RIU

Combating rice sheath blight in Bangladesh

Validated RNRRS Output.

Farmers in Bangladesh now have ways to lessen the damage that sheath blight can do to their rice crops. Sheath blight is a serious disease and difficult to detect. Due to better methods of detection, improved varieties of rice that are more resistant to blight (but still have good eating and cooking qualities), and simple biological control methods, farmers in the Comilla, Gazipur, Bogra and Rajshahi districts are already reaping better rice harvests. Agricultural organisations in Bangladesh use the new molecular techniques to detect rice sheath blight and develop better varieties. This will help combat the disease and make a major contribution to raising the country's food production by a quarter within five years—an important government goal.

Project Ref: **CPP59:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Warwick HRI, UK**
Source: **Crop Protection Programme**

Document Contents:

Description, Validation, Current Situation, Current Promotion, Impacts On Poverty, Environmental Impact,

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Description

CPP59

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Bangladesh, UK,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

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

Sustainable management of rice sheath blight

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

Crop Protection Programme

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

R7778 & R8446

Bangladesh Rice Research Institute [Dr. Taher Mia],

Rural Development Academy, Comilla,

Bangladesh Academy of Rural Development, Bogra

University f Rajshahi, Rajshahi, Bangladesh; linked to

International Rice Research Institute (IRRI), Dhaka/Philippines [Dr. M.A. Hamid Miah]

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

Rice production and supply in South Asia faces a multitude of constraints and successful management of pests and diseases which can affect the yield significantly is crucial to the ability of the farmers to gain profits. Diseases such as sheath blight and blast remain difficult to control. Increasing rice yield per unit area is the number one priority for BRRI, as part of a recent Bangladesh government initiative to increase food production by 25% within the next 3-5 years. Sheath blight is recognized as a high priority constraint to rice production in Bangladesh. Projects R7778 and R8446 developed and promoted outputs namely molecular tools for the detection and epidemiology of pathogen complex, biological disease control methods and improved rice varieties for the management of rice sheath blight.

Molecular tool kit for detection and epidemiological interactions of the sheath disease pathogen complex (ShB) in rice production systems was developed based on new knowledge generated on the pathogen complex. These technologies have been promoted to the project collaborators at BRRI and other organizations such as BINA, BARI and BAU within Bangladesh, utilizing the molecular laboratory established in a parallel DFID programme. Additionally, the knowledge and molecular tools developed on rice blast in West Africa with RNRRS funding (R7552) were also shared with the Bangladesh NARS scientists through seminars and training discussions bringing a cross-cutting perspective.

Florescent bacteria with high levels of antagonism against ShB pathogen and disease control potential were identified. Field work carried out on the application of biological control agents showed location specific interactions leading to delayed disease spread and reduction in ShB severity. Various agro-ecological parameters have a large influence on the use of these methods and opportunities exist for potential linkages to NARS in India, SMEs and IRRI, for further development and promotion of these technologies. Work with organic amendments showed that this approach could lead to the beneficial utilisation of organic waste along with the application of biocontrol agents in IPM programmes.

Rice varieties developed by the National Agricultural Research System in Bangladesh showing tolerance/ resistance to ShB were identified and on-farm demonstration and promotion work was carried out at various locations. Farmer field days conducted provided excellent opportunities for close interaction among farmers, DAE staff and BRRI R & D personnel on the awareness of the ShB disease, management practices and the farmer preferred varieties and their characteristics. Dissemination materials on the disease complex and management were prepared and distributed to farmers and service providers at the trial locations.

Along with the development and validation/promotion of technologies, RNRRS funded project work also facilitated and created: Knowledge- and skill-base at BRRI on a range of aspects of sheath blight management and also at BARI and BAU to use the molecular diagnostic technologies, and excellent partnerships at the national, regional and international levels (e.g. BARI, BINA, BAU, Univ of Rajshahi, BARD and RDA, NARS in India, IRRI and Univ of Louisiana); Close links with parallel RNRRS rice cluster projects and the PETRRA-seed health and awareness of recent developments at regional and international organizations in developing biological agents and host resistance to control rice sheath blight, thus providing the opportunities for developing integrated pest and disease management in rice production systems in Bangladesh contributing to increased food production, poverty reduction and the achievement of the Millennium Development Goals.

