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Rice wars

Rice, the staple food crop for more than half the world's population, among them the poorest, is the current target of genetic modification, an activity that has greatly intensified after the rice genome was announced two years ago (see "Rice is life" series, SiS 15, Summer 2002). Since then, all major biotech giants are investing in rice research.

At the same time, a low-input cultivation system that really benefits small farmers worldwide has been spreading, but is dismissed by the scientific establishment as "unscientific". This is one among several recent innovations that increase yields and ward off disease without costly and harmful inputs, all enthusiastically and widely adopted by farmers.

A war is building up between the corporate establishment and the peoples of the world for the possession of rice. The food security of billions is at stake, as is their right to grow the varieties of rice they have created and continue to create, and in the manner they choose.

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ISIS Report 02/07/04

Fantastic Rice Yields Fact or Fallacy?

A low-input rice cultivation system invented in Madagascar and spreading all over the world is apparently exposed as without scientific basis. Dr. Mae-Wan Ho *investigates*

Rice feeds more than half the world's population, but yields of the crop have been levelling out, and 400 million are said to endure chronic hunger in rice-producing areas of Asia, Africa and South America. According to the United Nations, demand for rice is expected to rise by a further 38% within 30 years. To call attention to the problem, 2004 has been declared the International Year of Rice. "Rice is on the front line in the fight against world hunger and poverty", said Jacques Diouf, director-general of the UN Food and Agriculture Organisation.

Many farmers all over Asia have already identified low-input, sustainable solutions to the problem (see other articles in this series).

One simple method that boosts rice yields at much lower cost to farmers originated outside Asia. The System of Rice Intensification (SRI) developed in the late 1980s in Madagascar, has since been spreading to other parts in Africa and to Asia. In Madagascar itself, some 100 000 farmers have converted to it. And more than 20 other countries, from Bangladesh to Thailand, have either adopted SRI, or field tested it, or expressed firm interest. In Cambodia, SRI was unheard of in 2000, but by 2003,

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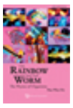

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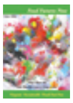

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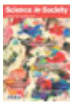

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nearly 10 000 farmers had converted to it, and that figure may reach 50 000 this year.

Advocates of SRI routinely report yields up to twice or more those achieved by conventional agriculture.

However, eminent agronomists are dismissing those claims as "poor record keeping and unscientific thinking"; and results of new field trials, published in March 2004 in the journal *Field Crop Research*, appear to support this view.

History of SRI

SRI was developed nearly 20 years ago by Father Henri de Laulanié, a Jesuit priest who worked with farming communities in Madagascar from 1961 until his death in 1995. In conventional rice growing, the plants spend most of the season partially submerged in water. During a 1983 drought, many farmers could not flood their paddy fields, and de Laulanié noticed that the rice plants, in particular, their roots, showed unusually vigorous growth.

From this and other observations, de Laulanié developed the SRI practice: rice seedlings are transplanted quickly when young, spaced widely apart, and most importantly, the rice fields are kept moist but not flooded. In addition, he emphasized using organic compost over chemical fertilizers, so that poor and rich farmers alike could practise SRI.

Norman Uphoff, a political scientist and director of the International Institute for Food, Agriculture and Development at Cornell University in Ithaca, New York, stepped into the picture in 1993. He was part of a team trying to find alternatives to the damaging types of slash and burn agriculture that was destroying Madagascar's rainforest. It was clear to Uphoff that if rice yields in the area could be increased from about 2 tonnes per hectare, as it was then, a lot of forest could be saved. He came across de Laulanié's not-for-profit organisation, 'Tefy Saina' meaning "to improve the mind".

Uphoff was looking for a yield of 4 tonnes per hectare, and when he heard them say they could get 5 or more, he did not believe them. But such doubts vanished once farmers in the rainforest regions started using SRI. The results were stunning. "By the end of the second growing season we were getting 8 tonnes per hectare". In 1997, Uphoff began promoting SRI throughout Asia.

