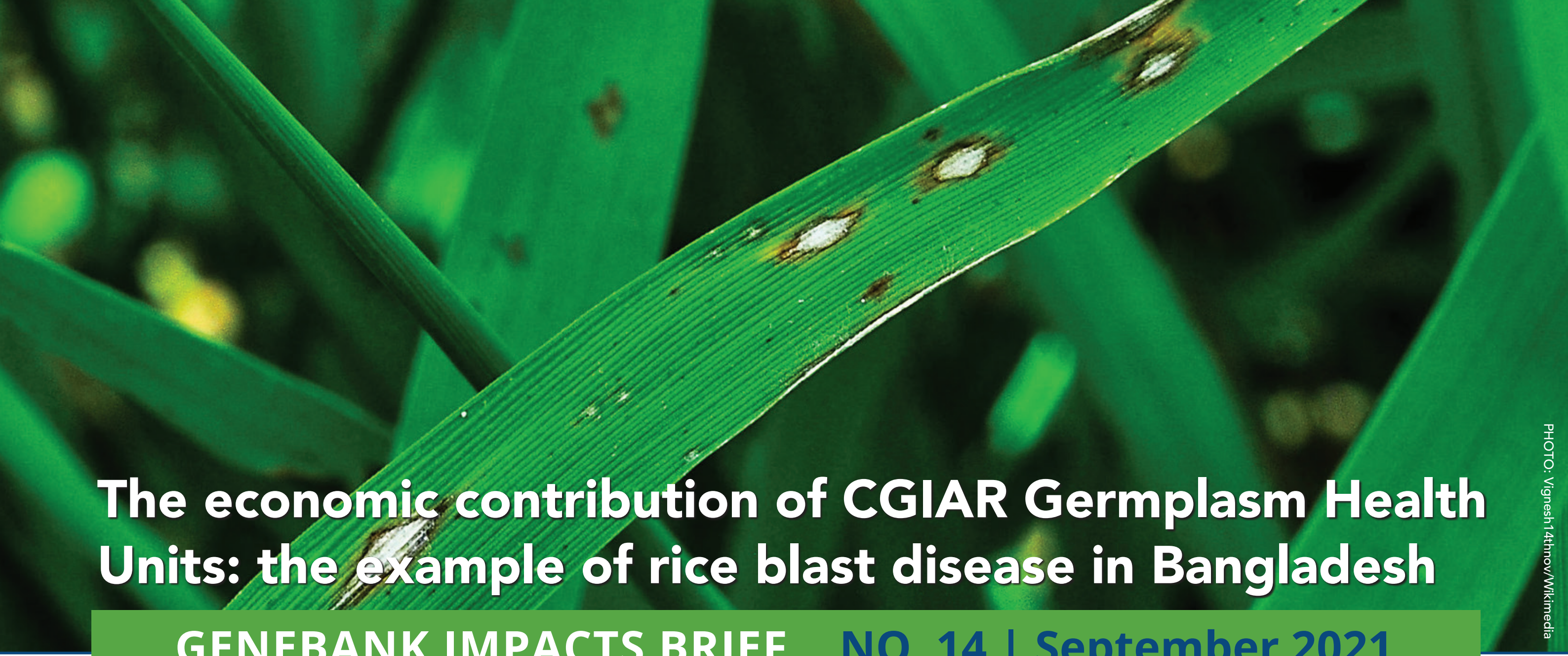
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The economic contribution of CGIAR Germplasm Health Units: the example of rice blast disease in Bangladesh

GENEBANK IMPACTS BRIEF NO. 14 | September 2021

HIGHLIGHTS

- Germplasm Health Units (GHUs) have indirect impact pathways to farmers through genebanks and breeding programs by enabling NARS partners and international breeding programs to have safe and efficient access to genetic resources and breeding materials.
- IRRI's Seed Health Unit enables breeding programs in Bangladesh to employ modern approaches to address the challenges of building durability from rice blast which can breakdown resistance of varieties within 3–5 years.
- Our model estimates about USD 295 million net benefits, and maximum of USD 1.46 billion, over a 20-year time frame of continuous blast resistance breeding and deployment. About USD 5.9 of the net benefits, and a maximum USD 62 million, could be attributed to IRRI GHU.
- The study reinforces the important, and often overlooked, role of the GHU in the international scientific partnership that aims to enhance genetic gains in rice, through efficient and timely access to clean and healthy germplasm.

