers prior to the chickpea-growing seasons in years 2 and 3 to inform participants and distribute promotional tools and technologies. In the 2001-2002 cropping season, the validated package from output 3 was promoted to target farmers. In the first season, the aim was to involve an initial target group of 500 representative farmers from the main target areas for validation but in subsequent years, the aim was to scale up promotion of the package.

Trials expanded dramatically in subsequent years. In 2001/2002, 1100 similar trials were set up with farmers, in new districts as well. In 2002/2003, more than 2000 farmers received the IPM package ingredients to try. Further, local scouts and farm leaders indicated that many elements of the IPM practice had been adopted by an estimated additional 5000 farmers, who had assimilated the knowledge by various local processes of communication. Farmer schools consisted of small groups of no more than 50 farmers from the same village who knew each other and were able to discuss IPM in the same language and with relevance to particular farming approaches peculiar to their village or district. The dissemination to the Nepali farming community was carried out directly through project promotion activities and through established NARC network and activities such as farmer schools. In addition, local media were also targeted for press releases and articles. To inform the scientific community in South Asia, articles and information bulletins have been produced and published.

2. Ensure sustainability of outputs and identify exit strategies.

It was central to the project plan to develop mechanisms that ensured sustainable outputs. It was important that ICM technologies still be used after the lifetime *of* the project. The first indication of success was when farmers told us in various surveys that they would continue with the ICM. Survey information indicates that this is the case with a majority of farmers involved. However, additional indicators of longevity were predicted from the involvement of a seed seller who set up interactions with community based organizations and commercialized the broader distribution of both the seed variety and the technologies by copying our information sheets. We also provided some seed varieties and technological advice to a parallel project working on legume production in rainfed rabi cropping systems via NGO, FORWARD. In some of our target farmers groups, we met with resounding success notably in Lalbandi village, Sarlahi district. In October 2001, we provided approximately 400 farmers with 1.2 kg each, which was enough to produce 1 katha (0.033 ha) each. The total area sown in this year was 13 ha. However in October 2003, the area in Lalbandi sown to chickpea was more than 120 ha indicating that farmers were adopting the technology, were securing their own seed for up-scaling and were expanding their winter cropping remit.

3. Determine impact of activities.

We conducted surveys throughout the project and the results of these surveys are published by Pande et al. (2003 a, b & c) and are presented by Bourai et al. (2005). The studies comprised a 7-day survey of group discussions with 300 farmers and the findings revealed that the impact on livelihoods was substantial with a majority of farmers describing improvements in all aspects of domestic life, although the extent of these impacts depended on the size of holding.

Overall domestic expenditure in the households increased by 45% over the course of the project reflecting farmers' increase in wealth. This extra income allowed the majority of households to increase expenditure on children's education, and purchase of food and medicine. One dramatic change was the number of farmers moving from mud houses to brick houses or even building them from scratch (5-10%). Upto 22% of farmers reported paying off debts. There was also a direct impact on employment with number of days of employment for ICM farmers increasing by 62% compared to non-ICM farmers.

Conclusions

The present study successfully promoted the adoption of crop protection technologies for improving the productivity and reliability of chickpea in smallholder farms in Nepal.

The following factors were understood to influence uptake and adoption:

- The institutional set-up for research and dissemination.
- Available crop protection strategies or technologies.
- Dissemination methods employed.
- Farmer circumstances.

It is evident that the institutional set-up for research and dissemination does exist. In the majority of cases, inadequate resources appear to be a constraint for both research and extension. There is therefore, a need to form partnerships in order to make the technology generation and dissemination process more responsive to farmers' needs. The public, private and NGO sectors, working as service providers together with the farmers, ought to be involved in the research and dissemination process. This would appear to be a feasible arrangement given the dwindling resources for agricultural research and extension.

It is also evident from the present study that the key attribute of any given crop protection technology is demonstrable efficacy and availability of technologies. For that reason, the majority of chickpea producers in Nepal should continue to employ chemical control methods although HNPV is an effective alternative and is described by D Grzywacz in this volume but is not presently generally available. Given the quality associated with chemical control strategy and increasing reports of insecticide resistance, there is an even greater need for establishing HNPV as a widely available alternative.

The present study revealed an array of pathways for disseminating crop protection outputs. NARC appears to have adequate and functional extension systems but the Department of Agriculture (DoA) is the principal extension service in country, and so it is essential that DoA shows commitment to up-scaling the outputs of this project to ensure broad uptake and ultimately poverty alleviation. In terms of strategies for scaling-up, the approach to most likely to succeed would be via the distribution of mini-kits.

The cost of ICM inputs for chickpea/katha are:

Seed (1.5 kg)	NRs 45
Seed treatment components including Rhizobium	NRs 10
Fertilizer (DAP)	NRs 40
Fungicide for BGM	NRs 25
Insecticide for pod borer	NRs 35
Plastic bag (for dry storage of seed for next year)	NRs 10
Information leaflet	NRs 15
Total	NRs 180

References

Bourai VA, Pande S, Neupane RK and Stevenson P. 2005. Farmers' empowerment, soil enrichment and wealth generation through IPM of chickpea in Nepal. *In* Proceedings of a workshop on Policy and Strategy for increasing income and food security through improved crop management of high yielding chickpea in rice fallows in Asia, 17-18 November 2004, Kathmandu, Nepal (Pande S, Stevenson PC, Neupane RK and Grzywacz D, eds.). Patancheru, Andhra Pradesh, India: ICRISAT and Chatham, UK: Natural Resources Institute.

Johansen. 2001. Opportunities for increasing chickpea production in Nepal. Proceedings of the International Workshop on Planning Implementation of on-farm chickpea IPM in Nepal, 6-7 September 2000, Kathmandu, Nepal (Pande S, Johansen C, Stevenson PC and Grzywacz D, eds.). Patancheru, Andhra Pradesh, India: ICRISAT and Chatham, UK: Natural Resources Institute.

Pande S, Bourai VA, Neupane RK and Joshi PK. 2003a. Chickpea production: Constraints and promotion of Integrated Pest Management in Nepal. On-farm IPM of Chickpea in Nepal - 1 , Information Bulletin No. 64. Patancheru, Andhra Pradesh, India: ICRISAT. 32 pp. ISBN 92- 9066-462-2.

Pande S, Bourai VA, Stevenson PC and Neupane RK. 2003b. Empowerment through enrichment. IPM of Chickpea in Nepal-2, Information Bulletin No. 65. Patancheru, Andhra Pradesh, India: ICRISAT. 28 pp. ISBN 92-9066-463-0.

Pande S, Bourai V and Neupane RK. 2003c. Wealth generation through chickpea revolution. IPM of chickpea in Nepal-3, Information Bulletin No. 66. Patancheru, Andhra Pradesh, India: ICRISAT. 36 pp. ISBN 92-9066-464-9.

Pande S and Narayan Rao J. 2001. Integrated pest management of chickpea in mid hills and hillsides cropping systems of Nepal: Progress report of an ICRISAT-NARC collaboration, 2000-2001. Patancheru, Andhra Pradesh, India: ICRISAT. 48 pp.

Pandey SP, Yadav CR, Sah K, Pande S and Joshi PK. 2000. Legumes in Nepal. Pages 71-97 *in* Legumes in rice-wheat cropping systems of the Indo Gangetic plain -Constraints and opportunities (Johansen C et al., eds.) Patancheru, Andhra Pradesh, India: ICRISAT and Ithaca, New York, USA: Cornell, University.

Stevenson PC. 2004. Promoting the adoption of improved and integrated disease and pest management technologies in chickpea by poor farmers in mid hills and hillside cropping systems in Nepal. Final Technical Report, DFID Crop Protection Programme (R7885) (ZA0440). Chatham UK: Natural Resources Institute. 76 pp.

Subba Rao GV, Kumar Rao JVDK, Johansen C, Deb UK, Ahmed I, Krishna Rao MV, Venkataratnam L, Hebbar KR, Sai MVSR and Harris D. 2001. Spatial distribution and quantification of rice fallows in South Asia-potential for legumes. Patancheru, Andhra Pradesh, India: ICRISAT. 316 pp.

Alternative pest control approaches: NPV for pod borer control and its uptake in Nepal

D Grzywacz[1], S Pande[2], NP Khanal[3] and R Maharjan[4]

Abstract

Pod borer is the most serious pest of chickpea in Nepal and its control based upon chemical insecticides alone has met major problems of resistance. There is a clear need for alternative pod borer control techniques. One of the most promising alternative controls is nucleopolyhedrovirus or NPV. This is effective, safe and has been adopted in a number of countries as part of the national pod borer IPM strategy. The chickpea IPM project has conducted evaluations of NPV in Nepal and results show it to be as effective or better than existing chemical control. However, if promotion of NPV in Nepal for pod borer control were to be adopted, a policy for the supply of NPV would need to be developed. Importation is feasible but local production would probably be cheaper. Several models of local production exist including farmer production, village production, state or extension service production and commercial private sector production and these models need to be evaluated for adoption in Nepal. A national system of regulation for NPV would also need to be developed.

Introduction

The pod borer *Helicoverpa* (Heliothis) *armigera* has been shown to be the most serious pest of chickpea in Nepal (Pathic 2001) and is the major pest of legumes, cotton and vegetables in much of South Asia (Reed et al. 1987). The main tool for control of this pest has been the use of chemical insecticides. However, in the last two decades control with chemicals in Asia has become increasingly unreliable and expensive due to the development of resistance to many chemical insecticides (Armes et al. 1992). It is true that new chemical insecticides, "new chemistries," are appearing that should overcome the resistance problem

[1]Natural Resources Institute, University of Greenwich, Chatham, UK.
[2]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[3]Forum for Rural Welfare and Agricultural Reform for Development, PO Box 11, Bharatpur 2, Chitwan, Nepal.
[4]Technical Officer, Regional Agriculture Research Station, Khajura, Nepalgunj, Nepal.

encountered by older chemical groups such as organophosphates, carbamates and pyrethroids. However, these will be much more expensive than the older chemicals and so may be difficult for poor farmers to afford. In addition, there is no evidence that pod borer will not in due course develop resistance to these new chemicals as it did to the older molecules.

There is therefore, an increased interest in and use of alternative biologically based control technologies, either as a replacement for chemical control or as a component for incorporation into an insect resistance management strategy. Most prominent among these options for pod borer is the natural pathogen nucleopolyhedrovirus (NPV) as a biological or biopesticide.

Issues for NPV adoption in Nepal

Nucleopolyhedrovirus (previously known as nuclear polyhedrosis virus) is a member of a naturally occurring family of viruses, the Baculoviruses, which cause diseases of insects and some other arthropods. About 600 species of these viruses have been identified to date (Hunter-Fuijita et al. 1998). NPV are specific insect viruses causing lethal infections in one or more closely related host species. The NPVs have been studied now for over 50 years and all safety reviews have confirmed that they are restricted to their invertebrate hosts and are completely safe for man, domestic animals and plants (OECD 2002). These viruses have been shown to have no effect on beneficial predatory or parasitic insects and are thus compatible with all biologically based IPM approaches that seek to preserve or enhance the natural enemies of crop pests.

NPVs as plant protection agents have been developed into a number of biological pesticides mainly against Lepidoptera in USA, Europe and Asia (Copping 2001). This group includes viruses of key lepidopteran pests such as *Helicoverpa* spp. and *Spodoptera* spp. many of which have become highly resistant to chemical insecticides. In all these species, the respective NPV cause a specific lethal and highly infectious disease of their host insects. The limited evidence from laboratory and on-held resistance is that resistance to NPV is slower to appear than with conventional chemical pesticides, a factor making their use as crop protection agents particularly attractive with those pests such as pod borer that have shown a rapid capacity to develop resistance to new chemicals (Moscardi 1999).

NPV for pod borer has now been developed as a commercial biopesticide by a number of private companies in India (Puri et al. 1997) as well as being produced by state sector producers (Sharma 2004) and similar products have been developed in China (Entwistle 1998) and Thailand (Warburton et al. 2002). A slightly different strain, the H.zeaNPV is now very widely used in Australia for pod borer control on a range of crops (Murray Personal communications).

The *Helicoverpa armigera* NPV or HNPV has been well studied, and following its first record in India in the 1960s, extensive research work has identified it as a very promising control agent for pod borer on a range of crops in India and Nepal (Grzywacz 2001, Grzywacz et al. 2004). Field trials in India have shown that NPV can control pod borer as effectively or better than commonly used pod borer insecticides such as pyrethroids, endosulfan or *Bacillus thuringiensis kurstaki* (Rabindra et al. 1992, Cherry et al. 2000).

Given NPV's demonstrated efficacy for controlling pod borer, should we now consider promoting its adoption in Nepal and what problems and constraints will such a strategy face?

First, we have to confirm that HNPV is technically effective in controlling pod borer when used in Nepali farming systems and ideally it should be better than existing chemical insecticides in controlling pod borer. Field trials carried out in Nepal in 2003 confirmed that NPV was more effective than the standard insecticide Thiodan (Stevenson 2004) on both traditional and new high yielding varieties of chickpea (Fig. 1). These trials also tested the use of promising adjuvants that had been suggested could improve the persistence and kill with NPV These had been tested in the laboratory with promising results. However

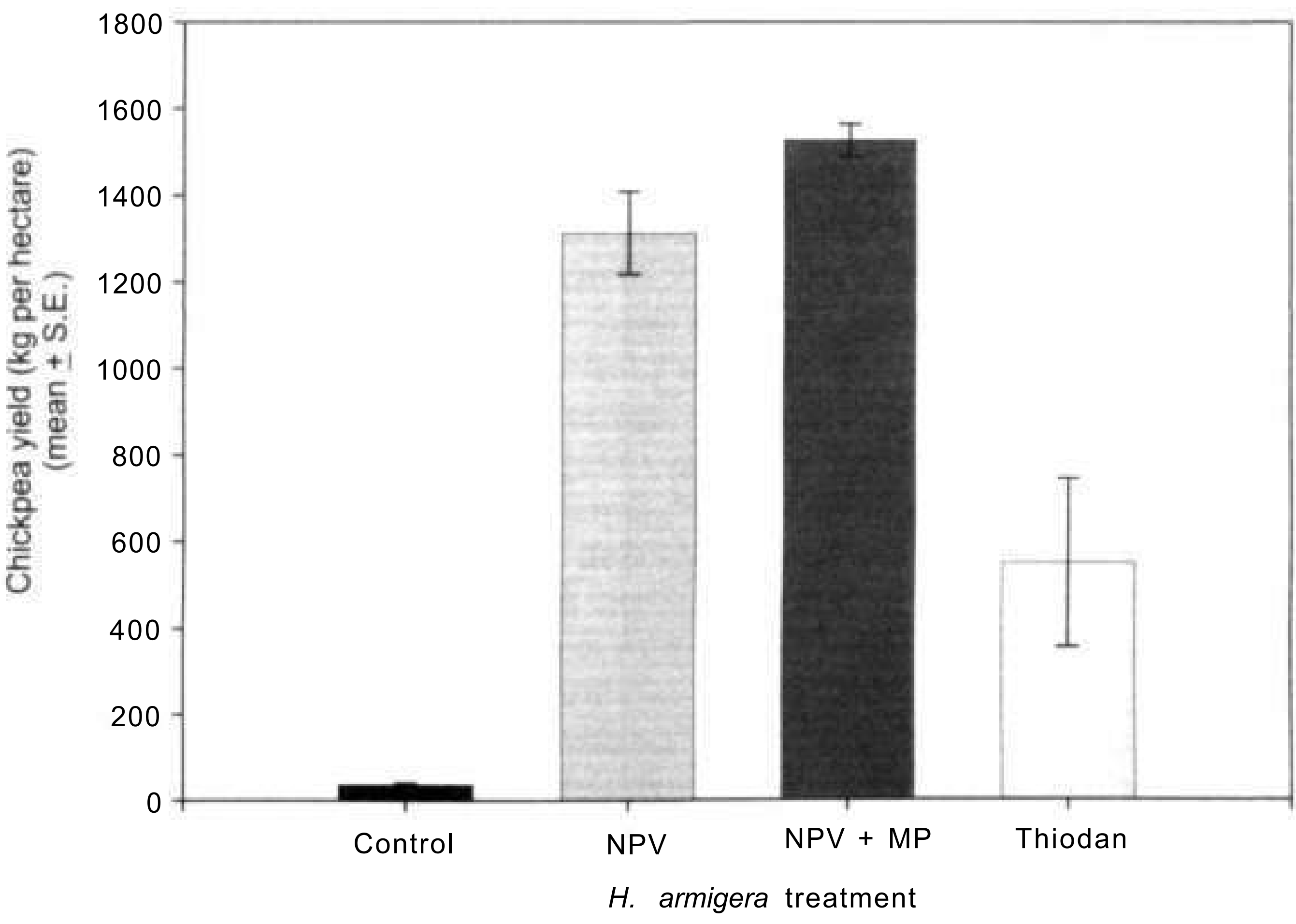


Fig. 1. Chickpea yield results from on-station trials of IPM packages with Avarodhi variety of chickpea, Rantpur, 2003.

field trials in Nepal with the best of adjuvants gave results generally no better and often worse than with unformulated NPV, and so their use cannot yet be recommended as standard (Stevenson 2004).

Secondly, we must ascertain if farmers will happily adopt this technology. This will require NPV performing to farmers' satisfaction and being available at a cost acceptable to them. Trials carried out as single replicate split plot trials with farmers evaluating HNPV in Nepal were also carried out in 2003 and these also showed the NPV as good as or better than the standard insecticides (Fig. 2). These trials need to be continued to gather additional efficacy data and the results could provide data for eventual registration of NPV Such station trials should be focused on areas where resistance to chemical insecticides is already reported as this is where the need for alternative control is most acute.

Most farmers prefer broad-spectrum insecticides because they are fast acting and can be used on a variety of crops. A specific control such as NPV is less attractive to farmers unless the broad-spectrum chemical alternatives are failing due to resistance, thus becoming unreliable and making chemical control too expensive. The use of NPV for pod borer control is being adopted by farmers in India and Thailand primarily, where chemical resistance is a

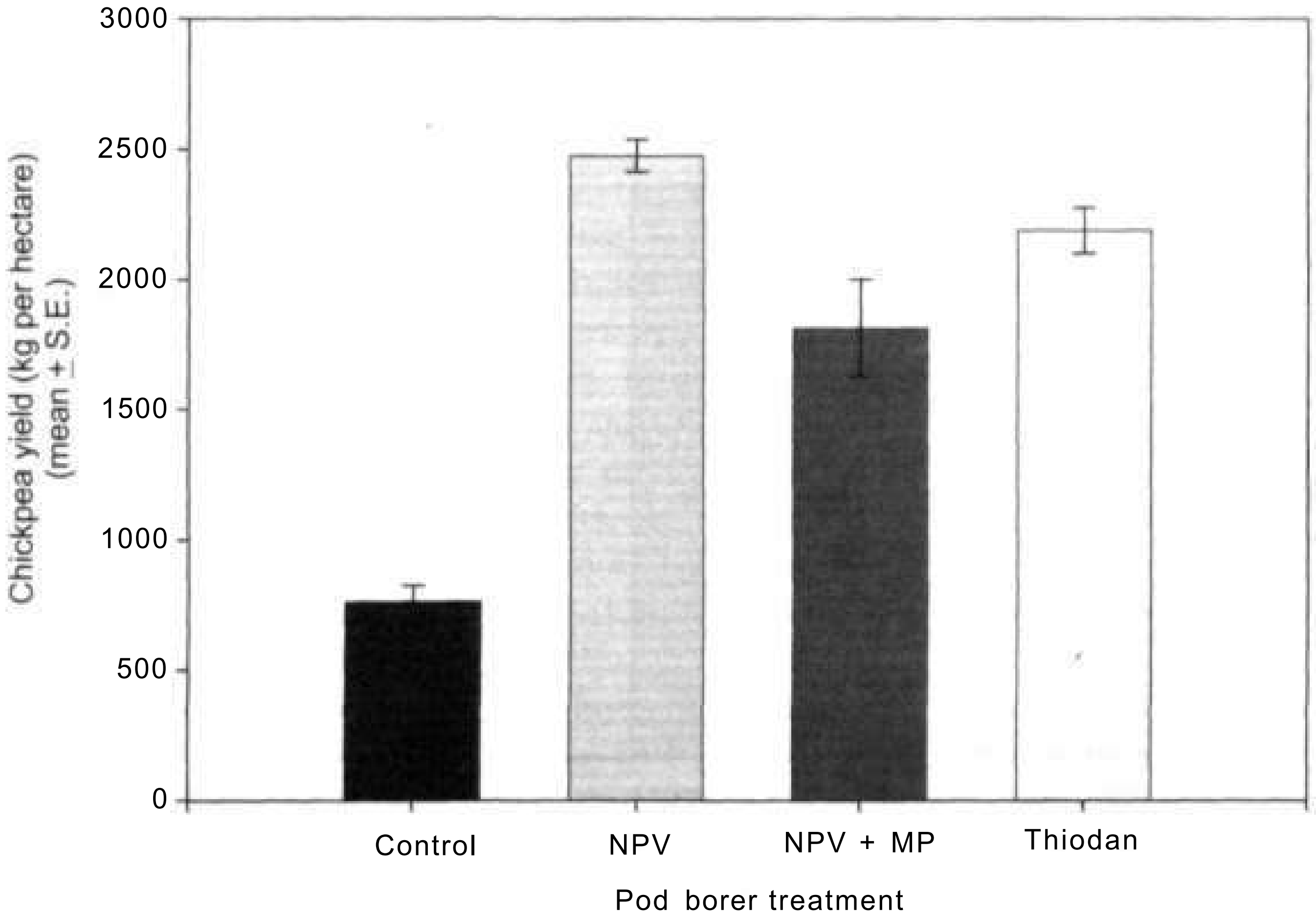


Fig. 2. Chickpea yield results from on-farm trials of IPM packages with Avarodhi variety of chickpea, Bardia, 2003.

serious problem. Reports of resistance to chemicals by pod borer causing failure of control were recorded from western Nepal in 2003 in districts adjacent to major cotton-growing areas. This pattern of insecticide resistance in pod borer often arises first in cotton growing areas and is very common in India as the overuse and misuse of insecticides on cotton is widespread and is a powerful driver of resistance in *H. armigera.*

The way forward in evaluating NPV for technical and farmer acceptance is to carry out trials initially with farmers in areas where chemical resistance is reported as a serious problem such as the Western Terai as part of on-station and on-farm trials along the lines of mother-baby trials.

A problem with getting farmers to adopt NPV insecticides is that they do not have the rapid kill associated with synthetic insecticides. As this is not observed with specific biological insecticides such as NPV, farmers find it initially disconcerting and see it as "evidence" of lack of action. The widespread kill of non-target arthropods may be perceived as an indication of an insecticide's potency. A specific biological insecticide such as NPV only produces visible evidence of corpses of target pests some days after application, typically 3-7 days when the infection cycle has been completed. It is important that farmers are educated to understand that in the meantime, NPV is not inactive but that by inducing illness, it causes a cessation of damage. Also, that by multiplying in the host NPV is capable of propagating and increasing its impact by spreading to new hosts and persisting in the system. It must be recognized that getting farmers to adopt a wait-and-see attitude to NPV and ignoring the absence of immediate impact is crucial if they are to accept its use. This in turn stresses the need for promotion of a biological insecticide such as NPV to be supported by adequate information and knowledge.

A program of NPV trials will need technical support, which should be provided by suitably trained staff from a NARC research station, extension staff or from a project NGO. On-station and on-farm trials of NPV carried out in an earlier phase of the project gave positive results and indicated that this technology can work in Nepal. To support a program for the adoption of NPV in Nepal, there will be a need to develop capacity in NPV technology. This has already begun as collaboration between ICRISAT and some NGOs but some development of research capacity with NARC would also be advisable. Training for extension workers should cover identification of pests, mode of action, quality control, bioassay protocols, field trials and production of NPV While good training material in these techniques is available (Hunter-Fujita 1998, Grzywacz et al. 2002) adequate training with competent experts is highly desirable for such staff.

Local production and regulation of NPV in Nepal

The adequate supply and relative cost of NPV will be a significant issue in Nepal. HNPV products for the trials in Nepal were obtained from companies in India and a large number of NPV products are available from research organizations or commercially (Sharma 2004). However, this may not be the most cost effective or acceptable strategy in the long term. An alternative would be to establish production of NPV in Nepal as this would probably lower costs and increase availability.

One of the attractions of NPV is that its production is not a technically complex process like the synthesis of chemical insecticides. NPV is produced by infecting live host insects in the early larval stage, then rearing them while the infection develops. In appropriately infected larvae, the NPV multiplies within seven days producing 2000-5000 million infectious NPV particles or occlusion bodies per larvae. Homogenizing 200-500 such larvae is enough to produce a suspension of NPV sufficient to treat one hectare of crop. These larvae can be reared on either freshly collected plant material, soaked chickpeas or an artificial diet sprayed or soaked in an inoculating solution of NPV. Rearing facilities can be simple involving rearing trays or containers in which to hold larvae while the infection develops and the NPV multiplies. An example of a low cost model system is one developed by Dr GV Ranga Rao of ICRISAT where all the equipment to set up a pilot unit costs about $450. A number of other similar systems for NPV propagation in developing countries have been previously described (Hunter-Fujita et al. 1998; Moscardi 1999, Grzywacz et al. 2002).

Thus, setting up NPV production in Nepal is feasible if local demand patterns and economics make this the most attractive option. NPV could be produced by local research institutes, or NGOs might become involved in such production as happens in some areas in India. In India, state sector producers either as part of commodity boards, state governments or the central government, play a major role in the supply of biological pesticides such as NPV and fungi (Sharma 2004).

Another option for mass production is for it to be undertaken by small to medium enterprises either devoted to biological plant protection products or as an offshoot of established agro enterprises. The development of such companies has often followed the transfer of the technology from pilot producers in the state sector to local companies once the success of an NPV product has been established and a market created. This has been seen in South America, Asia and now Africa (Moscardi 1999, Warburton et al. 2002).

In India, there have also been initiatives to start farmer or community-based production of NPV (Anon 2004). The concept here is that village production is the only way to allow poorest farmers' access to the technology, as this approach reduces costs as well as simplifying the supply chain. This is an interesting system potentially attractive for supply in Nepal as it produces NPV at minimal cost where it is needed. Some start up costs and technical support from NGOs or other extension organizations are essential in the establishment phase. However, the economic sustainability of these farmer/ village production models has questioned, as has product quality (Tripp and Ali 2001). So, the long-term viability of this system would need to be established before its widespread adoption was promoted.

Buying in NPV from India or producing locally may both pose significant quality problems. Early production in India was marked by uneven product quality and subsequent control failures (Kennedy et al. 1998), a problem by no means restricted to India (Warburton et al. 2002). Quality assessment of NPV is not technically complex but it does need to be carried out to internationally acceptable standards (Jenkins et al. 2000). A solution to this challenge would be to develop in Nepal expertise capable of conducting quality assessment of locally produced or imported NPV Such a central quality laboratory could be set up in Nepal as part of a national policy of NPV building capacity.

This brings us to the need to develop suitable regulation and registration policies for Nepal to ensure NPV products are safe and effective. On safety, the evidence is that NPV is completely safe, a judgment confirmed in a recent major independent survey commissioned by the OECD (OECD 2002). However, poor quality production can result in significant bacterial contamination of NPV products and it is conceivable that highly contaminated products may pose a microbiological hazard (Grzywacz et al. 1997), though as yet no actual cases have been reported in the literature. If NPV is to be promoted, there is therefore a strong case for developing quality control (*QC)* mechanism in Nepal and to carry out monitoring to ensure that NPV products imported or produced in Nepal are safe. As mentioned above, during the rapid expansion of NPV production in India in the late 1990s, a number of organizations produced NPV that was substandard. While these were not unsafe, they were sometimes not reliable and could lead to a loss of confidence by users. Developing NPV QC capacity in Nepal would thus serve not only to resolve safety issues but also address this quality issue.