Why SRI benefits farmers, consumers and the environment

SRI's benefits lie in important differences from conventional rice growing practice, which, proponents believe, interact synergistically to give high yields.

First, seedlings are transplanted at 8-12 days instead of 15 to 30 days after germination, singly as opposed to 2-3 seedlings, and spaced up to 6 times apart compared to traditional practice; for example, up to 50cm x 50cm instead of 20cm x 20cm. This represents a substantial saving on seeds, up to ten-fold or more in some cases. The increased spacing has the effect of encouraging tillers or side shoots to develop quickly, giving many more rice-forming panicles per plant.

Second, the fields are kept moist during all or most of the growing season instead of being flooded continuously. This tremendous saving on water is particularly important in areas of water scarcity, and avoids the damages of salination that accompanies over-irrigation. It also encourages vigorous root development, which in turn gives more vigorous growth of the rice plants.

Third, no herbicides are used. Weeding is done with or a simple rotary hoe, which returns the weeds to the soil as green manure. This financial saving is offset by increased labour, but labour shortage is seldom a problem for farmers in the Third World, and weeding becomes less arduous in successive years. Giving up herbicides is a health bonus for all concerned: the farm worker most of all, and the consumer; and there is no pollution of the environment and ground water.

Fourth, no mineral fertilizers are used, only liberal application of organic compost. This financial saving is accompanied by an improvement to the quality and fertility of soil, reducing runoff, and improving its water-retaining properties.

Despite its early start in Madagascar, SRI has only begun in other countries since 2000, and already, positive results are pouring in (see "Does SRI work?" this series).

Critical scientists

Major critics of SRI include John Sheehy, an agronomist at the International Rice Research Institute (IRRI) in Manila, the Philippines. He said most SRI field studies have appeared in conference proceedings and other publications not subject to peer review.

That is hardly surprising given the lack of interest from mainstream scientists, and its relatively recent uptake in countries other than Madagascar.

In March 2004, Sheehy, together with IRRI researcher Shaobing Peng, A. Dobermann of the University of Nebraska, Lincoln in the United States, and other researchers from Sheffield University in the UK; from Yangzhou University, Jiangsu, Hunan Agricultural University, Changsha, and Guangdong Academy of Agricultural Science, Guangdong, China, published their first trials of SRI under the telling title, "Fantastic yields in the system of rice intensification: fact or fallacy?"

This report was written up as a news feature in the top journal *Nature*, under the yet more telling title, "Feast or famine?" asking whether SRI was a diversion from "more promising approaches" to increasing yield such as genetic engineering.

Sheehy and coworkers planted a single rice cultivar, shanyou 63, at three experimental stations in Hunan, Guangdong and Jiangsu provinces of China, using SRI and conventional best practice in living-room-sized (8 x 5m) plots in the same fields. Weeds were suppressed with herbicides on the conventional plots but pulled by hand in the SRI plots. SRI plots received extra rapeseed cake fertilizer. Conventional plots were flooded as usual; SRI plots were kept saturated and only flooded 2 weeks before maturity.

Overall, no significant differences were found between the two cropping systems. SRI yielded 8.5% higher in Jiangsu, but 8.8% worse in Hunan.

Dobermann was reportedly "not surprised", as he said every component of SRI had been studied before and found to have little effect. The results also fit Sheehy's theoretical calculation of how much rice a field can produce, an upper limit set by the amount of sunlight falling on it. Based on weather data for Madagascar, Sheehy calculated theoretical maximum outputs for areas that have reported the most impressive yields of 21 tonnes/ha under SRI. By his estimates, the yields are as much as 10 tonnes more than is possible. "You can't get out more than gets put in," he reportedly said.

They concluded that, "SRI has no major role in improving rice production generally".