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

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

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

Rice and rice based cropping systems

7. What production system(s) does/could the output(s) focus upon?

Please tick one or more of the following options. Leave blank if not applicable

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

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

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

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

There are excellent opportunities to cluster the outputs of the work on rice ShB management with outputs of the RNRRS rice cluster projects particularly those in Asia, although some links to outputs from the projects such as rice blast (R6738 & R7552) in West Africa are also possible. The RNRRS outputs are related to weed management (R8409, R8233, R7377 and other), pest and disease management (R8424, R8164; R6519 and other; R8413 and other; R8447), biodiversity in rice–based cropping systems (R7570), PSP outputs on rice/ chickpea varieties in Bangladesh/India/Nepal (R8269), with potential links to outputs from NRSP on natural resource management work. These outputs targeted towards technologies and approaches to reduce the yield gap, increasing opportunities for employment and income, environmental benefits and capacity development are likely to lead to integrated approaches for increasing the productivity of the rice–based cropping systems through water, land and labour saving technologies and their efficient use.

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

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

Molecular technologies for ShB pathogen complex including three *Rhizoctonia* spp. (*R. solani*, *R. oryzae*, *R. oryzae- sativae*) were developed based on detailed analysis of and data from a limited number of disease/ pathogen samples (up to 30) from Bangladesh and reference material from elsewhere, as is the standard procedure. The PCR detection technologies were validated on more then 350 rice sheath disease samples collected from key districts in Bangladesh involving a BRRI pathologist on a research attachment. These technologies and the resources were promoted to BRRI through seminars, training and discussion sessions on Rhizoctonia molecular diagnostics provided by Dr. Sreenivasaprasad to BRRI pathology staff and also scientists form BINA and BSMRAU/IPSA participated in some of these sessions. Subsequent promotion and validation involved scientific staff from other divisions within BRRI (e.g. Breeding), BAU and BARI through a 4 day hands-on-training on pathogen molecular diagnostics including seminars with the BRRI pathologists trained earlier acting as resource persons. This lead to the establishment of a knowledge and skill base at these organisations for the application of pathogen molecular diagnostic technologies in future R & D programmes.

On-station validation work was conducted by BRRI scientists and associated staff from collaborating organisation such as BARD, RDA and Univ of Rajshahi and on-farm validation and promotion work was lead by BRRI scientists and associated staff working with farming community representatives from different districts in Bangladesh and in close interaction with the local agricultural officers/DAE staff. In field trials on biological disease control with biocontrol agents and organic amendments, randomised complete block design with three replications was used. Disease severity data was collected based on incidence and infected area according to the IRRI-SES system; disease and yield data were analysed using IRRISTAT 4.

In varietal validation and promotion work on improved and ShB tolerant varieties, BR10, BR23, BRRIdhan32, BRRIdhan34 and BRRIdhan38 were grown as per farmers' practices during T. Aman season in 2005, along with their own varieties (e.g. Swarna) with close interaction among participating farmers, support services and the R & D staff. Additional field days were organised to enable farmers and the wider community to see and judge the comparative performance of the varieties and differences in ShB severity along with popular varieties and also to obtain the farmer preferences and views. Overall 300 farmers representing the poor smallholder communities were involved in the validation and promotion work. And dissemination material on sheath blight symptoms, disease and crop management in *Bangla* were provided to the farmers.

11. ***Where and when*** *have the output(s) been validated?*

Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above ***(max 300 words)****.*

Molecular technologies for pathogen detection and epidemiological interactions were initially validated at Warwick HRI through the involvement of a BRRI scientist during 2004. Subsequently, the PCR based diagnostic technologies were promoted to BRRI and validated through in-house training at BRRI by scientific staff from BRRI pathology and breeding divisions, and staff from other organisations such as BARI and BAU during 2005.

Validation work on biological disease control outputs was carried out during Aus (April-August) and T-Aman (July-

Dec) seasons in 2005 at upzillas of Chandina, Comilla district; Sreepur, Gazipur district and Kaligonj, Tanore and Kakonhat of Rajshahi district in fields selected based on disease surveys conducted in the first phase.

Validation and promotion work on improved and sheath blight tolerant varieties was carried out during T-Aman 2005 at in upzillas of Chandina, Comilla district; Sreepur, Gazipur district and Puthia, Tanore and Paba of Rajshahi district. Validation and promotion work, including farmer field days, dissemination material on disease and crop management and farmer led varietal assessment were carried out linked to the trial locations within the high potential production system and irrigated/wetland rice based farming systems working with farmers representing poor smallholder farming communities. Further, stakeholder workshops conducted at BRRI-HQ provided opportunities for closer interaction with DAE, BARD, RDA, IRRI-Dhaka as well as NGOs and other R & D organisation linked to rice-based cropping systems establishing pathways for further up-scaling and adoption.