Any policy on regulating NPV may need to cover village or farmer production as well as commercial production and importation. The implications and requirements of a policy for biopesticides such as NPV are too many to be addressed in detail here, but reference to the models developed in other countries of Asia and Africa can illustrate the issues and possible solutions in detail (Pawar 2001, Grzywacz 2004). It should be noted that aid donors (USAID, DFID) have been very supportive of policy initiatives by developing countries that serve to overcome bottlenecks to the adoption of new and safer crop protection technologies.

Overall, there is a need to develop a favorable regulatory environment, if the development of new locally produced biopesticides is not to be discouraged. Unnecessarily expensive or over complex registration procedures if adopted will only impede the development of biopesticides, as these biopesticides are usually developed by small local organizations lacking the resources of major international chemical companies. In a number of Asian countries such as Thailand and India, local production of NPV by research institutes, extension services, farmers and communities was not subject to formal registration procedures. This stimulated the development of NPV for pod borer control and did much to facilitate its adoption by farmers, so creating a market for suppliers. A similar approach in Nepal might well be a suitable option.

Conclusions

1. NPV is a potential safe sustainable solution for pod borer control in Nepal.
2. NPV should be further promoted in trial areas for large-scale participatory evaluation by farmers.
3. Local research capacity in NPV use, quality control and production should be developed within an appropriate organization.
4. Initially imported material could be used for trials, but if acceptance is good, local production using appropriate public/NGO/private sector models of supply should be developed.
5. A regulatory policy to cover biopesticides for Nepal needs to be developed by the responsible agency.

One strategy might be to develop an NPV capacity in Nepal by training local scientists in NPV production, use, quality control and regulation. These could start by collaborating in farmer trials of NPV and if these are successful and a market for the NPV is created, they could go on to start local production. This could be done at a research center or field station by using one of the low input production systems similar to those promoted by ICRISAT. After evaluation, they would then transfer this technology to a local NGO, a community organization or local private business as judged most appropriate.

References

Anon. 2004. Tradition and science join forces to beat pests. Appropriate Technology, 31: 1.57-59 pp.

Armes NJ, Jadhav DR, Bond GS and King ABS. 1992. Insecticide resistance in *Helicoverpa armigera* in South India. Pesticide Science, 34, 355-364.

Cherry AC, Rabindra RJ, Grzywacz D, Kennedy and Sathiah R. 2000. Field evaluation of *Helicoverpa armigera*-NPV formulations for control of the chickpea pod-borer,

***H. armigera* (Hubn.),** on chickpea (*Cicer arietinum* var. Shoba) in southern India. Crop Protection, 19, 51-60.

Copping L. 2001. *The Biopesticides Manual Second Edition.* British Crop Protection Council, Farnham, UK. 525 pp.

Entwistle PR 1998. A world survey of virus control of insect pests: People's Republic of China. *In* Insect viruses and Pest Management (Hunter-Fujita FR, Entwistle PF, Evans HF and Crook NE, eds.).

Hunter-Fuijita FR, Entwistle PF, Evans HF and Crook NE. Eds. 1998. Insect viruses and pest management. Wiley, Chichester. 620 pp.

Grzywacz D, Richards A, Rabindra RJ, Saxena H and Rupela OP. 2005. Efficacy of biopesticides and natural plant products for *Helicoverpa armigera* control. *In* Proceedings of an ICRISAT-ICAR workshop on *Helicoverpa* management: The journey ahead (Sharma HC, ed.). 18-22 December 2001, ICRISAT, Patanchcm. In press.

Grzywacz D. 2004. Development and registration of biocontrol agents in India and Thailand. *In* Registration for biocontrol agents in Kenya, (Wabule MN, Ngaruiya PN, Kimmins FK and Silverside PJ, eds.). Proceedings of a workshop supported by PCPC, KARI and DFID-PSP, 14-16 May 2003, Nakuru, Kenya. Nairobi, Kenya: KARI/PCPB and Aylesford, UK: Natural Resources International Ltd. 101-110 pp. ISBN: 0-9546452-2-7.

Grzywacz D. 2001. Nucleoployhedrovirus: potential in the control of pod borer on chickpea in Nepal. *In* On-farm IPM of chickpea in Nepal: Proceedings of the International Workshop on Planning implementation of On-Farm Chickpea IPM in Nepal (Pande S, Johhansen C, Stevenson PC and Grzywacz D, eds.). 6-7 September 2000, Kathmandu, Nepal. Patancheru, Andhra Pradesh, India: ICRISAT and Chatham, UK: Natural Resources Institute. 94-98 pp. ISBN: 92-9066-438-X.

Grzywacz D, McKinley D, Jones KA and Moawad G. 1997. Microbial contamination in *Spodoptera littoralis* nuclear polyhedrosis virus produced in insects in Egypt. Journal of Invertebrate Pathology, 69, 151-156.

Grzywacz D, Rabindra RJ, Brown M, Jones KA and Parnell M. 2002. The *Helicoverpa armigera* NPV production manual. NRI Report 2706, University of Greenwich, Chatham. 130 pp.

Jayaraj S, Rabindra RJ and Santharam G. 1987. Control of *Heliothis armigera* (Hubner.) on chickpea and lablab bean by nuclear polyhedrosis virus. Indian Journal Agricultural Science 57, (10), 738-741.

Jenkins NE, Grzywacz D and Collins SA. 2000. Quality control-assurance of product performance. Biocontrol Science & Technology 10, 753-777.

Kennedy JS, Rabindra RJ, Sathiah N and Grzywacz D. 1998. The role of standardisation and quality control in the successful promotion of NPV insecticides. *In* Biopesticides and Insect Pest Management (Ignacimuthu S and Alok Sen, eds.). New Delhi, 1999. 170-174 pp.

Moscardi F. 1999. Assessment of the application of baculoviruses for control of Lepidoptera. Annual Review of Entomology 44: 257-289.

OECD. 2002. Consensus document on information used in assessment of environmental applications involving baculoviruses. Series on harmonisation of regulatory oversight in biotechnology No. 20. ENV/JM/MONO(2002) I OECD. Organization for Economic Cooperation and Development, Paris, France.

Pathic DS. 2001. Constraints and opportunities for sustainable chickpea production. *In* On Farm IPM of Chickpea in Nepal (Pande S, Johanson C, Stevenson PC and Grzywacz D, eds.). Patancheru, India: ICRISAT. 48-50 pp. ISBN: 92-9066-438-X.

Pawar AD. 2001. Procedures for registration of biopesticides an Indian perspective. *In* Augmentative biocontrol: Proceedings of an ICAR-CABI Workshop (Singh SP, Murphy ST and Ballal CR, eds.). 191-200 pp.

Puri SN, Murthy KS and Sharma OP. 1997. Resource Inventory for IPM -I, National Centre for Integrated Pest Management, ICAR, New Delhi.

Rabindra RJ, Sathiah N and Jayaraj S. 1992. Efficacy of nuclear polyhedrosis virus against *Heliothis armigera* (Hubner) on Helicoverpa resistant and susceptible varieties of chickpea. Crop Protection, 11, 320-322.

Reed W, Cardona C, Sithinantham S and Lateef SS. 1987. Chickpea insect pests and their control. *In* The chickpea (Saxena MC and Singh KB, eds.). Wallingford, UK: CAB International. 283-328 pp.

Sharma MC. 2004. Biorationals in Indian Agriculture. *In* Enabling small and medium enterprises to promote pheromone based pest control technologies in South Asia; Proceedings of a project workshop, 25-26 May 2004, Bangalore, India (Cork A, Jayanth PK and Narasimhan S, eds.). Chatham, UK: Natural Resources Institute. 88-91 pp.

Stevenson PC. 2004. Final technical report on promoting the adoption of improved and integrated disease and pest management technologies in chickpea by poor farmers in mid hills and hillside cropping systems in Nepal. DFID CPP Project R7885 (ZA0440).

Tripp R and Arif A. 2001. Farmers access to natural pest products: experience from an IPM project in India. Agriculture and extension network paper 113.

Warburton H, Ketunuti U and Grzywacz D. 2002. A survey of the supply, production and use of microbial pesticides in Thailand. NRI Report 2723. University of Greenwich, Chatham. 100 pp.

Farmers' empowerment, soil enrichment and wealth generation through chickpea-IPM in Nepal

VA Bourai[1], S Pande[2], RK Neupane[3] and PC Stevenson[4]

Abstract

IPM for chickpea is a sustainable development model developed and implemented in Nepal by DFID, NRI, ICRISAT and NARC. It has positively affected soil fertility, human health and aided income generation for the poor. The study was conducted with the help of PRA, RRA techniques. The results suggest that IPM-chickpea has brought about a revolution in study villages. The empirical studies on chickpea-IPM cultivars show that the technology is an effective tool for eradicating hunger in Nepal's Terai region. The resulting starvation is prevented by systematically recreating a minimum level of incomes and entitlements. The project has proved that in the short run something effective can be done to remedy these desperate situations.

The production of chickpea will lead to higher yields of paddy; restoration of soil health and fertility; increase in human nutrition and reduce consumption of fertilizers; import substitution and exports promotion; reduction in poverty, through wealth generation and social upliftment, besides creating opportunities for development in Nepal. This project has provided food and nutritional security to farmers.

The IPM-chickpea model can be replicated elsewhere in the world where the same agroecological features exist.

Introduction

Chickpea is the most preferred pulse crop in Nepal. The production in Nepal had been declining before IPM intervention mainly because of BGM and pod borers (*Helicoverpa armigera*). The epidemics brought down chickpea production drastically in the Central and Eastern Terai of Nepal. The viciousness

[1]Department of Economics, SGRR (PG) College, Dehradun, Uttranchal, India.
[2]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[3]Nepal Agricultural Research Council (NARC), Rampur, Chitwan, Nepal.
[4]Natural Resources Institute, University of Greenwich, Chatham, ME4 4TB, UK.

of their combined attack made it very difficult to rehabilitate chickpea farming in Nepal. The farmers became poorer due to repeated crop failure and shied away from taking further risks.

ICRISAT and NARC have reversed this trend by using Improved Pest Management technology, which changed the economics of the crop. A large number of marginal and poor farmers participated and learned technologies to avert the risk of the crop failure and improve their livelihoods.

Nepal has the lowest per capita income among the SAARC nations. Opportunities for employment on rural farms and in non-farm sectors are limited. Agriculture engages 81% of the rural population and the pace of transfer of labor from agriculture to non-agriculture sectors is slow. The lack of adequate opportunities in agriculture causes many social problems such as mass migration to agriculturally prosperous areas, to cities and outside the country. Since 1995-96, Nepal's import bill for food has been rising. The introduction of the IPM package has helped the farmers use rice and maize fallow lands and encouraged them to graduate to crops that are more remunerative.

Land holdings in Nepal are very small and marginal: approximately 89% are uneconomic; 8.4% are medium and only 2.6% belong to the large category[1] (Fig.1). Nepal is a small country and 50.3% of its population lives below the poverty line. It is ranked as the poorest country in the world on the development indicators of the World Bank[2] (Fig. 2).

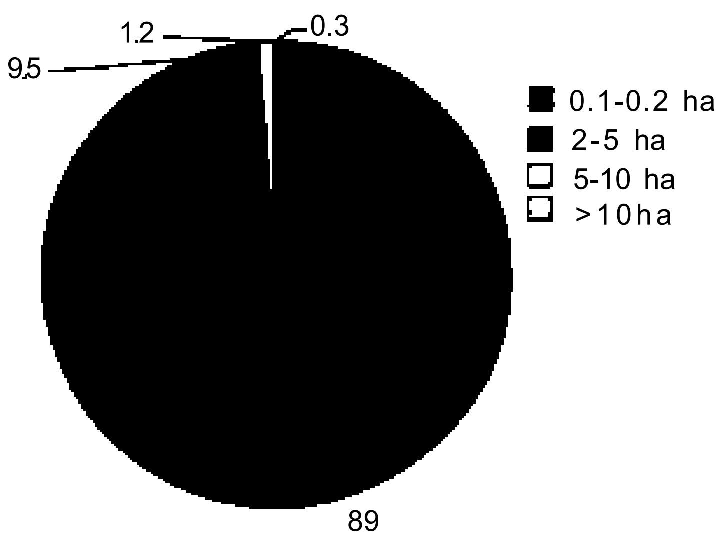


Fig. 1. Size of landholding in Nepal, 1991-92.

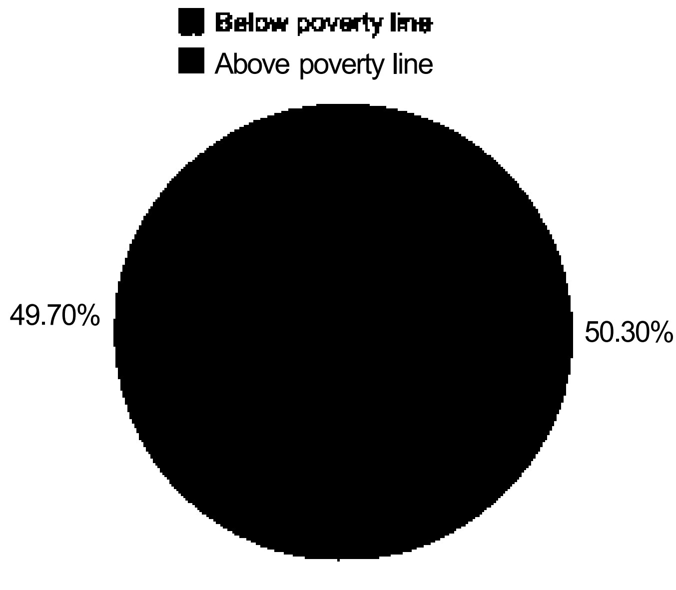


Fig. 2. Population below poverty line in Nepal.

To address this issue and help chickpea farmers, ICRISAT and NRI, in collaboration with NARC, have launched an aggressive program in the Terai region. The initiative was supported and funded by DFID. The aim of this program was to raise chickpea productivity through technology intervention

[1]Central Bureau of Statistics, HMG Nepal. 2002.
[2]World Development Report, Washington DC, The World Bank, 1991.

and improve the economic well being of chickpea producers. The objective of this study is to analyze the impact of IPM on livelihood of farmers (Fig. 3).

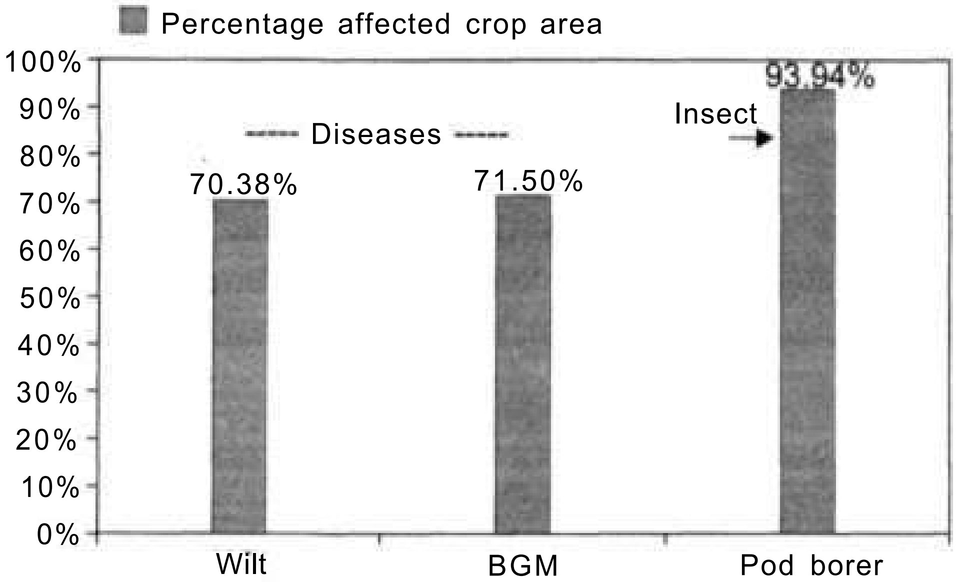


Fig. 3. Damage due to biotic constraints.

Methodology

Nepal is bounded by China in the north and India in the east, south and west. The east-west length of the country is 800 km and the width varies between 130 and 240 km (Fig. 4). The whole Nepal Terai adjoins the Indian Terai and is

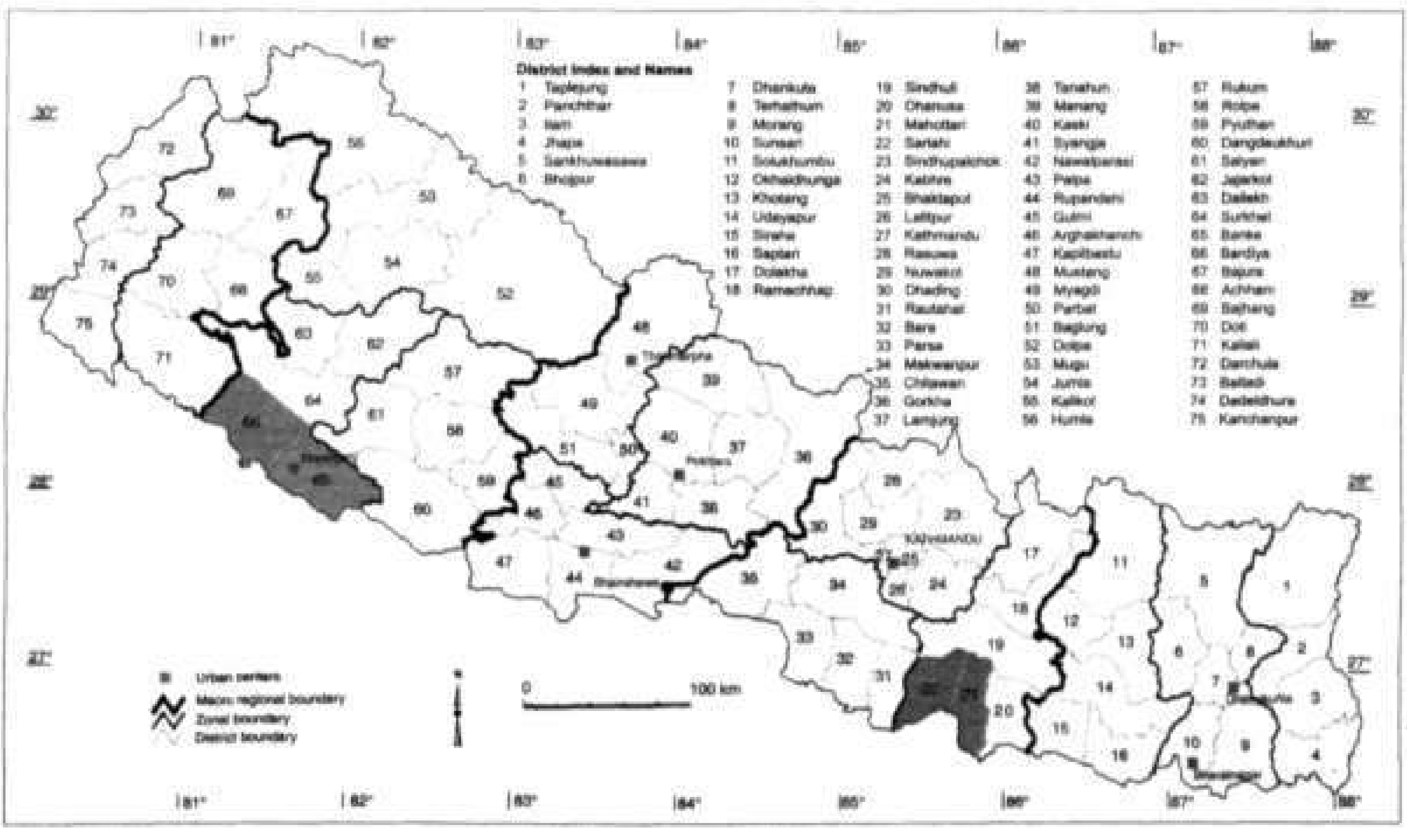


Fig. 4. Administrative divisions (districts) and major urban centers in legume-growing areas of Nepal.

the most fertile and productive belt in Nepal. Agriculture in the Nepalese Terai is deteriorating in the absence of appropriate products and a favorable policy environment.

The districts Bardia, Banke, Sarlahi and Mahottari were selected for the impact study on livelihood. These districts are situated in the midwest and central economic development regions of Nepal. The land area of the Terai is 23% of the total area, but accounts for 52% of the total cultivated land of the country (Manandhar and Shakya 1996). It is a narrow belt of 50 to 20 km in breadth, while its length stretches along the entire length of the country. The slope or gradient ranges from 2-10 m/kilometer.

Sampling

The data was recorded randomly from selected farmers. The study groups were:

1. Contact farmers of ICRISAT/NARC.
2. Non-contact chickpea growers.

Considerable time was devoted to each farmer to elicit personal data. The number of respondents contacted by NARC/ICRISAT was 200 in both the regions. To obtain unbiased results, 50 non-contact farmers (growing chickpea, but not using IPM) were also selected for the study (Table 1).

Table 1. Number of sample households in Nepal.

Eco-Regions	Districts	Villages	Contact farmers	Non-contact farmers
Mid-west region	Bardia	Munal Basti	40	10
		Kurvinpur	18	-
		Kamalpur	-	10
	Banke	Betehni	6	-
		Dhaulagiri	-	10
		E-Gaon	2	-
		D-Gaon	32	-
Central region	Sarlahi	Lalbandi	52	-
		Jabdik	-	10
	Mahottari	Bardibas	50	10
Total			200	50

Source: Field survey 2003

Data

The respondents were asked to fill in a questionnaire pertaining to livelihood impact in an exercise of participatory learning. The selected respondents were the decisionmakers who were later interviewed. The questions quantified the impact of IPM technologies on the farmers' livelihood. The research team, trained in Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA), worked on a one-to-one basis (ie, with individual farmers) for data collection.

Income generation

The use of IPM has increased family income in both the mid-west and central regions. The respondents from lower levels of income from agriculture (0-20%) were 18 percent of the sample before IPM use. This figure came down to 9% after 1PM use, while 41 percent respondents reported that their family income had nearly doubled (80-100%), which had been only 18 percent before IPM use. IPM has brought about more uniform and consistent income growth, and appeared to have greater impact in the central region compared to the mid-western region (Table 2).

Table 2. Family income from agriculture.

	Mid-west region		Central region	
Income	Before IPM	After IPM	Before IPM	After IPM
0 - 20%	18%	09%	12%	-
20 - 40%	20%	16%	24%	09%
40 - 60%	18%	18%	33%	07%
60 - 80%	26%	16%	14%	36%
80- 100%	18%	41%	17%	48%

Source: Field Survey, June 2003.

The percentage share of family income from chickpea among the 0-20 percent class of farmers before IPM was 70% in mid-west region, which changed to 37% after IPM. In the changed scenario from the 80-100% class, 4% respondents' income rose. Chickpea has become a vehicle of economic development in the central region (Table 3).

Impact on consumption

The dietary contribution of chickpea also showed positive results in the mid-western region. In approximately 80% of respondents, intake of chickpea had increased (Table 4).

Table 3. Family income from chickpea.

Class	Mid-west region		Central region	
	Before IPM	After IPM	Before IPM	After IPM
0 - 20%	70%	37%	63%	12%
20 - 40%	16%	35%	24%	25%
40 - 60%	11%	15%	08%	30%
60 - 80%	03%	09%	05%	18%
80-100%	-	04%	-	15%

Source: Field Survey, June 2003.

Table 4. Dietary contribution from chickpea.

Class	Mid-west region		Central region	
	Before IPM	After IPM	Before IPM	After IPM
0 - 20%	55%	20%	68%	02%
20 - 40%	43%	45%	30%	43%
40 - 60%	02%	30%	02%	40%
60 - 80%	-	05%	-	10%
80-100%	-	-	-	05%

Source: Field Survey, June 2003.

Impact on production

The respondents had shown preference for the crop due to low labor, low returns, high yield, as well as its nitrogen fixation quality (Table 5).

Table 5. Reasons for crop preference.

Reasons	Mid-west region	Central region
Low labor input	23%	15%
Low cost input	27%	15%
High yield	27%	58%
Benefits for soil/land	23%	12%

Source: Field Survey, June 2003.

Crop preference for profit

In the mid-western region (MWR), rice and wheat are the most preferable crops (although not the most profitable, because these cereals are the staples). Among the five most important crops, chickpea was most profitable. In the central region (CR), farmers chose chickpea as the most preferred and profitable crop (Table 6).

Table 6. Crop preference for profit.

	Preference (%) (Top 5)									
	Mid-west region					Central region				
Crops	1	2	3	4	5	1	2	3	4	5
Rice	64	02	09	14	05	23	14	20	08	02
Wheat	02	41	09	07	09	-	04	06	04	06
Maize	02	-	-	04	04	-	10	04	10	04
Pigeonpea	04	14	14	11	04	-	06	10	18	14
Chickpea	18	16	37	11	04	37	33	10	04	04
Lentils	04	20	14	34	16	-	04	04	10	12
Black gram	-	-	02	-	02	-	-	-	-	-
Grass pea	-	-	-	-	04	-	-	-	-	-
Vegetables	-	04	09	09	09	31	08	14	12	02
Others	-	-	02	02	14	02	04	02	-	06

Source: Field Survey, June 2003.

Crop preference for food

After IPM, many farmers reported choosing chickpea as the second most preferred crop (Table 7).

Impact on housing

Chickpea cultivation has had a major impact on the housing sector. In MWR, 64% households had thatched mud houses. Post-IPM, this has come down to 44%. The percentage of brick and mortar houses before IPM was 38%, but went upto 60%. In CR, 82% households had thatched mud houses, which came down to 67%. On the whole, 7% respondents in MWR and 10% in CR were able to construct new houses (Fig. 5 and 6).

Table 7. Crop preference for food.

	Preference (%) (Top 5)									
	Mid-west region					Central region				
Crops	1	2	3	4	5	1	2	3	4	5
Pigeonpea	52	11	14	02	04	48	22	12	02	-
Chickpea	16	43	30	02	02	40	40	10	06	-
Lentils	18	36	39	02	-	04	-	22	20	16
Black gram	-	02	02	14	04	-	06	12	08	24
Grass pea	-	-	02	07	04	02	02	04	08	02
Vegetables	07	04	09	41	07	06	08	14	24	10
Others	02	-	02	16	30	-	08	06	02	06

Source: Field Survey, June 2003.