Introduction

The historic success of global agriculture research in crop production and improvement is built on the firm foundation of scientific partnership between CGIAR centers and the national agricultural research systems (NARS). National food systems have benefited from this partnership, especially in countries where diets and agricultural production systems largely rely on genetic diversity traceable to foreign origins (Khoury et al. 2016).

However, seed-borne pathogens are often barriers to seed movement. Seed-importing countries need assurance that plant germplasm that enters their borders are free from any pathogen or pest of quarantine importance. The unintended introduction of diseases and pests is often irreversible and could spell significant crop losses. The increased risk of transboundary transfer of diseases and pests would likely discourage access and benefit sharing of germ-

BOX 1 The International Year of Plant Health

The United Nations General Assembly declared 2020 as the International Year of Plant Health (IYPH). This is a unique opportunity to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment, and boost economic development.

Plants are the source of the air we breathe and most of the food we eat, yet we often don't think about keeping them healthy. FAO estimates that up to 40% of food crops are lost due to plant pests and diseases annually. This leaves millions of people without enough food to eat and seriously damages agriculture – the primary source of income for rural poor communities.

Plant health is increasingly under threat. Climate change and human activities have altered ecosystems, reducing biodiversity and creating new niches where pests can thrive. At the same time, international travel and trade can quickly spread pests and diseases around the world causing great damage to native plants and the environment.


Photo: IRRI

Protecting plants from pests and diseases is far more cost effective than dealing with full-blown plant health emergencies. Plant pests and diseases are often impossible to eradicate once they have established themselves. Prevention is critical to avoiding the devastating impact of pests and diseases on agriculture, livelihoods and food security and many of us have a role to play.

Source: International Year of Plant Health (IYPH) plasm (under the CGIAR multilateral system) and, worse, might lead to the tightening of national quarantine and administrative requirements thereby slowing the international exchange of plant genetic resources. For this reason, the International Plant Protection Convention's (IPCC) and National Plant Protection organizations (NPPOs) craft phytosanitary standards and policies to prevent these adverse events from happening.

The role of Germplasm Health Units (GHUs)

GHUs were formalized in the 1990s to serve as a single gateway for international germplasm exchange through the recommendations of the Sixth International Plant Protection Congress in 1993 in Montreal. They perform seed health testing and facilitate issuance of phytosanitary clearances following the standards of the IPCC's conventions and policies of exporting and importing countries' phytosanitary policies and regulations implemented by the NPPOs (Kumar et al. 2021). The work of GHUs in ensuring safe, efficient and reliable germplasm exchange mechanisms underpin the advancements in international agricultural research programs and partnerships. However, the concrete contributions of GHUs are still perceived as one of the CGIAR's unknown success stories. To date, there is no existing evidence documenting the economic contributions of GHUs to impacts achieved through the global scientific partnership of the CGIAR.

The International Rice Research Institute's (IRRI) Seed Health Unit (SHU) (hereinafter referred to as IRRI GHU) is one of the 11 GHUs of the CGIAR, particularly for rice. As early as the 1960s, IRRI has been performing its seed health testing for seed certification. In 1982, IRRI and the Philippines' BPI the country's NPPO, agreed to establish and authorize the GHU to conduct major rice seed health testing phytosanitary certification and post-entry clearance. Since 2002, IRRI GHU became the designated gateway for all rice seeds going in and out from IRRI (Kulkarni 2019).