Current Situation

C. Current situation

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

R7778 started as a mainly strategic science-based project. However, the project team, fully supported by the programme management (additional one year funding through R8446), also developed outputs on disease management. Within this short four year funding period, the project team managed to fast track the pathogen characterisation work through to the validation and promotion of outputs on molecular technologies for pathogen detection and epidemiological interactions, biological disease control and farmer preferred, improved and ShB tolerant varieties.

Molecular technologies on pathogen diagnosis are being used in-house at BRRI with the potential for use created at other organisations such as BARI, BINA, BAU and BSMRAU through promotion and training. Men and women farmers linked to the varietal demonstration trials and field days, identified BRRIdhan32 as the most preferred followed by BRRIdhan38 and BRRIdhan34 based on maturity period, tolerance to diseases particularly ShB, low fertilizer requirement, good yield and also grain characteristics such as aroma and fine grain. Farmers are keen to grow the aromatic and fine grain varieties as they can get support for production and procurement from BMDC and also in view of the income generation potential through export. Earlier surveys revealed lack of awareness among the farmers about the disease and its management. The biological disease control and varietal promotion trials and field days provided an opportunity for close interaction among farming community, extension staff and R & D scientists and to enhance farmers' awareness of the ShB symptoms, conditions and factors such as close planting, susceptible varieties and inappropriate use of fertilizers such as top dressing with urea that favour the disease and management practices including improved and disease tolerant varieties. Application of split-K to improve crop management and contribute to ShB management and new BRRI varieties BR44 and BR45 are tolerant ShB and other diseases such as BLB. DAE staff emphasised to the farmers the importance of planting improved varieties in the place of *Swarna* and BR11, as these have become susceptible to various diseases including ShB. Dissemination material in *Bangla* were provided to 300 farmers at three locations to facilitate further promotion of the knowledge and technologies in their community with each farmer aiming to spread the knowledge among ten neighbours (farmer-to farmer extension) paving the way for wider use of the outputs on sheath blight control, varietal use and crop management.

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

Outputs related to the pathogen molecular diagnostics are being used by agricultural R & D organisations in Bangladesh in disease management and related brreding programmes. Outputs related to ShB management and varietal use are being mainly used in Comilla, Gazipur, Bogra and Rajshahi districts in Bangladesh where the disease surveys and PRA, validation and promotion work were carried out.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

As discussed above, within the 4 year funding period, most of the time and resources were focused on generating strategic knowledge of the pathogen, developing tools for molecular diagnosis, capability development and establishment of knowledge-skill base, identification of biocontrol agents and useful varieties with only one year during late 2004 to early 2006 available for the validation/promotion of outputs. This timeframe is too short for ensuring wide adoption of outputs and to assess the impact at farm level. However, the close interactions among the poor small holder farming community, service providers, R & D agencies, the partnerships built and the enthusiastic participation and response of the farmers to use sheath blight disease management technologies including improved rice varieties suggest that the use of outputs is an on-going process.

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

Close links with parallel RNRRS rice cluster projects and DFID funded PETRRA Project and within this the Seed Health Improvement Project (SHIP). Molecular facility established at BRRI through DFID-PETRRA funding was fully utilised with close co-operation and links to the SHIP project lead by Dr. Taher Mia. Close and proactive interaction developed with the senior management at BRRI and IRRI-Dhaka leading to strong support and also wider links with regional NARS in India and international organisations such as IRRI and universities in UK and USA involved in ShB biocontrol and rice resistance breeding. Existing research systems in Bangladesh and their links to associated agencies enabled RNRRS project to link into and align with the priorities and demands of the national system. Contact and partnerships established among the research, extension and policy continuum (e.g. BARI, BINA, BAU, Univ of Rajshahi, BARD, RDA and DAE) by inviting the representatives (including at the senior managerial level) to participate in stakeholder workshops and capability development training. The network of contacts with farmers and farming community BRRI, IRRI-D and the partner organisations have were useful for the validation and promotion work. Knowledge- and skill-base established at BRRI on a range of aspects of sheath blight management and also at BARI and BAU to use the pathogen molecular diagnostic technologies. Participation of both men and women farmers, local government representatives, *Upazilla* Agricultural Officers, DAE and BRRI staff including senior members in validation and dissemination activities emphasizing the enthusiasm of the farming community and the importance given by the research and extension agencies to develop systems for interaction with and promotion of technologies to farmers. These provide the opportunities for further capacity building at the level of research, service providers as well as end users of technology and wider adoption of the outputs for pest and disease management in rice production systems in Bangladesh.