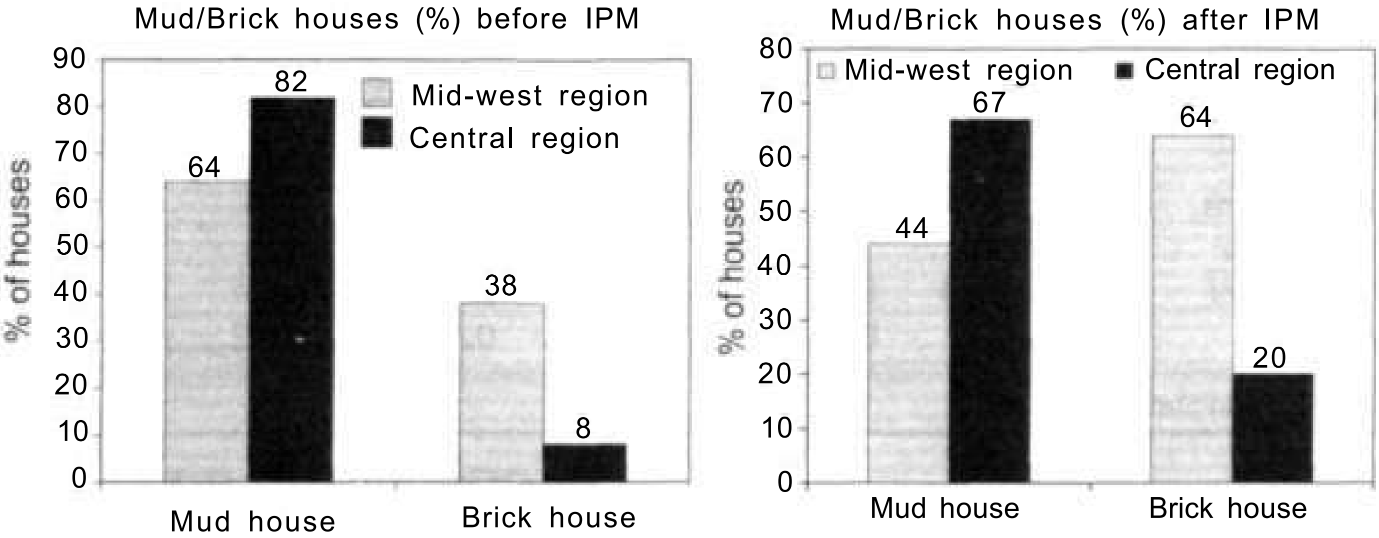


Fig. 5 and 6. Mud/brick houses % change in study area.

Spending of chickpea earnings

Chickpea has become a very important source of earning in regions. According to farmers, it fetches the highest profit in terms of cash. In MWR, 56% farmers have reported increased incomes available for household expenses. These respondents are now able to buy groceries in ample quantities. They also have electricity in their houses. Apart from these, they are spending more on medicines and healthcare. In CR, 26% farmers reported similar results. In MWR, 4% farmers have paid back former debts. In CR, 22% farmers were able to discharge debts (Fig. 7). The most important trend is that 11% farmers in the mid-west are purchasing new improved chickpea seed called Avarodhi, while 13% are doing so in the central region with their enhanced income.

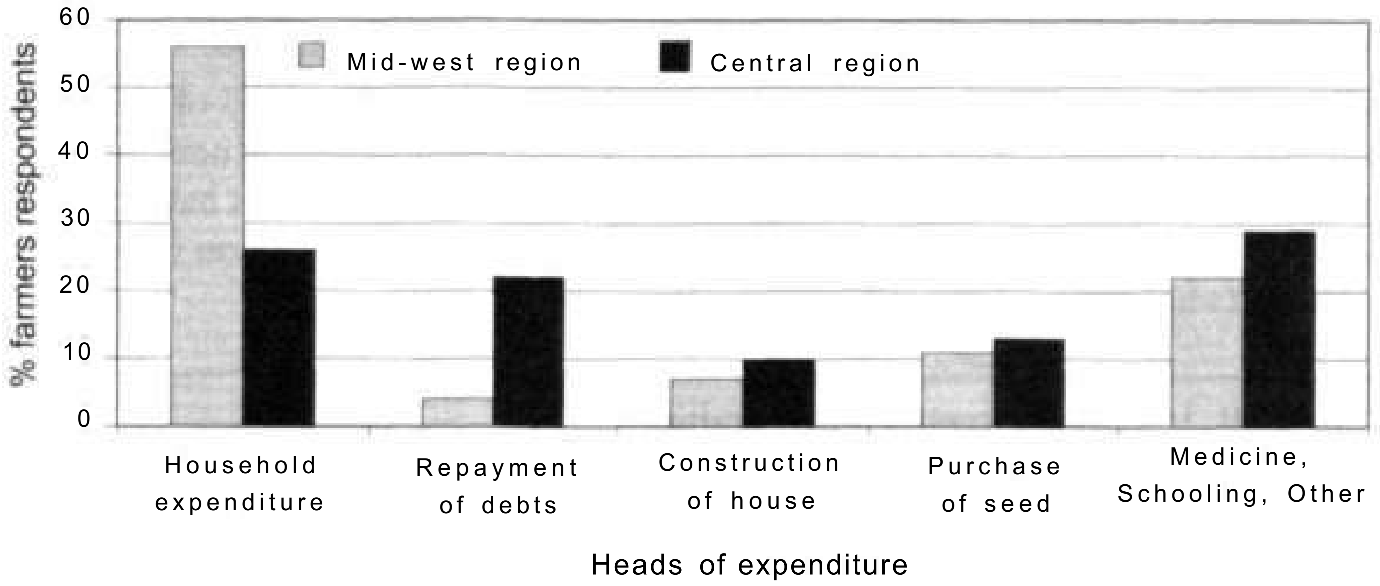


Fig. 6. Change in household expenditures after IPM.

Table 9. Change in household expenditure after IPM.

Expenditures	% Change after IPM	
	Central region	Mid-west region
School education	80	51
Wedding expenses	59	57
Clothes expenditure	49	25
Social/family expenditures	33	*66*
Agriculture technology	27	23
Medicines	20	30
Overall average change	45	42

Source: Field survey, 2003.

IPM technologies have made major changes in the expenditure pattern of the farmers. In CR, there has been 80% increase in expenditure on children's education, while the figure is 51% for MWR.

Increase in expenses on weddings is 59%) and 57 % in central and mid-west regions, respectively. Expenditure on clothes has increased by 49% in CR and 25% in MWR. Social/family-related expenditure has increased by 33% in CR and *66%* in MWR. However, increase in expenditure on agriculture technology has been 23% in both regions. The allocation for healthcare and medicine has risen by 20% in CR and 30% in MWR (Table 15). The cumulative increase is 45% in CR and 42% in MWR. Assuming the annual rate of inflation at 5%, farmers' income and expenditures have increased three-fold in three years in real terms (2000-2003).

Impact on livestock ownership

Chickpea income has also marginally changed livestock ownership of chickpea farmers in Nepal. About 14% in CR and 16% in MWR more farmers are able to buy oxen. Similarly, 20% more farmers in CR and 10% in MWR have bought milch cattle. A few have also started small dairies, while possession of poultry and goats has gone up as well (Table 10).

Table 10. Impact on livestock ownership.

	% Change in purchasing of livestock in Nepal	
Livestock	Central region	Mid-west region
Oxen	14	16
Milch cattle	20	10
Poultry	6	30
Goats	42	11

Source: Field survey, 2003.

Impact of chickpea on wealth generation

Economic benefits for farmers can be calculated from various angles: A benchmark survey in December 2000 found that CR had no improved varieties of chickpea. But IPM-Chickpea has reversed the trend, and now an average household seed transaction is about 127 kg of Avarodhi. Farmers are selling seed to other farmers and also to national NGOs @ NRs 27/kg. Even if only 10% of chickpea farmers transacted such quantities of seed, the seed economics would generate benefits equaling NRs 68,580.00. If adoption of IPM and improved seeds spreads at the same rate then chickpea cultivation has even greater potential to generate wealth.

Consumption and sale of surplus product

Chickpea farmers sell surplus produce to others. A three year average shows us that per katha output of chickpea is 50 kg. On average, a land holding of 10 kathas translates to 500 kg per farmer. If farmers sell half of the produce at NRs @27/kg, 5000 kg chickpea pumps in an additional 1.35 lakh rupees into the village economy. Apart from the 50 kg of chickpea that is retained for family consumption, this is equivalent to savings of NRs 1500/family. Even if only 10% families are taken into account, the savings work out to NRs 30,000 per year. One chickpea-IPM benefit model is presented in Fig. 8.

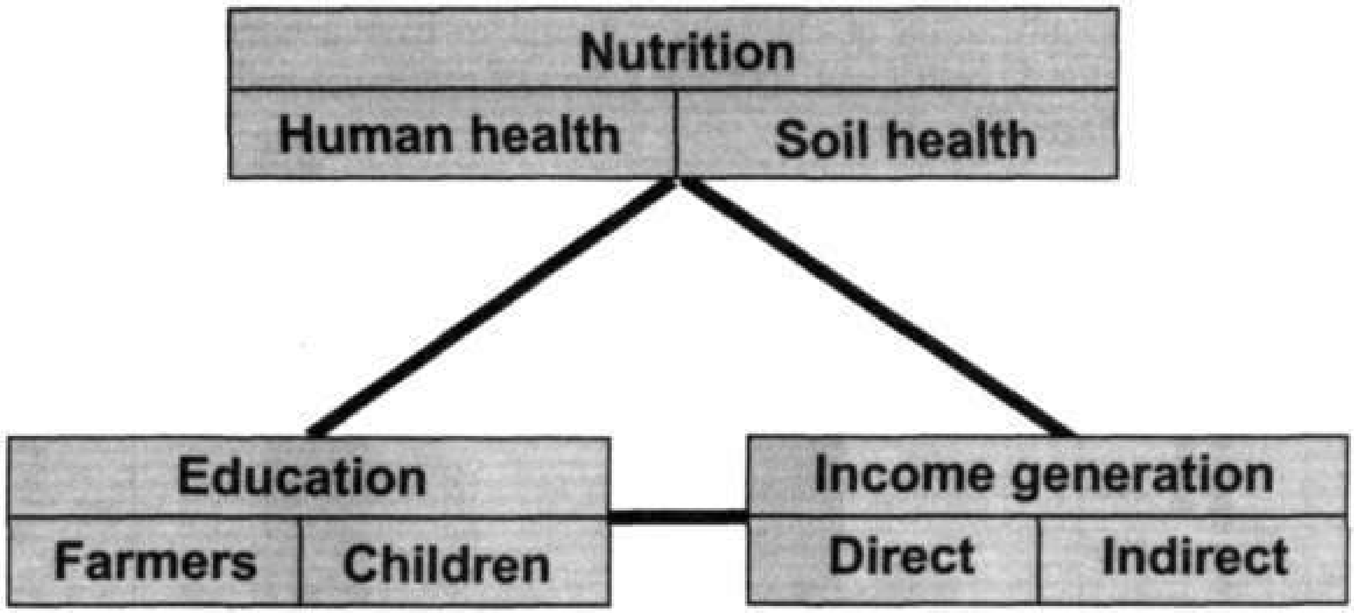


Fig. 8. Chickpea-IPM sustainable development model.

Reduced burden of fertilizers

The farmers reported that the use of chemical fertilizers has gone down due to chickpea cultivation. After chickpea harvesting, 24 man-days of labor/ha was saved on FYM input in the next paddy crop due to nitrogen fixation, leading to the savings worth NRs 1200/household. The total FYM saving in the village equaled NRs 8000. Savings on urea was NRs 3133, and NRs 2286 on DAP. The total fertilizers' savings was NRs 13,419 (Fig. 9).

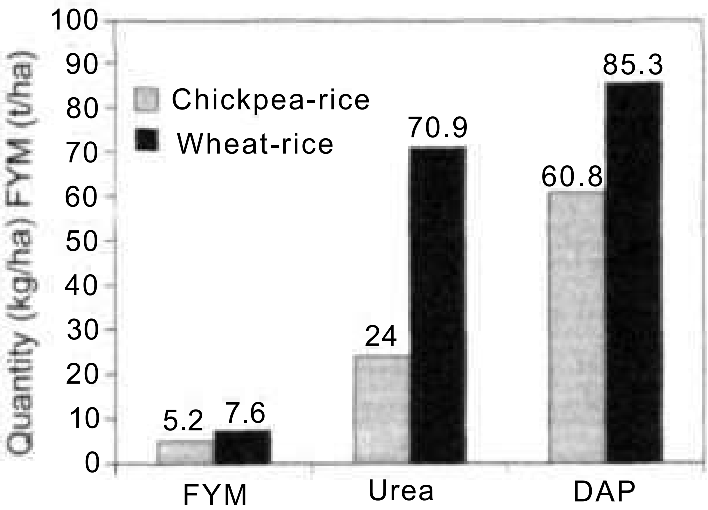


Fig. 9. Consumption of fertilizers in rice under different rotations, Nepal.

Increase in yield due to restoration of soil fertility

Crop rotation with chickpea increases yield of paddy to 7.71 quintal/ha, ie, an additional income of NRs 5397/household. For 20 families which is 10% of the households studies, additional income amounts to NRs 107940.

The income of an average contact chickpea farmer has increased by NRs 15148. The amount of wealth generated by chickpea has a multiplier effect on the economy.

This particular example is deliberately taken from a low profile village called D-Gaon to make a cautious assessment. The impact is more spectacular than the figures show. When the same method of calculation is used for the entire study area, the cultivation of chickpea is found to have generated NRs 21, 20,853 in additional wealth and 1000-man days of more seasonal employment in the study villages (Fig. 10).

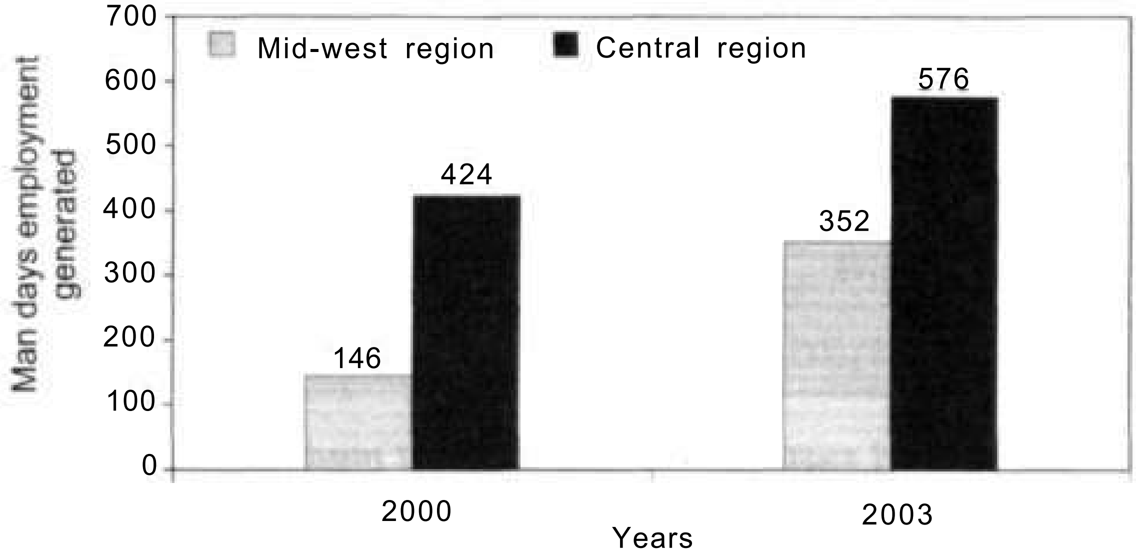


Fig. 10. Employment generation in the study area.

IPM cultivation of chickpea is generating additional employment in the study area. In comparison to 2000, employment has increased (Fig. 10). The utilization of fallow lands is likely to generate substantial incomes and employment opportunities for thousands of smallholders in the region in the future. Chickpea cultivation is projected to generate an additional NRs 8000/ha.

Estimates indicate that chickpea cultivation on rice fallow generates almost 50 man days of employment per hectare. If 10% of the rabi rice fallows were brought under cultivation, it would generate approximately 1.29 million man days of employment per annum. 30% of fallows would add another 3.88 million man-days of employment. (Bourai et al. 2002)

Impact on biodiversity

The impact of this study can be seen through the spread of improved varieties of seed (Fig. 11). Avarodhi has maximum spread in the study areas. Chickpea farmers in MWR report 83.33% Avarodhi seed transaction, while in CR it is 100%. Some other improved varieties reported in circulation among a small number of farmers in MWR are Chandra (4.1%), Koseli (8.3%) and Tara (4.1%). Overwhelmingly, a large number of farmers prefer Avarodhi to other varieties.

Seed transaction

Bardibas is an identified chickpea seed village, where farmers reported a number of seed transactions with their relatives, friends, NGOs, NARC and traders

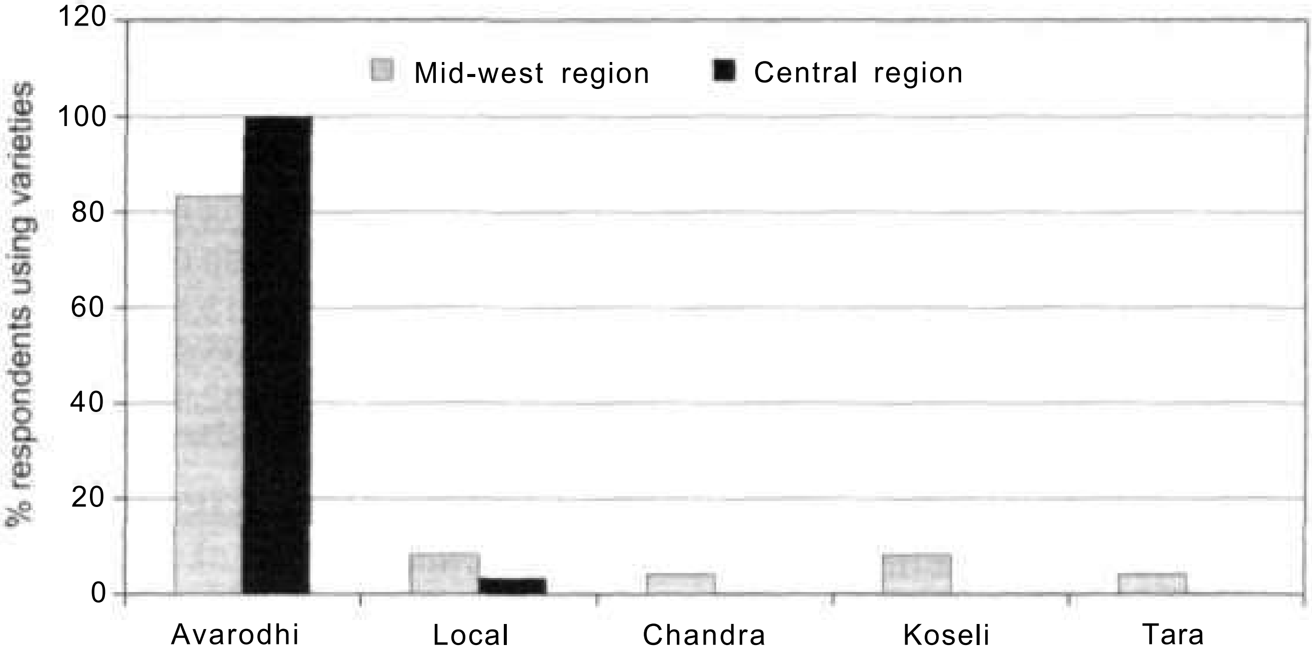


Fig. 11. Presence of chickpea varieties in the study areas.

(Table 20). The seed has been transacted far and wide. In all these villages, Avarodhi has spread due to its disease tolerance, high yield, and availability of IPM technology (Fig. 12). Lalbandi and D-Gaon are other very important seed villages from where self-generated demand of Avarodhi is spreading elsewhere. The demand for Avarodhi with IPM technology is accelerating in the study areas of Nepal (Fig. 12). The average seed transaction is 127 kg/household in NWR and 279 kg/household in CR. The price for seed is NRs 27/kg and NRs 33/kg respectively (Table 12).

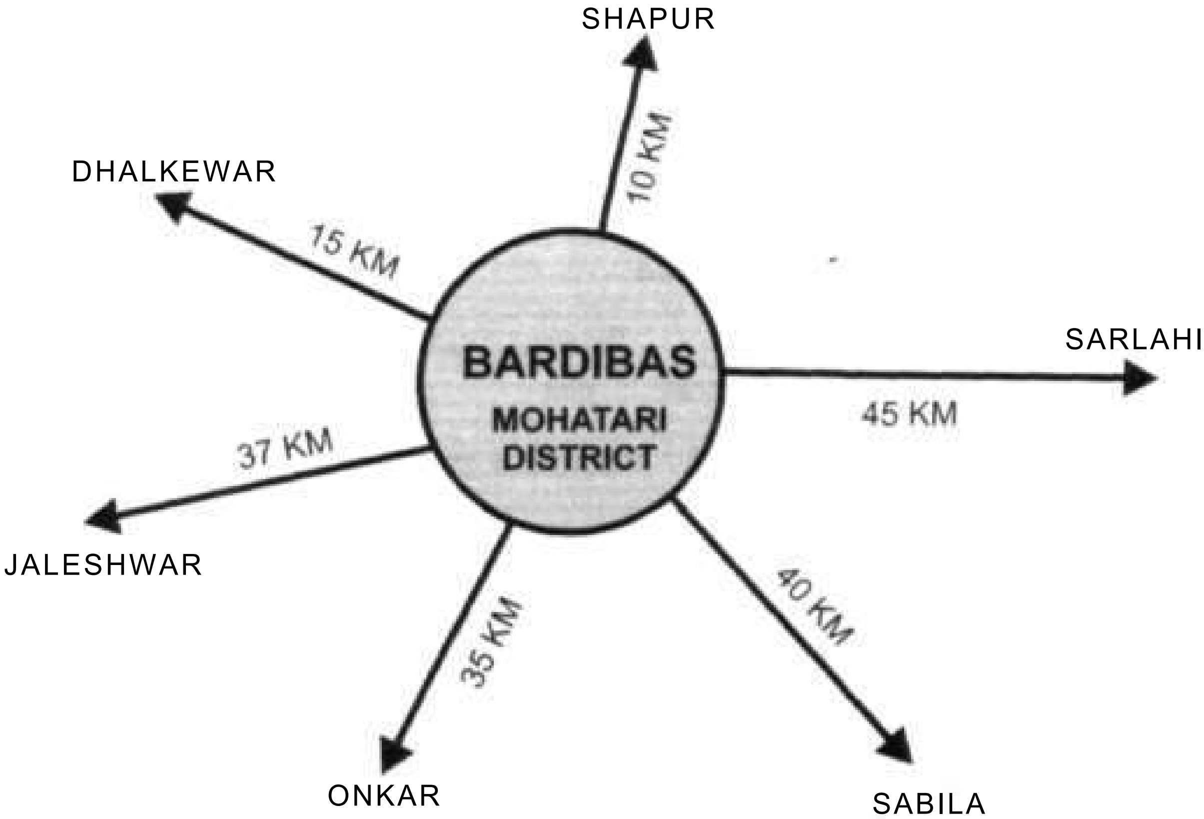


Fig. 12. Seed spread from the seed villages.

Table 11. Total benefits from chickpea-Case study of village, D-Gaon.

	(In NRs)
Seed transaction benefits	68,580
Sale of surplus product	1,35,000
Consumption of chickpea	30,000
Reduced burden of fertilizers	13,419
Increased yield due to restoration of soil fertility	35,980
Total	2,82,979

Table 12. Average quantity/price of seeds transaction.

	Mid-west region	Central region
Average amount (in kg)	127	279
Average price (in NRs)	27	33

Farmers in the study areas are able to produce and store chickpea seed. In MWR, 62% farmers are able to produce their own Avarodhi seed, 4% farmers get it from other farmers, while 20% get the seed from farmers' co-operatives. In CR, 94% farmers produce their own seed; 4% farmers buy it from other farmers, while only 2% farmers buy it from commercial sellers. Seed transactions takes place through a number of methods viz, sale, barter, gifts to relatives and others (Table 13, 14).

Table 13. Percentage breakup of chickpea sources.

	Mid-west region				Central region			
Source of Seed	Chick-pea	Rice	Wheat	Pigeon-pea	Chick-pea	Rice	Wheat	Pigeon-pea
Self-produced	62	77	56	53	94	92	62	82
From other farmers	4	18	18	13	14	4	10	8
Commercial sellers	-	4	9	–	2	2	4	-
Farmers' cooperative	20	9	9	2	-	-	-	2

Table 14. Types of seed transactions.

Transactions	Mid-west region (%)	Central region (%)
Sale	83	73
Barter	4	19
Gift	21	32
Other	12	8

Resource utilization

In MWR, 91% of the respondents have used rice fallows for chickpea production. In CR, 75% respondents use rice fallows and 49%, maize fallows. The overlapping is due to many respondents cultivating both rice and maize (Fig. 14). The rice fallow land is an important natural resource, which provides sufficient moisture to chickpea growth (Kumar Rao et al. 1998). If agronomic manipulations are made and short duration rice varieties are provided for the uplands, the synergy will bring a boom in the region. The chickpea average area/household has increased in MWR and CR. Before IPM, the figures were 1 katha/household in MWR and 0.5 katha/household in CR (Fig. 13).

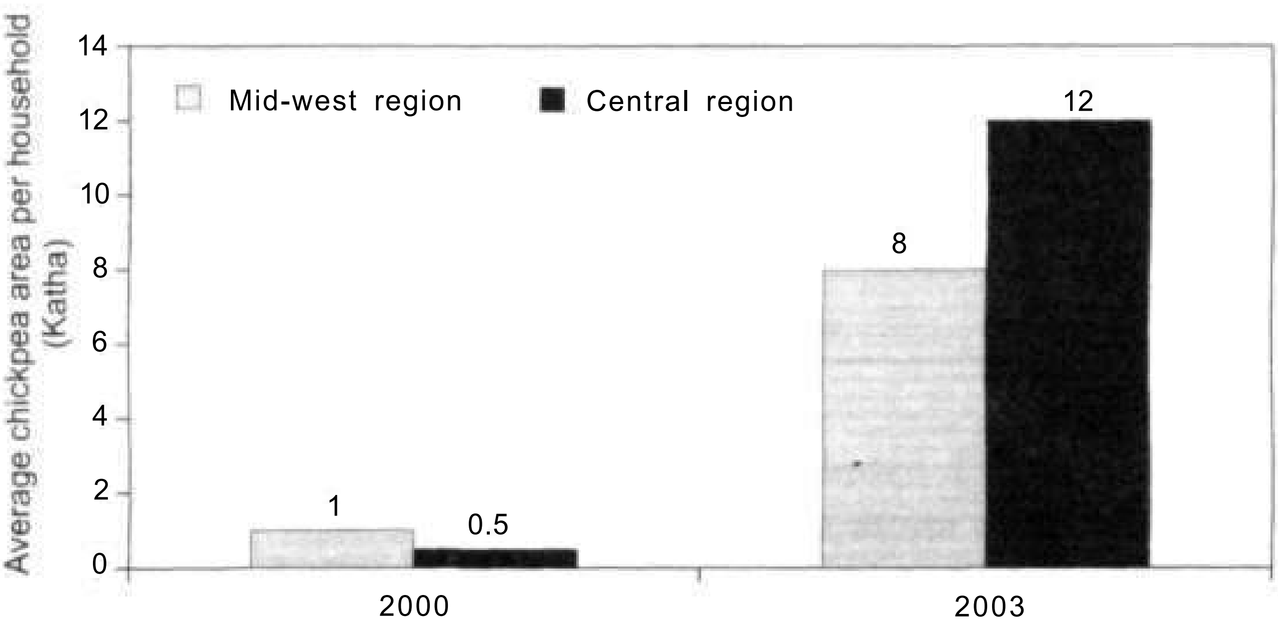


Fig. 13. Average chickpea area changed/household after IPM.

Chickpea not only enhances soil fertility through nitrogen fixation but also provides ground cover and fodder, and is a nutritious high-value human food. Chickpea is an integral part of the diet cooked as dal and eaten with roti (unleavened wheat bread) and boiled rice. The importance of chickpea has been recognized for enrichment of soil fertility through its ability to symbiotically fix atmospheric nitrogen and tolerate drought hazards (Fig. 14).

