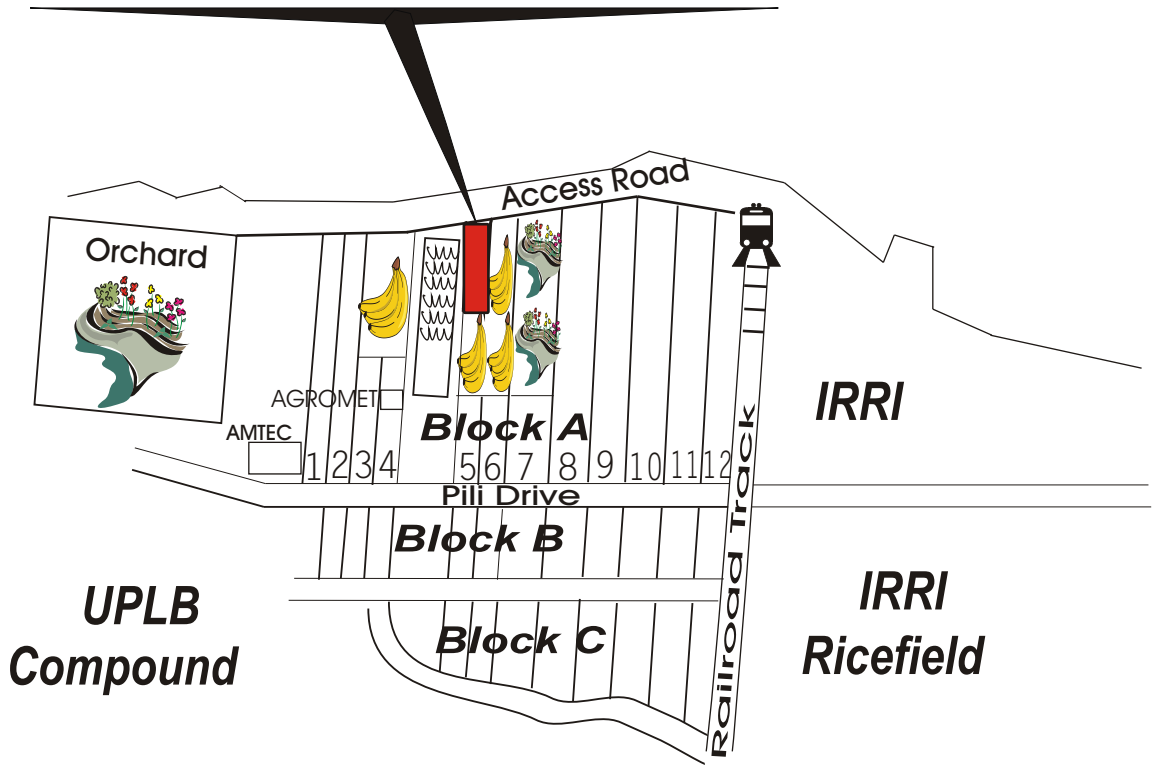
BB Rice



IRRI's First Transgenic Field Test

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INTRODUCTION

In the next few months, the International Rice Research Institute (IRRI), based in Los Baños, Laguna, the Philippines, plans to conduct its first open field test of a transgenic variety of rice in Southeast Asia. IRRI will conduct the field tests in collaboration with its national counterpart, the Philippine Rice Research Institute (PhilRice). The first transgenic rice that IRRI and PhilRice plan to test has been genetically engineered to resist bacterial blight (hence the short-hand "BB rice"). IRRI intends to conduct its field test at the University of the Philippines Los Baños (UPLB) Central Experiment Station, while PhilRice plans to conduct its field test at the PhilRice experimental site in Maligaya, Muñoz, Nueva Ecija.

While IRRI has already conducted experiments on this transgenic rice under contained conditions at its headquarters in Los Baños, its planned field test in the open environment marks an entirely new stage in the deployment of rice biotechnology in Asia. Once IRRI and PhilRice carry out the trials, transgenic rice will only be a short step from farmers' fields. Presently, to our knowledge, only China has conducted widespread field tests of transgenic rice in Asia. IRRI's move, however, has a resolutely international objective: to deploy genetically engineered rice throughout the region. That is why IRRI's first field test calls for a close inspection of the issues at hand.

The most immediate question concerning the field test of BB rice is that of risk. Genetic engineering is vastly different from other methods used by breeders. While all other processes for breeding rely on natural functions of organisms, genetic engineering moves genes from one organism to another in ways that could never be possible in nature. The science is not precise and the interactions between the genetically engineered organism and the surrounding environment are unpredictable. For this reason, many countries have adopted stringent regulations over the field release of transgenic crops.

The impacts of transgenic crops go well beyond biosafety, however. There are many potentially severe socioeconomic impacts or "risks" associated with the technology. Before a technology is accepted, questions must be answered about how it will impact the long-term welfare of communities and there must be a decision-making process where the affected community can make its own judgements about whether or how the technology should be used. A thorough assessment would look not only at the environmental consequences but also at who controls the technology, who stands to benefit from it, and, not least important, what alternative solutions exist.

In the Philippines, where the field test of BB rice will take place, these larger questions were acknowledged in the establishment of the National Committee on Biosafety in October 1990 and the subsequent publication of its biosafety guidelines. The guidelines, the first of their kind in Southeast Asia, clearly state:

> Genetic manipulation of organisms should be allowed only if the ultimate objective is for the welfare of humanity and the natural environment and only if it has been clearly stated that there is no existing or foreseeable alternative approaches to servicing the welfare of humanity and the environment.[1]

And:

> The proponent must demonstrate – taking into consideration scientific, ecological, economic, social and ethical concerns – that the proposed objectives of the research … cannot be addressed/realized adequately and achieved by alternative approaches.[2]

These larger questions surrounding the field release of BB rice in the Philippines can only be properly addressed through meaningful public consultation, especially with those who will be most affected – the farmers.

The stakes in this debate are high. BB rice, as IRRI knows, will set a precedent. A favorable decision on the pending field test application will set the wheels in motion to take agriculture, throughout South and Southeast Asia, deep into biotechnology. Therefore, as stipulated by the Philippines' biosafety guidelines, this is the time to reflect on the possible alternatives and to ask how agricultural development for Southeast Asia's most important crop should proceed, both in the Philippines and the region.

1. EMERGENCE OF A BACTERIAL BLIGHT PROBLEM

Bacterial blight was first reported in the Fukuoka Prefecture, Japan, in 1884. The disease (see box) was unknown in the area until farmers began using soybean cake and green manure to fertilize their lowland rice fields.[3] This was the first clue that bacterial blight has a voracious appetite for mixtures of rice and nitrogen. Since then, the disease has traveled the world to settle in places where the two are found in abundance.

What is bacterial blight?

Bacterial blight is a water-borne disease. It infects rice plants when droplets carrying the bacteria (*Xanthomonas oryzae* pv. *oryzae)* land on leaf wounds, which are caused by a range of factors including heavy rains and typhoon winds. Rice plants are more susceptible to the disease under high temperatures and humidity, and when nitrogen fertilizers are used. Given the factors that contribute to bacterial blight, cultural management is an obvious and effective means for farmers to control the disease.

