Improving the robustness, sustainability, productivity and eco-efficiencies of rice systems throughout Asia

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About the Project

The project will address one of the most pressing needs for the Asian region: maintaining the supply of the most important staple food in the world – rice.

Demand for rice is expected to double by 2050, a challenging target in the midst of competing demands for land and water, and a changing and variable climate. Most of these increases have to come from Asia, a region that currently produces 95 per cent of world rice production. Production increases must be achieved sustainably without negatively impacting on people and the environment.

Solutions to raise productivity in rice systems must focus on holistic combinations of intervention actions at all levels. An equal focus on sustainability (e.g. resource use) and social issues (e.g. land tenure, education and knowledge systems) is vital. Systems approaches will be the foundation of the next agricultural revolution, particularly simulation modelling, which is ideally suited to integrate disciplinary knowledge and provide proactive evaluation of technologies and policies.

The project aims to empower the next generation of scientists and policy makers in providing the most pertinent advice and making the right decisions when it comes to redesigning current approaches in resource allocation, agronomy and knowledge dissemination.

Inception Meeting

The project kicked off in January 2013 when a group of young to mid-career scientists from across the Asian region met at the University of Peradeniya, Sri Lanka.

Under the guidance of a team of experienced systems researchers, the group brought together scientists from Australia, Pakistan, India, Indonesia and Sri Lanka.

Participants of the inception meeting visit a rice field in Anuradhapura, Sri Lanka.

The workshop included a field tour of Sri Lankan rice production systems, presentation of past and present rice systems research of each participant, discussion of the issues relating to sustainable and eco-efficient rice production, identification of important regional themes and research needs, and design of discrete cross-country activities that will contribute to the overall collaborative research program.

APSIM Training in Indonesia

In late August, David Phelan from The University of Tasmania travelled to Bogor Agricultural University in Indonesia to facilitate a one week workshop with six Indonesian team members from the project.

The workshop provided professional development to the participating project scientists through a crop simulation workshop, using the APSIM (Agricultural systems simulator) model. Particular emphasis was placed on understanding the APSIM-ORYZA rice model and parameterising it for the specific farming systems of interest in Indonesia. The workshop involved working through the APSIM training manual, and testing APSIM across diverse agricultural climatic zones in Indonesia by characterising the agricultural climatic zones and different rice production systems.

The workshop was very successful. All participants exhibited enthusiasm and capability in understanding and learning the APSIM model. From the beginning of the week, the participants were able to work through the basics of the model, and by the week's end were capable of initiating simulations replicating local rice systems under various scenarios, modifying agronomic and climatic factors.

Discussions were also held concerning sub-projects, reviewing aims, methods and activities. The workshop helped to increase simulation modelling capacity within the Indonesian project team, and will ultimately help to achieve the goals of the project.

Nitrogen use in Indian Rice Production Systems

Nitrogen (N) is the most important nutrient in rice-based production systems and contributes immensely to increased productivity. N use efficiency in rice is typically very low, and depends on the timing and method of fertilizer application, and to a large extent on water management. Many processes of the N cycle in rice cropping systems are influenced by the availability of water. N dynamics in flooded rice fields are significantly different from those of water saving rice cultivation systems. This makes knowledge of N transformations and the fate of applied fertilizer N in rice water management systems essential to reduce the N fertilizer cost and minimize the environmental impacts.

Crop simulation models replicate a range of complex processes in the soil-plant-atmosphere continuum and can be used to evaluate the production uncertainties associated with various management options. Simulation studies with various water and N management strategies in rice based systems can assist in better decision making for improving N use efficiency. Models can be used to simulate different climates, identifying optimal water and nutrient management strategies.

As a part of the APN project, the team is documenting the constraints in various rice growing ecosystem in South Asia and describing the water and N dynamics. Through the use of crop simulation models the current systems will be described and improved systems will be designed for better resource management.

Aerobic Rice in Pakistan

Rice is a highly valued cash crop and the second most important staple food in Pakistan. Paddy fields are mostly irrigated and cover 2.7 million ha, with annual production of about 6 million tonnes.

Transplanting rice seedlings in Pakistan.

Historically, water availability has been a decisive factor for total rice production in the water limited country. In recent years (2010-2013), paddy production was affected badly by intense rains, overflowing rivers, and occasionally rainfall early in the season. These extremes resulted in a 10 per cent decline in cultivated area and production in the last fiscal year (2.3 million ha and 5.5 million tonnes, respectively).

Limited water storage capacity related to the size and number of dams prevents the effective use of flood water, and farmers often experience water shortage during the rice growing season. Strategies aimed at rational use of water are urgently required to safeguard sustainable rice production and food security.

Masood Awan from the University of Agriculture, Faisalabad-Pakistan, evaluated the potential of an alternate production system, aerobic rice. Aerobic rice involves cultivating rice in unpuddled, dry direct-seeded, non-flooded fields. The aerobic rice system aims to improve resource use efficiency of rice-based cropping systems, in particular water, labour, and energy.

Field experiments during 2009 and 2010 at the research station of the University of Agriculture, Faisalabad–Pakistan, investigated the possible irrigation water savings and crop performance under aerobic conditions. Water productivity (g grain kg^{-1} total water input) improved significantly with values up to 0.38, significantly higher than the national average value of 0.16 under conventional flooded cultivation. This might save farmers three to four irrigations, offering a leverage point where water scarcity is a greater threat to production than land scarcity.

Surveys of rice and non-rice farmers of Punjab province in three major cropping systems (rice-wheat, mixed-cropping, cotton-wheat) supported the basic biophysical research. Most farmers were unaware of the existence of aerobic rice and the possibility it offers, but expressed their keen interest in experimenting with it.

Aerobic rice is a transformational technology with significant potential, but it is not a silver bullet. There are risk factors associated with it that need to be considered on a case-by-case basis. Improved eco-efficiencies of water, labour, and energy might occur at the cost of decreased efficiencies of N and land use, and an increased reliance on biocides for managing weeds.

Risks of crop failure can be reduced by filling the knowledge gaps through additional research and through farmer training. Targeted breeding programs especially for basmati rice are urgently needed to unlock the potential of aerobic rice in regions previously not considered for aerobic rice production.

Aerobic rice is a future production system to cope with resource constraints. A range of stakeholders aiming for the successful adoption of aerobic rice can benefit from the findings of this study, which will be published shortly.

Visit our website

A project website has been launched at
www.apnrice.com

The website includes information about the project, presentations from the inception meeting, and a video detailing the project.

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