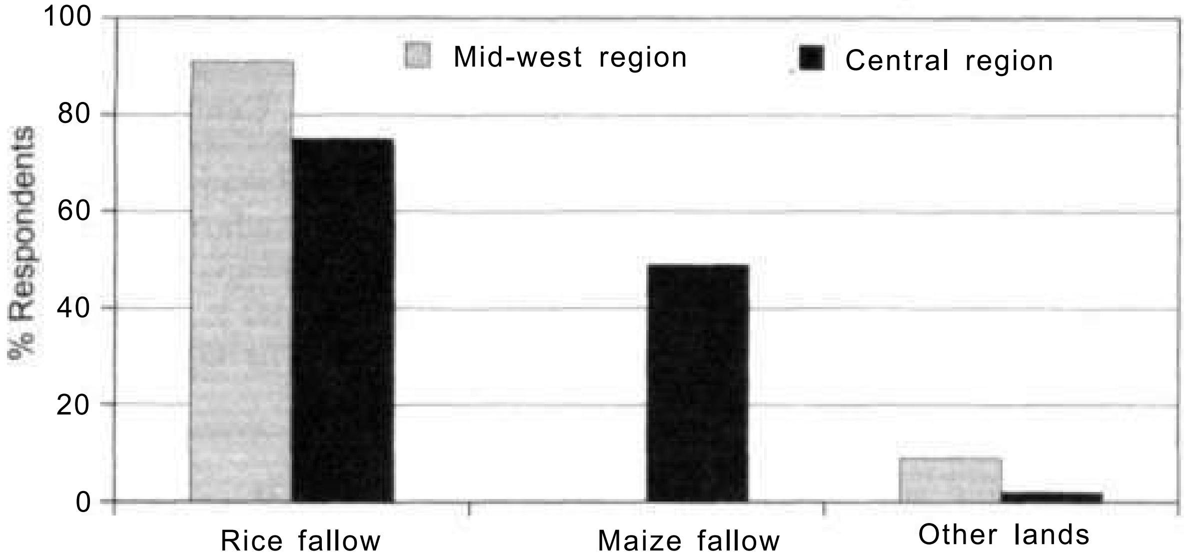


Fig. 14. Utilization of fallow land.

Table 15. Chickpea demand projections for 2010 in Nepal.

Items	Estimates
Present consumption ('000t)	13.8
Population growth rate (%)	2.2
Income growth rate (%)	2.4
Demand growth rate (%)	3.2
Income elasticity	0.4
Projected demand for chickpea seed ('000t)	20.9

Source: Joshi et al. 2001.

In Nepal, pulses are in short supply. This offers major opportunities to increase pulses production by bringing fallow land under cultivation. Table 15 shows chickpea demand projections for 2010 (Joshi et al. 2001). The short supply of chickpea is attributed to its shift in production from favorable to marginal areas. In favorable regions, the coverage of wheat and rice has increased at the cost of coarse cereals, pulses and oil-seeds. Lack of technology to improve the yield of pulses and thereby their lack of profitability paved the way for the cultivation of crops such as rice and wheat which were less risky and comparatively profitable. The hope of raising pulses production lies in marginal areas such as rice and maize fallows (Table 17).

Table 16. Output and income projections from chickpea.

Years	Average land area (ha) under chickpea	Average chickpea output/katha	Average total chickpea output (kg)	Actual total output (t)	Chickpea price (million NRs)
2000	.18	50	277	5.55	1.66
2001	.20	50	307	6.15	1.89
2002	.26	50	385	7.70	2.31
2003	.36	50	535	10.71	3.21
2004	.53	50	784	15.69	4.70
2005	.80	50	1157	23.15	6.94
2006	1.14	50	1680	32.60	9.78
2007	1.62	50	2377	47.55	14.20
2008	2.23	50	3275	65.51	19.65
2009	3	50	4399	87.99	26.39
2010	3.90	50	5775	115.50	34.65

Extrapolation formula used $Y3 - 3\ Y2 + 3\ Y1 - Y0 = 0$

Table 17. Estimate of rice fallow areas in Nepal.

Eco-Regions	Rice fallows (million ha.)	Rabi fallows as % of Kharif rice area
Eastern	0.217	50.9%
Central	0.018	4.5%
Western	0.068	25%
Mid-western region	0.055	38%
Far-western region	0.015	11.79%

Further, if IPM technology were disseminated to 5% of marginal and sub marginal farmers, then the estimated supply of chickpea in Nepal in the year 2010 would be 3,99,000 tons. These estimates are based on some assumptions:

1. About 0.36 million ha rice fallow land is suitable for chickpea production
2. Chickpea will automatically extend to rice and maize fallows
3. The extrapolation of land use is based on increase per year of chickpea coverage
4. The constant margin of profit will remain up to 2010.

The demand and supply gap will exist even after continuous efforts. In the neighboring countries, demand for chickpea will not depress its price in Nepal. The production of chickpea will lead to higher yields of paddy, restoration of soil health and fertility, increase in human nutrition, lesser consumption of fertilizers, import substitution, exports promotion, reduction in poverty, equitable distribution of wealth and social justice, through empowerment of the weak and marginal farmers, besides creating sustainable development in Nepal.

Chickpea has the ability to give better harvests than the other crops on marginal lands. However, there are increasing concerns that continuous rice-wheat cropping has caused deficiency of soil nutrients and degradation of soil. The use of fertilizers is being promoted for raising rice-wheat productivity and maintaining soil fertility. However, the high cost of fertilizers, their non-availability at the right time, and poor purchasing power of farmers have limited the use of fertilizers in Nepal. Besides, with their excessive use leading to environmental hazards, donors have reduced or stopped fertilizer-aid altogether. Against such a backdrop, IPM-chickpea is playing a vital role for a sustainable economic, environmental and ecological development.

Yield and price risk

Risks with regard to yield and prices are higher for pulses production compared to cereals (Byertlee and White 2000), mainly due to conditions in which pulses are grown ie, in marginal areas and under largely rainfed conditions. Fig. 15 shows that in study areas chickpea has crossed these risk barriers.

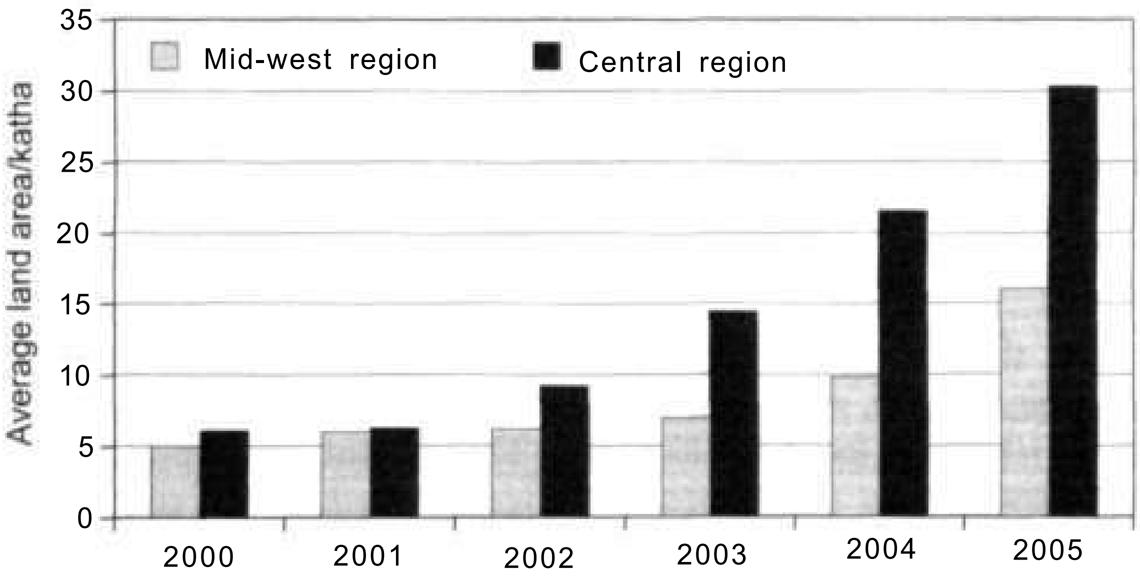


Fig. 15. Increase in average land area of chickpea/household.

Nepali farmers were turning their backs on chickpea in the last two decades, and adoption of improved varieties was negligible - about 8% of all chickpea growing area in 1999-2000. Today many numbers of chickpea farmers are using new Avarodhi seed in Nepal Terai. The seed sector has also been considerably developed, and technology has been transferred to the study areas.

In Lalbandi (CR), every farmer has become a seed producer, providing seed to farmers in other villages with a condition that the seed taker will return double the quantity in the following season.

Conclusion

The empirical study of IPM-chickpea cultivars shows that the technology is effective and provides a tool for eradication of hunger in Nepal. IPM-chickpea enhances peasants' entitlements, since biotic and abiotic stresses were associated with the loss of entitlements.

IPM-chickpea has proved that in the short run something highly effective can be done to remove miseries and starvation. Usually, it is taken for granted that nothing much can be done to remedy these desperate situations at least in the short run.

The success of chickpea adoption is due to various strengths of the project. The project is able to utilize rice fallows, maize fallows and other uplands. Chickpea is a highly remunerative winter crop. The additional income earned from it frees poor farmers: its benefits are reaching the poorest among the poor and it seems to be a farmer-friendly technology.

The IPM-chickpea model can be applied as a tool of poverty eradication anywhere in the world where the same agroecological conditions exist.

References

Bourai VA, Joshi KD and Khanal N. June 2002. Socioeconomic constraints and opportunities in rain fed rabi cropping in rice fallow areas of Nepal.

Byertlee D and White R. 2000. Agricultural intensification and diversification through food legumes: Technological and policy options. *In* Linking research and marketing opportunities for pulses in the 21st century (Knight R, ed.). Kluwer Academic Publishers, The Netherlands.

Joshi PK, Parthasarthy Rao P, Gowda CLL, Jones RB, Silim SN, Saxena KB and Jadgish Kumar. 2001. The World Chickpea and Pigeonpea economics, facts, trends, outlook. Patancheru, Andhra Pradesh, India: ICRISAT.

Kumar Rao JVDK, Johansen C, Rego TJ. 1998. Residual effects of legumes in Rice and Wheat cropping system of the Indo-Gangentic Plain. Patancheru, Andhra Pradesh, India: ICRISAT.

Manandhar DN and Sakhya DM. 1996. Climate and crops of Nepal. Nepal: Nepal Agricultural Research Council and Swiss Agency for Development and Cooperation.

Rabi cropping and promoting winter legumes in rice fallows in Nepal

N Khanal[1], KD Joshi[2,3] and D Harris[2]

Abstract

The rice fallows in the Nepal's Terai manifest an intricate problem situation engendered by marginality of the resource base, biophysical and socioeconomic diversity, seasonality and complex livelihoods strategies of the farmers.

The rainfed rabi cropping (RRC) project was initiated in 2001, with the aim to intensify the rice-fallow system in the Terai by capitalizing on the low external input agricultural technologies. A series of on-farm trials including participatory varietal selection, crop establishment methods, nutrient management and pest management were conducted on rice, chickpea, field pea, lentils, mungbean, buckwheat and niger. Introduction of short to medium duration rice varieties such as Sugandha 1, Barkhe 1017, BG 1442 and Barkhe 2014, facilitated timely planting of winter crops by utilizing the residual soil moisture in the postrainy season. Chickpea varieties KPG 59, GNG 469, Tara and KAK 2, field pea variety Sano Kerau (a small-seeded local landrace), lentils variety ILL 7723, and mungbean variety VC 3960-88, VC 6372 (45-8-1), NM-92 and NM-94 have been preferred and adopted by farmers. Seed priming, molybdenum loading through seed, foliar spray of cattle urine and application of boron were found beneficial for increasing yields of test crops in the rice fallows. Seventy-five active farmers have been groomed as local resource persons (LRPs). Six multi-purpose nurseries have been established for promoting on-farm plantation and thereby enhancing availability of fodder and fuel-woods as alternative source of cooking energy. About 933 farmers have been organized into 55 groups for collective approach to seed management and other cooperative activities. With farmers' organized efforts and backstopping from the project, nearly two-thirds of the rice fallows in the project area have been brought under winter cultivation and overall systems productivity has been increased.

[1]Forum for Rural Welfare and Agricultural Reform for Development, Post Box no. 11, Chitwan, Nepal.
[2]Centre for Arid Zone Studies, University of Wales, Bangor.
[3]International Maize and Wheat Research Centre, South Asia Regional Office, Kathmandu, Nepal.

However, inherently poor soil fertility, use of dung-cakes as cooking energy, erratic weather conditions, problems of pests, stray animals and rising expectations of the communities towards external supports are the continuing challenges to the sustainability of the system. Further broad-based, holistic efforts are needed to enable farmers augment their resource-base and fight the challenges.

Introduction

About 26% of the total rice area in the Terai remains fallow after harvest of rice in the postrainy season. Based on the avenues indicated by the DFID-supported study (Subbarao et al. 2001) and other experiences gained in Nepal, the rainfed rabi cropping (RRC) project was initiated with the aim to intensify the rice-fallow system in the Terai through capitalizing on the low external input agricultural technologies. Some on-farm trials on winter crops and socioeconomic studies were carried out in the pilot phase from October 2001 to June 2002 (Khanal 2002). Based on the understanding of the constraints and opportunities for crop diversification, the second phase of the project has been in operation for the period from July 2002 to March 2006. The project has been implemented in Jhapa, Morang, Saptari, Siraha and Kapilbastu districts of Nepal (Fig. 1). The interventions primarily involve participatory varietal selection (PVS) and on-farm verification of rainfed technologies on wide range of crops including rice, chickpea, field pea, lentils, mungbean, soybean, cowpea, pigeonpea, niger and buckwheat. For addressing the intricate problem situations and enhancing the sustainability of the system, the project has included other supportive activities such as development of local resource persons, strengthening community based

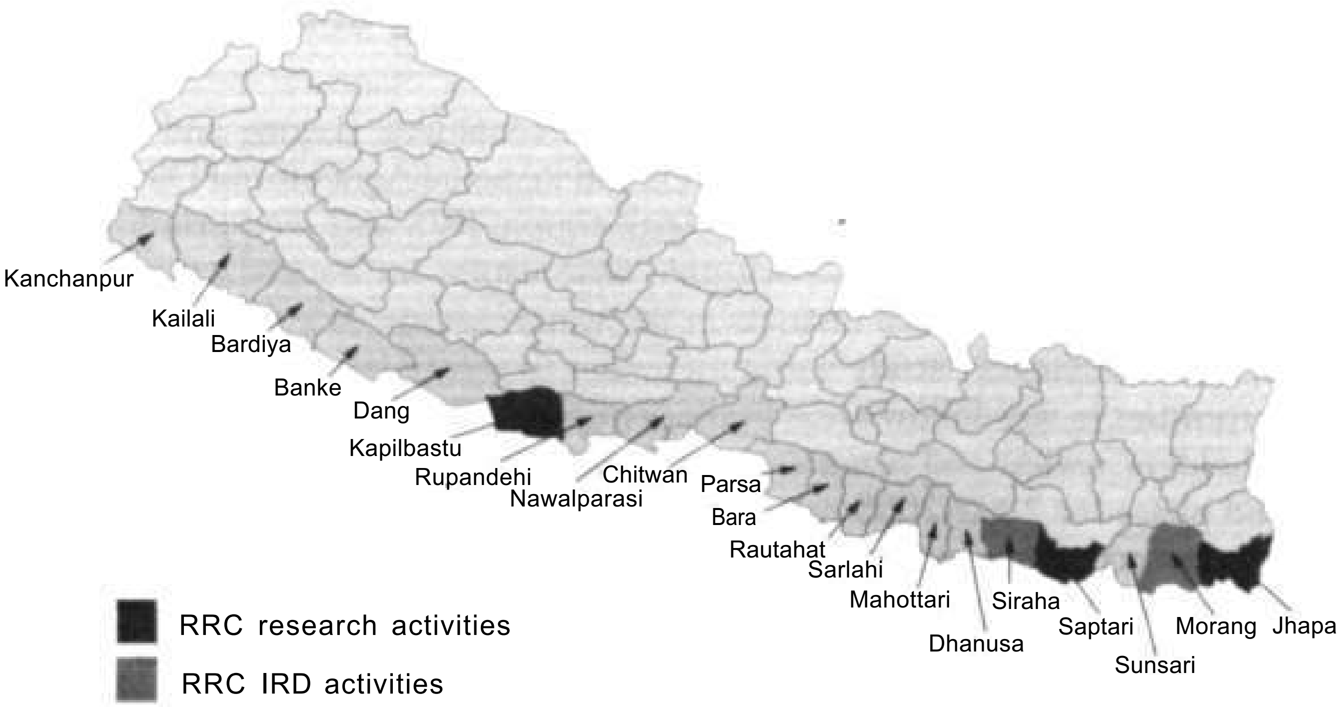


Fig. 1. Map of Nepal showing rainfed rabi cropping project districts.

seed systems, establishment of agro-forestry nurseries and on-farm plantations and sensitization about regenerative energy technologies.

Methodology

The complex problem situation in rice fallows calls for a holistic approach, clear perspectives and plurality of efforts. The project has followed a system-based participatory action research and development process, in which the interventions are reshaped through a learning cycle over time to address the problem situation. This has brought together interdisciplinary expertise and shared roles of multiple actors. With technical backstopping and coordination from the Centre for Arid Zone Studies (CAZS) and financial assistance from DFID-PSP, the project has been harnessing collaborative support from various stakeholders such as concerned District Agricultural Development Offices (DADOs), National Grain Legume Research Programme (NGLRP) of Nepal Agricultural Research Council (NARC) and International Crops Research Institute for Semi-arid Tropics (ICRISAT) and some technical support from Asian Vegetable Research and Development Centre (AVRDC).

The target communities have their own stake in all stages of the learning and action cycle. The project does not seek to replace existing practices but improve the local problem situation. It intends to provide a basket of choices of low-cost and simple-to-adopt technologies to marginal farmers. It is the farmers who decide which technologies fit their own interest and need, based on their perceived comparative advantages. However, farmers are facilitated in technical matters for enabling them to make right decisions.
The intervention process involved following three facets of strategies:

(i) Initiation of on-farm testing and upscaling of technological options.

Initiation of the intervention started with stakeholders' sharing and planning workshops at the local level with DADOs and Regional Agricultural Directorate in 2001. The RRC pilot was initiated with simple PVS and seed priming trials on chickpea and field pea and adaptive observation on buckwheat in Jhapa, Morang, Saptari and Siraha districts in the winter season of 2001. At the same time, a socioeconomic study was undertaken to scrutinize the constraints and opportunities in rice fallow areas in those districts. The findings were shared at stakeholders' review and planning workshops at ICRISAT in June 2002 and the second phase for 2002-2005 ensued.

In the second phase, various technological options on rice, chickpea, lentils, field pea, mungbean, pigeonpea, cowpea, buckwheat and niger were tested. These included on-farm trials on PVS, crop establishment methods, tillage practices, nutrient management, intercropping and pest management on the test crops. Chickpea received major focus for its perceived comparative advantage attributed to high market price and adaptation in moisture stress conditions.

(ii) Internalization of local potential

In the participatory development process, it is necessary that the farmers are involved in all stages of the intervention process and feel ownership of the new initiatives. For this, the farmers have been capacitated through training, excursions, interactions, workshops and on-site coaching. In the course, some nodal farmers have strived to develop their farms as the local "center of excellence". These farmers have been continuously groomed and mobilized as local facilitators and are anticipated to serve as local resource persons (LRPs) after the exit of the project.

Another aspect of internalization of the local potential is through the augmentation of the local resource base. Promotion of multi-purpose tree nurseries offering alternative sources of energy and strengthening community-based seed management systems have been taken as the principle strategies for enhancing agro-biodiversity and nutrient recycling on-farm. As the learning centers for general farmers, livestock shed improvement for urine collection and use, and improved composting practices have been demonstrated through the local facilitators.

(iii) Institutionalization of the initiatives for lasting impacts

The project has facilitated the development of farmers self-help groups and their networking to help them evolve as the farmers' cooperatives. Most of the groups have been registered at DADOs. It is through these organizations and their networks that the communities have gained better access to service providing agencies. For instance, the Apex Committee of Saptari acquired support from District Public Health Office to organize an eye-clinic camp at the community. The farmers' groups and their networks have started to arrange agricultural inputs required for their groups collectively from the wholesalers at 20-30% cheaper prices than their individual approach.

The groups have been facilitated to generate group welfare funds as emergency aid or run micro-finance schemes as the measure of investment for farming. These funds are generated from the monthly savings and rents of machineries and other group properties. This scheme has also been effective in providing sense of attachment among the group members for collective activities and increased intra- and inter-group cooperation.

Results and discussions

(i) Understanding the context of rice fallows

Through the system-based participatory action research and development process, the project team has now an enhanced understanding oflocal capabilities, resources and livelihoods strategies of the people. Relevant facts and figures can be obtained in Khanal and Joshi et al. (2004). Table 1 summarizes the features of the rice fallows and their implications for the agricultural research and development approaches.

Table 1. Features of rice fallows and their implications for agricultural research and development.

Features	Manifestations	Implications
Marginality	- Small holdings, mostly abutted to large blocks of absentee landlords - Crops prone to stray animals damage - Lack of irrigation facility - Poor soil fertility - Lack of alternative income sources - Poor resource management capability of farmers - Poor access to institutional services	- Input-intensive options are risky ventures for farmers Low-input, simple-to-adopt options are required - Interventions with inductive capital support for local resources augmentation and local capacity building are desirable
Heterogeneity	- Variation in farmers' resource base or access to resources - Differential access to information and external services - Varied culture, priority needs and interests between households and communities	- Common generalization of problem situation may not work - Range of options need to be provided to adapt to the local specificity
Seasonality	- Erratic rainfall, droughts, fog etc. - Yield fluctuations - Uncertainty of market or price fluctuations - Temporal variability of food sufficiency and availability of fodder - Temporal peaks and slack periods of need of farm labor	- High time specific and prescriptive technology that call for high alert on the part of farmers do not suit the context - Options with assured market and high stability against stress situation are desirable
Intricacy	- Farmers' complex livelihoods strategies involving integrated farming, off-farm and non-farm activities to adapt to the harsh situation	- Single commodity perspective does not work; holistic approach to local capacity-building is required to bring about lasting changes

(ii) Major achievements

Table 2 highlights the major achievements of the project since 2001. Details are available in Khanal (2001), Khanal et al. (2003); Khanal, Harris et al. 2004; Khanal, Joshi et al. 2004 and Khanal et al. 2004.

Table 2. Summary of major achievements of the project since 2001.

Activities accomplished	Achievements
Group building and networking	933 farmers including 376 women are organized into 55 groups. They are participating in technology testing and seed production activities. Most of the groups are registered at DADOs and have generated group welfare funds. Inter-group network has been established to evolve as farmers' cooperative.
Development of leader farmers	75 active farmers were provided with training on group mobilization, integrated crop management, seed production and nursery techniques. They have been mobilized as local catalysts in the intervention and will act as local resource persons after phase-out of the project.
Multipurpose nurseries and plantation	Six multi-purpose plant nurseries have been established. They produced saplings of neem, bamboo, mulberry and various leguminous fodder species and these were supplied to the group for plantation.
PVS on rice in shallow bunded rainfed system	Farmer preferred new varieties Sugandha 1, Pant Dhan 10, Barkhe 1027 and BG 1442 for higher yield and better qualities than those of previously used. These varieties yield 10-15% more, mature 15 to 30 days earlier and thus facilitate early establishment of winter crops in the residual moisture. Farmers are evaluating several other promising varieties and some of them have been already adopted (Khanal et al. 2003; Khanal and Khanal et al. 2004).
PVS on rice in intermediate deep water regime	Barkhe 2001 and Barkhe 2014 were preferred by farmers for their 20-30% higher yields and better agronomic and postharvest qualities than existing farmer varieties. Several other varieties have shown promising performance and are under further evaluation process (Khanal et al. 2003; Khanal and Khanal et al. 2004)

Continued

Table 2. *Continued.*

Activities accomplished	Achievements
PVS on chickpea	Chickpea crop has been rehabilitated, despite the challenges of BGM, collar rot and pod borer. Varieties GNG 469, KPG 59, Tara, KAK 2 and ICC 37 were identified to be more promising with about 15 - 20% more yields than local varieties (Khanal et al. 2003).
PVS on lentils	Variety ILL 7723 has been preferred by farmers for its bolder grain size. Farmers have also adopted Khajura I, Khajura 2 and Simrik due to their promising performance (Khanal et al. 2003).
PVS on pea	Variety E-6 has been preferred by farmers for its earliness with about 85 days to maturity after sowing. Sano Kerau, a small seeded cultivar collected from Chitwan district has been preferred for its good adaptation in the low fertility and moisture stress condition (Khanal et al. 2003).
PVS on mungbean	Variety VC 3960-88, VC 6372 (45-8-1), NM-92 and NM-94 have been preferred for most agronomic and postharvest traits including earliness, yield (25% higher than local), pod and grain size, grain colour, smell and taste. Adaptation of the varieties for spring, summer and autumn season crop was verified (Khanal and Harris et al. 2004).
Adaptive demonstration on buckwheat	A local landrace collected from Chitwan was preferred by farmers for its adaptation in low fertility and poor management conditions. The crop matures within 80 days after sowing. In a reasonably fertile soil, it is possible to grow mungbean after buckwheat, thus tripling the cropping intensity with rice-buckwheat-mungbean (Khanal et al. 2003).
Adaptive demonstration on niger	It can be successfully grown in low fertility conditions, provided planting is done immediately after the harvest of early maturing rice, by the end of September. Some farmers have preferred this crop (Khanal et al. 2003).
Integrated nutrient management on chickpea and field pea	Supplementation of boron either as basal application or foliar spray significantly increased yield (28%) of chickpea. Four sprays with cattle urine at 20% concentration resulted 11 and 27% increase in yield of chickpea and field pea (Khanal and Joshi et al. 2004).
Seed priming on mungbean, chickpea and lentils	Soaking seeds in 0.5% sodium molybdate solution significantly increased nodulation and yield (23%) in mungbean. Preliminary results are promising in chickpea and field pea and need further verification (Khanal and Joshi et al. 2004).

Continued

Table 2. *Continued.*

Activities accomplished	Achievements
Mixed cropping of chickpea and coriander.	Farmers believe that coriander repels pod borer if grown as a mixed crop. The on-farm experiments could not prove it. However, if grown together, there was no effect on chickpea yield and production of coriander was bonus (Khanal et al. 2003).
Chickpea pod borer management	NPV has been found as effective as Endosulfan in suppressing pod borer. Efforts are under way to recycle NPV at the local level.
Pigeonpea and cowpea on paddy bunds	Average production of pigeonpea planted in paired rows in 25 m-long bunds was 3.6 kg grains. It also yielded nearly the same amount of fodder. Additionally, substantial amount of fuel-woods was recovered, which was sufficient to cook 10 meals for a 5 to 7 member family. Likewise in about 25 m bund length, a farmer produced nearly 30 kg of green pods of cowpea and earned about Rs 600.
Seed production	Testing and seed production of crop varieties are going hand in hand. The participants tended to save seeds of preferred varieties for following seasons and provided them to neighbours and relatives. In the preceding seasons, farmers produced more than 5 metric tonnes of rice, 2 metric tonnes of chickpea and one metric tonne of mungbean in the project area. They are also regenerating seeds of other introduced crops for their own subsistence requirement.