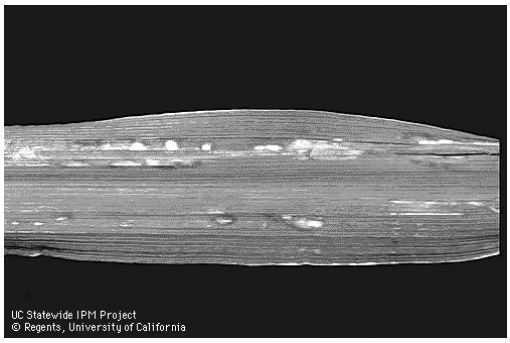
[1] Department of Science and Technology, "Philippines Biosafety Guidelines", DOST, Manila, 1991, Section II.1.4, p. 14. Available on the World Wide Wed under http://www.binas.unido.org/binas/regs.php3.
[2] *Ibid*., Section II.3.10, p. 29.
[3] T.B. Adhikari, "Effects of Rice Genotype and Environment on Bacterial Blight Progression", Master's Thesis, University of the Philippines Los Banos, the Philippines, 1991, p.6.

Bacterial blight only became significant in Southeast Asia forty years ago.[4] Before then, the traditional practices and varieties of rice farmers kept the disease at bay. The situation changed drastically in 1959 when IRRI was established by the Rockefeller Foundation. IRRI introduced IR8 – its first semi-dwarf, nitrogen-responsive variety – in 1966 and within a few years, IR8, along with the chemical fertilizer it required, blanketed the region.

The susceptibility of IRRI's prized high-yielding varieties (HYVs) was immediately apparent.[5] In 1970, the Japanese Technical Cooperation Agency (JTCA) warned, "It is clear that such varieties are assisting the disease to spread wider."[6] The JTCA's Director-General questioned the logic behind the use of HYVs to increase production:

> [Bacterial blight] has made little harm as far as local varieties had been cultured without any fertilization … But almost all HYV varieties which these [Southeast Asian] countries have adopted are very susceptible to bacterial blight. Besides, they require a large amount of fertilizer, which, therefore, is considered to be a big barrier to the implementation of increased production of rice.[7]

But IRRI had other ideas and it, along with its local counterparts, continued to push IR8 far and wide, even into those areas most vulnerable to bacterial blight and other diseases. The area planted with HYVs in the Southeast Asian countries using IRRI varieties jumped from 1.4 million hectares in 1966 to 34.4 million hectares in 1980. There was a similar increase in fertilizer use – soaring from 1.4 million tons in 1965 to 9.6 million tons in 1980.[8]



Results were as expected. In fields planted with HYVs, bacterial blight often cut yields by 20 to 50 percent throughout the 1960s. All over Southeast Asia epidemics broke out, with loss of yields as high as 80 percent in some areas.[9] Problems were compounded by the fact that the disease becomes more virulent in the presence of susceptible hosts, especially under monoculture conditions. Uniform crops exert selection pressure on the disease, and those strains of the disease for which the rice has no defense end up quickly dominating the other populations.[10]

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[4] Shih-Pan-Yu Hsieh, "Ecological Studies of *Xanthomonas oryzae*, the causal organism of bacterial blight", Phd Thesis, University of Hawaii, 1973.
[5] T.M. Mew, C.M. Vera Cruz and E.S. Medalla, "Changes in race frequency of *Xanthomonas oryzae* pv. *oryzae* in response to rice cultivars planted in the Philippines", *Plant Disease*, No. 76, pp. 1029-1032.
[6] Overseas Technical Cooperation Agency, "Bacterial Leaf Blight of Rice Plant in Southeast Asia", 1970, p.8.
[7] Keiichi Tatsuke, "Foreword" in Overseas Technical Cooperation Agency, "Bacterial Leaf Blight of Rice Plant in Southeast Asia", 1970.
[8] Countries referred to are Bangladesh, India, Indonesia, Malaysia, Burma, Nepal, Pakistan, Philippines, Sri Lanka, and Thailand. Source: IRRI, *World Rice Statistics: 1993-1994*, Manila, 1995.
[9] IRRI, "One Step Ahead: Outpacing Bacterial Blight of Rice", Manila, 1996, p. 1, and T.B. Adhikari, "Effects of Rice Genotype and Environment on Bacterial Blight Progression", Master's Thesis, University of the Philippines Los Baños, 1991, p. 8.
[10] *Ibid.*, p. 2.

At first, researchers looked to agrochemicals to get out of the mess they had created. But most agrochemicals proved ineffective against bacterial blight and those that offered some protection were too hazardous and destructive for use on rice farms.[11] The next option was to seek a solution through breeding. Luckily for IRRI, some farmers in southern India stuck with traditional varieties – which may have produced lower yields, but were durable against disease. IRRI collected one of these varieties, named TKM6, labeled its resistance gene as Xa4, and then quickly set to work trying to breed the gene into its HYVs. The first IRRI variety incorporating the Xa4 gene was launched in 1969 and since then almost every rice variety bred at IRRI or by its national counterparts has incorporated the gene. In the 1980s, about 90 percent of the rice land in the Philippines was planted with varieties possessing the Xa4 gene.[12]

Xa4 did provide some immediate relief, but the problem was far from resolved. To its dismay, IRRI soon learned that it had unleashed a highly adaptable disease that would not be so easy to conquer. By 1972, only three years after the first high-yielding Xa4 variety was introduced, bacterial blight was once again wreaking havoc on farms sown with HYVs. As recognized later by IRRI, "The widespread deployment of rice varieties containing bacterial blight resistance genes has brought about significant changes in the population structure of *Xanthomonas oryzae* pv. *oryzae* (Xoo)." IRRI's Xa4 varieties could resist one race of *Xoo*, but, with the widespread use of the gene in HYVs, a second race of *Xoo* emerged that Xa4 could not withstand. Within a few short years, that race accounted for 80 percent of the bacterial blight population. Today, as new resistance genes are identified and incorporated into IRRI lines, the disease continues to adapt, as in the Philippines, where a third race of bacterial blight dominates.[13]

Bacterial blight continues to cause significant damage in rice fields in Asia and it has spread to Africa, Latin America, USA and Australia.[14] In 1996 IRRI reported:

> New forms of *Xoo* have emerged in many localities. The disease is a chronic, low-level problem in many countries, and local epidemics (such as in the Punjab in 1994) are still a threat almost everywhere rice is grown.[15]

Diversity to the rescue

Within a few short years, IRRI and its national counterparts brought bacterial blight to epidemic proportions in areas of the world where it had never been a problem or even existed. Fortunately, farmers have pursued a more cautious approach and, over generations, have produced a number of disease-resistant varieties.

By collecting farmer varieties and "wild" material throughout the world, IRRI has now identified around 2,200 lines resistant to bacterial blight.[16] The bulk of these varieties come from three geographic centers:

[11] IRRI, "Rice Diseases in Northern and Eastern India, Nepal and Bangladesh: A Report of an IRTP Monitoring Tour", Manila, 1979, p. 2.
[12] T.M. Mew, C.M. Vera Cruz and E.S. Medalla, *op. cit.*, pp. 1029-1032.
[13] IRRI, "One Step Ahead", *op. cit.*, p.3
[14] Pamela C. Ronald, "The molecular basis of disease resistance in rice", *Plant Molecular Biology*, No. 35, pp. 179-186.
[15] IRRI, "One Step Ahead", *op. cit.*, p. 1.

one in the area comprising Bangladesh, Nepal and North-East India, a second in Southern India and Sri Lanka, and a third in Java and the surrounding islands.[17]

By incorporating these resistant varieties into their breeding program, IRRI has managed to keep infestation of bacterial blight at manageable levels, with the exception of the occasional outbreak. The situation, however, is far from stable and IRRI remains in a race to, as it says, "stay one step ahead of bacterial blight."