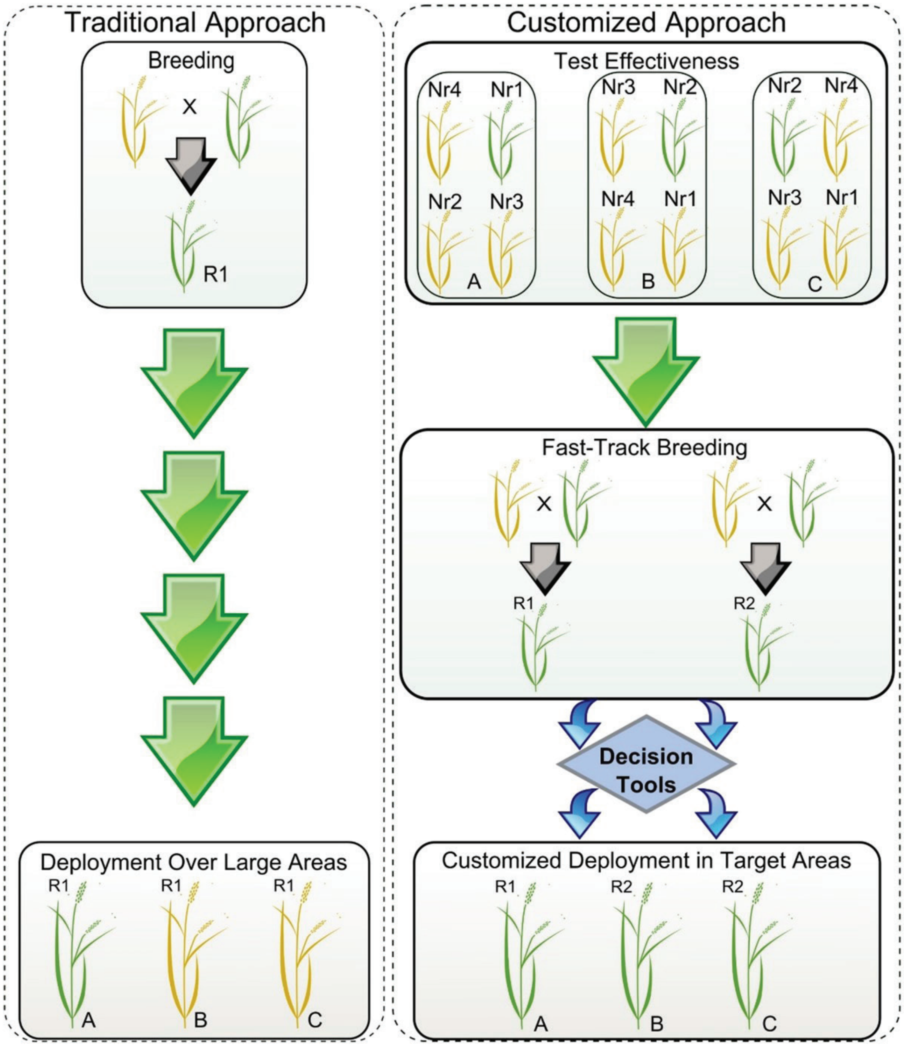

Figure 1. Simplified scheme showing the deployment of resistant varieties using traditional versus customized approaches. R1 and R2 represent resistant elite varieties carrying hypothetical genes 1 and 2. Yellow and green plants represent susceptible and resistant phenotypes, respectively. Locations A, B, and C represent cropping regions that do not share boundaries. Nr1, Nr2, Nr3, and Nr4 are near-isogenic lines (NILs) for each of the available resistance genes 1, 2, 3, and 4. (Source: Dossa et al. 2015)

