RIU

Beating tungro virus disease in rice

Validated RNRRS Output.

A suite of new techniques to tackle the devastating rice losses caused by tungro is now helping small-scale farmers in Indonesia, the Philippines and India. Better understanding of the leafhopper insect that spreads the virus has led to better growing practices, especially late planting. New resistant rice varieties have been produced, as well as a spatial model which helps identify the best strategies to cut the incidence of disease. A simple, reliable and relatively low-cost diagnostic kit for the virus has also been developed to help rice breeders and extension services. Farmers in Bali (Indonesia) are already growing the improved varieties on over 40,000 hectares, while farmers in East Java and Lombok (Indonesia), and Mindanao and the Visayas (Philippines) are also benefiting. Training manuals are also available.

Project Ref: **CPP45:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP45

Research into Use
NR International
Park House
Bradbourne Lane
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UK

Geographical regions included:

India, Indonesia, Philippines,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.

Improved pest and disease management for irrigated rice systems

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

The research was supported by the Crop Protection Programme of the Department for International Development (DFID). Funding for the breeding work associated with the development of tungro-resistant rice varieties was from the International Rice Research Institute. In Indonesia, support for the dissemination of resistant varieties was from the Indonesia government. In the Philippines, financial support for the promotion of improved tungro management practices was provided by the Provincial government of Iloilo in the Visayas.

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.

The following CPP research projects contributed to the outputs: R6519, R5243, R5244, R5245.

Lead institute:

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Main partner organisations:

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Indian Council for Agricultural Research, Krishi Ansusandhan Bhavan-1, Pusa, New Delhi – 110012 (Dr Mangala Rai;)

Bangladesh Rice Research Institute, Bangladesh Rice Research Institute, Gazipur 1701. (Dr Nazira Qureshi Kamla; naziraqk@yahoo.com).

Food Crop Research Center VII, Jl. Supratman no. 71, Sumerta, Denpasar, Bali. (Dr IGN Astika).

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*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 tungro, a vector-borne virus disease, is one of the most serious biotic constraints to rice production in south and southeast Asia. There are periodic large-scale epidemics of tungro which cause significant economic losses and more localised epidemics which also have a severe impact on farmers' livelihoods. Before the DFID-funded research was commissioned, tungro control relied on insecticides and vector-resistant varieties but neither provided sustainable control.

A key output from the first phase of the research was an **improved understanding of the epidemiology of the disease**, including new knowledge of the ecology of the leafhopper vectors and the dynamics of disease spread. This led to the development of **improved strategies for the management of tungro** based on a combination of varietal resistance and cultural practices, particularly the avoidance of late planting. Validation of these management strategies was enhanced through the development and use of a **spatial model**. The model was used to evaluate the effects of the deployment of resistant varieties and the closer synchronisation of planting dates on tungro incidence. Model outputs enabled optimum disease reducing strategies to be identified.

Improved rice varieties with resistance to rice tungro viruses were developed in collaboration with the International Rice Research Institute (IRRI) and with national rice breeding programmes in India, Indonesia and the Philippines. The advanced breeding lines showed high levels of resistance in multi-locational trials over several cropping seasons and, in contrast to most of the vector-resistant varieties, the resistance has remained effective since their release as approved varieties. In Indonesia, two varieties are now widely grown in East Java, Bali and Lombok. The popularity of the varieties is due to their good yield, superior eating quality and disease resistance.

Using the results from surveys of farmers' perceptions of tungro disease, the modelling studies and participatory tungro management trials, methodologies were developed to promote the uptake of improved tungro management practices. **Training manuals** were produced and used in training courses in tungro identification and management for agricultural extension officers and farmers, respectively. The manuals can be used as stand-alone courses in tungro-endemic areas or as modules in Farmer Field Schools which address a wider range of issues. The manuals are available on-line on the IRRI Rice Knowledge Bank.

A simple, reliable and relatively low cost **diagnostic kit for rice tungro bacilliform virus** was developed as an aid to rice breeders and a practical tool for agricultural extension services.