That was a remarkable sweeping dismissal of the extensive research and trials done by both scientists and farmers on numerous rice varieties in 19 countries over two or more growing seasons. Especially so, when the conclusions are based on the results of limited trials of a single variety for only one growing season.

Riposte

Chinese scientists have experimented with SRI since 2000, and their experience had indicated that not all varieties responded to SRI, and that responses improve in successive seasons. Dobermann himself had referred to the possibility of confounding effects when SRI was compared to traditional systems that did not represent the current "best practice". Of course, what is best practice for corporate agriculture is not necessarily best practice for the farmer.

Thus, Sheehy and workers could have stressed the obvious benefits to small farmers, consumers and the environment, *even from the results of their own trials*. They have obtained the same yields with less than half the seeds in SRI, with no inputs of herbicides, and substantial saving on water.

Norman Uphoff pointed out, in a detailed rebuttal to appear in *Field Crop Research*, that Sheehy and colleagues have simply not followed the SRI practice in their trials. It did not include the measures recommended for water management and weeding to ensure active soil aeration. Moreover, the high concentrations of chemical fertilizers used with the putative SRI plots (180-240 kg N/ha) would simply have inhibited the soil activity that enhances plant nutrition and growth.

"The merits of SRI methods have been validated by scientists at leading institutions in China, India and Indonesia, the largest rice-producing countries in the world," he remarked.

Why are scientists in research stations failing to replicate the enormous yield gain with SRI methods obtained by farmers? For example, IRRI started trials with SRI at Los Baños in 2002, and obtained a yield of only 1.44t/ha; and the next season, it was still just 3t/ha. Yet, concurrent SRI trials in the government's Agricultural Training Centre in Mindanao, using three varieties (PSBRc18, 72H and 82) yielded an average of 12t/ha.

When asked by IRRI staff why this discrepancy occurred, Uphoff suggested that IRRI's on-station soils, after decades of monocropping and application of fertilizers, insecticides, fungicides, herbicides etc., might be "almost dead", and hence unable to respond to SRI practices, which depend on increasing the abundance and diversity of soil microorganisms to enhance plant growth and health.

The basis for dismissing the high yields obtained in some parts of Madagascar as "fallacy" is highly questionable. It rests on a 'model' for predicting theoretical maximum yield using 'constants' derived solely from empirical observations on conventionally grown crops, which have no independent justification in terms of the plant's metabolism. For example, biomass accumulation depends on the balance between photosynthesis (which builds up biomass) and respiration (which decreases it), and that can change under different conditions. A healthy plant is also more efficient in using energy and accumulating biomass than an unhealthy one.

An indication that yields more than 20 tonnes/ha may not be "impossible" is that such yields have been recorded for rice growing systems in China in historical times.

Professor Yuan Longping, an expert in breeding high-yielding hybrid rice, who brought SRI to China, stated, "According to the estimates of most plant physiologists, rice can use about 5% of solar energy through photosynthesis. Even if this figure is discounted by 50%, the yield potential of rice would be as high as 22-23t/ha in temperate regions."

Uphoff maintained that the critics' assumptions are too firmly rooted in conventional practice. Models for estimating maximum yields will not necessarily translate to SRI. "The coefficients for the calculations are based on plants with stunted root systems. SRI plants have extensive root systems," he said.

Nor will single-season trials reveal the full potential of SRI, because over time, better oxygenation leads to the build-up of soil bacteria that interact with the roots and improve the condition of the soil. Even if SRI fails to increase yields when first introduced, as was the case in Thailand, for example, further seasons will see it come into its own.

Proponents insist that SRI is popular because it really increases yields impressively. T.H. Thiyagarajan, dean of the Agricultural College and Research Institute in Killikulam, India, rejects criticisms of individual aspects of SRI. In combination, he says, the whole is greater than the sum of its parts. "The synergistic effect of all these components is the crucial thing." He helped convince the Tamil Nadu state government to spend US$50 000 to promote SRI to local farmers.