2. ENTER BB RICE

In 1977, a scientist with the Central Rice Research Institute (CRRI) in India obtained a strain of a wild rice, *Oryza longistaminata*, from Mali, West Africa. At CRRI, the rice was tested for resistance to bacterial blight and was found to be resistant to a number of strains. In 1977, IRRI's head breeder, Dr. Gurdev Khush, visited the Rice Research Institute of Rajendra Agricultural University at Mithapur, India, and obtained a sample of the *O. longistaminata*, which had been distributed to the University by CRRI. Dr. Khush brought the African rice back to IRRI and for the next twelve years led an intensive breeding project to transfer blight resistance from *O. longistaminata* into IRRI's HYV, IR24. In the course of their breeding activities, IRRI scientists found that the resistance could be the work of one gene, which they named Xa21, found on a small region of a particular chromosome. By 1990, they were able to isolate this gene and breed it into the IR24 variety to produce a new resistant line, dubbed IRBB21. In all, the development of IRBB21 took eleven seasons, suggesting that in tropical countries the breeding of resistant lines through conventional crossing with wild varieties takes six years.[18]

It was at this time that Dr. Pam Ronald began to work on the Xa21 gene at Cornell University, in the United States, in collaboration with IRRI staff stationed there. Using a sample of IRBB21, she began a project to identify the precise location of the Xa21 gene in the rice genome. Once the gene could be located, she would then be able to clone it and use it in genetic engineering. In the midst of her work, Ronald left Cornell for a faculty position with the University of California, Davis, also in the US. There, she succeeded in cloning the Xa21 gene in 1995. And that same year, her teams of scientists and UC Davis filed for a patent on it.[19]

UC Davis did not have the capacity to do the transformation of rice with the Xa21 gene itself, so it looked to other laboratories. One of the few laboratories with the capacity was the International Laboratory for Tropical Agriculture Biotechnology (ILTAB), which was, at the time, located in nearby La Jolla, California. ILTAB genetically engineered the plants by shooting the Xa21 gene with a tiny gun into the cells of the designated rice variety. The rice

[16] Rasabandith Sengpaseuth, "Inheritance of resistance to bacterial leaf blight in some rice varieties", Master's Thesis, Central Luzon State University, 1998, p. 3.
[17] *Ibid.*, p. 26.
[18] Kerry ten Kate and Amanda Collis, "Benefit-Sharing Case Study: The Genetic Resources Fund of the University of California, Davis", Submission to the Executive Secretary of the Convention on Biological Diversity by the Royal Botancal Gardens, Kew, no date, available on the World Wide Web as http://www.biodiv.org/chm/techno/casestudies_pdf/Ucdavis.pdf
[19] *Ibid.*

varieties that ILTAB is genetically engineering with the Xa21 gene include BG90-2 from West Africa, two IRRI HYVs – IR64 and IR72 – and two hybrid rice parental lines from China – an indica restorer line, Minghui 63, and a japonica maintainer line, 37 Wan A.[20] Field trials of BB rice have already taken place in China, with financial support from the Rockefeller Foundation.[21]

Researchers believe that the protein produced by the Xa21 gene is able to detect diseases, such as bacterial blight. Once it detects the disease it sends an alert signal, causing the cell to activate its defense mechanisms against the disease. Xa21 is a particularly effective resistance gene. Initial studies of the UC Davis and ILTAB BB rice showed that it was resistant to 29 of 31 strains of *Xoo* for which it was tested.[22]

With a patent in hand and successful results from field tests of BB rice, Dr Ronald sent BB rice out far and wide. Researchers in Europe, the US, Asia, and Africa are working to introduce the Xa21 gene into locally used HYVs.

Furthermore, research and development for the gene is not limited to rice; plans are under way to utilize the gene in all crops affected by blight.[23]

Constructing BB rice

There are several steps in the genetic engineering of a rice variety with the Xa21 gene.

First, the gene is cloned. The Xa21 gene is actually a short segment of DNA within the rice genome. Within this segment of DNA, there is a protein, which is what the cells of *Oryza longistaminata* reproduce to combat bacterial blight. Researchers refer to this protein as the trait for resistance to bacterial blight. Identifying the precise location of Xa21 is difficult. Dr. Ronald likens it to "trying to find a friend's house in New York City or Tokyo without an address or description."[24] By 1990, researchers had, however, produced a basic map of the rice genome with the assistance of genetic markers. Using this map and the same genomics system used in the human genome project, researchers at UC Davis were able to identify the location of the Xa21 gene. Ronald admits that much of the discovery had to do with "sheer luck", as the gene turned out to be located very near to the first chromosomal marker that she happened to look at, making the cloning process relatively easy.[25]

Once the gene is cloned, it is transferred to bacterial cells and multiplied. The gene is then cut from the bacterial cells and spliced into rice cells through several possible methods. The most common method used with Xa21 is a biollistic method operated by ILTAB. Under this approach, microscopic gold pellets are coated with the DNA and shot with a gun into rice cells. Since the scientist has no idea where the

[20] S. Zang *et al.*, "Field testing in China of bacterial blight resistant transgenic elite indica and japonica plants," no date.
[21] Kerry ten Kate and Amanda Collis, *op. cit.*
[22] Pamela C. Ronald, "The molecular basis...", *op cit.*, pp. 179-186.
[23] Pamela C. Ronald, "Making rice disease resistant", *Scientific American*, 1997, pp. 101-105.
[24] *Ibid.*, p. 102.
[25] *Ibid.*

gene ends up in the cell, or if it is incorporated into the cell's genome, the gene is usually inserted along with another gene construct incorporating resistance to an antibiotic. Thus, when the transformation is complete, researchers can test to see which cells have incorporated the DNA by exposing them to the antibiotic. Those cells that survive the exposure have taken up the DNA, although not necessarily the trait for resistance to bacterial blight. Using tissue culture methods, scientists then transform these cells into plants. Most of these plants will actually not have resistance to bacterial blight. For instance, of the 1,500 transgenic plants that UC Davis first developed, only 50 were highly resistant to bacterial blight. Nevertheless, with these 50 plants, the researchers could save the seeds and, through several years of breeding, were able to produce stable lines of transgenic plants incorporating the Xa21 gene.[26]

3. IRRI TAKES UP THE WORK

In 1991, CAB International and IRRI released a publication, entitled *Rice Biotechnology*, as part of a series of books on biotechnology in agriculture. In that publication, Robert Herdt, Director of Agricultural Sciences with the Rockefeller Foundation, outlined research priorities for rice biotechnology. Herdt's study remains IRRI's only published assessment of research priorities for biotechnology. According to Herdt, bacterial blight affects 8.1% of the rice growing area in Southeast Asia causing $57.5 million in crop losses – and nearly $100 million in South Asia. Yet, for Herdt, conventional approaches to the disease were already "effective and sustainable" and "biotechnology approaches seem likely to be ineffective." In his ranked ordering of research problems with potential for biotechnology applications, bacterial blight is near to the bottom.[27] So why is IRRI pursuing BB rice?