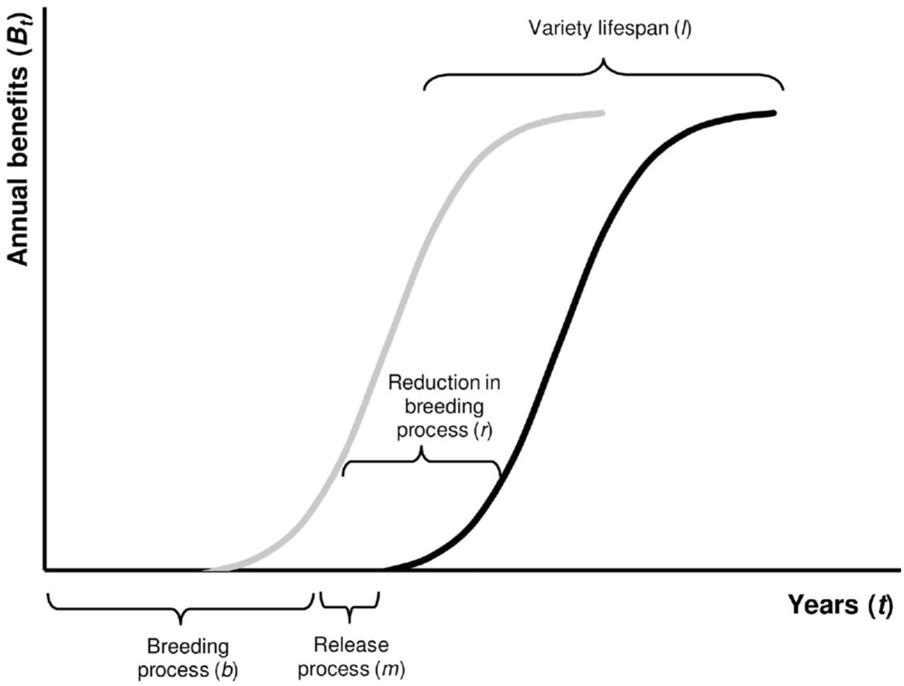

Figure 2. Time dimension of a breeding and illustration of time-saving on breeding process (Source: Lenaerts, de Mey, and Demont 2018)

Rice blast disease

Rice blast is arguably the most economically important pest in Bangladesh and is considered a threat to national food security. Blast disease can infect the rice plants' aboveground tissues and all its organs at all developmental stages, which could cause total crop failure. Blast outbreaks are known to be recurrent and known for its destructiveness across ecosystems and seasons. Conventional methods to breeding resistant varieties have been known to be ineffective. Many new rice varieties have shown high levels of blast susceptibility, and those that are blast-resistant often lose their resistance within three to five years.

Advancements in breeding practices such as rapid generation advance, marker-assisted selection and pyramiding of R genes has enabled customized or localized deployment of resistant genes to increase the durability of resistant rice varieties to blast (Figure 1). The success of this approach hinge on safe and efficient germplasm exchange mechanisms (Figure 2).

Data and Methods

The study measures the economic contribution of IRRI GHU to breeding program that avert yield losses from rice blast disease (*Pyricularia oryzae* Cavara) in Bangladesh. We first analyze that pathways through which GHU contributes to impact (Figure 3). Then we use a farm-level panel data-set collected between 2013 to 2016 and data on blast incidence collected from field surveys in 2011 to 2012 to run an *ex-ante* economic surplus analysis within a productivity maintenance framework. We then apportion the incremental benefit contributions of the GHU by discounting and applying a time-saving multiplier. To address uncertainties in our estimates, we augment our model with Monte Carlo sampling to simulate distributions of model parameters.

Results

IRRI GHU's contribution pathway are linked to genebanks and breeding programs (Figure 4). Because of the nature of GHU operations, the IRRI GHU's causal link to the farmers is indirect. But their work is instrumental in enabling the partnership of international research programs and NARS partners to succeed. Apart from giving NARS partners better access to genetic resources and breeding materials that benefit from advanced technologies and approaches, IRRI GHU also has facil-