In fact, the individual components have been tested in Madagascar and other countries, and each component was found to increase yield. The one that appeared to give the most increase was transplanting younger seedlings. But this practice is more challenging for inexperienced farmers used to handling sturdier older seedlings.

New evidence

Norman Uphoff's weighty response drew attention to new evidence from scientists in China (see "Does SRI work?" this series), Indonesia and India. SRI evaluations were started in Tamil Nadu Agricultural University in India in 2001, and by 2003, it had demonstrated such improvements in yield and profitability that the state government provided $50 000 for spreading SRI practice. About half the rice crop in the Cauvery Delta, the main rice-producing area of Tamil Nadu, will be given over to SRI cultivation; the farmers are so impressed with the size of the harvest and cost savings, including water, over the past two years.

While Sheehy and coworkers reported that SRI crops took 2 weeks longer to mature, that was most likely due to the soil not being well drained and aerated. When properly managed, crops mature more quickly under SRI. In Andhra Pradesh SRI crops matured 10 days earlier, while in Cambodia, they ripened about one week before the conventional crops.

The claim that SRI gave no advantage compared with "best practice" or officially recommended improved cultivation methods is also refuted. In Nepal, farmers compared SRI with their own usual practices and 'improved' practice. In 2002, the average SRI yield of 8.07t/ha was 37% higher than the average with improved practices, and 85% higher than the average with farmers' practices.

A. Satyanarayana, rice geneticist responsible for introducing SRI in the Indian state of Andhra Pradesh since the summer season of 2003, responded to *Nature*'s news feature by pointing out that, "The experiences of farmers are quite different from what is reported by sceptical scientists."

More importantly, the costs of SRI are low and its potential productivity very high, which is "more important than ever now that the Green Revolution technologies are showing signs of fatigue."

He gave further evidence that SRI definitely works for Andhra Pradesh farmers and called on scientists to collaborate constructively with farmers (see "Top Indian plant geneticist rebuts SRI critics", this series).

Sources

Stoop WA, Uphoff N and Kassam A. A review of agricultural research issues raised by the system of rice intensification (SRI) from Madagascar: opportunities for improving farming systems for resource-poor farmers. *Agric Sys* 2002, 71, 249-74.

Sheehy JE, Peng S, Dobermann A, Mitchell C, Ferrer A, Yang J, Zou Y, Zhong X and Huang J. Fantastic yields in the system of rice intensification: fact or fallacy: *Field Crops Res* 2004, 88, 1-8.

"Feast or famine?" Christopher Surridge, *Nature* news feature, 2004, 428, 360-1.

Satyanarayana A. ANGR Rice, research and real life in the field. (Agricultural University, Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India.) *Nature* correspondence 2004, 429, 803.

Hengaskijk H and Bindraban P. Rice: location is vital in crop management. *Nature* correspondence 2004, 429, 803.

Yang L-P. Keynote address Proceedings of international conference, *Assessment of the System of Rice Intensification*

(SRI), Sanya, China, April 1-4, 2002.

Uphoff N. Facts and fallacies regarding "Fantastic yields in the system of rice intensification". *Field Crop Research* (in press).

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Rice wars

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ISIS Report 05/07/04

Top Indian Rice Geneticist Rebuts SRI Critics

Dr. A Satyanarayana responds to criticisms of SRI as someone responsible for introducing the practice to the Andhra Pradesh state of India.

I read the news feature "Rice cultivation: feast or famine" in *Nature* (25 March 2004) with great interest as I was responsible for introducing the System of Rice Intensification (SRI) in the Indian state of Andhra Pradesh since the kharif (summer) season of 2003.

I found the message conveyed by the article not quite balanced. The experiences of farmers are very different from what is said by sceptical scientists. Instead of trying to understand how a rice plant can respond differently under an SRI environment, they are confused about the potential of SRI, giving information based on rice cultivation under flooded conditions that are definitely not SRI practice.