BB as "benign biotech"?

IRRI – as well as PhilRice – could have chosen other types of transgenic rice for its first field test application. For instance, three modern varieties of rice have been genetically engineered with a Bt toxin gene and IRRI has already field-tested varieties of transgenic Bt rice in two locations in China. IRRI has experimented with Bt rice since 1993, when it first imported transgenic seeds to the Philippines. In fact, IRRI received approval from the National Biosafety Committee of the Philippines to conduct tests of Bt rice within its greenhouse in 1996, nearly two years before approval was given for greenhouse tests of BB rice.

IRRI has also conducted research on transgenic rice with resistance to the tungro virus since at least 1992, when it received approval for its "Transgenic Plants with Tungro Genes Project". In 1997, Claude Fauquet of ILTAB told the press that ILTAB would collaborate with IRRI on field tests for tungro-resistant rice the following year.[28] Tungro resistance has also been on PhilRice's agenda. In February 1999, PhilRice received permission to import tungro resistant transgenic rice seeds from ILTAB and test the varieties at its screenhouse.

[26] *Ibid.*, pp. 101-105.
[27] Robert W. Herdt, "Research Priorities for Rice Biotechnology," in *Rice Biotechnology,* G.S. Khush and G.H. Toenniessen (eds.), Alden Press Ltd., London, 1991, pp. 19-54.
[28] Martha Groves, "Plant Researchers Offer Bumper Crop of Humanity", *Los Angeles Times,* 26 December 1997.

Research on transgenic rice with resistance to sheath blight has also advanced and transgenic varieties have already been tested at IRRI's greenhouse.[29] IRRI claims that the transgenic plants show increased resistance to sheath blight and even projected in 1999 that field tests would take place in 2000.[30]

All the above transgenic varieties involve a controversial transfer of genes across species. Bt rice incorporates a gene from the soil microbe, *Bacillus thuringiensis*. The tungro-resistant rice incorporates a gene from the virus itself. On the other hand, although many of the sheath blight resistant varieties incorporate a chitinase gene from other plant species, IRRI has worked on a variety incorporating a rice chitinase gene. The variety, however, only showed "some resistance", and it still uses a foreign gene to cause over-expression of chitinase.[31] All of these varieties have public relations liabilities, as field tests could easily provoke public criticism over biosafety concerns.

Herdt's study would indicate that there is no real *need* for BB rice and IRRI's choice for its first field release among its numerous transgenic rices would indicate that *need* is indeed not the issue. In the joint proposal for the field test submitted by IRRI and PhilRice, the applicants assert, "The field release of [bacterial blight resistant] IR72 transgenic lines will be the first major demonstration that genetic engineering is an invaluable tool in rice improvement programs." Any first field test is, in many ways, the most important field test. Therefore, BB rice should be seen as a trial run to test the regulatory waters and the public's reaction. If IRRI and PhilRice can overcome public opposition to genetic engineering and carry the tests out smoothly, it will set a solid precedent for future biotechnology research and development in rice. In this respect, Rockefeller's low priority for BB rice and IRRI's high priority for it match up perfectly. BB rice is set to be IRRI's first transgenic rice released into the environment because of the public relations factor.

BB rice might allow IRRI to avoid some of the biosafety controversies that have flared up over other transgenic crops – both here in Asia and elsewhere. For one, the isolated gene comes from another variety of rice and not from another species. In fact, the Xa21 gene has already been incorporated in IRRI's HYVs through conventional breeding and IRRI believes that its current use on farms will calm public fears.

Second, the Xa21 gene can be activated in the transgenic rice without the use of a foreign promoter. All genes are attached to promoters, which regulate the function of the gene. A promoter essentially tells the gene when to replicate or, in other words, produce protein. In most genetic engineering experiments, the natural promoter is cut from the gene and an aggressive promoter from a virus or bacteria is fused onto it. With BB rice, on the other hand, the segment

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[29] M. Cohen and S. Savary, "The importance of pests and challenges to their management", in K.S. Fischer (ed.), *Rice Production Systems in the Asian Region: Volume 1 - Challenges for Rice Research in Asia*, December 1996. Accessed from the World Wide Web at http://thecity.sfsu.edu/~sustain/chap4.html on 15 March 2000.

[30] IRRI, "CE2: Applying Biotechnology to Accelerate Rice Breeding and Broaden the Rice Genepool", in *Sustaining Food Security Beyond 2000: Medium Term Plan 1998-2003*, p. 90. Available as on the World Wide Web at http://www.cgiar.org/irri/Mtp2001/CE2.pdf

[31] I. Potrykus *et al*., "Transgenic indica rice for the benefit of less developed countries: Toward fungal, insect, and viral resistance and accumulation of B-carotene in the endosperm" in *Rice Genetics III: Proceedings of the Third International Rice Genetics Symposium*, IRRI, Manila, 16-20 October 1995.

of DNA comprising the Xa21 gene contains both the trait for bacterial blight resistance and its naturally occurring promoter. This promoter is capable of functioning within the transgenic variety and there is no need for a viral promoter.

The most significant biosafety concern that *can* be pointed to in the BB rice field test is that the resistant varieties that both IRRI and PhilRice are planning to sow will carry controversial selectable marker genes. Selectable marker genes are engineered into transgenic plants so that scientists can determine which of the genetically engineered cells and plants they have engineered carry the desired trait. For instance, some plants incorporate selectable marker genes with traits for tolerance to herbicides. After the plants have been genetically engineered, the scientist can spray the plants with the herbicide and only those plants that have been successfully genetically engineered will survive. Other markers include genes for antibiotic resistance, and the selection process works much the same way.

The concerns related to the markers are exposed in the accompanying box.

Concerns over antibiotic resistance genes

The transgenic rice that IRRI and PhilRice have applied to field test incorporates a gene for resistance to the antibiotic hygromycin (*hph [aphIV]*). The hygromycin gene is part of a genetic DNA construct (pHX4) inserted into the transgenic rice. The construct also carries a promoter gene from the cauliflower mosaic virus (CaMV35S).

Transgenic crops with antibiotic resistance genes can encourage the development of antibiotic resistance among pathogenic bacteria.[32] There are a number of ways that bacteria can develop resistance to antibiotics. One method is through a "horizontal" transfer of DNA across different species of bacteria. Pathogenic bacteria have been especially successful in developing resistance because they have acquired open systems for horizontal DNA transfer and are even capable of receiving DNA horizontally from non-bacteria sources. For example, it is possible for a horizontal transfer of DNA to take place from plants to pathogenic bacteria. Such an event is extremely rare unless the circumstances that favour it are multiplied – which is what the widespread use of BB rice will do.