(iii) Preliminary impact

A cursory survey in the project area after two-years of project intervention showed that nearly two-thirds of the fallow area has been brought under winter and summer cultivation.

Some farmers have entirely grown the crop varieties introduced by the project. Overall systems productivity in rice fallows has increased substantially with 20 to 30% more yield with new rice varieties and average production of around 0.5 tonnes per ha of winter or summer crops.

(iv) Continuing challenges

- BGM and pod borer in chickpea.
- Terminal drought and westerly dry wind leading to premature senescence of the winter crops.

- Erratic and unpredictable rainfall posing risk for rainfed farming.
- Soil fertility as the major constraints for increasing productivity.
- Free-grazing system posing risk to crops.
- Tenancy system limiting farmers' choice of technological options.
- Rising expectations among the community members from external supports.

Conclusion

Rice fallows manifest a complex problem situation that demands a holistic approach and plurality of efforts. So, working with an agroecosystems perspective and multi-stakeholders' collaboration is essential to address the problem situation, and increase systems productivity and sustainability. A component-crop approach to research and development may not lead to sustainable outcomes. Local empowerment strategy is the key for lasting impact on the livelihoods of the communities.

Acknowledgements

This document is an output from a project (PSP R 8221) funded by the UK's Department for International Development (DFID) and administered by the Centre for Arid Zone Studies (CAZS) 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 various districts of Nepal for their contribution in this research. FORWARD management and field staff who helped in this research are acknowledged.

References

Khanal NN. 2002. Intensifying the rice fallows through rainfed winter cropping: Results of chickpea, field pea and buckwheat trials in the eastern Terai of Nepal. Paper presented at the 25th National Winter Crops Workshop, 11-12 September 2002, Kathmandu, Nepal.

Khanal NN, Joshi KD and Harris D. 2004. Working with systems perspective: An innovative approach to improve overall systems productivity in Nepal. Paper presented in the Sharing Workshop on Participatory Research Methodology for improving the access of farmers to new crop germplasm and enhancing food security in the High Barind Tract of Bangladesh, 9-10 October 2004.

Khanal NN, Joshi KD, Harris D and Chand SP. 2004. Effect of micro-nutrient loading, soil application and foliar sprays of organic extracts on grain legumes and vegetable crops in marginal conditions in Nepal. Paper presented in an International Workshop on agricultural strategies to reduce micronutrient problems in mountains and other marginal areas in South and South East Asia, 8-10 September 2004, Kathmandu, Nepal.

Khanal NN, Harris D, Sherpa LT, Giri RK and Joshi KD. 2004. Promotion of mungbean in cereal fallows in the low hills and Terai agroecosystem of Nepal. Paper presented in the Final Workshop and Planning Meeting for the DFID-Mungbean Project, 27-31 May 2004, Punjab Agriculture University, India.

Khanal NN, Giri RK, Sherpa LT, Thapa S, Thapa K, Chaudhary R and Rayamajhi B. 2003. Promotion of rainfed rabi cropping in rice fallows of Nepal: Review of achievements from July 2002 - June 2003. *In* Report of review and planning meeting of rice fallow rabi cropping project (Joshi KD, ed.). 23-24 June 2003, Godawari, Lalitpur, Nepal.

Khanal NP, Khanal NN, Joshi KD, Sherpa LT, Thapa S and Giri RK. 2004. Participatory varietal selection in rice: FORWARD'S experience in rainfed bunded and intermediate deep-water regimes in the Terai of Nepal. Paper presented in the 24th summer crops workshop, 28-30 June 2004, NARC, Nepal.

Subbarao GV, Kumar Rao JVDK, Kumar J, Johansen C, Deb UK, Ahmed I, Krishna Rao MV, Venkataratnam L, Hebber KR, Sai MVSR and Harris D. 2001. Spatial distribution and quantification of rice-fallows in South Asia - Potential for legumes. Patancheru, Andhra Pradesh, India: ICRISAT

Bridging the gap: Role, responsibilities and approaches to scaling-up IPM of chickpea in Nepal

NP Khanal and N Khanal[1]

Abstract

In spite of its great potential as a land with diverse environments and multiple cropping systems, the production of chickpea in Nepal is declining as a result of increasing biotic and abiotic stresses. Pod borer, Botrytis grey mold, wilt, nutrient deficiencies and unpredictable rainfall have curtailed its promotion in the rice-fallow system. Despite the various efforts made in development and scaling-up of IPM technology, its adoption could not be sustained in resource-poor farm communities due to technological, marketing, information, policy, local capability gaps in the development and promotional pathways.

To bridge the gap and scale up technology, different stakeholders at the local and international level should play interdisciplinary roles and in areas of their strengths. Particularly, international organizations in empowerment national organizations through new innovations on suitable pest management technologies; national research organizations and universities in generating farmers' decision support information and germplasm conservation; the Ministry of Agriculture in intra-organizational coordination and policy support; the Department oj Agriculture in information support and local seed system strengthening; non-governmental organizations in sensitization and strengthening of bottom up components, on-farm testing, market networking etc; private agencies in marketing quality inputs and outputs and farmer groups in on-farm participatory research and development. This multi-stakeholder partnership should employ the approaches of local empowerment in technical and managerial skills, to augment the natural resource base and promote micro-financial practices.

Introduction

The role of chickpea in the Nepalese farming system is crucial to its potential role in human nutrition, crop diversification, soil nitrogen economy and adaptability

[1]Forum for Rural Welfare and Agricultural Reform for Development, Post Box No 11, Chitwan, Nepal.

in diverse environments and multiple cropping systems. It has been estimated that the total rice-fallows in Nepal are 392,000 ha, and this amounts to 26% of the total rice area of the country (Subbarao et al. 2001). Chickpea has great potential to be fitted in these rice fallows during the postrainy season. However, the production of the crop is declining as a result of various biotic and abiotic stresses (CBS 2003; Khanal et al. 2003; Khanal and Neupane 2004). This paper attempts to discuss the role, responsibility and approaches required to bridge the gap in scaling-up IPM technology in Nepal.

The state of affairs

Technological gap

Pod borer, BGM, wilt and nutrient deficiencies have been identified as the major yield limiting factors of chickpea in Nepal. Although various efforts have been made in the development and promotion of IPM technology (Pande and Rao 2000), farm communities still do not have appropriate packages to cope with the problem. As a result, chickpea crop production is limited only to certain pockets of the country. The IPM technology recommended in Nepal is costlier and not easily accessible to poor farm communities. On the other hand, excessive use of chemical pesticide has threatened production sustainability, health and environment. Various botanicals, organic products, bio-agents have been reported effective by many researchers; individuals and company but neither of them have been demonstrated properly in farmers conditions, nor generated a convincible database (Grzywacz 2001; Khanal 2002).

Helicoverpa Nuclear Polyhedrosis Virus showed promising result in managing *Helicoverpa* (Fig. 1) in various on-farm experiments; however, their applicability and local production technology are still to be justified. Late planting, wide spacing, mixed cropping and Bavistin spray has been recommended against BGM, but the technology has not been properly demonstrated. Most of the soils in eastern and central Terai of Nepal are deficit in organic carbon as well as major and micronutrients, and suitable options are to be explored to solve these problems.

Marketing gap

Marketing of inputs viz. seed, fertilizer, pesticides (chemical and bio-pesticides), hormones, sprayers etc has not been streamlined in favor of IPM in Nepal. There is huge demand for quality seed in the country. Currently, a few farmer groups have started production of seed and are facilitated by the National Grain Legume Research Program, DADOs, seed companies, NGOs and private sectors. There is a growing tendency to introduce agrochemicals without proper evaluation in the market and issue haphazard recommendation to farmers.

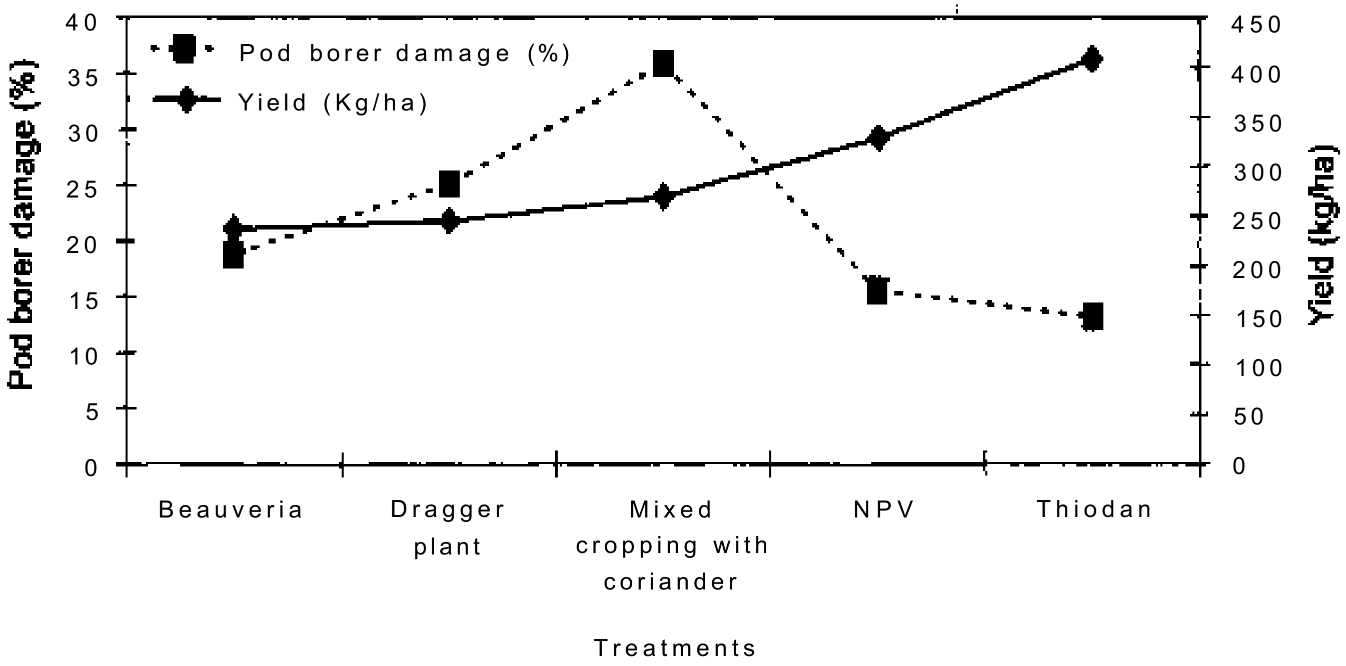


Fig. 1. Efficacy of different treatments in controlling pod borer in mid, central and western Terai of Nepal, 2003/04+.

+Note: This result is based on on-farm trials conducted at Saptari and Kapilbastu districts of Nepal, which were replicated thrice in each location. There was significant difference among the treatments in both pod borer damage (P = 0.03, LSD = 7.5) and yield (P = 0.04, LSD = 70). Pod borer damage is significantly correlated with yield (r = 0.75, P = 0.05).

Information gap

Technical messages tend to be published in English meant just for sharing with donor communities and official use in a limited quantity. Very little technical material is written in the Nepali language and there by accessible to farmers. Available materials are costlier, and unsuitable for resource-poor farmers. IPM is quite popular among agricultural professionals-students, development workers, scientists, teachers and farmers-but they are unaware of practical approaches and recent technological advancements because there is no suitable information, training and exposure.

Coordination gap

Formal coordination among stakeholders-research institutions, universities, extension services, media, private sectors and non-governmental organizations -is very weak when it comes to research and development activities. In most cases, whatever coordination maintained is on a personal basis.

Policy/strategic/incentive gap

In spite of Nepal's Pesticide Act 1991 and recent pesticide regulations, application of different agrochemicals has not been regularized. Because of the open border with India, different agrochemicals, pesticides and hormones are being introduced commercially without proper evaluation of their effectiveness and marketed through agro vets. The agricultural professionals in the country are not very interested in new technology and the system lacks an incentive or reward system to encourage this.

Local capability: knowledge, skill and institutional gap

Although participatory technology development is popular among agricultural professionals, it could not take shape as there is a tendency to implement technological interventions through top-down approaches. The technology therefore could not be widely disseminated.

A few farmers have been sensitized about IPM, but they are ignorant about insect-pest and diseases, proper diagnostic methods, eco-biology, economic threshold levels, availability of suitable management options with comparative advantage analysis. Farmers are neither getting technical facilities nor loans required for chickpea production.

Practical approaches

The first step in scaling-up IPM technology is to understand local capabilities, resources and livelihoods strategies of the people. The approach employed should be interdisciplinary, and adapted to local specificity:

Thinking holistically: Naturally occurring resident antagonists play an enormously important role in the management of soil borne pests and diseases. They can be managed or exploited in an IPM program. Crop rotation has been recognized as the most important pest management tool in chickpea as it allows the time for resident antagonists to lower the inoculum's potential of wilt-complex disease of the crop below damage threshold before that crop is sown again. So, suitable crop production technology associated with the next alternative crop should be identified.

On the other hand, the addition of organic matter such as compost, barnyard manure and green manure is known to intensify the soil-sanitizing benefits of resident antagonists' microbiological system and sometimes eliminates the need for crop rotation. Crop rotation, multiple cropping and addition of well-rotted organic matter enhances the activities of such antagonists. Similarly, suitable rice varieties applicable to the rice-chickpea system may be appropriate to capture the residual soil moisture and maintain appropriate crop husbandry practices. Thus, a system perspective approach is required to harness the benefits of biophysical interactions.

Empowering technical and managerial skills of local institution and farmers (Human capital): To achieve the required scale and to ensure sustainability of technological enhancement, strengthening local capabilities to innovate and manage the resource base may be more important than the technologies themselves. So, it is necessary to involve the farmers in all stages of technology verification and provide opportunities for them to feel ownership of the program. Furthermore, they should be capacitated in agroecosystem analysis, pest/disease diagnosis, identifying economic/action threshold levels, crop and pest biology, possible options existing in local situations etc, through action research, routine monitoring, training, excursions, interactions, workshops and on-site coaching.

In this process, farmers should not only become well informed about technology and processes pertinent to their own situations, but also be able to innovate other technologies in changing environments and tackle new problems along with their on-farm resource management skills. In the course, some nodal farmers may have strived to develop their farms as the local "center of excellence", which might serve as learning center to other farmers. Leader farmers may also serve as local resource persons (LRPs) in the community.

Promoting collective efforts (Social capital): Organization is one of the essential components of sustainable livelihoods systems. Thus, formation of farmers' self-help groups and their networking help them evolve as farmers' cooperatives. Thus, the communities may gain better access to different service providing agencies associated with IPM of chickpea. The farmers' groups and their networks may arrange agricultural inputs (seeds, agro-chemicals etc) required for their groups collectively from the wholesalers at cheaper prices or promote themselves locally.

Augmentation of natural resource base (Natural capital): This includes diversification of cropping systems, enhancing varietal diversity, nutrient recycling (better utilization of local resources, improved composting, seed priming etc), promotion of suitable bio-control formulations (eg, *Trichoderma* spp. against wilt-complex and NPV against *Helicoverpd),* promotion of botanical pesticides (eg, neem, bakaino etc) through on-farm plantation, alternative energy resources (eg, biogas, agro-forestry, improved heating devices etc), strengthening community-based seed management systems **etc.**

Promoting micro-financial practices (Financial capital): The concept of a group welfare fund is necessary as an emergency aid or to run micro-finance schemes as the means of investment for farming. The funds are generated from monthly savings and rents from hiring out machinery and other group properties. This scheme has also been effective in providing a sense of attachment among the group members for collective activities and has increased intra- and inter-group cooperation.

Roles and responsibilities

For sustainable scaling-up of technology, the role of multi-stakeholders is crucial in their own area. The role of various stakeholders has been summarized in Table 1.

Table 1. Role and responsibilities of different stakeholders in scaling-up IPM in chickpea.

Stakeholders	Role and responsibilities
International research institutions and universities	New innovations on plant resistance and pest suppressing technology; capacity strengthening of NARS and NGO partners.
Nepal Agricultural Research Council (NARC) and universities	Adaptive research to fit new innovations to the local context; germplasm conservation/maintenance; generating decision support information for farmers.
Ministry of Agriculture and Cooperatives (MoAC)	Intra-organizational coordination, quality control, strategic and policy support (eg, use of GM varieties in the Nepalese context) and market regulation.
Department of Agriculture (DOA)	Information support to communities; scaling-up locally verified innovations; promote quality seed supply mechanisms; strengthen community-based seed systems and other initiatives.
Non-governmental organizations (NGOs/ INGOs)	Sensitization and strengthening of bottom-up components to access information and institutional services; on-farm testing; facilitation for the development of community safety nets: local seed management systems, information exchange forums, marketing networking for input access and output disposal etc.
Private sector (Agro vets/ Seed companies etc)	Marketing of quality input and output in response to local needs and demands, functional linkage between producers and consumers.
Media (newspapers, television, FM-radio etc)	Dissemination of appropriate technology to farmers and make planners aware of new problems and issues associated with the crop.
Farmers/groups	Taking up stake in on-farm participatory research and development, utilization of new innovations and feedback to all other agencies.

Conclusion

- For sustainable scaling-up IPM technology, a plurality of efforts is needed from multi-stakeholders.
- International organizations should focus on strengthening of national organization through providing resistance sources and pest suppressing technology. National research organizations and universities should concentrate on adaptive research, MOA should step in with policy support, DADO in the area of technology dissemination and NGO/INGO in local capability building, market networking etc.
- Local empowerment and enrichment of natural resource base should be the guiding criteria.
- Quality database and local production technology of biopesticides is the urgent need for sustainable promotion of technologies.

Acknowledgements

This document is an output from a project (PSP R 8221) funded by the UK's Department for International Development (DFID) and administered by the Centre for Arid Zone Studies (CAZS) 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, extension staff and specialists for their contribution to this research and development project. FORWARD management and field staff who helped in this research are acknowledged.

References

CBS. 2003. Central Bureau of Statistics. National Planning Commission, Kathmandu, Nepal.

Grzywacz D. 2001. Nucleopolyhedrovirus: Potential in the control of pod borer (*Helicoverpa armigera)* in chickpea in Nepal. Pages 94-98 *in* On-farm IPM of chickpea in Nepal: Proceedings of the international workshop on Planning and Implementation of On-farm chickpea IPM in Nepal, 6-7 September, Kathmandu, Nepal (Pande S, Johansen C, Stevenson PC and Grzywacz D, eds.). Patancheru, Andhra Pradesh, India: ICRISAT; and Chatham, UK: Natural Resource Institute.

Khanal NP. 2002. Integrated management of lentils and chickpea wilt-complex. Masters thesis, Institute of Agriculture and Animals Science, Rampur, Chitwan, Nepal.

Khanal NP and Neupane RK. 2004. Opportunities and constraints associated with lentils, chickpea and pigeonpea in mid and far-western region of Nepal. Rampur, Chitwan, Nepal: National Grain Legume Research Program.

Khanal NN, Giri RK, Sherpa LT, Thapa S,Thapa K, Kumari R and Rayamajhi B. 2003. Promotion of rainfed rabi cropping in rice fallows of Nepal: Review of achievements from July-June 2003. *In* Report of review and planning meeting of rice fallow rabi cropping project, 23-24 June 2003, CIMMYT South Asia Regional Office, Kathmandu, Nepal.

Pande S and Rao JN. 2000. Integrated management of chickpea in the rice based cropping systems of Nepal. *In* Program report of the ICRISAT and NARC: Collaborative works in farmers' participatory on-farm trials on the validation of improved production practices in seven villages of five districts in Nepal. Patancheru, Andhra Pradesh, India: ICRISAT.

Subbarao GV, Kumar Rao JVDK, Kumar J, Johansen C, Deb UK, Ahmed I, Krishna Rao MV, Venkataratnam L, Hebber KR, Sai MVSR and Harris D. 2001. Spatial distribution and quantification of rice-fallows in Soutn Asia-Potential for legumes. Patancheru, Andhra Pradesh, India: ICRISAT.

Developing positive outcomes from livelihood studies

B Pound[1]

It is important to consider different types of farmer clients, those with more resources and those with fewer. One way to cater for these different categories is to offer a basket of options and let them choose. However, that may not be appropriate in the case of chickpea, which can be knocked out at early, mid and late stages of production. The other way is to develop a low cost, low risk, medium output package to be promoted alongside the high input, high output package.

Wealth ranking is a useful tool for research and for extension. It is quick and easy and sufficiently precise if done with sensitivity and awareness. Once the community is categorized into (say) three wealth groups, the groups can be sampled to ensure poor, medium and better off farming families are represented in technology testing, impact assessment etc.

Zero tillage could be a useful additional option. It would allow earlier planting under some soil/climatic conditions, it might improve weed control and would bring in row planting that makes subsequent operations far easier (eg, spraying a randomly planted crop is difficult and inefficient.)

So far, the project has championed chickpea. Now that chickpea has been shown to have a value, especially to those farmers able to afford and handle the technology, it is time to decide whether to continue to promote chickpea in an isolated, commodity way, or as one of several alternatives for rice (and maize?) fallows. Within the present project, the latter might be difficult, but it is a thought for future proposals (apart from other grain legumes, millets, cover crops, green manures or short term livestock fodder crops might have a place-these might have the attraction of being much lower external input than chickpea).

There is a need to follow up on farmer adaptations, farmer problems and farmer suggestions (a good example is the mixing of BGM and pod-borer chemicals for simultaneous spraying). This follow-up will provide the "second-generation" research questions and will also be useful as the dissemination strategy is developed.

[1]Consultant, E-mail: barrypound@calendra. freeserve.co.uk.

Upscaling zero tillage in rice fallow lands of the Indo-Gangetic Plains: Some experiences

RK Gupta[1] and S Pande[2]

Introduction

South Asia is one of the major rice producing regions of the world, with about 50 million ha under its cultivation. Much of this area has a single crop per year, usually rainy season rice and no crop is grown after the rains. The Indo-Gangetic Plain (IGP) alone in South Asia occupies about 8 million ha under rice during the rainy season. Approximately, 2.5 million ha of rainfed rice land in IGP is left fallow. The large and growing population of the region especially in the IGP requires ever-increasing quantities of locally available food grains.

The large land areas that lie fallow with adequate moisture to grow a second crop for much of the year are particular cause of concern in IGP. Subbarao et al. (2001) estimated 14 million ha rice fallow lands in South Asia (Bangladesh, Nepal, Pakistan and India). However, these studies may under-represent the true total, because it failed to identify any rice fallow lands in Ballia district of Uttar Pradesh in India, and the current study identified nearly 17,000 ha of rice fallows in the same district. If this figure were to be added, the total area would stand at 36,904 ha (Fig. 1).

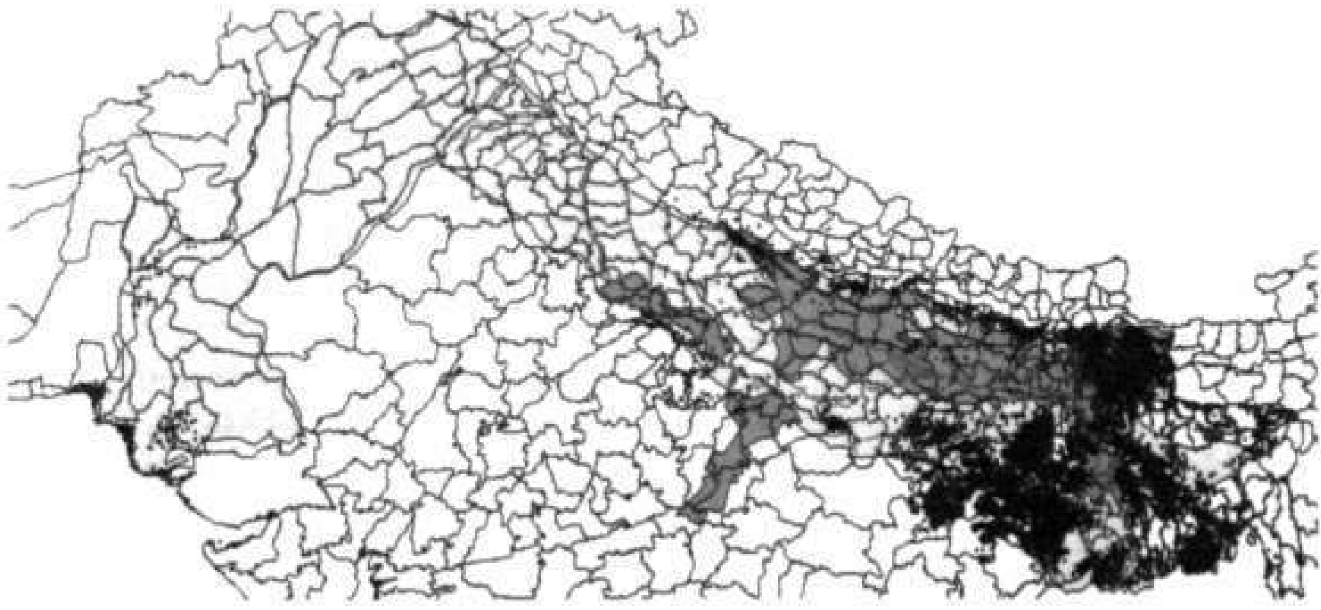


Fig. 1. Rice fallow lands in Ballia, UP.

[1]Rice Wheat Consortium, CIMMYT-India, NAASC, DPS Marg Pusa Campus, New Delhi, India.
[2]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.

Since rice is grown on some of the most productive lands, there is substantial scope to increase cropping intensity by introducing a second crop during the rabi season. Legumes such as chickpea, khesari, lentils, mung bean and black gram are potential crops for rice fallows. These crops may not require supplemental irrigation and contribute substantially to enriching soil fertility of these soils by fixing atmospheric nitrogen and adding organic matter. In addition, they may sustain the rice-based systems by breaking the disease and pest cycle associated with the sole cropping system. Similarly, they could enhance the microbiological activity and thereby nutrient availability of the soil following rice. Satellite image analysis estimates and GPS based survey were used in further identify and characterize rice fallows in Tal areas of eastern IGP that could be brought under targeted zero tillage technology for the establishment of second crop including legumes.

Soil characteristics of rice fallows

Rice fallows have fine textured soils with good water holding capacity. According to USDA Soil Taxonomy, these soils are broadly classified as alfisol, inceptisol, entisol and vertisol. These soils are generally fertile, and calcareous deep. They vary in texture from silt loam to silty clay loam, and are poorly and/or imperfectly drained. These soils often develop cracks at end of the rabi season indicating availability of moisture for supporting a short duration second crop on residual soil moisture. These soils have low to medium quantities of soil organic matter and medium to high soil fertility with adequate residual soil moisture. Table 1 gives the estimated soil fertility status of the tal lands.

Table 1. Soil fertility of soils in tal* lands.

Character	Rajpur tal (Bhagalpur)	Barahia tal (Begusarai)
PH	7.0-7.4	7.1-7.9
EC (dS/m)	0.30-0.40	0.20-0.43
Organic carbon (%)	0.25-0.63	0.22-0.92
Available P (kg P_2O_5/ha)	25.0-43.0	19.0-51.5
Available K (kg K_2O/ha)	144-432	300-1110
Available Zn (ppm)	0.48-5.64	0.35-4.09
Available Cu (ppm)	0.79-2.91	0.48-1.60
Available Mn (ppm)	29.3-166.4	3.2-6.4
Available Fe (ppm)	14.5-54.5	5.2-14.8

*Highly fertile soils due to fresh deposition of sediments; crop establishment practices in the tal lands need to be appropriate.