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

The outputs relate to irrigated rice crops in rice-based cropping systems in south and southeast Asia. The approaches and methodologies used in developing the outputs could be applied to irrigated rice systems in African countries, particularly where cropping intensity is increasing and where more inputs of fertiliser and pesticides are being used. Outputs related to the development of integrated pest management strategies and their use in training programmes are quite generic and the experience could be utilised in a range of crops in high potential 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				*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**).*

In south Asia, tungro is currently a sporadic problem and major outbreaks occur infrequently. However, rice-growing countries remain concerned about the disease because of its highly destructive nature and the past history of resistance breakdown. Consequently, there is a continuing demand for up-to-date information on resistant varieties and other tungro management options.

Information on tungro management could be provided as part of a wider package of rice integrated pest management practices. This would bring together outputs from several CPP projects which developed component technologies for rice pest and disease management in Bangladesh and India: namely, weed management in irrigated rice (R8409, R8233 and R7377); rodent management in rice-based cropping systems

(R8424 and R8164); rice sheath blight management (R7778); rice stemborer management (R8413 and precursors); and rice hispa management (R7891). Outputs from each of these projects might feed into the application of findings from the project 'Managing rice pests in Bangladesh by improving extension service information for policy and planning (R8447). Any new initiative along these lines might usefully be linked with the Bangladesh Rice Knowledge Bank which is maintained by the Bangladesh Rice Research Institute.

Since most of the projects mentioned above have knowledge-based outputs that need to be promoted more widely, there would be benefits in applying lessons learned through the CPP project 'Linking demand with supply of agricultural information' (R8429 and R8281). Similarly, there would be useful synergy in linking with approaches developed in the project 'IPM promotion through improved training manuals' (R8417 and R8341).

The demand-led approaches used in the development and promotion of tungro-resistant rice varieties may be usefully compared with those developed for other crop pathosystems; for example, tomato leaf curl virus (R8425 and R8247) and groundnut rosette disease (R7445 and R6811).

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)**.*

The spatial model of tungro dynamics, which was developed from an improved understanding of the epidemiology of the disease, was validated in an intensive area of irrigated rice production where tungro disease was endemic. This work was conducted over a two year period by approximately 200 small-scale irrigated rice farmers and staff of the provincial agriculture office and the municipal agricultural office. The farmers who participated in the research were predominantly male but included several female-headed households. Most farmers owned less than one hectare of rice land, but a small minority owned between one and four hectares.

Validation of the improved tungro-resistant varieties was done initially through multi-locational trials conducted over four seasons at two sites in each of three countries. The trials used a randomised complete block design with at least three replications. Unlike many similar trials, the plot size was sufficiently large (8m x 8m, with a 2m separation distance between plots) to ensure that the performance of the test lines could be adequately assessed. The most promising advanced breeding lines with resistance to rice tungro viruses were then evaluated in on-farm wet season trials in Philippines and India. No such trials were conducted in Indonesia, but the selection of lines to the Varietal Release Board was done following an assessment by farmers of their cooking quality and taste.

Validation of improved tungro management strategies, involving an appropriate mix of deploying resistant varieties and using cultural practices, was done on-farm in two countries in India and Philippines. The courses in tungro identification and management which were developed for agricultural extension officers and farmers were evaluated in training programmes.

Validation of the rapid, low-cost diagnostic kit for rice tungro bacilliform virus was done by virologists in Indonesia, Philippines, India and Bangladesh. The most detailed evaluation was done by the Plant Pathology department of the Bangladesh Rice Research Institute in collaboration with the Department of Agricultural Extension.

*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)**.*

Validation of the spatial model was done in1993-94 in the municipality of Polangui in Camarines Sur province in south Luzon, Philippines.

The on-station evaluation of tungro-resistant varieties was done in 1994-95 in the following locations:

- Rice Research station, Maros, South Sulawesi, Indonesia.
- Celuk Crop Protection laboratory, Gianyar Province, Bali, Indonesia.
- Midsayap Research Station, North Cotabato Province, Philippines.
- IRRI farm, Los Banos, Laguna Province, Philippines.
- Chakdaha Rice Research station, Nadia Province, West Bengal, India.
- Tirur Rice Research station, nr Kancheepuram, Tamil Nadu, India.