There are two ways for an antibiotic resistance gene to transfer from the plant to bacteria. One process takes place in the human or animal digestive tract. When the genetically engineered food is digested, the food breaks down and its DNA is "freed" or becomes "naked". At this point, the DNA usually becomes unstable, but it is possible for some genes to remain intact. The exceedingly small size of the antibiotic-resistance gene increases the likelihood of this occurring. In every stomach there exists a multitude of bacteria in varying physiological states and there is a strong possibility that some of them will be capable of incorporating the "naked" DNA into their own genetic make-up. Furthermore, the ecosystem of the digestive tract favours horizontal gene transfer across bacteria of different species and could cause a rapid development of antibiotic resistance among harmful bacteria. A second process takes place in the fields. When the crops, and particularly their roots, decompose, horizontal gene transfer can occur with the bacteria in the soil.[33]

[32] Patrice Courvalin, "Plantes transgéniques et antibiotiques", *La Recherche*, No. 309, Paris, mai 1998, accessed from http://www.larecherche.fr/VIEW/309/03090361.html on 23 November 1999.
[33] *Ibid*.

In October 1998, the British scientific association, the Royal Society, stated that it was no longer acceptable to have antibiotic resistance marker genes in genetically engineered crops. These concerns were later echoed by some experts on the British government's Advisory Committee on Novel Foods and Processes. In a letter to American authorities, Dr. John Heritage, a member of the committee, wrote, "While the risk is small, the consequences of an untreatable, life-threatening infection spreading within the population are enormous."[34] In February 1999, the European Parliament called for a ban on antibiotic resistance marker genes in modified crops.[35] The call has since been reinforced by a vote in the EP's Environment Committee on the March 21, 2000 to prohibit the use of antibiotic resistance marker genes.[36] Even Gordon Conway, President of the Rockefeller Foundation, has called on companies to abandon antibiotic resistant marker genes, maintaining that "alternative selection markers are now available and should be used."[37]

Concerns also exist about the promoter gene (CaMV 35S) from the cauliflower mosaic virus. Studies have shown that new viral strains can arise when a virus recombines with a viral transgene. A 1993 report found that the cauliflower mosaic virus is capable of recombining with cauliflower mosaic virus transgenes genetically engineered in plants. The recombination can alter the host range of the virus and change the symptoms that it produces.[38] A more recent study at the John Innes Centre in the United Kingdom found a "recombination hotspot" in the CaMV 35S promoter, suggesting that it is prone to recombination.[39] Some scientists now argue that elements of the CaMV 35S promoter may recombine with "dormant, endogenous viruses" to "create new infectious viruses in all species to which the transgenic DNA is transferred."[40]

A better way of breeding?

There is really little justification for genetically engineering rice for bacterial blight resistance. So far, the only advantage indicated by IRRI is that the genetic transformation of BB rice is more efficient than conventional breeding. Supposedly, with biotechnology, breeders can cut back on the time it normally takes to transfer characteristics of a plant, particularly a wild plant, into HYVs. Additionally, IRRI argues that genetic engineering is a more precise process, allowing breeders to select only those characteristics that they desire for incorporation into their elite lines. According to IRRI and PhilRice's joint field trial application, "In breeding for resistance through the conventional approaches, some desirable traits are inevitably transferred as well to the breeding line … Through genetic engineering, only a well-defined specific gene is incorporated into the breeding line without further disturbing its genetic background."

[34] "Scientists warn of GM crops links to meningitis", *Daily Mail*, London, 26 April 1999.
[35] Greenpeace International, "Chronology of the approval and bans of Novartis Bt maize in Europe", accessed from the World Wide Web at http://www.greenpeace.org/~geneng/reports on 15 September 1999.
[36] European Parliament, Revision of Directive 90/220, Common Position, Second Reading, Vote in Environment Committee, 21 March 2000.
[37] Gordon Conway, "Crop Biotechnology: Benefits, Risks, and Ownership", presented at the OECD Conference on the Scientific and Health Aspects of Genetically Modified Foods, Edinburgh, 28 February-1 March 2000. Accessed from the World Wide Web at http://www.oecd.org/subject/biotech/conway.pdf on 5 April 2000.
[38] J. Schoelz and W. Wintermantel, "Expansion of viral host range through complementation and recombination in transgenic plants", *The Plant Cell*, No. 5, 1993, pp. 1669-79.
[39] A. Kohli, "Molecular characterization of transforming plasmid rearrangement in transgenic rice reveals recombination hotspot in the CaMV promoter and confirms the predominance of microhomology mediated recombination", *The Plant Journal*, Vol. 17, No. 6, pp. 591-601.
[40] Mae-Wan Ho, Angela Ryan and Joe Cummins, "Cauliflower Mosaic Viral Promoter: A recipe for disaster?", accessed from the World Wide Web at http://www.i-sis.org/camvrecdis.htm on 5 April 2000.

IRRI and PhilRice's assertion is misleading. Genetic engineering is far from an exact science and can produce any number of unintended side-effects in transgenic plants. At several points during the transformation process, changes may occur to the DNA that the scientists had not planned for.[41] In a 1999 paper on transgenic rice, IRRI plant biotechnologst Dr. S.K. Datta wrote, "Only a few plants from a transgene population will behave in the expected way without insertional mutagenesis, copy number of effects, somaclonal variation, and pleiotropic effects."[42]

When PhilRice conducted a screenhouse study of BB rice, it found that "The untransformed IR72 significantly produced taller plants and higher percentage of filled grains compared to the transgenic lines."[43] The transformed rice also had a lower percentage of productive tillers and shorter average panicle length. The researchers suggest that the changes can be attributed to "somaclonal variation whereby DNA changes occurred while the plants are in the stage of cell culture," but they could not be sure.[44] Other changes, not tested for or less visible, may have escaped the researchers.

Despite the obvious problems identified in the PhilRice study, in their joint application for field tests of BB rice, IRRI and PhilRice claim that, "Based on greenhouse and screenhouse trials conducted at the PhilRice, Maligaya, Muñoz, Nueva Ecija during 1998 and at IRRI during 1999, there is no difference in morphology and agronomic characteristics between transgenic IR72 and non-transgenic IR72."

Yet another magic bullet

The technology may be new, but the concept is not. BB rice is a continuation of the reductionist "magic bullet" approach to agriculture that IRRI has employed since it first introduced disease problems into South and Southeast Asia in the 1960s.

In a 1996 position paper defending its biotech program, IRRI summarized its approach to disease management:

> Mankind's progress in using science to combat insect pests and diseases is a continuous race between plant breeders and pests. We have numerous examples of how plant breeders developed plants with resistance to insects and diseases to find, many years later, that the pest or disease organism mutated to overcome resistance genes. The important thing is for scientists to be always ahead of these organisms.[45]

Staying on top of the game is no easy task. In 1990, IRRI claimed that IRBB21, its rice line with the Xa21 gene incorporated through conventional breeding, showed resistance to all known races of *Xoo* in the Philippines.[46] Soon after, however, several races of *Xoo* that were able to

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[41] P.H. Dale and H. McPartland, "Field performance of transgenic potato plants copared with controls regenerated from tuber discs and shoot cuttings", *Theoretical Applied Genetics*, No. 84, 1992, pp. 585-592.
[42] S.K. Datta, "Transgenic Cereals: *Oryza sativa* (rice)", *Molecular Improvement of Cereal Crops*, pp. 149-187.
[43] L.S. Gueco *et al.*, "Bacterial blight resistant and agronomically desirable transgenic IR72 lines containing Xa21 gene identified", no date.
[44] *Ibid.*
[45] IRRI, "Position Paper on House Resolution 280", 21 February 1996, p. 10.
[46] K. Ikeda, G.S. Khush and R.E. Tabien, "A new resistance gene to bacterial blight derived from *O. longistaminata*", *Japanese Journal of Breeding*, No. 40, (suppl. 1), pp. 280-281.

overcome the Xa21 gene were identified. These races were found in Korea and, most alarmingly, in the Philippines.