In low fertility soil, use of 100 kg DAP/ha has been found superior for pulses. Additionally use of borax @ 15 kg/ha for gram and Sulphur (a) 20 kg/ha for lentils has been found to increase yield by 15-20%. Also NPK fertilizer use@ 80 : 40 : 20 per ha is appropriate for most crops. Use of Rhizobium in pulse production increases yield by 10-15%.

Major crops for rice fallow lands

Wheat, winter maize, Indian mustard and potato are the major crops wherever irrigation and winter rains are assured. However, under occasional rainfed situations, linseed with Indian mustard as a mixed crop is commonly cultivated. In this environment, chickpea and wheat as mixed crop are also common and grown traditionally. In certain areas under rainfed situations, chickpea and wheat mixed crop, chickpea and lentils as *paira* crop in/after the rice are grown as relay crop. In some areas where limited but assured supplemental irrigation is available, wheat and mustard are grown as sole crops.

Resource conservation technologies: Zero-tillage and surface seeding

Major causes for rainfed rice lands to remain fallow include lack of irrigation facilities, and rice vacating the fields late to permit planting of a second crop during the rabi season. Such situations are typical of *Tal, Chaur* and *Diara* lands. In many upland and midland areas, where there is no ground water development for irrigation, land also remains fallow. Rice fallow lands generally belong to poorer farmers who have no irrigation facilities.

In areas that lack irrigation facilities, timely seeding taps residual moisture of the previous rice crop. Relay cropping or surface seeding of cereals and legumes in particular could offer potentially good cost effective options for resource-poor farmers. Certainly, surface seeding has the potential to increase farm incomes. Residual soil moisture contents in these deep alluvial soils after rice are sufficient for taking short duration legumes such as lentils and chickpea. These crops not only increase crop diversification in the cropping system, but also contribute to soil fertility. It is observed that available and workable technological options were never reached to the eastern IGP to reduce rice fallows. Therefore, diffusion of knowledge about Resource Conservation Technologies (RCTs) is an appropriate option for the complex ecologies in eastern IGP in particular and similar environments elsewhere. It is believed that most rice fallows here could be put under crop production using surface seeding and zero till planting techniques (Chandana et al. 2004).

Some of our efforts in bringing rice fallows into double cropping are:

- Broadcasting (paira) cropping in poorly drained soils: lentils/chickpea.
- Zero-till planting of chickpea and lentils that are profitable in normal soils.
- Line sowing of lentils and chickpea 25 cm and 30 cm apart by using a ZT drill has been found superior to traditional practices.
- With the ZT drill, it is possible to reduce the seed rate of lentils and chickpea substantially by almost 50%.
- Inter-cropping of gram : wheat in 3:1 ratio in line-sown condition is better than mixed cropping.

Legumes and their cultivars for Eastern IGP

In the rice fallow cropping systems, several temporal and spatial variations in the relations of the two major crops of the system are observed. Rice and wheat may be grown: (i) in the same plot, (ii) in different plots during a year, and/or (iii) in same plot in different years.

While rice and wheat may be the main crops grown in the same plot, other crops such as maize, chickpea, mustard, mung bean, lentils, sesame, black gram, pigeonpea and potato are the major replacement crops. Legumes are known as risk management crops in the rice fallows (Pande and Gowda 2004). Recently, we found that among legumes, lentils cultivar Arun (PL77-12), which is resistant to yellow rust, stemphyllium blight and tolerant to low temperatures is the most suitable for RCT. Its seed rate with seed drill @ 30 kg/ha has been found more productive than the prevalent practice of 100-130 kg/ha. Similarly, chickpea cultivar RAU-52 and DHG 82-4 and field pea variety 80-60-5 were found suitable for RCT and rice fallows in eastern IGR In tal lands, we have evaluated chickpea varieties following improved crop and pest management practices and found that with minimal inputs these varieties could give grain yield of 1.5-2 tons/ha (Table 2).

Table 2. Performance of chickpea cultivars in tal lands.

Variety	Yield (tonnes/ha)
SG 2	1.59
C 235	1.47
H 208	1.76
DHG-82-12	1.83
DHG-82-10	2.01
DHG 83-1	1.91
Pant G. 114	1.40
Local	1.78

Enabling factors for up-scaling

Effective promotion of RCTs for underutilized lands including rice fallows will require a well-organized database of land information that includes distribution and extent of certain land types and areas with specific problems (eg, soil moisture shortage, excessive wetness, salt affected lands and flood events). Geographic information systems and remote sensing technologies provide unique tools for achieving this goal. They provide backstopping for upscaling agronomic practices in problem areas. Application of remote sensing can help gather important data for pre-planning diffusion and targeting strategies of RCTs. However, enabling factors for upscaling of any technology including RCTs in particular must:

- Be time-tested
- Be simple and affordable
- Be farmer friendly
- Identify the champions and involve stakeholders
- Engage critics

RCTs, IPM and legumes

In general, it is believed that legumes do not respond to management. However, extensive testing of various combinations reveals that in spite of apparent higher productivity, rice-wheat and rice-rice are as remunerative as rice-legumes combination. This combination was found to be economical and ecologically harmonious. The efficiency of this system however, depends on several factors including genotype of the legume, population density and integrated crop and pest management.

Four options are readily available for introducing legumes through RCTs in the rice fallows: 1) To include short duration varieties of legumes, 2) to substitute low yielding cultivars with high yielding cultivars, 3) to introduce improved agronomic practices, and 4) to introduce integrated pest management as an integral part of the crop management. While introducing legumes in the rice fallows, we followed these components:

- Seedtreatmentwithfungicideslikecaptan,thiram/carbendazim@2g/kg seed or *Trichoderma viride* 4 g/kg seeds which gives protection from wilt and blight in pulses (damages 30-40% seedlings in initial growth stage).
- Chlorpyriphos @8-10 ml/kg seed, which has been found quite effective to control cutworm.
- Dusting of insecticide like malathion 5% @25 kg/ha.
- Spraying of monocrotophos @1 ml/liter, which is useful to control aphids that badly affect oil seed and lathyrus. Rust, wilt and stem rot are major diseases of lentils and gram. A spray of 2.5 kg Indofil M-45 in 100-liter water is recommended.

- Spraying 1.5 ml karathane or 3 g sulfex per liter of water to combat powdery mildew, a serious disease of pea.
- Use of Zero tillage machine for timely sowing of pulses and wheat, which has been found quite effective.

Conclusion

Adaptation of legumes in rice fallows provides a range of options. In the present scenario, legumes hold great promise for rice fallows as they are locally well adapted, need low input, sustain long term productivity of soil, besides being an important part of the local diet, culture and economy. Expansion of legumes into rice fallows will also need critical inputs such as seed, timely sowing and crop establishment, and crop and location specific IPM. Availability of critical inputs and easy credits, besides crop insurance and reasonable minimum support price are some of the policy issues, which can propel the farmers to grow legumes in rice fallows with minimum risk and profitability and thus help diversify the existing system.

References

Chandana P, Hodson DP, Singh U, Singh AN, Gosain AK, Sahoo RN and Gupta RK. 2004. Increasing the productivity of underutilized lands by targeting resource conserving technologies - A GIS/remote sensing approach: A case study of Ballia district of Uttar Pradesh in the Eastern Gangetic Plains. Mexico DF: CIMMYT. 43 pp.

Pande S and Gowda CLL. 2004. Role of legumes in poverty reduction in Asia: A synthesis. Pages 204-219 *in* Role of legumes in crop diversification and poverty reduction in Asia (Gowda CLL and Pande S, eds.). Proceedings of the joint CLAN Steering Committee Meeting, 10-12 November 2003, ICRISAT, India. Patancheru, Andhra Pradesh, India: ICRISAT. 234 pp.

Subbarao GV, Kumar Rao JVDK, Kumar J, Johansen C, Deb UK, Ahmed I, Krishna Rao MV, Venkatratnam L, Hebber KR, Sai MVSR and Harris D. 2001. Spatial distribution and quantification of rice-fallows in South Asia: Potential for legumes. Patancheru, Andhra Pradesh, India: ICRISAT. 316 pp.

Role and responsibility of the media in promoting cost-effective farmer-friendly agricultural technologies

BM Basnet[1]

Introduction

The Nepal Agricultural Research Council (NARC) is an apex organization responsible for research on various aspects of agriculture and assists the government in formulating policies and strategies on agricultural research and development in the country. NARC can contribute to production and productivity only when information and adoptive technologies generated by its research system are successfully transmitted to the potential users: farmers, I/NGOs, private entrepreneurs, clients etc. Similarly, NARC scientists and researchers' abilities to conduct high quality research and generate farmers' need-based, problem-oriented technologies would be enhanced if they are well facilitated with access to modern information technology.

NARC's Communication, Publication and Documentation Division (CPDD) should be responsible for both enhancing access to information technology for scientists, researchers, technical officers and communicating research results to potential beneficiaries/clients.

The future role of information services is even more crucial to agricultural research. There is an explosion of information has shrunk the world and information technology (IT)/ICT is becoming very significant.

His Majesty's Government (HMG) of Nepal is going to set up an Information Technology Park in Banepa, near Kathmandu. The 'Media Village' has already been established near the Tribhuwan International Airport in Kathmandu. The government has adopted the concept of Telecenters' in association with UNDP, the Ministry of Science & Technology and a high level Commission for Information Technology will enable information flows between Kathmandu and grassroot levels/rural areas. A private company called Surya Nepal Pvt. Ltd. will also be launching Surya Krishi Seva (E-Chautari) with a network of 100 computers with the help of NARC in the area of agricultural technologies. The main focus is on sharing information/experiences/knowledge among organizations at the national, regional and international levels. IT must be used not only commercially, but also to have social, educational and practical impacts

[1]Publication & Documentation Division, Nepal Agricultural Research Council, Kathmandu, Nepal.

towards poverty reduction. The 10^{th} Five Year Plan has also supplied a great thrust to ICT development in Nepal.

The use of mass communication in Nepal has served to reach a large number of farmers. Providing agricultural development information to all farmers in the country is beyond the capacity of inter-personal and group communication channels. For wider dissemination, it is mass media that is capable of conveying updated technical information to farmers and other agriculturalists rapidly and regularly. Various media,-print, electronic media such as FM radio and video-are used in Nepal. Other methods of communication for agriculture development include exhibitions/fairs, farmers' field days and subject-specific campaigns (Phuyal 1999).

The Nepalese Constitution asserts the People's 'Right to Information'. The government has followed up on this by setting up community information centers in rural areas. The government's Information and Technology Policy has also been a great step towards formalizing the status of information and communication in Nepal and is also a bid to embrace the latest IT innovations for the overall development of the country. The IT Professional Forum (ITPF) has also been formed. The recently enacted Cyber Law aims at boosting e-commerce.

Against this background, it would be timely and appropriate to conduct a regional meeting on the best use of information and communication technologies for development. The meeting would throw up suggestions and recommendations for further developing this sector. This is particularly urgent in the light of the fact that countries that have invested in information technology have also progressed on social and economic fronts, while those that failed to make proper use of IT have lagged behind. Technology, therefore, is one of the main components of the 20-year agriculture perspective plan (APP) as well as NARC's Vision 2021.

NARC was established by the NARC Act in 1991. CPDD also came into existence within NARC's structure and it has been a successful move. Mandated to generate agro-technologies, NARC's activities in communication and documentation had to be started from scratch as not much work had been done prior to this. It is important to understand that agricultural research is conducted for farmers but there is very little value to that research unless the results reach intended targets.

Funding also generally comes to agriculture research activities but not for research communications. It would make sense, therefore, for research proposals to have communication budgets built in or made allowance for.

It is imperative that we place Nepal on the Global IT map. It is equally important to train scientists and researchers in the use of computers. If we are to have rapid transfer of technologies, it is essential for scientists, technicians, educationists and extensionists to have access to modern information services and increase their work efficiencies.

The success of NARC will be judged not only on the performance of its scientists but on how well it keeps the public informed of activities and accomplishments. It is highly necessary to ensure effective flow of agricultural information among the country's agrarian population.

CPDD's structure

CPDD communicates NARC's research under four major functional categories, depending on the information to be disseminated and the audiences it is meant to reach: Technical and scientific communication, Program communication, Public communication and Promotional communication.

Technical and scientific communication

The majority of CPDD's communication activities fall into this category. NARC's research results are communicated to its internal and external clients through both print and electronic formats. These publications generally contain major findings of NARC's research programs. Editorial committees, which will be formed at different levels - regional stations, research institutes and NARC-will ensure the quality, validity and consistency of these publications. After being technically reviewed and approved by the editorial committees, the publications would go to CPDD for processing and value addition and be channeled through appropriate media. Alternatively, the concerned organization could take up the responsibility of broadcasting the information. These communications would be different from publications such as annual reports, journal articles, books etc.

General programs communication

Subcategories under this head are: Intra-program communications, formal reporting to line organization and communicating,to donor agencies. Publication of annual work programs, annual reports, periodic progress reports, newsletters in print and electronic formats would fall under this category.

Public communication

Communications to multiple receiver groups such as planners, policymakers and the general public would fall under this category. The objective would be to make the NARC's research program and its achievements more visible to wider audiences. Communication material such as program brochures, radio and TV programs, videos and slide shows are included.

NARC also maintains an Exhibit Room especially for visitors, with research outputs and other exhibits on display.

Promotional communication

Promotional communication activities include maintaining the image of the council, and nurturing regular linkages and relationships with organizations within and outside the system. It would also attract donors for grants and credits support for the development of research capabilities. CPDD can use conventional methods eg, publication and distribution offliers, diaries, calendars, liaison visits to relevant institutions by NARC/CPDD/appropriate staff, as well as using electronic media such as internet, email, web-site publishing, radio, FM Radio, TV etc (CPDD 1996).

Existing ICT strategies/planning

Considering the growing information and communication needs in the NARC system and increasing workloads for CPDD, its capacity should be developed in phases. CPDD's capacity in terms of organization, manpower, equipment, skills and programs should be strengthened to meet NARC's growing needs (Mundy and Phuyal 1999).

Nepal's own national radio broadcast may be weak and the country's national TV may have little coverage, but international programming is available albeit at higher costs. In order to be heard and seen, therefore, we may need to shift from the hitherto formal tone that smacked of 'preaching' to a more informal and participatory type of programming that includes and engages the audiences. Instead of disseminating of information from central headquarters, we need to go closer to the audiences and cater to what they need from us. Radio Nepal and Nepal Television along with the Agriculture Information and Communication Centre have started moving along these lines.

In their regional broadcasts, Radio Nepal and Nepal Television now air programs more specific to the region and in a language more comprehensible to farmers of the region. The print media has also begun to focus on regional publications.

Another recent development was the starting of community-based FM broadcast. This was made possible by the Broadcast Act, which allowed the private sector to launch FM transmissions. The immense popularity of these programs has opened up new avenues.

One strategy could be to intersperse short messages in an entertaining manner. Short musicals or jingles containing messages specific to the city/village could be broadcast through FM channels. In fact, this medium allows reach sections ofpeople in an even more localized manner than the mainstream regional broadcasts. Private sector participation in this media has been encouraging.

Radio and Television broadcasting has been expanding in Nepal - there are now five television channels and over 3,400 newspapers including dailies and weeklies in the private sector.

Nepal is facing a digital divide within the country itself. Moreover, Nepal's unique topography does not permit universal application of technology throughout the country. Hence, an exchange of experience among media planners will lead us towards finding an appropriate solution to those challenges (SAIC 1998).

I urge everyone to share ideas/experiences about successful agricultural programs through the print and electronic media. There are several success stories that have not been told well enough, widely enough and clearly enough. The question of impact in telling that success story better is a major concern and it should be our focus.

When it comes to administration, NARC's outlying stations, RARS require to carry out various communication activities: managing and updating libraries, organizing seminars, workshops, field days and facilitating researchers to have access to scientific information systems etc. It is necessary for all four RARS offices to have a Regional Communication, Publication and Documentation Unit (RCPDU) attached to it (Phuyal 2000). A core team of three to four members in each center must be designated to work in RCPDUs. They should be provided with training in development communication skills and given the task of coordinating and implementing communication activities at their station. These tasks may include managing on-station and outreach research information, collaborating with CPDD to generate, edit and produce information materials such as brochures, annual reports, research briefs etc and managing the station's library. This would successfully decentralize the communications approach.

References

CPDD. 1996. Proceedings of the First National Workshop on Agricultural Research Communications organized by Communication, Publication and Documentation Division (CPDD) and the Nepal Agricultural Research Council (NARC), 28-29 April 1996, Kathmandu.

Mundy P and Phuyal U. 1999. Developing agricultural communications in Nepal by Development Communication Specialists, MASDAR and SEEPORT: Report of a First Consultancy, 1-31 August 1999.

Phuyal U. 1999. Developing agricultural communications in Nepal. Second report of a first consultancy, 1 August - 30 September 1999.

Phuyal U. 2000. Developing communication strategy for agricultural research in Nepal JV SEEPORT Consultancy, CMS Nepal & IAAS: A Report submitted to Project Coordinator, Agriculture Research and Extension Project (AREP), March 2000.

SAIC. 1998. Regional Workshop of Experts in SAARC countries on transfer of technologies in agriculture organized by SAARC Agriculture Information Centre (SAIC), 2-5 November 1998, Dhaka.

Agriculture and mass media in Nepal: Link or missing link?

Y Lamsal[1]

Abstract

Despite its huge role in Nepal's economy, media coverage on agricultural issues is not very much. This is mainly because of the absence of effective communication strategy on the part of the government, lack of knowledge/orientation and motivation of journalists on farm issues and lack of farmers' access to media. There is a need for a bottom-up communication approach that ensures farmers' access to media through which they can influence planning and decisionmaking. The promotion of farm journalism by mobilizing local/community media, sensitizing national media and involving farmers could be an important step in developing media-friendly information and a farmer friendly dissemination system, which would bridges the existing gap among administrators, scientists, farmers and media. As ignorance is a big handicap for effective media coverage on agricultural issues, a national network of journalists interested in agriculture reporting/ writing could be created. Media mobilization should be included as one of the major components of the project.

The role of agriculture in Nepal's economy needs no elaboration. Nepal is an agricultural country with over 75 percent of its population depending on farming for survival. Its share in Nepal's GDP is almost three-fourths and also occupies a lion's share in export trade. These statistics would lead any layman to assume that Nepal is self-sufficient when it comes to food production. However, the reality is ironical because Nepal is, in fact, a food importer country.

For most people engaged in farming, agriculture is a compulsion rather than a choice. Many farmers are in this business because opportunities are scarce in Nepal. Had they been provided with alternatives, the farming population would readily switch to other professions-testimony to the fact that farming in Nepal is not a profitable, lucrative venture. Although the government in principle has accorded high priority to agricultural development, it is not so in practice. Much has been spent in Nepal for farmers, but the benefits don't seem to trickle down to those it is intended for.

[1]The Rising Nepal, Associate Editor of South Asian Media Network and Executive Member of Center for Alternative Agriculture Media.

Agriculture in media

The role of media in informing farmers about new farm technology and achievements in agriculture needs no elaboration. Media creates a triangular link between planners/policymakers and agriculture scientists/technicians; between planners and farmers and between scientists and farmers. The relationship among these three important constituents is close and feeds all humanity.

Farmers are indigenous scientists, who have learnt farm techniques from their time-tested knowledge and experiences. The experiences of farmers from one place can be highly beneficial for farmers elsewhere. The media can play a role by linking farmers as well. It is through the media that farmers can learn about the experiences and achievements of their counterparts. The media must play multiple roles-to inform, educate and interact. The media can educate farmers on several issues including new technology, use of improved seeds, fertilizer etc. It can also create a forum for planners, scientists and farmers.

The National Agricultural Research Council (NARC) has adopted communication strategies and made some efforts to mobilize mass media. It runs agricultural programs in television and radios, and we see some stories in the print media as well. However, they appear more as promotional articles than spontaneous participation of the mass media in disseminating information to farmers.

However, current media coverage on agricultural issues is dismal. Based on a cursory scanning of leading newspapers and magazines for a period of one week, it was found that politics dominated the contents of mass media in Nepal (almost 50%) followed by economy (20%), entertainment (10%) and sports (10%). Social issues got the least priority (10%)). If analyzed in terms of percentage, agricultural issues would occupy less than even one percent, although agriculture occupies a large share in Nepal's economy.

Farm stories are not as sensational as politics, crimes, corruption and conflict. In my long years of journalism, I have never seen any story related to agriculture in the front pages of our national-newspapers unless there was politician or celebrity involved in it.

Agriculture has a direct link with economy, health, environment and development, but development has never been the priority of the Nepali media. There are many reasons for this. Agricultural journalism/reporting is not rewarding or glamorous in the context of present day 'market journalism'. The market or the readers dictate media content. Most farmers are illiterate and poor, and rural areas are not the lucrative markets for media. As media gets more commercial and market-oriented, the focus obviously is on urban issues, which sell their products and promotes their businesses. Farmers have little say in decision-making and cannot dictate terms or attract media attention. Although farmers constitute almost three-fourth of Nepal's population, they have no access or control over media.

Most importantly, writing on farm issues is not easy. It requires energy, time and patience to first understand the issues and put them across in a farmer-friendly manner. The purpose of agricultural journalism is to communicate in a way that attracts the attention of readers, interests them in the subject, makes them understand, and finally helps them in decisionmaking. In the present environment, journalists are not interested, or do not invest time and energy in understanding less rewarding issues and sectors like agriculture. To be a farm journalist is still an unpopular and difficult choice. Journalists and mediapersons are basically an urban breed, with urban biases, while agriculture is a rural phenomenon. Most influential media persons have little knowledge about rural issues.

Journalists in the districts are more informed and aware, but often cannot influence media organizations to highlight these issues. There are no journalists in Nepal who specialize in agriculture, or work on the agriculture beat. Those reports that are written are perfunctory, event-oriented, superficial and poor in quality. There is seldom any follow up on issues and stories and in-depth, investigative reporting is rare.

In the absence of education and training for journalists on farm journalism, easy-to-understand dissemination of farm news, newer technologies, research findings and new agricultural strategies and related developments has been difficult. There is also no institute in Nepal that conducts training on farm journalism.

The situation is however changing for the better. District newspapers are getting professional and are trying highlight issues that have been neglected by the national media. Community radio is growing in importance. There is a tremendous scope for agriculture media. Our focus then should be on mobilizing rural and district media to report effectively on farm journalism.

The need for farm journalism

To better disseminate news on farm journalism, it is necessary to:

- Focus on need-based communication systems for farmers.
- Promote alternative efforts in agricultural communication.
- Identify and document similar and related initiatives worldwide and disseminate them among Nepali farmers.
- Encourage self-help among farmers.
- Bridge the communication gap between farmers and scientists/government.
- Focus on farmers' innovations and pro-farmer issues.
- Create a group of farm journalists and encourage better media coverage on agricultural issues.
- Encourage universities and training institutes to introduce courses and develop training modules on farm journalism.

What can be done to promote farm journalism?

New strategies are needed to promote farm journalism:

1. Educating media persons through training or other regular interactions.
2. Creating a national network of journalists interested in agricultural reporting/writing.
3. Identifying the needs and problems of journalists in agriculture reporting/writing.
4. Creating rural journalists by involving farmers and encouraging them to start cost effective community journalism.
5. Preparation of a media kits for journalists with all necessary information in one packet: sources to be contacted, reference materials etc, which would give them comprehensive knowledge on Nepal's agriculture and trends in the world.
6. Exchange program for journalists.
7. Institution of an annual award for best agriculture journalist.
8. Regular interaction programs between farmers and journalists.
9. Field visits for journalists.
10. Creation of an institute for training journalists on farm journalism.

Country-wide extension of Integrated Crop Management of chickpea in Nepal: Lessons learned and future approaches

PC Stevenson,[1] S Pande[2] and B Pound[3]

Abstract

This paper discusses lessons that have been learned both from discussions at the present meeting and those distilled from experiences of project partners during the collaborative activities of NARC, ICRISAT and NRI under the Crop Protection Programme's (DFID) project to rehabilitate chickpea in Nepal (DFID R7885). Chickpea is a crop that can compete with alternatives; it is highly profitable when grown with appropriate technology and improves livelihoods for poor farmers. Markets per se are not a limiting step for the nationwide expansion of improved chickpea production in Nepal (most chickpea consumed in Nepal is still imported), but aspects of marketing are, and need addressing to ensure trouble free expansion of chickpea production. Aspects of infrastructure also need addressing, especially the connectivity between research and extension organizations in Nepal, to enable joined-up extension services and technology support. Seed storage has too low a priority for both farmers and extension services and needs greater focus. Pesticide quality and insecticide resistance need monitoring and infrastructure and policy/legislation to support biological alternatives such as NPV needs attention. Farmers' past experiences with particular management tools (eg, familiarity with insecticides from vegetable production) often coincided with success, and finally skills of diagnosis and timing for applications of technology needs particular attention across all farmers. Because chickpea is self-fertilizing, farmers can produce and maintain their own seed stock negating the long-term role of seed production enterprises in up-scaling. The project also encouraged low cost inputs, which are less financially rewarding for Small and Medium Entrepreneurs (SMEs). There is, however, always a need for technology inputs and seed provision for new farmers so there is still a role for the private sector.

[1]Plant Chemistry, Natural Resources Institute, University of Greenwich, Chatham Maritime Kent, ME4 4TB, UK.
[2]International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[3]Consultant, E-mail: barrypound@calendra. freeserve.co.uk.

Self-help groups increasingly need to take on the role of seed producers. Agriculture holds a position of low priority in popular media such as newspapers and television, so alternatives need to be exploited to ensure widespread knowledge dissemination.

Introduction

This meeting of international researchers, HMGN institutions, NGOs and farmers has been a forum for some forthright and constructive presentations and discussions, and has provided valuable information about up-scaling successful research and development strategies for alleviating poverty through agricultural development in Nepal. Much of the information surrounding the production constraints for chickpea have been highlighted along with the problems associated with their management. The constraints can be classified as research, extension and farmer constraints, and action will need to be taken at each of those levels before an efficient, effective and sustainable technology is in place at a country-wide scale. The constraints include:

- Marketing (market linkages, market studies, market information)
- Changing farmers' perceptions of chickpea as an income generating crop
- Changing government perceptions so that the subsidy system can equally favor pulses
- Seed multiplication and storage (formal and informal)
- Further development of pest management technologies
- Action to improve the quality of available pesticides
- Credit (convincing credit organizations that chickpea is a creditworthy enterprise, and educating them on appropriate "chickpea credit packages")
- Developing chickpea as part *of* a farming system rather than as a single commodity
- Information materials production and information dissemination (by a range of media/methods)
- Advocacy and promotion (success stories; how to best utilize the "champions" you have already got)
- How to fit the promotion of this technology within the rigid bounds of NARC and DoA-or how to complement/supplement their capacities by using NGOs, farmer organizations, private enterprise etc.

We have also heard similar stories about other crops from similar systems and much about affordable and practical ways to manage constraints. Farmers themselves have provided valuable personal insight into the successes that can be achieved by following the associated technology guidelines promoted by the ICM of chickpea in Nepal project-especially where farmers use the information sheets (Appendix 1). In this paper, we highlight lessons learned from these experiences that are important considerations for up-scaling.