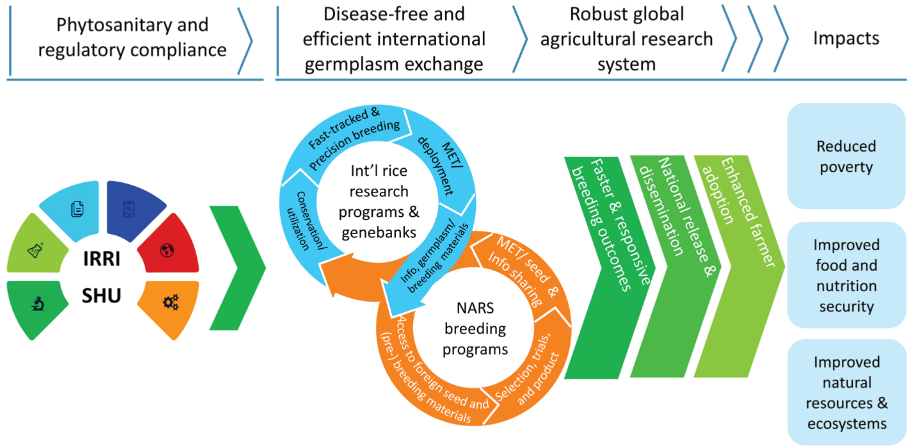

Figure 3. IRRI's SHU impact pathway

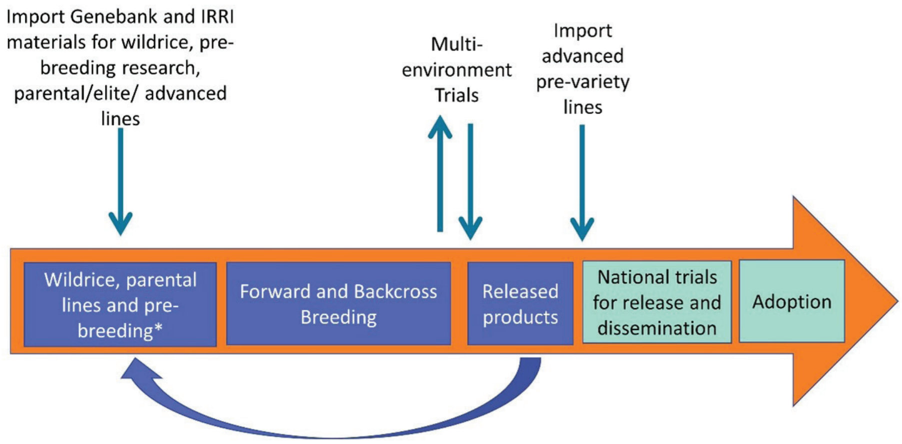

Figure 4. Entry points for IRRI GHU germplasm exchange (Source: interviews)

Table 1. Summary statistics of simulation results for customized deployment breeding program

	Gross Benefits (in Million USD)		Net Present Value (in Million USD)	BCR
	Aman	Boro		
Maximum	314	1,223	1,461	73
Minimum	-86	-7	-94	5
Mode	54	254	295	24
Mean	62	315	362	26
Standard deviation	41	135	169	9

Table 2. Summary statistics of simulation results for IRRI GHU time-saving benefits

	NPV (in Million USD)	BCR
Maximum	62	3,666
Minimum	0.29	3.8
Mode	5.9	112
Mean	12.6	305.8
Standard deviation	8.5	283

itated rice blast research (Figure 3). For example, international research partnership on blast resistance dates from the mid-2000s with the *Differential System for Blast Resistance for a Stable Rice Production Environment*. This scientific effort involves the Japan International Research Centre for Agricultural Sciences (JIRCAS), IRRI and Africa Rice Centre, and NARS partners such as the BRRI. Another is the GHU's germplasm exchange facilitation for the International Network for Germplasm Evaluation Research (INGER), which provide access to advanced pre-variety breeding lines to NARS partners.

Simulating for the most probable outcome, our model estimates about USD 295 million net benefits, and maximum of USD 1.46 billion, over a 20-year time frame of continuous blast resistance breeding and deployment. About USD 5.9 of the net benefits, and a maximum 62 million, from the development of blast resistant rice varieties in Bangladesh could be attributed as GHU's contribution. The results are sensitive to the rate of yield loss savings, which is contingent with the yield, timing of deployment, effectiveness of varietal resistance, and lifespan of varietal resistance to blast (Tables 1 and 2).

The study reinforces the important, and often overlooked, role of the CGIAR GHUs in the international scientific partnership that aims to enhance genetic gains in rice,

Photo: IRRI

IRRI GHU staff conducting routine seed health testing.

through efficient and timely access to clean and healthy germplasm. Slowing down of the international germplasm movement could take a toll on the future economic gains from agricultural research.

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