On-farm trials were carried out over a three-year period in 1996-1998 in three villages in the municipality of Midsayap, North Cotabato Province, Philippines; Central Bulanan, San Pedro and Villarica. Similar trials were conducted in the villages of Vishar and Pudumavilangai in Kancheepuram district, Tamil Nadu Province, India. Farmers hosting these trials were progressive farmers who had established links with the local agricultural extension services. Other farmers in the villages participated in field days to assess the performance of the varieties. Exchange visits were arranged enabling farmers from different villages within each country to share experiences.

Validation of improved tungro management strategies was done with groups of between 20 and 30 farmers in the five villages in Philippines and India. The groups included men and women and these were considered to be broadly representative of the farming households in the villages. Most farmers relied primarily on rice production for their subsistence and income and had holdings of less than 1 ha. Training programmes for farmers and agricultural extension officers were conducted in Laguna Province, Philippines in 1999.

Current Situation

C. Current situation

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

The improved tungro-resistant varieties are currently being used by small-scale rice farmers in Bali, East Java and Lombok in Indonesia. These farmers grow rice intensively in irrigated production systems. In the Philippines, the improved varieties are being grown by small-scale irrigated rice farmers in Mindanao and the central islands of the Visayas where tungro disease continues to persist. Cultural practices for tungro management, are being used by farmers in the locations where the on-farm trials were conducted. These practices are part of a wider set of options for rice pest and disease management and were developed to help meet the needs of farmers for control of other constraints such as rice stemborers and leaffolders.

The diagnostic kit for rice tungro bacilliform virus is not currently being used. This is probably due to the fact that some of the reagents required, especially the antisera, are not readily available. There appears to be a limited market for a commercial product and so there is little incentive for investment by private companies.

The tungro management training modules are available to download from the IRRI Rice Knowledge Bank but the extent to which the material has been used is not known.

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).***

As indicated in para 12, the tungro-resistant varieties are being used in different locations in Philippines and Indonesia. The varieties have not been disseminated in India for two main reasons. Firstly, tungro does not occur frequently enough and is not sufficiently widespread to encourage farmers to actively seek resistant varieties. Secondly, the advanced breeding lines with the most effective resistance in India are not preferred by consumers due to the long, slender and sticky nature of the grain. However, one of the lines (IR68-305-18-1) has been crossed with improved lines developed at the rice research station in Tirur and the rice breeding station in Coimbatore. As a result, resistant material is now available in the breeding programme and can be utilised if tungro problems recur in the future.

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

In Indonesia, the improved tungro-resistant varieties have been adopted on a large scale. In Bali, the variety *Tukad unda* was being cultivated on more than 10,000 ha in 1999, less than two years after its release. By 2004, this variety was being grown on 40,000 ha, representing 50 percent of the irrigated rice area (IGN Astika, personal communication). The variety *Tukad petanu* was also grown in Bali but on a much more limited scale. It is not known whether the usage is still spreading in Bali, but the potential for further uptake is probably limited. Each of these varieties is also grown in east Java and on Lombok island, but the scale of use is not known.

In the Philippines, the tungro-resistant varieties are being grown in tungro-endemic areas in Mindanao and the central islands of the Visayas. No data are available on the scale of current use or whether usage is increasing. In Tamil Nadu, India, where tungro-resistant lines were used in the state rice breeding programme, there are no data on current usage. This may be limited as incidence of tungro disease in the state has been low since the late 1990's.

It is difficult to estimate the extent of use of other components of the improved tungro management strategies developed as a result of the research. In Tamil Nadu, rice farmers in Kancheepuram district have adopted recommended cultural practices (T. Ganapathy, personal communication). Similarly, farmers in Nadia district in West Bengal are also implementing them (A.K. Chowdhury, personal communication).