Economics

Encouraging farmers to go back to producing chickpea can be complicated by their perception that chickpea requires a high investment and that there is a lack of systematic marketing. However, the ICM of chickpea in Nepal project has shown that with a small additional investment (see Stevenson et al. in these proceedings) the rewards are greatly increased to a point where production costs are effectively halved. What's more, farmers themselves reported at this meeting that marketing the crop is not a problem. Despite farmers' perceptions that markets were not a limiting step and that there was always a demand in the market, aspects of up-scaling were identified as areas needing attention suggesting that these had been neglected-such as market linkages, market studies, market information. Clearly country-wide up-scaling will require some thought with respect to markets and infrastructure. Overall, it was accepted that there is a considerable shortfall of chickpea in Nepal and the deficit of production is approaching 90% according to some observers here. Thus in the grand scheme-as perceived by farmers-there will always be a market but facilitating distribution beyond villages where chickpea is grown and storage facilities will be strategic hurdles that will need to be borne in mind as the scaling-up of chickpea production takes off.

The question of whether chickpea is a commercially viable crop was also raised but this is clear from the outcome of livelihood studies undertaken as part of the present project and are detailed in Bourai et al. (2005) in this volume. Chickpea is a crop that can compete with alternatives since with considered and careful application of ICM, chickpea out yields alternative legumes and in terms of financial return exceeds wheat. This fits with current policy described by Dr Upadhaya, Member of the National Planning Commission, as re-orienting towards commercial, income-generating crops including non-cereal crops such as pulses. Upadhaya also highlighted the need for better complementarity between NARC and extension systems such as DoA and only then could Nepal really expect to go from the 3500 farmers touched by this project to a respectable proportion of the 2.8 million farming families in Nepal.

Land tenancy and problems associated with hidden subsidies for cereals crops works against them being prioritized by farmers and the balance of subsidies and indeed emphasis in MoAC needs to be changed.

Management of pests and diseases, and alternative approaches

The environmental concerns of controlling pests and diseases on chickpea with chemicals are predictable. However, the application rates promoted are extremely low especially compared with rabi alternatives such as wheat.

Caution needs to be taken with quality though and some NARC backstopping to check regularly the materials being used by farmers could help in this respect. Adulterated pesticides can lead to lower efficacy and build up of pesticide resistance in target organisms. Furthermore, it should be remembered that the efficacy of pesticides in some parts of the country are reportedly worse than in others. Notably, Thiodan, the insecticide promoted by this project was often reported to be ineffective at controlling pod borer in the mid-west. It is likely that this is due to local populations of pod borer arriving from nearby cotton in India that are sprayed up three times a week. Thus, the likelihood of pesticide-resistant populations of pod borer is high. Transgenic approaches to the control of *Helicoverpa* pod borer have been introduced in Bangladesh and may be an alternative route for controlling this intractable insect pest of chickpea in Nepal. However, as with other novel control strategy such as HNPV, the appropriate regulatory structures are not in place in Nepal and need to be implemented. Currently, it is not possible to promote NPV to farmers since it is not sustainable in the absence of a local large-scale production of the virus and no expertise for quality control or technological backstopping. Future plans to move to the use of bio-pesticides would benefit from investment of time and funds into the development of an in-country expertise such as between an NGO like FORWARD and the government scientists from NARC.

BGM has a broad range of hosts and consequently cross infection from other sources was highlighted as an unforeseen pathology - notably from pigeonpea *(Cajanus cajan)* - a crop grown frequently on paddy bunds and in close proximity to chickpea. Marigolds are also grown frequently in rural gardens as an ornamental addition and are culturally important. The flowers are particularly susceptible to BGM and the occurrence of hyphae spores on these flowers would normally be visible before or at the same time as chickpea and certainly be more visible. The use of marigolds as an early warning mechanism for BGM on chickpea has also been highlighted by ICRISAT (S Pande, pers. comm.) and could thus indicate to farmers when to spray Bavistin as promoted under ICM of chickpea in Nepal.

There were some reports that BGM-tolerant varieties were available in India and some hope for a natural control measure for this persistent disease. However, resistance in crops like chickpea is invariably dependent upon the production of small anti-fungal molecules called phytoalexins at the point of infection but only when fungal hyphae are invading roots (Stevenson et al. 1997) or leaves (Stevenson and Haware 1999). The reason it is so difficult developing resistance to BGM is because the disease attacks the flowers, which are not able to produce phytoalexins, so chickpea plants are susceptible to disease even when the leaves and roots are apparently resistant.

It is also worth noting that farmers who had previously used their land for the production of vegetables especially tomatoes - a crop that requires inputs such as pesticides-were able to adopt the ICM of chickpea very successfully and have been more likely to continue to do so after the lifetime of the project. This has been particularly so in Sarlahi district where fields of rotting tomato have been replaced by fields of chickpea that require far less investment in crop protection inputs. It is likely that previous experience of the value that management of pests and diseases has to yield and crop security is an indicator of likelihood of more successful adoption. Some participants have pointed out that the technology may be too complicated for some farmers. This may well be true where farmers do not have experience of the investment of technologies and effort into rabi crops particularly legumes and are more likely to broadcast onto rice fallows and see what comes up. These farmers may be less likely or able to adopt a strategy such as that promoted under this project.

Seed production, information flow and dissemination

The need to address information flows was highlighted and although was addressed to some extent in the present project, CBO/NGO partnerships and the ultimate integration of DoA extension is absolutely paramount to any successful up-scaling along with improved roles for commercial organizations. Seed sellers, for example, are considered an important route for up-scaling and sustainability. This project itself has highlighted their role in the exit strategy. However, most commercial interest in seed production is associated with crops in which hybrid seed is required. Since chickpea is a self-fertilizing crop, once farmers have a particular variety they can maintain their own seed stock thus negating the long-term potential role of small and medium enterpreneurs. So, in theory, unless the provision of seed is associated with the provision of quality technologies and perhaps even ICM guidance, the role of the commercial sector may be limited. The reality is somewhat different, however. Although many farmers do reserve seed for subsequent seasons, many do not and see most advantage in selling as much as possible as early as possible to secure the cash for a crop as valuable as chickpea. Thus, the role of seed sellers is still important especially with a crop that requires an involved technology - the seed seller can provide the seed along with the correct technologies as well as the technology back stopping.

Alternatively, self-help groups or community based organizations are increasingly taking on responsibility for seed production and one farmer reported a group in which investments reap financial rewards from investments that are highly impressive.

Agriculture has not yet found its due place and space in the media, despite it being a predominant feature of Nepali life. Research needs to develop a media-friendly information system and a farmer-friendly dissemination system. There need to be separate, but integrated information flows for national (policy) and local (farmer) levels of dissemination

Crop diversity

Crop diversification, especially as part of an improvement program for legumes in rainfed rabi cropping is considered by most development policymakers and scientists to be a key element of any national development strategy, in this case for Nepal. The Agricultural Perspective Plan Support Program (APPSP) of the Ministry of Agriculture and Cooperatives in Nepal recognizes the importance of diversity particularly for legumes but also for other vegetables and this led to the successful ADB-supported Crop Diversification Project in Mid- and Far-West Nepal. The current phase of the present project recognizes the limitations of promoting a single crop and this was indicated in the Project Memorandum. However, the ICM package is an involved technology, and so embedding it in the national agricultural strategy may only be possible with highly focused efforts, ie, by promoting it as a single crop development strategy. Otherwise, particular technologies that are crucial only for one crop in a crop diversification strategy, (eg, pod borer control in chickpea) could become low priority as it has little relevance in the other crop alternatives such as lentils or grass pea. This in turn, could lead to heightened effort for chickpea production as part of a chickpea production strategy but without emphasis on crucial but particular aspects to chickpea production leaving farmers with poor returns from chickpea. Ultimately this would lead to the same problem that farmers are facing now - low confidence in their ability to achieve good and profitable yields. High yields from chickpea are almost impossible to achieve without specific management of pod borer and other constraints. When they are managed however, few crops can yield as well as and earn as much as chickpea.

Single commodity approaches were cited as inappropriate also because it is considered important to present a set of options within a systems context. It was frequently suggested that farmers should be able to choose their route out of poverty from a range of options that they believe are more suitable to them. This is particularly so given that some farmers will want to grow different crops for personal or traditional reasons or perhaps because in some regions chickpea is less appropriate owing to climate. However, many farmers at our workshops confessed to not knowing what and to do and sought continual direction from technology experts in their strategy to grow chickpea. Moreover, it should be remembered that this project is promoting a strategy to increase (and more than double) chickpea yields among traditional chickpea growers who used to grow the crop happily, but the success of which requires the application of fairly involved technologies that we have promoted for chickpea ICM. Because they are involved or complex, a concerted effort to embed this practice alone is needed to ensure farmers have a clear, tried and tested experience of all the inputs and subsequent benefits. Once this has been achieved, then its role in a crop diversification approach can be considered.

It is, of course, important to be able to understand why some farmers don't continue to adopt given strategies after the experience of demonstrations and farmer field schools particularly after the lifetime of a project. It is possible that the absence of the technological backstopping and continued direction mentioned above is a problem. In which case, one particularly effective mechanism for transferring information and maintaining a good knowledge base among farmers rather than relying on that supplied by technical field visits by extension workers is through farmer cross visits or through traveling seminars involving farmers. These are also very effective in motivating farmers to consider new technology. Even the farmers at this meeting who are group leaders and largely successful at implementing involved strategies have suggested that this is an important component of sustainability.

India, Bangladesh and beyond

One emphasis of this phase of the project with respect to up-scaling is across borders and the need to help neighboring countries achieve their own development goals through the uptake of technologies developed in this project. This is particularly so for Bangladesh, where legumes are being relegated to marginal lands where they achieve poor returns and, as witnessed in Nepal, productivity is declining as a consequence. Alarmingly, Bangladesh will need 748,000 tonnes of legumes by 2010, and they are far short of that at present. There are 1000s ha of suitable land in the Barind Tract for expansion of chickpea as well as other legumes but as with Nepal there are constraints - but it should be noted that these are not always the same. While *Helicoverpa* pod borer is a severe constraint in both Nepal and Bangladesh, collar rot is reportedly a more serious problem than BGM or wilt. *Helicoverpa* and BGM are both the major biological constraints to chickpea production in India where yields are similar to those achieved in Nepal. Thus transferring technologies from apparently the same agricultural system in one country to another is not necessarily straightforward and detailed studies need to be undertaken before up-scaling elsewhere.

Other valuable lessons from Bangladesh are that greater impact is achieved if extension messages reach all clients at the same time, rather than sequentially.

One of the most important factors in the success of the ICM of chickpea in Nepal project was the willingness of local farm group leaders to take a lead role in adoption. This role needs to be rewarded with incentives and perhaps even direct pay but is worth it since local individuals especially educated farmers or local leaders who are known and respected by farmers likely carry more influence than government representatives. This is also important in ensuring continued adoption after a project has run its course. Also, as we found in Nepal, farmers are encouraged by awards that recognize high achievement: an approach that might successfully be applied in neighboring countries. Successful up-scaling needs local champions, and needs to engage and win over critics. Awards should be encouraged as an additional strategy to build up incentives. It not only adds a competitive element but is also an indication that the agricultural administration is taking notice of the changes that it is encouraging.

Lessons from other projects

Experiences from the Plant Sciences Research Programme of DFID's project on rainfed rabi cropping in rice fallows of Nepal established that farmers were largely unaware of the ways in which rice fallows could be exploited but that when these were identified to farmers they were keen to plant legumes. Time of sowing is critical to success so as to make best use of receding moisture; this varies across the Terai, with moisture staying longer in the eastern parts and soils drying earlier in the western regions. Chickpea is notable among legumes for its very deep root and adaptation to arid climate but is still highly dependent upon water at germination. This can be largely circumvented by ensuring that farmers employ seed priming as part of their seed treatment strategy if sowing in drier soils, although this should be avoided if soils are already moist. This can be indicated crudely by the presence of wet film around a footprint where water is squeezed out of the soil. Our strategy does suggest farmers use seed priming to enhance germination but this is far from being a blanket solution.

The PSRP project also determined that sowing behind the plough is the best planting method and combining with neighbors to grow larger blocks reduces theft, edge effects and cattle grazing and helps facilitate and economize effective spraying against pests and diseases. This requires good community cohesion. An additional constraint was identified in the apparent molybdenum deficiency but this can be overcome by adding molybdenum to seed priming water.

The rainfed rabi cropping project also determined that participatory varietal selections led to promising varieties in a similar manner to the selection of Avarodhi by farmers on the ICM of chickpea in Nepal CPP project. PVS using mother-baby-daughter trials has also been successful in selection of wheat. Only one "mother" is required at each site but replicated through multi-site trials controlled by researchers. Data can be analyzed so that each location is a replicate, but monitoring is done by farmers. When farmers have selected their favorite variety, then the 'daughter' material of the preferred material is further tested by them.

In rice/wheat production systems, some farmer groups were reportedly producing>100 tonnes of rice seed, and were amalgamating into cooperatives suggesting that up-scaling of seed production technologies was possible.

Mechanisms for scaling-up

The supply of mini-kits was cited as a tried and tested way to encourage seed production and is the principal extension tool for the Department of Agriculture. However, when mini-kits are used by farmers for food production and not seed production, this could result in a shortfall of certified seed if a variety being distributed is in short supply. This would certainly be the case with Avarodhi, the variety preferred by farmers during the 1CM of chickpea in Nepal project. However, the idea of using mini-kits provides an opportunity for farmers to experience the potential benefits of improved yields on a small scale and this should be the basis for self-financed uptake and their provision should be accompanied by the *caveat* that farmers must retain some of this 'gift' if they wish to continue production. This has worked very well with farmers in the Lalbandi where enough seed was provided for about 13 ha in 2001 and in 2003 farmers had sown 120 ha. New initiatives under the Agricultural Perspective Plan Support Programme through District Agricultural Development funds such as the District Extension Fund and the Local Initiative Fund provide opportunities for CBOs and NGOs to self-fund up-scaling. Other avenues for seed production need to be identified though to ensure that enough certified seed is produced through innovative farmers. Buy back schemes are another way in which the volume of seed available to extension services can be secured and this itself provides farmers by example with experience of seed production -perhaps the most important consideration in an up-scaling strategy. Currently, NARC produces 2814 kg of chickpea foundation seed and this is sufficient to cover the existing area but not more. In recognition of this problem, the NARC Outreach Programme has added the "frontline" demonstration method for pre-released varieties. In this process, researchers and extension staff interact directly with farmers in PVS/Farmer Field School (FFS). However, FFS have not been sustained beyond the project life and farmers tend to lose interest once the benefit stream from the projects dries up. The principal challenges of chickpea are the unavailability of the quality seed and the risks associated with unregulated farmer-produced seed. Furthermore, chickpea is perceived as high risk owing to recent nationwide crop failures (1997/98), and so considerable efforts need to be made to redress this perception. ICM of chickpea requires knowledge, which is thought beyond the interest of many farmers especially when alternatives such as wheat or lentils are available-and this is despite the fact that chickpea for yield and price per kilo is far superior to the alternative rabi crops.

Direct feedback from farmers

One farmer from Lalbandi-Krishna Kumari Shrestha reported that she had 200 kg of seed for distributing among farmers and that she was also helping other farmers with information regarding the technologies. She also confirmed that Avarodhi had been self selected by them in participatory varietal selections. She also contradicted what many scientists were reporting about farmer perceptions about the high cost of investment for chickpeas. She reported that among the crops she grew which include vegetables, chickpea required the least investment. She also announced that chickpea was in fact the most successful crop in Lalbandi, Sarlahi district, that she had full faith in chickpea and that the whole village had benefited from the increased wealth it had generated.

Additional issues associated with upscaling of chickpea ICM

Zero tillage could be a useful additional option as discussed by Barry Pound earlier in these proceedings. It would allow earlier planting under some soil/ climatic conditions, it might improve weed control and would bring in row planting that makes subsequent operations far easier (eg, spraying a randomly planted crop is difficult and inefficient.)

Summary of lessons learned

Economics

- Chickpea is a crop that can compete with alternatives. It is highly profitable with the right technology and can help improve livelihoods for poor farmers.
- If rewards are sufficient, farmers will adopt and reinvest (sustainable).
- Markets not a limiting step for chickpea in Nepal. Product must have a market opportunity especially with countrywide up-scaling.
- Connectivity between NARC and extension systems such as DoA essential.
- Storage a crucial and currently low priority for farmers and needs careful pest management.

Pest and disease management

- Pesticide quality crucial and adulteration frequently reported. Needs monitoring by DoA/NARC.
- Insecticide resistance reported in western parts of the country (possibly associated with cotton in neighboring India?). Needs addressing with alternatives.
- NPV could be used and works but no infrastructure for backstopping quality control or production, legislation and policy.

- Transgenic approaches may be considered (are being used in Bangladesh).
- Key life stages need to be understood and recognized by farmers.
- Farmers adopting chickpea as new crop did better if they had had previous experiences with similar technologies - ie, tomato to chickpea.
- Cross infection by BGM from other species occurs (eg, pigeonpea) therefore, broad thinking required for improved management.
- Careful skills of diagnosis need to be taught to farmers with well-informed technical backstopping.
    - Key life stages for successful control of insects essential.
    - Apparent resistance disguises actual susceptibility of the flowers to disease.
    - Early warning (eg, Calendula high susceptibility) and diagnosis
- Technologies too complicated for some farmers.

Seed production

- Chickpea is self-fertilizing. Once farmers have a variety, they can maintain their own seed stock negating long-term role of seed production SMEs in up-scaling.
- Always a need for technology inputs. We encourage low cost inputs - less financially rewarding for SME, therefore low interest.
- Self help groups increasingly take on the role of seed production. This works and helps ensure wider knowledge dissemination.

Crop diversity

- Crop diversity is valid to poverty alleviation but requires a strong focus on key technologies for each crop to ensure success of individual components
- Suitability of crop alternatives depends on agricultural conditions and farmer acceptability - both elements need to be clear.
- Adequate technical backstopping for new initiatives essential and often lacking.

Dissemination

- Popular media such as newspapers and television gives agriculture a low priority, so novel and alternative, local or traditional mechanisms need to be exploited to ensure widespread dissemination of information and knowledge.

References

Stevenson PC, Turner H and Haware MP. 1997. Phytoalexin accumulation in roots of chickpea seedlings (*Cicer arietinum* L.) associated with resistance to Fusarium wilt caused by *Fusarium oxysporum* f.sp. *ciceri).* Physiological and Molecular Plant Pathology 50:167-178.

Stevenson PC and Haware MP. 1999. Maackiqin accumulation in species of *Cicer* L. associated with resistance to botrytis gray mold (*Botrytis cinerea*). Biological Ecology and Systematics 27(8):761-767.

Summary, recommendations and lessons learned

The Editors

Summary

These proceedings have described and discussed a new technology along with associated and similar work that can lead to important improvements in the nutrition and income of poor farmers in the Terai of Nepal. The technology has been shown (under farmer-management) to double the yields of chickpea, and double the profits made from it as a cash crop. Furthermore, it can remove most of the risks of crop failure that have reduced farmer confidence in the crop in recent years.

Chickpea (*Cicer arietinum* L.) is a major component of the largely vegetarian Nepalese diet, providing a source of protein for the rural and urban poor. Yet, the area under chickpea production in Nepal has declined severely owing to persistent disease and insect damage affecting farmer confidence and interest in a crop that often fails. In the few places where it is grown chickpea yields are less than 800 kg/ha, but the crop can and often does completely fail.

However, an Integrated Crop Management (ICM) strategy has been evaluated by more than 3500 farmers across the Terai on smallholder farms that more than doubles yields to over 2100 kg/ha and, since the investment required for ICM is low, halves the unit costs for production to NRs 9.3/kg so more than doubles profits. More importantly, ICM guarantees a harvest.

The strategy uses improved cultivars (high yielding and disease tolerant), ultra-low and judicial pesticide application (fungal and insect control), seed priming (to enhance germination), reduced fertilizer inputs (prevents dense canopy and improves plant stand) and Rhizobium inoculation, where deficient, to improve plant growth.

Currently Nepal imports 90% of its chickpea but there is a potential to expand this crop into the estimated 373,000 ha of winter rice fallow across the Terai, particularly in the mid-western region. This could increase farmer wealth by $270 per family per annum of an average sized holding and eliminate the need for importing chickpea.

The technologies provide an economically and environmentally acceptable approach to improved chickpea production. The impact on livelihoods has been shown to be substantial, with the majority of farmers reporting improvements in all aspects of domestic life.

The rewards for Nepal are import substitution, export promotion, improved human and livestock nutrition, enhanced soil health and enhanced farmer wealth and empowerment. Women often manage chickpea production too, so increasing its production is empowering for women farmers. Empowerment enhances poor people's ability to realize their potential and enables them to profit from poverty-reduction opportunities by strengthening their socio-cultural and economic capabilities. The 10th Plan has included gender and equity as a cross cutting and sectoral issue.

Recommendations

The editors of these proceedings consider that the most important outcome of this workshop should be that the government of Nepal, under the direction of MoAC and through the extension processes and outreach capacity of NARC and DoA engages with farmers across chickpea growing regions to embed chickpea ICM into the national agricultural strategy. In doing so, the scaling-up of chickpea ICM will impact positively on the livelihoods of hundreds of thousands of the rural poor in Nepal especially in the western region and so address directly key facets of the 10th Plan - Nepal's Poverty Reduction Strategy Paper.

The editors also consider that the publication of a strategy document will provide guidance for widescale adoption. This document should describe the new technology in detail so that it is clear to policy setters and donors exactly what is required and explains what needs to be done at policy, strategy and field levels to achieve this widescale uptake. The rewards for Nepal are import substitution, export promotion, improved human and livestock nutrition, enhanced soil health and improved farmer wealth. In brief, the mechanisms required to scale up ICM have been identified through discussion with Nepali institutions and the participants of this workshop.

A component of the mechanisms for writing this document were discussion groups whose purpose was to *identify priority issues and preliminary strategies for scaling-up chickpea technology.* About 36 participants took part in these discussions and the outcomes of the preset agenda for each group are detailed below. The participants were organized to discuss Policy, Seed Sector, Information and a fourth group that centered on farmer feedback.

The areas that need addressing include:

- Marketing
- Fitting promotion into the strategies of NARC and DoA so they can work together
- Improve complementarity between GOs and with NGOs and CBOs
- Recognition of chickpea as an income-generating crop
- Promotion of pulses through a balanced subsidy system
- Seed availability, quality, cost and storage
- Further development of pest management technologies

- Action on pesticide quality
- Access to credit
- Developing chickpea as part of a farming system
- Information materials production and dissemination
- Advocacy and promotion of success stories

Group Discussion: Formats

Group Discussion

Discussion groups

Four discussion groups were formed from 36 participants, who included 5 farmers. The purpose of the group work was to involve Nepali, Indian, Bangladeshi and UK staff in identifying priority issues and preliminary strategies for scaling-up chickpea technologies.

Scaling-up will have two dimensions: a) Extending the coverage of the technology over a wider geographical area and across a greater number of people (horizontal scaling-up), and b) incorporating the technology into the norms, structures, processes and practices of relevant research and development institutions (vertical scaling-up).

It will be important to bear equity, the heterogeneity of clients and sustainability (institutional, financial and environmental) in mind while developing the strategy. In addition, there will be a need for good monitoring and evaluation, together with the flexibility to respond to what comes out of the evaluation/reflection processes.

The topics chosen for Groups 1-3 are key to scaling up chickpea in Nepal and the wider region, while Group 4 drew on the experiences of five Nepali chickpea farmers who have worked with the project. The four topics are outlined in Box 1.

For each Group, a series of guide questions were formulated. The Groups kept to the questions during the two hours allotted for this exercise, and then presented their thoughts.

Box 1. Topics for group discussion

Group 1: Policy and funding issues
Group 2: Seed multiplication issues
Group 3: Information supply issues
Group 4: Farmer experience with chickpea technology

Group 1: Policy and funding issues

1. What are the elements of an enabling policy environment for the scaling-up of chickpea in Nepal and in the wider region? Prioritize.
2. How should each element be addressed and who should be responsible for each action?
3. How will up-scaling countrywide be paid for (excluding direct support from major donors)?

4. Is there a good market for chickpea? Are there problems with processing and marketing the crop, and if so how can these problems be resolved?

Group 2: Seed multiplication issues

1. What different models exist for making seed available to farmers?
2. What are the stages of the model, and which organizations are responsible at each stage?
3. What are the advantages and disadvantages of each model?
4. What are the roles of government institutions, NGOs, CBOs and private organizations in each model?

Group 3: Information supply

1. What types of information are needed by different stakeholders, and how can your suggestions be validated?
2. What options exist for developing and transmitting information needed by each stakeholder?
3. What are the advantages and disadvantages of each option?

Group 4: Farmers experience with chickpea

1. What has worked well, and what has not worked so well with the introduction of new chickpea technology, in your experience?
2. What would you like to see happen next? Who should be responsible for each action? What is the role of the community?
3. How can chickpea production and marketing be made sustainable so that communities are not dependent on the project or on government?
4. How do you suggest that new communities are helped to adopt chickpea?
5. What information do farmers need, and how would you like it to be presented?
6. Is there a good market for chickpea? Are there problems with processing and marketing the crop, and if so how can these problems be resolved?

Results of group discussions

Group 1: Policy and funding issues

What are the elements of an enabling policy environment for the scaling-up of chickpea in Nepal and in the wider region?

- Policy support for NPV production at local level.
- GM-chickpea testing on-station under controlled conditions.

- Subsidy for prophylactic sprays for BGM control (both chemicals and equipment).
- Seed access enhancement:
  - NARC - foundation and breeder seed
  - Certified and improved seed
  - Import of seed until self-sufficiency.
- Revolving fund and technical backstopping for strengthening community-based seed production systems.
- Make chickpea R & D a national priority:
  - Capacity strengthening
  - Infrastructure and facilities
  - Manpower development
  - Promotion of FFS approach.
- Micronutrient management R & D , with emphasis on B, Mo, P and Rhizobium.
- Zonation of rice fallow areas and inclusion of lowland maize fallows.
- Crop insurance (NB: this is mentioned in the 10th Plan, but is not in place yet).
- The pay-offs for policy support to chickpea will be:
  - Import substitution
  - Export promotion
  - Soil health
  - Human and livestock nutrition

How will up-scaling countrywide be paid for (excluding direct support from major donors)?

- National funding should be provided from regular budget (some of which is donor money that goes through national budget lines).
- Some components could be financed by donor projects.
- Needs advocacy to obtain share of NARC/DoA/NSC funding for chickpea.

Is there a good market for chickpea? Are there problems with processing and marketing the crop, and if so how can these problems be resolved?

- There is no marketing problem, as there is huge unsatisfied national demand.

Group 2: Seed multiplication issues

What different models exist for making seed available to farmers?

- There are two main models: the formal seed multiplication sector, and the informal (community) sector, which is much larger but characterized by less quality control.

- The formal sector consists of:
  - NARC stations
  - Farms under DoA
  - National Seed Corporation (NSC)
  - NGOs, private seed companies
  - Agrovets
- The informal sector consists of:
  - Farmer groups/CBOs
  - Individual farmers
  - Farmer-farmer seed supply

What are the stages of the model, and who are the responsible organizations at each stage?

- Breeding/breeders seed: NARC
- Foundation seed: NARC and qualified private organizations
- Certified seed: NARC, seed companies, farmer groups, individual farmers
- Truthfully labeled seed: Seed companies, farmer groups, individual farmers

What are the advantages and disadvantages of each model?

	Advantages	Disadvantages
Formal sector	• Assured quality • Assured purity • Institutional creditation	• May not be able to supply in time • No commercial incentive • Administrative issues/price fixation
Informal sector	• Profit drives good delivery time and quantities • Demand driven	• Lack of quality assurance • Lack of infrastructure to produce quality seed and sufficient quantity • High price

What are the roles of government institutions, NGOs, CBOs and private organizations in each model?