Current Promotion

D. Current promotion/uptake pathways

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

Through projects R7778 and R8446, technologies for pathogen detection and epidemiological interactions and disease management including the use of biocontrol agents and improved and disease tolerant varieties were developed and their validation and promotion work was carried out across Bangladesh in 3-4 districts where rice and the ShB are important. Increasing the rice yield per unit area by minimizing the yield gap due to knowledge gap on varieties and pests and diseases is the highest priority for BRRI and other agencies associated with rice R & D, as part of a recent Government initiative on increasing food production by 25%. In this context, continued promotion of the outputs is an on-going process and likely to take place to some extent through the core programmes of these organisations as, for example, farmers in Comilla were willing and keen to grow BRRIdhan38 to gain higher income through production and procurement support from BMDC.

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

Although good contacts and partnerships have been established among the key stakeholders, stronger connectivity and better co-ordination among different organisations and stakeholders involved in rice R & D and production/supply are needed. Partnerships become expensive and need to be managed carefully as they increase in size and complexity particularly as institutional remits and boundaries are difficult to overcome at individual project level. Resource and time limitations restrict the number and size of the stakeholder engagement events. Lack of closer and stronger public-private partnerships affect the development and promotion of new technologies such as biological disease control agents. Similarly in the context of varietal promotion, inefficient seed multiplication and distribution systems are a major constraint and seeds of improved varieties are an important component of farmers' demands and in the EU-funded FoSHoL project this is being recognised as a major issue.

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

Mainstream rice research and development organisations need to be fully geared towards participatory, on-farm research with close links to NGOs/CBOs, service providers with appropriate links to the market, credit providers and enterprise developers. This will require wider networking and closer engagement with policy makers and also a more joined-up thinking at the policy level within the national systems/government. The IRRI-BRRI MoU or a similar arrangement adequately amended to implement work through wider partnerships. Longer timeframe along with operational flexibility is required to build and strengthen partnerships and effective working mechanisms to support wide scale promotion and adoption. An integrated approach to related outputs in the context of the rice cropping systems. Capacity building focused at organisational, process and group/community level, e.g. working with farmer groups and associations and working with service providers to achieve local ownership of the outputs and farmer-to farmer extension. Wide application of biological disease control will require closer links among the R & D organisations developing similar technologies for various commodities and closer links with the SMEs backed by governmental support both at the resource and policy levels. Similarly, efficient seed systems would require R & D agencies involved in developing improved varieties and service providers such as DA/BARDA/RDA working closely with CBOs/NGOs and the farming community to set up a sustainable network backed up by resource and policy level support. In other geographic locations and commodities, RNRRS projects have developed successful models for community based seed multiplication and distribution systems.

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

The project workshops, farmer field days and other fora were used as an opportunity to initiate contact and partnership with a wide range of stakeholders involved in rice R & D, production and supply, including other international donors programme, e.g. DANIDA-SPPS/IPM/Biocontrol. This networking and partnership building is essential not only for wider adoption of outputs but also to optimise the efficiency of the technologies as various R & D agencies are dealing with similar problems and are developing related technologies. For example, Rhizoctonia is a wide host range pathogen and is important not only in the context of rice but also rice-vegetable and rice-wheat systems. Scientists at institutes/organisations such as BARI, BAU, BINA, BSMRAU who took part in the discussion fora and training workshops are keenly interested in the promotion and use of Rhizoctonia molecular diagnostic technologies. Building on the knowledge and skill-base established in pathogen molecular diagnostics and the molecular facility established at BRRI-Gazipur with DFID funding, there is an opportunity to develop this into a training centre and diagnostic service provider at a national level and Dr. Taher Mia, who leads the molecular facility (PETRRA-SHIP project) is keen to develop this idea which also has the support of the BRRI management.

Similarly, in the context of biological disease control, BARI scientists involved in developing biocontrol agents were willing to share their experience and expertise to improve the technology. Further, BARI have a collection of more than 500 isolates of Trichoderma and Bacillus and are interested in utilising agro-industrial wastes such as tea waste, wheat bran for multiplying these biocontrol agents using low cost technologies. Closer linkages with BARI and other BARC-Institutes would also help in developing disease control packages targeting rice production systems rather than a commodity and disease-specific approach. Similar approaches have been successfully developed for ShB control elsewhere, for example, scientists at TNAU and the University of Madras, Tamil Nadu, India have developed talc-based formulations of bacterial antagonists for ShB control. SMEs have been actively involved in farmer uptake of these types of biocontrol agents for rice ShB control in Tamil Nadu, India. Similarly, ICAR institutes have developed bacterial and fungal biocontrol agents for ShB in other parts of India. These experiences point the way forward and that closer linkages with national and regional NARS in India as well as IRRI, and local SMEs would be beneficial to further develop the biocontrol agents in Bangladesh. GoB has identified SMEs as a priority sector and as the driving force for industrialisation and a national taskforce and well as a special cell has been set up with strong support at the highest policy and political levels.