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).***

In Indonesia, the promotion of the tungro-resistant rice varieties was greatly facilitated by the intervention of the relevant provincial governments. In Bali, where the tungro problem was particularly severe throughout most of the 1990's, the provincial government worked with the government Crop Protection agency to multiply and promote the seed. During the first year of promotion, the cost of the seed was subsidised by the government and this appears to have been instrumental in its extremely rapid adoption.

The promotion and adoption of the tungro-resistant lines in the Philippines was done by the Philippine Rice Research Institute (PhilRice) in partnership with the Department of Agricultural Extension. The requirements for approval of a rice variety for national release are strict and each of the criteria has to be met. However, the system does have some flexibility and allows a variety to be approved for release in specific locations where this is justified by the need. In this case, the Philippine Seed Board approved the varieties for release in certain tungro-endemic areas.

On Mindanao island in the Philippines, the adoption of new varieties is facilitated through communication channels provided by informal networks of farmers and traders. This system appears to have operated quite effectively in tungro-prone areas once PhilRice had bulked up sufficient quantities of seed. In the islands in the central Visayas, such informal networks are less visible and a more targeted approach was required. In Iloilo province, promotion and adoption of the varieties was done with the support of the provincial government. A partnership was developed with PhilRice, IRRI and the Provincial Agricultural Office and an awareness campaign was implemented with the support of the governor of the province.

Where formal seed systems exist, but have some limitations, the need for effective inter-agency cooperation is extremely important in ensuring effective promotion of new varieties. Local governments, acting in response to pressure from their constituents, can play a significant enabling role.

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)***

The adoption of improved tungro management practices, within a wider framework of integrated pest and disease management, leads to a substantial reduction in insecticide usage. This brings benefits for human health as storage and application methods for pesticides in tropical rice-based systems are notoriously unsafe. Spray equipment is poorly maintained and often leaks during use, and operators tend to walk through areas of the crop that have just been sprayed. When granules of toxic chemicals such as carbofuran are applied in the field, farmers are usually directly exposed as they walk through the standing water. Studies conducted in Central Luzon in the Philippines have established a direct link between pesticide usage and farmer health.

The reduction in pesticide use has benefits for aquatic organisms such as fish, snails and frogs that are collected by farmers in some regions for home consumption or for sale. In seasonally flooded ecosystems, such as those in floodplain areas in Bangladesh, rural households obtain a significant proportion of their protein intake through the rearing or capture of fish and other aquatic organisms. Additional income may also be obtained through the sale of these products.

Actual yields of rice fall far short of attainable yields and the need to close this ‘yield gap’ is a key issue in rice production in the tropics, particularly in intensive irrigated systems. The reduction of losses due to pests and diseases contributes significantly to the maximisation of grain yields. This places less pressure on fragile marginal lands which farmers try to exploit when production in more favourable areas does not meet local needs.

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

No significant adverse environmental impacts have been identified as a result of the application of improved pest and disease management practices. There has been some concern about the loss of genetic diversity due to the widespread adoption of improved rice varieties with a relatively narrow genetic background. However, in intensive irrigated systems where tungro is a problem most farmers have already adopted modern high-yielding varieties and this process is not likely to be reversed. The production of tungro-resistant varieties, which are developed through back-crossing of elite lines with traditional varieties, adds diversity to the existing genepool.

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)***

There is little evidence that tungro disease is favoured by climatic changes that have already taken place or which are projected to happen in the short- to medium-term. It is possible that the increased frequency of extended dry periods, which tend to affect populations of natural enemies more than those of rice pests, may lead to a higher risk of plant- and leafhopper outbreaks and this is likely to lead to more serious rice virus disease problems.

One of the main benefits of improved management of outbreak pests such as brown planthopper and tungro disease is to reduce the vulnerability of rural households to shocks. On a global scale, yield losses caused by these problems are relatively low but serious impacts are felt by communities in areas where outbreaks do occur. Total crop loss frequently occurs in tungro outbreaks and this leads to far more serious consequences for rural households than those resulting from the more regular but limited damage caused by chronic pests.