BB rice is not a solution to bacterial blight. Even UC Davis' Pam Ronald acknowledges the problem:

> It is difficult to predict the durability of engineered or naturally occurring resistance in the field. For example, because lines carrying Xa21 have not yet been planted over large areas for a long period, it is unknown if the multiple isolate resistance conferred by the Xa21 gene will be durable in a particular location. Furthermore, recent results indicate that the three *Xoo* isolates are capable of overcoming the Xa21 resistance in the donor and engineered lines.[47]

Dr Ronald voiced these concerns in a 1997 article. Since that time, another five strains of *Xoo* have been discovered that can overcome the Xa21 resistance in BB rice, some of which are found in the Philippines.[48]

IRRI is once again confronting the wrong question with the wrong answer. Its approach to disease management relies almost entirely on breeding. In advertising the benefits of BB rice, IRRI conveniently forgets its role in spreading the disease. In one promotional piece for IRRI rice in which the Xa21 gene was incorporated, Dr. Gurdev Khush and other colleagues write, "In the pre-green revolution period, [bacterial blight] caused widespread yield loss."[49] When IRRI's top scientists fail to understand the nature of the problem, what kind of solutions can be expected?

The other way: cultural management

According to the Farmer-Scientist Partnership for Development (MASIPAG), an independent network of farmers, NGOs and scientists in the Philippines, there are at least eight ways that farmers can control bacterial blight in rice:

1. Avoid excessive use of fertilizers rich in nitrogen.
2. Do not use residues from infected plants as organic fertilizer.
3. Provide only adequate irrigation and sufficient drainage.
4. Save the seeds from those plants with resistance to plant for the next season.
5. Maintain diversity in the farm by planting different crops at the same time or changing crops every season to decrease the pest population.
6. Be cautious in transplanting seedlings from the seedbed to the field, since tearing of the roots is a significant cause of infection.
7. Plant different varieties of seed, and those developed from multiline breeding, with different levels and means of resistance as a precaution against large crop loses.
8. Remove infected plants and other possible hosts of the pathogen.

[47] Pamela C. Ronald, "The molecular basis...", pp. 179-186.
[48] Personal communication, 17 March 2000.
[49] Kenneth Fisher, Hei Leung, and Gurdev Khush, "Box 2, Molecular Breeding: Biotechnology at Work for Rice", in G.J. Presley, "Agriculture Biotechnology and the Poor: Promethean Science", accessed from the World Wide Web at www.cgiar.org/biotech/rep0100/contents.htm on 3 March 2000.

Based on MASIPAG's experience, bacterial blight is not a large-scale problem in the Philippines, since farmers can easily deal with it.[50]

IRRI and its national counterparts, such as PhilRice, are working against these sustainable, farmer-led solutions. As IRRI and PhilRice launch expensive biotech programs to outrun bacterial blight, both institutions are happily giving the pathogen a head start with other programs that will increase incidences of the disease. Bacterial blight is a controllable disease that even IRRI's conventional breeding program has had a fair amount of success in handling. However, the new hybrid varieties and IRRI's super rice are highly susceptible to the disease. It is not surprising, therefore, that for PhilRice, its hybrid rice program and its biotechnology program are "closely intertwined."[51]

4. PIECES OF A LARGER PROCESS

The upcoming field test of BB rice in the Philippines is part of a larger strategy to promote transgenic rice in the region. As the process unfolds, the actors and the agenda appear in sharp relief, offering a valuable insight into the mechanisms and means through which corporate biotech is emerging in South and Southeast Asia.

Passing the biosafety hurdles: co-optation or consultation?

Biosafety refers to the new dangers presented by the release of genetically modified organisms into the environment. Often, biosafety regulations are enacted in response to public concern over possible hazards from biotechnology as these hazards become known. For example, the current biosafety policies at IRRI sprung from a scandal surrounding its experimentation with several strains of the rice blast fungus. The scandal also influenced the very development of biosafety guidelines in the Philippines, which were written before those of any other country in the region.

In the 1980s, IRRI imported foreign strains of the blast pathogen, which were donated and developed by several institutions, including DuPont, in order to hybridize and test the pathogens at IRRI's research labs in Los Banos. Given that the disease is not a major problem in the tropical lowlands, IRRI's research risked introducing highly potent and exotic forms of the disease into a defenseless environment. When news of IRRI's activities broke, the public was outraged and IRRI was forced to account for its actions. The Philippine Senate even launched an investigation of IRRI for, among other points, abusing its diplomatic privileges and importing foreign isolates without proper import permits. It was soon after the blast scandal that the Philippines government established its own National Committee on Biosafety and the subsequent biosafety guidelines.

In 1996, IRRI was back in the headlines when it tried to import transgenic Bt rice seeds to the Philippines. A resolution was brought to the Philippine Congress, which argued that, among a number of concerns, "There was no prudent compliance … as regards the need to hold public

[50] Personal communication, 4 May 2000.
[51] Personal communication with Dr. Gabriel Romero, 5 April 2000.

deliberations on biosafety issues as fairly denoted in the Philippine Biosafety Guidelines."[52] IRRI dismissed the allegation, claiming that it had held a "public meeting" at the University of the Philippines Los Baños (UPLB) concerning its facilities for testing transgenic plants. Unfortunately, whether such a "public meeting" constitutes a "public consultation" is not easily determined since the guidelines do not define "public consultation".

At this point, there is reason to suspect that a broad-based public consultation about the field tests of BB rice will not take place. IRRI's Deputy Director-General, Dr. William Padolina, insists that IRRI will follow the government regulations to the letter, but already some aspects of the guidelines have been breached. For instance, according to the Philippine Biosafety Guidelines, the IBC must be composed of five members and "at least two of the members shall not be affiliated with the institution and shall represent the interest of the surrounding community with respect to health and the protection of the environment."[53] Yet the UPLB IBC is composed entirely of scientists from the campus and the two members that IRRI identifies as its "community representatives" are former IRRI scientists!

Dr. Padolina also insists that the public consultation process begins once preliminary approval is given by the NCBP.[54] At that point, IRRI will "inform" the governor of Laguna (the province where IRRI is located) and the mayor of Los Baños, and IRRI's IBC will undertake public consultations with the "community". Since the biosafety guidelines are silent about what constitutes a "public consultation" or the relevant "community", the parameters will be left to the discretion of the IBC itself. At this point, therefore, there is no way of knowing if Dr. Padolina is actually referring to the 14 scientific institutions operating in and around UPLB comprising the "Los Baños Scientific Community", as has been the case in the past, when he speaks about the "Los Baños community". If the composition of the IRRI IBC is any indication, there is little reason to expect broad-based representation in public discussions. Such an outcome would significantly impact the "discussions on the comparative ecological, economic and social impacts of alternative approaches" (Section I.B.2.1.3) that the IRRI IBC is responsible for holding.