Setting up seed systems that will enable multiplication and distribution of seeds of farmer and market preferred rice varieties so that farmers can get support for production and procurement from finance/credit providers such as BMDC would lead to wide scale adoption of varieties. During the stakeholder workshop held at BRRI, Mr. A.K. M. Enamul Haque, Director, DAE, Dr. Baqui, BRRI-DR and Dr. Mustafi, Head, BRRI-Agricultural Economics Division were supportive of the idea of developing additional linkages and closer ties with NGOs and DAE to establish community based seed multiplication and distribution systems. Dr. Noel Magor, Head of IRRI-Dhaka office also confirmed that seed is a major issue in farmers demand and in the new FoSHoL project farmers have good seed is important. Dr. Hamid Miah, IRRI Liaison Scientist suggested that future efforts could focus around development of technology visibility and impact at particular sites closely allied with IRRI and the national government supported programmes (e.g. SRI). The project team also benefited by developing links and interactions with other RNRRS funded projects and closer co-ordination of these linkages will be essential in up-scaling and wider adoption of the RNRRS outputs and their integration through a systems level approach and also in working with R & D organisations, service providers, other stakeholders and policy makers.

Impacts On Poverty

E. Impacts on poverty to date

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

Socio-economic surveys, PRA on farmers livelihood issues linked to rice production including ShB management and dissemination of knowledge on crop and disease management technologies were carried out in Comilla, Gazipur, Rajshahi and Bogra districts where the validation and promotion work were carried out in close co-operation with partner organisations such as BARD, RDA and University of Rajshahi and also involving BRRI socio-economics staff with links to the farmer groups/communities being used in PETRRA projects. The issues were highlighted and discussed at the stakeholder interactions. The datasets are centrally deposited at the BRRI-HQ, Gazipur on database facilities shared between the pathology, biometrics and socio-economics divisions. The idea of moving these types of datasets generated in various RNRRS projects into knowledge bank being developed by IRRI has been discussed at the programme level and could be achieved in the RIUP phase.

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

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a*

positive impact;

- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

Within the 4 year funding period including strategic research, validation, promotion and dissemination of outputs related to ShB management took place among the small holder communities in the irrigated/wetland based rice production systems in Bangladesh. PRA work with farming community representatives and farmers revealed a lack of awareness of the crop and disease management technologies (wrong use of pesticides and fertilisers). Though demonstration trials and field days involving 300 men and women farmers representing poor small holder farmers knowledge/awareness of the outputs on disease management and the availability of improved varieties has been promoted and the farmers are keen to embrace these technologies as they see opportunities for production and procurement support from finance/credit providers. Knowledge and skill base that will continue to contribute to technology development on biological disease control and varietal development through a sound understanding of and technologies for pathogen detection and epidemiology and also the links and partnerships among a range stakeholders essential for up-scaling and out-scaling of the outputs on disease intervention and seed systems for improved varieties have been established which will indirectly benefit the poor and the impact can be assessed through future studies.

Environmental Impact

H. Environmental impact

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

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

There is clear potential for positive impacts and environmental benefits as most of technologies are components of the currently followed integrated crop and disease management programmes and have passed environmental risk scrutiny in general. For example, targeted disease intervention based on correct pathogen and disease identification, use of biological agents, improved varieties and optimised agronomic practices will all lead to reduction in the use of chemicals in agriculture. For example, PRA work revealed that farmers who could not recognise the ShB symptoms sometimes used pesticides; similarly, urea top dressing increases ShB incidence and split-K helps to reduce the disease and farmer awareness of these and related issues has been increased through participation in the on-farm trials, field days and dissemination material.

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

None anticipated as most of technologies are components of the currently followed integrated crop and disease management programmes in other projects, crops and countries.

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

Yes, adoption of current outputs with parallel varietal breeding efforts in a systems approach to improve rice production/productivity will contribute to the well being of poor people and increase their resilience in general. In Asia, around 2 billion people receive nearly 60-70% of the daily calories from rice. The rice production and processing chain provides employment and income generation opportunities for millions of poor people. And improved varieties with increased tolerance to biotic and abiotic stresses will be useful in coping with adverse climatic conditions.