Having worked as a plant geneticist for over 3 decades on the genetic improvement of leguminous crops under rice-based cropping systems, I have released 34 varieties of various grain legumes that are widely adopted in rice-pulse or rice-rice-pulse cropping systems covering over one million hectares in the state. I have been responsible, from 1995 to 2000, for research in the Krishna and Godavari deltas, which, with 1.5 million ha of rice-growing area, are known as the rice bowl of Andhra Pradesh. At

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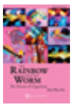

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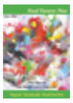

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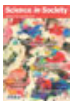

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I-SIS is a not-for-present, I am Director of Extension for the state agricultural university (ANGRAU) and transfer of technology is my job. So, I do know about the rice crop.

In January 2003, I was able to learn about SRI on a study tour to Sri Lanka, and was amazed to see the potential of this system. On returning to Andhra Pradesh, I started educating farmers on the skills involved in SRI and motivated them to take up this system on a small scale in demonstration plots. We planned to organise 50 demonstrations through ANGRAU's extension service and 150 through the State Department of Agriculture. But more than 300 farmers took up SRI during the summer season of 2003.

On average, the size of the demonstration plot was 0.4 ha, with the largest at 1.6ha. As many as 10 different varieties, chosen by the farmers themselves, were tried in all 22 districts of the state, under different soil and irrigation systems. The results achieved were highly satisfactory, giving an average yield advantage of over 2.0 t/ha. About 40 farmers got yields over 10t/ha, and 5 districts had average yields over 10t/ha. The highest recorded was 16.2 t/ha followed by 15.7t/ha.

The average over all the demonstration plots was 8.36t/ha compared to 4.9 t/ha with conventional practice and the state average of 3.89t/ha. These yields are not theoretical. They were properly recorded after thorough drying. On seeing the performance of this system, many farmers volunteered to practice SRI during the current winter season on more than 5 000 acres in the state.

Many farmers used SRI on over 10 acres. One farmer (Mr. N. V. R. K. Raju) practiced SRI on over 100 acres (40ha.), and an average yield of more than 10 t/ha is expected. I request sceptics to visit Andhra Pradesh and see SRI in practice before drawing conclusions.

Under SRI, the rice crop is maturing 10 days earlier than with usual cultivation practices, irrespective of the variety, which is contrary to what was stated in the *Nature* news feature, that SRI takes two weeks longer to mature. Also, SRI required less water and less chemical inputs. SRI gave higher grain as well as straw yield. Moreover, the SRI rice crop has withstood cyclonic gales and a cold spell.

It is unfortunate to say in the headlines of the news feature that proponents call SRI a "miracle". No one has ever said this because SRI results are quite explainable. Planting young seedlings carefully and at wider spacing gives the plant more time and space for tillering and root growth. Careful water management keeping the field wet and not flooded gives better yield because it supports healthy root growth. This practice should be encouraged everywhere as the whole world is facing water shortages. Weeding rice fields with a rotary weeder helps by churning the soil and incorporating the weed biomass as it aerates the root zone. This encourages the soil microorganisms to proliferate and makes the soil living and healthy. All of these practices are known to agronomists, and there is nothing new or magical.

The productivity of SRI as a function of input is very high, which is more important now as the Green Revolution technologies are showing fatigue. SRI has the potential to give higher yields at lower costs. Even when the farmers were unable to practice all the aspects the first season, just planting young seedlings carefully at wider spacing with somewhat better water management resulted in over 2.0t/ha extra yield compared to conventional methods using higher inputs. With more experience and mastering of skills, still higher yields are possible, as those obtained by the best farmers clearly suggest.

Rice yields all over the world have leveled out under the present system of flooded cultivation. Genotype x environment interactions are known to affect the plants' phenotype and performance. We need to be looking for alternatives to the present costly practices with an open mind. SRI is still evolving with the innovations of the farmers making implements and practices more labour-saving.