Ultimately, the NCBP, as readily acknowledged by IRRI, is responsible for determining whether or not IRRI has complied with the biosafety guidelines. Fortunately for IRRI, the NCBP has so far proven highly supportive of the proponents of biotechnology. In the only other applications for field trials of transgenic crops, which were made by Monsanto and DuPont for Bt corn, the committee overruled local government resolutions objecting to the trials and ignored gaps in biosafety data supplied by the proponents. The public consultations stipulated by the guidelines, therefore, proved inconsequential. In this context, IRRI's insistence that it will comply with all NCBP demands does not resolve concerns about safety and public participation.

The NARS: partners or proxies?

At present, the most significant factor guiding IRRI's biotechnology program is the availability of the technology. Neither IRRI nor the national agricultural research systems (NARS) have had much success in isolating and cloning their own genes, leaving the development of transgenes to

[52] IRRI, "Position Paper on House Resolution 280", Manila, 21 February 1996, p. 8.
[53] Department of Science and Technology, *op. cit.*, Section B.1.1, p. 11.
[54] Personal communication with Dr. William Padolina, 24 April 2000.

the private sector and the labs of the North. Research and development at these institutions in the North rarely, if ever, addresses the concern of non-profitable sectors, such as small rice farmers. Furthermore, their research is most often patented and distribution requires royalty payments or licensing fees that put the technology out of the reach of national breeding programs in the South. IRRI's biotech program is, therefore, severely limited by its dependence on the institutions and companies of the North, and it can only sit and wait for potential "technology transfer" opportunities to arrive.

When such opportunities have come about, IRRI has jumped all over them. No matter how far-fetched the benefits may be to small farmers in the South, IRRI tends to incorporate these technologies in its research and development programs with little consultation with the NARS and minimal assessment of the impacts. For instance, when the Swiss Federal Institute of Technology developed a provitamin A gene construct for rice, it was IRRI's management that prioritized IRRI's involvement[55] – before consultation with the NARS and without a thorough evaluation of the social and economic impacts. IRRI has now applied for a permit to import the gene construct for the vitamin A trait and will be carrying out research to insert the gene into IRRI varieties.

Priorities for research seem to come together on an ad hoc basis: sometimes it is called for by IRRI management, and at other times it is the individual perceptions of IRRI's scientists. According to Dr. Datta, "We, as scientists, see what is important, and we initiate collaboration."[56] Most of the biotech applications that IRRI is currently working on – including vitamin A rice, resistance to tungro, resistance to yellow stem borer, resistance to blast, and resistance to sheath blight – are a continuation of the work that Dr Datta was doing when he was a scientist at the Swiss Federal Institute of Technology.

The only really clear guidance seems to come from one of IRRI's most committed funders – the Rockefeller Foundation. More than any other institution, the Rockefeller Foundation has set the agenda for research and development of transgenic rice. The Foundation has pumped in over $100 million dollars into research on biotechnology for rice, with IRRI playing a key role. The Foundation sets its own priorities, of course, and nearly all funds that it provides to IRRI are targeted at specific biotechnology programs. In fact, much of the research carried out on the Xa21 gene has been supported by the Foundation.

In this ill-structured decision-making process, research priorities rarely address the needs of farmers. BB rice is a case in point. IRRI's decision to use BB rice as the first field test is primarily an exercise in public relations: to establish a precedent in terms of public acceptance of transgenic rice in general. According to Dr. Datta, BB rice "will be well appreciated by the public because the Xa21 gene is already quite well known." He admits that although resistance to bacterial blight is not a major concern as a trait, BB rice "is the safest product one could demonstrate and a good starting point for transgenic rice."[57] PhilRice concurs, explaining that BB rice is a "less controversial" transgenic variety that "will not rattle a lot of people."[58]

[55] Personal communication with Dr. S.K. Datta, 22 March 2000.
[56] Personal communication, 22 March 2000.
[57] Personal communication, 22 March 2000.
[58] Personal communication, 5 April 2000.

IRRI is also trying to portray the field test of BB rice in the Philippines as a shining example of co-operation with the NARS. Even though both institutions claim that they are quite capable of carrying out the field tests independently, they decided to make a joint application to the NCBP. But beyond the application, there is little evidence of collaboration. First, PhilRice and IRRI are conducting their field tests in different locations; PhilRice will be conducting its field trials in Muñoz, Nueva Ecija, and IRRI will be conducting its field trials at an experimental station at the University of the Philippines Los Baños (UPLB). Second, while IRRI will field test varieties transformed at its own facilities, PhilRice will test varieties imported from an American institution, the International Laboratory for Tropical Agriculture Biotechnology (ILTAB). With so little practical collaboration, it would seem that the "joint" field testing application is primarily a set-up for IRRI to avoid being the lone target of public criticism.

Similar motivations may be at work in the decision to locate the IRRI field trial at a UPLB experimental station instead of the IRRI's own 252-hectare farm, which it leases from the University. IRRI argues that since its own grounds are fully in use, it does not have enough land available to satisfy the area required under the biosafety guidelines.[59] UPLB has therefore agreed to offer one of its experimental stations for the trial and, in so doing, has become a third party in the application. As a result, UPLB – wittingly or unwittingly, depending on who you talk to – now shares responsibility for the trials and has become a co-proponent with IRRI.

BB rice and the International Laboratory for Tropical Agriculture Biotechnology (ILTAB)

One of the most disturbing aspects of the "joint" field test is that PhilRice is not even carrying out the tests as part of its own breeding program. PhilRice's field test of BB rice is part of ILTAB and UC Davis' efforts to test *their* BB rice seeds against different *Xoo* strains across the globe.[60] As with the variety that IRRI will test, ILTAB's variety is a transgenic IR72 engineered with the Xa21 gene patented by UC Davis. However, whereas IRRI incorporated the Xa21 gene into IR72 itself, the seeds that PhilRice will test were transformed by ILTAB and imported on 1 January 1999.

ILTAB, UC Davis and PhilRice have already conducted initial tests of BB rice within PhilRice's screenhouse in Nueva Ecija. The tests assessed the response of the transgenic rice to 10 different Philippine races of *Xoo*. According to the report from the screenhouse test, "Experiments will be incomplete, however, unless transgenic germplasm is tested and widely deployed in the field and extensively monitored." The report continues, "Products of genetic engineering for pest and disease management and other important traits are expected in the near future. As recipients of such products, Filipinos must also become familiar with the technology."[61]

ILTAB has also collaborated with the Thai Department of Agriculture's Rice Research Institute. In 1994, Thai scientists from the Institute took samples of Khao Dok Mali-105 (jasmine) rice to ILTAB's laboratory in California to modify it with the Xa21 gene. The collaboration was supported by the Rockefeller Foundation. Thai scientists then returned to Thailand with transgenic tissue cultures in 1997 and began to breed transgenic BB jasmine rice. According to a report in Thailand's English-language newspaper *The Nation*, the Department of Agriculture grew the seeds on a small test plot and harvested

[59] "Trials of transgenic rice in the Philippines proposed," *AgBiotechNet*, accessed from the World Wide Web at http://agbio.cabweb.org/news/Research.htm#Trials on 15 Oct 1999.
[60] Personal communication with Dr. S.K. Datta on 22 March 2000 and with Dr. Gabriel Romero on 5 April 2000.
[61] L.S. Gueco *et al., op. cit.*

123 transgenic seeds.[62] Since then, the Department of Agriculture says that it stopped research due to biosafety hurdles and fears about infringing the UC Davis patent.[63]

ILTAB was established at the Scripps Institute in California with financial support from several US federal agencies, the Rockefeller Foundation, and the French public research institute ORSTOM. Its stated mission is to transfer biotechnology to developing countries. The founder and director is Dr. Roger Beachy, who worked with Monsanto to develop its glyphosate tolerant crops when he was formerly with Washington University. Beachy and ILTAB have now relocated to the Donald Danforth Plant Science Center, just outside of Monsanto's headquarters in St. Louis, Missouri. The Center was built with over $80 million from Monsanto. According to Beachy, "We want to have as much diversity of funding as we can. I want to see the involvement of as many private companies as we can attract."[64]

A new life for IRRI in the life sciences?