- GOs (NARC, DoA, NSB, NSC):
  - Quality control
  - Make policy
  - Market linkage
  - Dissemination
  - Source seed
  - Price setting

- Variety release and maintenance
- Coordination
- Training

- NGOs:
  - Scaling-up
  - Formation and mobilization of seed producer groups
  - Varietal development
  - Training
  - Market linkage
  - Input/technology supply
- CBOs:
  - Seed production
  - Resource persons for farmer-farmer training
  - Help in varietal development
  - Sell inputs/technology
- Private organizations:
  - Marketing seed
  - Sale of inputs/technology
  - Dissemination of information

Note: The six "improved" varieties of chickpea that are being piloted have not yet reached the foundation seed stage (still at breeder seed stage). Avarodhi has come from India, and has been tested for 3-4 years. The test results need to be submitted so that the variety can be approved for release. The seed of Avarodhi from India needs to pass certain conditions before it can be accepted for marketing.

Group 3: Information supply

What types of information are needed by different stakeholders, and how can your suggestions be validated?

- Printed information on production technology for farmers in local language, with photographs and drawings. Needs to be location specific, and need to differentiate between resource-rich and resource-poor farmers
- Audio visual aids
- Electronic media: National and local TV; national, FM and "local" radio; email; networks
- Information on postharvest technology
  - Grain/seed preservation
  - Optimum time to sell grain to market
  - Market information (where, size, prices, quality conditions...)

- How to set up cooperative producer and seller groups
- Credit information (who, where, rates, conditions...)
- Input suppliers (who, where, prices...)

What options exist for developing and transmitting the information needed by each stakeholder?

- Budgetary provision shouldbe included in all project costs forthe development of a communication/dissemination strategy and its implementation.
- Should carry out information needs assessment for each stakeholder.
- Provision of funds to farmer groups for the production and promotion of seed, bio-control agents etc.
- Training of farmers, extension agents, NGOs, private sector and researchers (need to develop training materials: eg, manuals and modules).
- Bridge the knowledge gap with journalists: researchers' outputs are unintelligible to journalists.
- Use of local newspapers; wall posters; PA systems in local haats, melas etc. (need cassettes with simple messages on them).
- Need to know consumers' preference (taste, variety, cooking qualities etc) and transmit that to producers and traders.
- Incentives, awards, certificates etc.
- Documentation of success stories for promotion (including policymakers). Local resource-people can help with this (it was emphasized that the village "resource-person" model was working well and being absorbed into formal planning.
- Monitoring and evaluation of information effectiveness, and modification of materials.
- Updating of materials.
- M & E to provide information to donors, project management and project partners about progress.
- Need to use the expertise developed in India on communication.

What are the advantages and disadvantages of each option?

- Disadvantages:
  - Competition with other fallow crops
  - Lack of continuous flow of technology that can be converted into new information
  - Need to transmit information in a timely way (ie, with due regard to season and farmers activities)

Group 4 - Farmers' experience with chickpea

1. What has worked well, and what has not worked so well with the introduction of new chickpea technology, in your experience?
2. What would you like to see happen next? Who should be responsible for each action? What is the role of the community?
3. How can chickpea production and marketing be made sustainable so that communities are not dependent on the project or on government?
4. How do you suggest that new communities are helped to adopt chickpea?
5. What information do farmers need, and how would you like it to be presented?
6. Is there a good market for chickpea? Are there problems with processing and marketing the crop, and if so how can these problems be resolved?

What has worked well in your experience?

- Technique of seed selection
- Technique of seed treatment
- Technique of seed storage
- Project recommendations for control of BGM and pod borer (although they modified the recommendation by combining the two chemicals and spraying at the same time)
- Cross visits (traveling seminars)

What didn't work well?

- Spraying of NPV, especially mixed with milk - chemical not readily available, and expensive.
- Rhizobium treatment. Farmers said that it wasn't available and that it was costly. However, NARC staff say it is available from Khumultar, and that it is cheap from that source.

What would you like to see happen next?

- Chickpea crop free from disease and pests.
- Frequent visits from technicians.
- Training on cultivation technology for chickpea.
- Farmers' field visits to other locations (they are also prepared to host visits).

Who should be responsible for the above?

- GOs, NGOs, INGOs.

What should the role of community be?

- Being helpful to other communities/neighboring farmers.
- To give training to other communities/neighboring farmers.
- To sell seed to other communities/neighboring farmers.

How can chickpea production and marketing be made sustainable?

- By forming chickpea producer groups in each society.
- By helping neighbors and other communities grow chickpea.

How do you suggest new communities are helped to adopt chickpea?

- By demonstrating economic benefits.
- Help with marketing.
- Convincing others that chickpea can grow without irrigation.

What information do farmers need?

- Effective technologies for growing chickpea, in the form of training or booklets.

Is there a good market for chickpea?

Yes. No problems with processing and marketing.

Participants and Invitees

His Majesty's Government of Nepal (HMG Nepal)

HN Dahal
Minster of Agriculture and Cooperatives
Singhdurbar Plaza
Kathmandu, Nepal

U Chaudhary
Assistant Minister of Agriculture and Cooperatives
Singhdurbar Plaza
Kathmandu, Nepal

HK Upadhyaya
Member, Planning Commission
Singhdurbar Plaza
Kathmandu, Nepal

C Pokharel
Member, Planning Commission
Singhdurbar Plaza
Kathmandu, Nepal

GP Pandey
Secretary
Ministry of Agriculture and Cooperatives
Singhdurbar Plaza
Kathmandu, Nepal

KK Shreshta,
Joint Secretary, Planning,
Ministry of Agriculture and Cooperatives
Singhdurbar Plaza
Kathmandu, Nepal

BR Kaini,
Joint Secretary, Monitoring and Evaluation
Minstry of Agriculture and Cooperatives
Singhdurbar Plaza
Kathmandu, Nepal

TB Thapa,
Member Secretary,
NARDF
Ministry of Agriculture and Cooperatives
Singhdurbar Plaza
Kathmandu, Nepal

Nepal Agricultural Research Council/National Agricultural Research Institute/National Grain Legumes Research Programme/National Oilseeds Research Programme

DS Pathik
Executive Director
Nepal Agricultural Research Council
Singhdurbar Plaza
PO Box 5459, Kathmandu, Nepal

SL Maske
Director, Crops and Horticulture
Nepal Agricultural Research Council
Singhdurbar Plaza
PO Box 5459, Kathmandu, Nepal

BK Baniya
Director
National Agricultural Research Institute
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

TP Pokharel
Principal Scientist
OR Division,
Nepal Agricultural Research Council
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

BM Basnet
Principal Scientist and Chief of Communication,
Publication & Documentation Division (CPDD)
National Agricultural Research Institute
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

SL Joshey
Principal Scientist
Entomology Division
National Agricultural Research Institute
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

RK Neupane
Principal Scientist (Agronomy)
OR Division
Nepal Agricultural Research Council
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

NK Yadav,
Principal Scientist (Agronomy)
National Grain Legumes Research Programme
Rampur
Chitwan, Nepal

YN Ghimire
Principal Scientist
OR Division
Nepal Agricultural Research Council
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

R Khadka
Principal Scientist (Economics)
OR Division
Nepal Agricultural Research Council
Khumaltar, Lalitpur
PO Box 5459, Kathmandu, Nepal

M Joshi
Principal Scientist (Agronomy)
Nepal Agricultural Research Council
Singhdurbar Plaza
PO Box 5459, Kathmandu, Nepal

VK Dutta,
Principal Scientist (Agronomy) and Head
Regional Agriculture Research Station
Khajura
Nepalgunj, Nepal

B Mishra
Principal Scientist (Agronomy) and Head
National Oil Research Programme (NORP)
Nawlpur, Nepal

RN Chowdhary
Principal Scientist (Pathology)
National Oil Research Programme(NORP)
Nawlpur, Nepal

CR Yadav
Principal Scientist (Agronomy) and Head / R&D
Regional Agricultural Research Station
Tarahara, Sunsari, Nepal

S Joshi
Principal Scientist (Pathology)
Division of Plant Pathology
National Agricultural Research Institute
Khumaltar, Lalitpur
PO Box 1126, Kathmandu, Nepal

DB Gharti
Technical Officer
National Grain Legumes Research Programme
Rampur
Chitwan, Nepal

DN Pokhrel
Technical Officer
Regional Agriculture Research Station
Khajura, Nepalgunj
Nepal

Department of Agriculture

SS Shrestha
Director General
Department of Agriculture
Harihar Bhawan
PO Box 10522
Lalitpur, Nepal

KK Lal
Manager and Office Incharge
Seed systems
SQCC, Department of Agriculture
Harihar Bhawan,
PO Box 10522
Lalitpur, Nepal

H Bhandari,
Program Director
Crop Development Directorate
Department of Agriculture
Harihar Bhawan, Lalitpur
PO Box 10522
Kathmandu, Nepal

CIMMYT/IARC-Nepal

G Ortiz Ferrara
Principal Scientist,
Country Representative
CIMMYT-South Asia
Singhdurhar Plaza
PO Box 5186, Nepal

SE Justice
Research Affiliate
CIMMYT-South Asia Regional Office
Singhdurhar Plaza
PO Box 5186, Nepal

KD Joshi
Scientist/Research Coordinator
CIMMYT-South Asia Regional Office
Singhdurhar Plaza
PO Box 5186, Nepal

H Wedgwood
Rural Livelihoods Adviser
DFID-Nepal
PO Box 106
Lalithpur
Nepal

I Hancock
Team Leader
Department of Agriculture
Hariharbhawan
Lalithpur, Nepal

J Morrehnof
Consultant
APP, Department of Agriculture
Hariharbhawan
Lalithpur, Nepal

P Mainali
Programme Manager
APP Support Programme
Department of Agriculture
Hariharbhawan
Lalithpur, Nepal

Other NGOs

Y Lamsal
Deputy Executive Editor
The Rising Nepal
GPO Box 8262, Kathmandu
Nepal

KP Devkota
Scientist
LI-BIRD
PO Box 324, Mahendrapool
Pokhara, Nepal

N Khanal
Programme Coodinator
FORWARD
PO Box 11, Bharatpur-2
Chitwan, Nepal

B Pyakuryal
Professor
Economics Department
Tribhuvan University
PO Box 6129, Kathmandu
Nepal

Farmers

Farmers from the village Pithuwa

Farmers from the village Lalbandi

Farmers from the village Bardibas

Farmers from the village Rajahar

Farmers from the village D-goan

Bangladesh

J Uddin
Senior Scientist
Pulses Research Centre
Regional Agricultural Research Station
Ishurudi - 6620, Pabna
Bangladesh

MA Bakr
Principal Scientific Officer, Project Manager
LBM Development Pilot Project
Pulses research Centre
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701,
Bangladesh

NRI/Consultants

PC Stevenson
Reader, Plant Chemistry,
Natural Resources Institute
Medway University Campus,
Central Avenue, Chatham Maritime
Kent ME4 4TB, United Kingdom

D Grzywacz
Principal Insect Pathologist
Natural Resources Institute
Medway University Campus,
Central Avenue, Chatham Maritime
Kent ME4 4TB, United Kingdom

B Pound
Consultant
Email: barrypound @ calendra.
freeserve.co.uk

Rice Wheat Consortium-India

RK Gupta
Regional Facilitator, Rice-Wheat
Consortium
CIMMYT India/RWC, CG Block,
National Agricultural Science Centre
(NASC) Complex
DPS Marg, Pusa Campus
New Delhi 110 012, India

Universities, India

HS Tripathi
Department of Plant Pathology,
College of Agriculture,
GB Pant University of Agriculture
and Technology,
Uttaranchal, India

ICRISAT-India

JDH Keatinge
Deputy Director-General,
ICRISAT,
Patancheru 502 324
Andhra Pradesh, India

CLL Gowda
GTL-Crop Improvement
ICRISAT
Patancheru 502 324
Andhra Pradesh, India

MC Bantilan
GTL - SAT futures and development
pathways
ICRISAT
Patancheru 502 324
Andhra Pradesh, India

JVDK Kumar Rao
Special Project Scientist
ICRISAT
Patancheru 502 324
Andhra Pradesh, India

S Pande
Principal Scientist (Pathology)
ICRISAT
Patancheru 502 324
Andhra Pradesh, India

JN Rao
Sr. Scientific Officer
ICRISAT
Patancheru 502 324
Andhra Pradesh, India

Appendix

Information Sheet on Integrated Crop Management published in Nepalese

चना खेतीका उन्नत प्रविधि तथा एकीकृत रोग र कीरा व्यवस्थापन (आइ. पी. एम.)

चना नेपालको एक बहुउपयोगी हिउँदे कोसे बाली हो । विशेष गरी तराई र भित्री मधेशमा धान पछि यसको खेती गरिन्छ । हाम्रो दैनिक जीवनको खानपीनमा निकै महत्व राख्ने चना बालीको उत्पादन त्यसिको सन्तोषजनक रहेको छैन । उन्नत खेती प्रविधि प्रयोग गर्दा वर्षेनी उब्जनी राम्रो भई चनाबालीबाट निकै फाइदा लिन सकिन्छ । चना खेतीको उन्नत विधि अपनाउने कृषकहरूले वार्षिक झण्डै ४०/५० हजार रुपैयाँ आम्दानी गर्नुको साथै घरायसी प्रयोगको लागि पर्याप्त चना राख्न समर्थ भए । यसरी आर्थिक लाभ संगसंगै खानलाई पनि मनग्गे भएको थियो । चना खेतीले जमीनको उर्वराशक्ति बढाउनमा पनि मद्दत गर्दछ । यसको लागि हाम्रा किसान दाजुभाइ र दिदीबहिनीहरूले केही कुराहरूको ख्याल राख्नु पर्दछ । हावापानी, मलखाद, जमीनको तयारी, रोप्ने विधि र विशेष गरी बोट तथा जरामा लाग्ने रोग र कीराहरूको विषयमा हामी तपाईंहरूलाई केही संक्षिप्त जानकारी दिंदैछौं ।

हावापानी : बोट फस्टाउन र बढी उब्जनीको लागि चिसो र सुख्खा मौसम उत्तम हुन्छ ।

जमीनको तैयारी : एक अथवा दुईपटक जोती चिस्यान कायमै रहन दिन पाटा लगाउनु पर्दछ । झारपात र पहिलो बालीका ठुटाहरू निकाल्नु पर्दछ । जमीन सुख्खा भएमा हल्का सिंचाई गरेमा उमार एकनास र राम्रो हुन्छ ।

मलखाद : पहिलो पटक बाली लागाउँदा १०% चीनी पानीको घोलले बीऊ भिजाई जीवाणु मलले उपचार गर्नु पर्दछ । रासायनिक मलको हकमा, डाईअमोनियम फोस्फेट (डी ए पी) १०० कि. ग्रा./हेक्टर (लगभग ३ कि. ग्रा. प्रति कट्ठा) जमीन तयार गर्दा एकनासले माटोमा मिलाउनु पर्दछ ।

रोप्ने विधि र समय : मध्य र पूर्वीतराई, भित्री मधेशमा कार्तिकको तेस्रो देखि चौथो हप्ता र पश्चिमी क्षेत्रमा कार्तिकको पहिलो देखि दोस्रो हप्तामा रोप्नुपर्दछ । हलोको सियो पछाडि, लाइनमा झण्डै १० सेण्टीमीटरको फरकमा बीउ खसाली पाटा लगाउनु पर्दछ । धान नकाट्दै, घुसुवाबाली (Relay crop) को रुपमा पनि चना छर्न सकिन्छ ।

रोग र कीराहरूबाट बालीको सुरक्षा

बीऊ र माटोबाट सर्ने रोग : जरा, डाँठ र फेद कुहिने रोग, ओइलाउने रोग र खैरे रोग ।

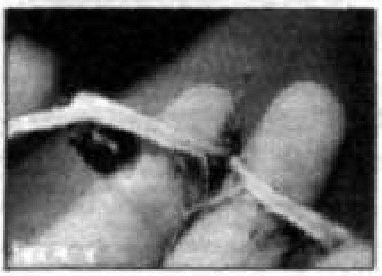
लक्षण

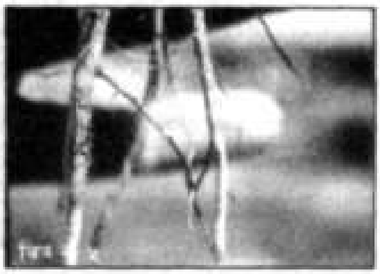
- पातहरू ओइलाएर पहेंलो हुँदैजान्छन् । पछि ती बोटहरू खेतमा मर्छन् र बेर्नाहरूको रंग फिक्का हुन्छ । (चित्र नं. १)

चित्र नं. १

- फेद कुहिने रोग – माटोको सतहमा सेतो ढुसी । (चित्र नं. २ र ३)

- डाँठको भित्री भाग कालो हुन्छ र जरा सुक्छ । अनि मसीना जराहरू झर्दछन् । (चित्र नं. ४ र ५)





रोकथाम

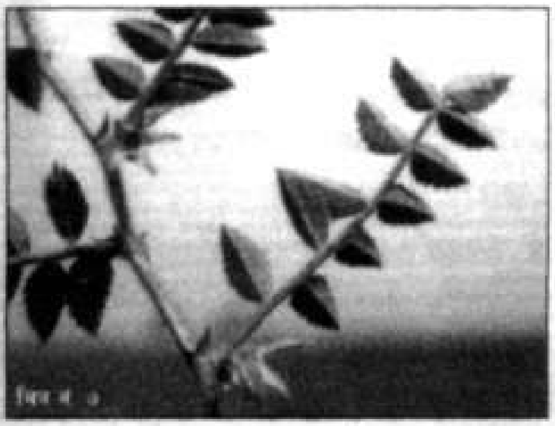
- सर्वप्रथम रोग निरोधक जातहरू जस्तै "अवरोधी" प्रयोग गर्नु पर्दछ । होइन भने बीऊ उपचार अनिवार्यरूपमा निम्न तरिकाले गर्नु पर्दछ :–

  बेभिष्टिन (कार्बनडाजीम) ३ ग्रा. वा बेनलेट - टी (बेनोमाईल + थिरम्) ३ ग्रा. वा थीराम + क्याप्टान २.५ ग्रा. प्रति कि. ग्रा. बीऊको दरले उपचार गर्नु पर्दछ।

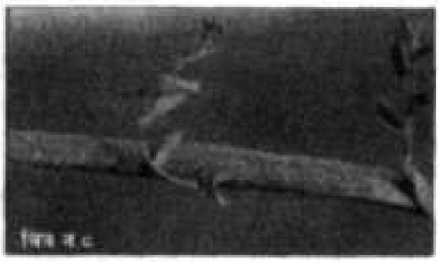
बोट्राईटिस खैरे वा फुस्रे रोग

लक्षण

- जाडोमा धेरै दिन कुहिरो लाग्दा र तापमान घट्दा यो रोगको प्रकोप बढ्छ।
- कोशाहरू नलाग्ने (चित्र नं. ६) र फूलहरू मर्ने (चित्र नं. ७)।



- डाँठमा खैरो ढुसी (चित्र नं ८) र हाँगाहरू कुहेको (चित्र नं. ९)।


चित्र नं ८

रोकथाम

- यो रोग बीऊबाट पनि सर्छ। यसैले पहिले बताइएको बीऊ उपचार विधि वा डाइथेन एम ४५ (मानेब) २.५ ग्रा. प्रति कि. ग्रा. बीऊको दरले बीऊ उपचार गर्न सकिन्छ।

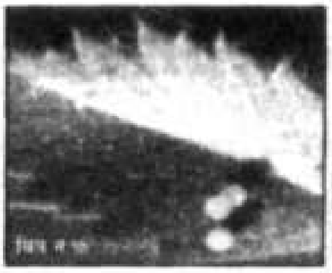

चित्र नं ९

- यस बाहेक वायुमण्डलमा धेरै आद्रता र ठण्डा मौसम रहेको अवस्थामा पहिलो पटक फूल फुल्ने बेलामा, ८ लिटर पानीमा १६ ग्रा. बेभिष्टिन मिलाएर १–२ पटक छर्नु पर्दछ। बेभिष्टिन नपाएको खण्डमा गोलभेंडा र आलुमा प्रयोग हुने ढुसीनाशक विषादी (प्रति कट्ठा ८ लिटर पानीमा २४ ग्रा. डाइथेन एम ४५) प्रयोग गर्न सकिन्छ।

कीरा

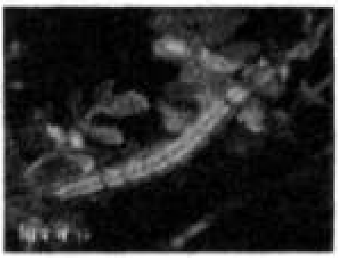
कोसे गवारो वा बहादुरे कीरा

(Pod Borer)



लक्षण

- कोसे गवारोको पोथी पुतलीले चनाको पातमा फुल पार्दछ (चित्र नं १०) र फुलबाट स-साना लाभ्रेहरू निस्कन्छन्। लाभ्रेहरूले चनाको कलीलो पात तथा कोपिला खाई नष्ट गर्दछन्। विकसित लाभ्रेहरूले कोशामा प्वाल पारी भित्रको गुदी खाई खोक्रो बनाई दिन्छन्। (चित्र नं ११ र १२)



रोकथाम

- कोसे गवारोबाट धेरै नै आर्थिक क्षति हुने तथा कुनै एक उपायबाट मात्र यसको नियन्त्रण गर्न नसकिने भएकोले, एकीकृत कीरा व्यवस्थापन (आइ. पी. एम.) विधिबाट यसको क्षति न्यून गर्न सकिन्छ। यसको लागि निम्न लिखित पाइलाहरू चाल्नु पर्दछ :-

हेरचाह

कोसे गवारोबाट बाली जोगाउनको लागि, यसको संभावित आक्रमणको समय तथा प्रकोप सम्बन्धी अनुगमन गर्न अति आवश्यक पर्दछ। फेरोमोन पासो (Pheromone Trap) भन्ने सस्तो यन्त्रबाट यस्तो जानकारी लिन सकिन्छ। (चित्र नं. १३)। फेरोमोन पासोमा राखिएको पोथी पुतलीको गन्ध (Female Hormone) ले भाले पुतली आकर्षित भई पासोमा फस्छ र पासोमा फसेका पुतलीको संख्याको आधारमा आउने दिनहरुमा हुन सक्ने कीराको प्रकोपको संकेत मिल्न सक्छ।

एक हेक्टर क्षेत्रफलमा बराबरी दुरीमा ३ देखि ५ वटा फेरोमीन पासो झुण्ड्याउँदा, ४/५ दिन पछि ४/५ वयस्क पुतली पासोमा परे भने अगाडिका १४-१५ दिनमा कीराको प्रकोप झन् बढ्ने छ भन्ने बुझ्नु पर्दछ। अझ प्रति वर्ग मिटर १-२ लाभ्रे भेटियो भने यसबाट धेरै आर्थिक हानी हुन्छ। यस्तो अवस्थामा :-

- न्यूक्लियर पोली हाइड्रोसिस् भाइरस वा एच.एन.पी.भी. (HNPV) भनिने जैविक कीटनाशक २५० मि.ली. लगभग ४०० लिटर पानीमा मिसाइ एक हेक्टर चना बालीमा घाम अस्ताउने समयमा छर्नु पर्दछ।

- निमको बीउ (सुकेको १२-१३ कि.ग्रा.) २५ लीटर पानीमा भिजाई, पिसेर, छानेर निकलेको रस २५० मि.ली. प्रति हेक्टर हिसाबले आवश्यक पानी मिसाइ छर्नुपर्दछ। यसले मानिसलाई कुनै हानी पुर्‍याउदैन। त्यति गर्दा पनि भएन भने निम्न लिखित औषधिहरू विधि अनुसार प्रयोग गर्नु पर्दछ :-

  - इन्डोसल्फान ३५ ई.सी. ३ मि.लि. प्रति लिटर पानीमा, वा मोनोक्रोटोफोस १ मि.लि. प्रति लिटर पानीमा, वा क्लोरपाइरिफोस् २.५ मि.लि. प्रति लिटर पानीमा मिसाएर एक हेक्टरको हिसाबले छर्नु पर्दछ।

उक्त उपायबाट पनि लाभ्रेको नियन्त्रण भएन भने निर्देशानुसार डेसिस वा साइपरमेथ्रिन पनि प्रयोग गर्न सकिन्छ।

बीउ भण्डार र खपटे नियन्त्रण

बाली काटेपछि बीउ भण्डार गरिराख्नु किसानहरूका लागि अत्यन्तै आवश्यक छ। किन भने आफ्नै गुणस्तरीय बीउ भएमा, कमसल र मिसावटको सम्भावना भएको बाहिरबाट ल्याइने बीउको भर गर्नुपर्दैन। यसबाट खर्च घट्नुकोसाथै बाली राम्रो भई सन्तुष्टि हुन्छ।

लक्षण

खपटे खेतबारीमा लाग्दैन, तर पाकेको कोशा धेरै दिनसम्म खेतमा छाडि राख्यो भने लाग्छ। यसबाट चनामा लाम्चा प्वालहरू देखिन्छ। (चित्र नं.१४)

रोकथाम

खपटेको रोकथामको लागि चनाका पाकेका दानाहरूलाई घाममा राम्ररी सुकाई, सफा गरी, कीरा नलाग्ने भाँडामा राख्नु पर्दछ।

सेल्फोस्, फोस्टोक्सिन वा फोस्फ्यूम जस्ता धुँवाउने विषादी १ चक्की प्रति टन बीउमा राखी हावा नछिर्ने बन्द भाँडामा बीउ भन्डारण गरेमा खपटे लाग्दैन। थोरै बीउको लागि कपुर चक्की, वनस्पति तेल वा नीमको पात वा नीमको बीउको धुलोले पनि उपचार गर्न सकिन्छ।

विस्तृत जानकारीको लागि सम्पर्कसूत्रहरू :
राष्ट्रिय कोसेबाली अनुसन्धान कार्यक्रम, रामपुर, चितवन फोन : [illegible], इमेल : ngiip@wlink.com.np
DFID नेपाल कृषि अनुसन्धान परिषद्, सिंहदरबार प्लाजा, काठमाडौं फोन : [illegible], इमेल : cfdnarc@ntc.net.np CPP
ICRISAT, पाटनचेरु, आन्ध्र प्रदेश फोन : [illegible], इमेल spande@cgiar.org
आभार : DFID = अन्तर्राष्ट्रिय विकास विभाग

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does agricultural research and innovative capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million people – the poorest of the poor – overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Future Harvest Alliance of Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

Contact information

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India
Tel +91 11 25849552/25842553/25841294
Fax +91 11 25841294

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550
Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey (Regional hub WCA)
BP 12404
Niamey, Niger (Via Paris)
Tel +227 722529, 722725
Fax +227 734329
icrisatsc@cgiar.org

ICRISAT-Bamako
BP 320
Bamako, Mali
Tel +223 2223375
Fax +223 2228683
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776,
Bulawayo, Zimbabwe
Tel +263 83 8311 to 15
Fax +263 83 8253/8307
icrisatzw@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi
Tel +265 1 707297/071/067/057
Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
c/o INIA, Av. das FPLM No 2698
Caixa Postal 1906
Maputo, Mozambique
Tel +258 21 461657
Fax +258 21 461581
icrisatmoz@panintra.com

Visit us at **www.icrisat.org**

ISBN 92-9066-479-7

Order code CPE 156

329-2005