There is more than enough evidence accumulated here and elsewhere for scientists to take SRI seriously. I hope that the scientific community will collaborate in further research. Possibly it can refine the technology and reveal the factors responsible for the higher productivity observed. That would be more constructive and more in the spirit of science than dismissing it with limited or faulty data and preconceptions.

The author is Director of Extension, Acharya N. G. Ranga Agricultural University, Hyderabad-500030, Andhra Pradesh, India, and this article is adapted from his response to the Nature news feature mentioned.

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ISIS Report 06/07/04

Does SRI Work?

The first reality check of a low-input rice-growing system took place two years ago and more successes documented since. Dr. Mae-Wan Ho *reports*

The clearest sign that SRI works, if not miracles, then certainly well enough, is the number of participants drawn to the first in-depth international assessment of it

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depth international assessment of it.

Nearly a hundred people from 18 countries were listed as participants in the 192-page proceedings of the 4-day conference, which took place in Sanya, China, in April 2002. More than three-quarters were scientists, with policy-makers, representatives of non-government organisations, international organisations, private companies and farmers making up the rest. Participants from the host country China made up more than half of the total, and all were scientists from prestigious rice research institutes, agriculture academies or universities.

The conference was convened, not to assess whether SRI works – for that was the experience of almost everyone who presented papers at the conference - but to assess across nations, "the opportunities and limitations" of a practice that "can give yields about twice the present world average without reliance on new varieties or agrochemicals."

The conference did bring together a substantial body of evidence from around the world that SRI can increase yield in a variety of soils, climatic conditions, with various local adaptations, and using both indigenous and commercial ‘high yielding’ rice varieties.

SRI has been "practice-led" thus far, but participants at the conference felt it was time for scientists to catch up and research the knowledge-base, so that a healthy dialectical relationship between practice and knowledge can be achieved to help advance this important project of delivering food security and health to more than half the world’s population.

Since then, more successes have been reported, leaving the scientific establishment even further behind (see "Fantastic rice yields fact or fallacy?" this series).

Super-yields in Madagascar

The province of Fianarantsoa, situated in the south-central highlands of Madagascar, now lays claim to the highest yielding rice-fields in the world since the introduction of SRI in the 1990s.

The highlands are subtropical, with annual rainfall averaging 1375mm. The rainy season occurs during the hot months in the year, where the average temperature rises above 20C. The Fianarantsao region is often affected by cyclones during the rainy season.

Fianarantsoa attained rice yields of more than 8t/ha in the first year of applying SRI methods, up from the 2t/ha national average. SRI in this region is increasingly linked with the use of compost in rotational cropping with potatoes, beans or other vegetables in the off-season. In the second and succeeding years, the residual and cumulative effects of soil organic matter from composting increased yields still further, to 16t/ha. By the sixth year, yields as high as 20t/ha were measured on farmers’ fields in Tsaramandroso, Talatamaty and Soatanana.

Bruno Andrianaivo, senior agronomist of FOFIFA (National Centre for Applied Research on Rurual Development in Madagascar) emphasized that such high yields cannot be achieved immediately, but requires the cumulative effects of 6 years under SRI.

However, simply on the conservative figure of 8t/ha yield from SRI practice Andrianaivo estimated a net return to the farmer of 5 million Fmg (about US$770), compared with around 250 000 Fmg (less than US$40) for conventional practice.

Acceptance in China

Professor Yuan Longping of China National Hybrid Rice Research and Development Centre played a key role in creating high-yielding super-hybrids throughout the late 1990s and early 2000s by conventional breeding methods. His Centre had already broken all records in boosting rice-hybrid yields when he first heard about SRI from a paper written by Norman Uphoff of Cornell International Institute for Food, Agriculture and Development (see "Fantastic rice yields fact or fallacy?" this

series).