Biotechnology has turned the original conception of the relationship between IRRI and the NARS on its head. Under the initial vision, IRRI's objective was to build up the capacity of the NARS until they became strong enough to go it alone. IRRI was then supposed to disappear. When IRRI was incorporated in the Philippines in 1960, the Memorandum of Agreement with Philippine government stipulated that the Institute would function for a period not exceeding 50 years from its date of incorporation, "unless earlier terminated in accordance with the law." Yet, mechanisms to measure the independent strength of the NARS were never formalized, and IRRI's existence has rarely been challenged. Biotechnology is perhaps extending the timeframe indefinitely.

In its current conception of its relationship with the "advanced" NARS, IRRI sees its role in "technical support and training in upstream strategic research areas."[65] However, with biotechnology, "training" means little more than facilitating the study of the occasional PhD student or working with the Rockefeller Foundation on various "shuttle research program" exchanges, which can also involve laboratories in the North such as Cornell University or ILTAB. The exchanges are quite effective in encouraging interest in transgenic crops and some basic involvement at the national level in biotechnology research and development. The problem is that they only accentuate dependence on foreign institutions. This is a general problem with biotechnology. It is dominated by those with the capacity and the patent protection. The NARS do not have that capacity.[66]

This is where IRRI is supposed to offer its support. According to the Institute, "IRRI is undertaking support research by accepting a responsibility for problem solving in specific areas where the Institute, in consultation with its national partner institutions, has proven to have a

[62] P. Hongthong, "Ministry asked to stop GMO research," *The Nation*, Bangkok, 14 March 2000.
[63] *Ibid.*
[64] Vic Comello, "Roger Beachy: A Leader in Revitalizing Plant Science," *R&D Magazine*, December 1999. Available on the World Wide Web at http://www.rdmag.com/features/11soy.htm
[65] IRRI, "Accelerating the impact of rice research: IM1 strengthening partnerships with NARS", *IRRI Project summary and highlights 1998*, Manila, 1998.
[66] IRRI, *Sustaining Food Security Beyond the Year 2000: A global partnership for rice research: Medium Term Plan 1998-2003*, Manila, 1998, p. 21.

comparative advantage."[67] One of the areas identified is biotechnology.[68] But IRRI, itself, can only exert minimal influence over developments in biotechnology. The private sector clearly dominates the field and IRRI can only play the role as a center for evaluating potential technologies, or worse, a facility to transfer technology from the North into local varieties. This is precisely the role that the transnational biotech corporations hope IRRI will play. Bruce Bickner, the Chief Executive Officer of DeKalb Seeds – an American subsidiary of Monsanto – argues that, in the new transgenic seed market, local seed companies will function as "regional product testers and merchandisers."[69] With the private sector showing more and more interest in rice, even IRRI's Dr. Datta feels that such a trend is inevitable for IRRI to escape. He says that, with respect to biotechnology, IRRI will become "an evaluator of genetically engineered products for the NARS," and will be responsible for identifying which products are worthwhile. Indeed, the transformation has already begun, as IRRI has just received export permits to send transgenic seeds to Indonesia and India.[70]

CONCLUSION

IRRI hopes that its first field test of transgenic rice will convince the public of the benignity and benefits of biotechnology, and it has selected a variety of transgenic rice that it believes will not arouse hostility. But scratch a little at the surface, and the field test and the transgenic variety become perfect examples of everything that is wrong with the technology and IRRI's biotech program in general.

BB rice is not a long-term solution to bacterial blight. It is another finger in a leaky dam that IRRI has evidently no real desire to fix. IRRI has not shown a genuine interest in sustainable solutions to the disease – not when it first introduced HYVs in Asia and not now as it begins its large-scale promotion of hybrid rice and "super rice", both with severe susceptibility to the disease.

The field test also demonstrates the ways in which IRRI turns inward to shelter itself from scrutiny and a broader vision. To date, the process behind the field test lacks transparency and proper mechanisms for public input. There has been no meaningful discussion of the benefits to farmers or of how the technology could even reach them. But, once again, farmers are not the reason for the field test. The issue here is biotechnology and the field test is a means to push biotechnology forward in the region.

IRRI has no mandate to push the biotech envelope in Asia or anywhere else for that matter. While it may hide behind its national counterparts and unrepresentative agencies such as the IRRI IBC, it remains unaccountable to farmers in the South. The issue of accountability is particularly problematic with biotechnology, as techniques like genetic engineering carry far-reaching social and economic risks. There will be an unavoidable increase in corporate control of rice, with deep implications for the region. Small farmers have the least to gain from this

[67] Klaus Lampe, "Rice Research: Food for Four Billion People", *GeoJournal*, Vol. 35, No. 3, 1995, p. 257.
[68] IRRI, *Sustaining Food Security..., op. cit.*, p. 8.
[69] R. Pistorius and J. van Wijk, *The Exploitation of Plant Genetic Information: Political Strategies in Crop Development*, Print Partners Ipskamp, 1999, p. 149.
[70] Personal communication with Dr. S.K. Datta on 22 March 2000.

technology and, actually, the most to lose. And they are the ones most marginalized from the decision-making process. This is an unacceptable situation. The introduction of BB rice – IRRI's first transgenic rice to be openly grown in the region – represents a critical moment for the public, and particularly the farmers, to reassert control over the direction of agricultural research and development.

BB Rice: IRRI's First Transgenic Field Test
was researched by Devlin Kuyek for a group of organisations and individuals cooperating in a joint project on current trends in agricultural R&D which will affect small farmers in Asia. The organisations participating in this research project are Biothai (Thailand), GRAIN, KMP (Philippines), MASIPAG (Philippines), PAN Indonesia, Philippine Greens and UBINIG (Bangladesh). Also participating in their individual capacities are Drs. Romeo Quijano (UP Manila, College of Medicine, Philippines) and Oscar B. Zamora (UP Los Baños, College of Agriculture, Philippines).

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ABOUT THE COVER

IRRI plans to grow out its first transgenic rice not on its own lands, but in the nearby fields of the University of the Philippines Los Baños. The genetically engineered plants will be grown together with a few rows of traditional purple rice (check variety), surrounded by *Sesbania*, banana trees.... and a 24-hour security guard.