Yuan conducted the first trial of SRI in his Centre's station in Sanya from winter 2000 to spring 2001. Only three varieties yielded above 10t/ha, and SRI gave an average increase of around 10% over the conventional practice. The following year, tests were conducted in the summer at the Centre's station in Changsha. Two varieties yielded 12t/ha, and one 12.9t/ha, a record for the Centre so far. This encouraged more Chinese scientists to conduct SRI research. Of the 8 locations in which his Centre was involved, 5 locations got good results, with yields over 12t/ha.

Since then, trials by a private sector company, the Meishan Seed Company in Sichuan Province, using a modified SRI method, achieved yields of 15.67/ha and 16t/ha in two different plots, both new records in Sichuan Province (yield in the conventional field was 11.8t/ha).

Yuan's preliminary evaluation of SRI is enthusiastic: "SRI is a promising way to increase rice yield and to realize the yield potential of any variety…whether high-yielding variety (HYV) or local variety." He confirmed that the method can promote more vigorous growth of rice plants, especially tillers and roots, and noted in addition, less insect and disease problems during the vegetative growth stage, and that there are definite varietal differences in response to SRI practices: those with strong tillering ability and 'good plant type' are more favourable for SRI cultivation. "SRI gives higher output with less input, but requires very laborious manual work which makes it more suitable for small farms in developing countries" he said. Moreover, SRI should be modified and adapted to suit local conditions, and as experience teaches.

For China, he recommended a long list of modifications, including using tray nurseries to raise the young seedlings instead of flooded seedbeds, so as to reduce the trauma of transplanting; and controlling tiller-formation, for although increased tillering gives many more rice-forming panicles, the percentage of productive tillers falls off with the number of tillers, so there is a optimum maximum number.

He definitely thinks there is scope for combining genetic improvement with SRI methods. For example, breeding plants with a strong ability to form tillers would be appropriate for improving the response to SRI.

Detailed analyses of the trials were presented in several multi-author research papers. For example, the economic benefits of applying SRI methods were estimated for the hybrid rice Liangyoupei 9, which came both from savings and increased yield. The amount of hybrid seed needed in SRI methods was only 3 - 4.5kg, which represented a seed saving of 8.3 - 10.5kg and nursery saving of 90%, thereby reducing the cost by 215 Yuan/ha. As only compost was applied, the saving on the 10-12t/ha fertilizer that would have been used was 1 200Yuan/ha. The saving on water, some 3 000 tonnes, was about 150 Yuan/ha. The total saving with SRI methods thus amounted to about 1 565 Yuan/ha. Add to that a 15% increase in yield (1.5 tonnes/ha) and the farmer gets a total *additional* profit of about 3 000 Yuan/ha (about US$ 360).

The Sichuan Academy of Agricultural Sciences has done SRI trials for three years in succession. Its 2003, trials showed an average SRI yield of 13t/ha. Another series of trials in 7 regions of Zhejian Province using 8 varieties all resulted in increased yield under SRI; the average increase being 1.5t/ha over already high-yielding controls.

The China National Hybrid Rice Research and Development Centre introduced hybrid varieties into Africa and recommended that they be used with SRI methods. In 2003, a 9.2t/ha yield was obtained with hybrid GY032 in Guinea under SRI methods, which was 4 times the national average yield.

SRI in Gambia

The Gambia, a small country (11 700km^2) in West African, is a

50 km-wide ribbon of land extending eastward from the coast, bisected by the River Gambia and surrounded on three sides by Senegal. Its annual rainfall is 900 to 1400mm; the rainy season between late May and early October. Rice is the staple of the country and there are 5 very different production systems: upland, lowland rainfed, irrigated (pump and tidal), freshwater swamps and seasonally saline mangrove swamp.

Annual rice consumption averages 70 to 110kg per capita; domestic production lags behind by 60%, and the balance is met by imports. The national average yield of rice is only 2t/ha.

SRI was introduced to The Gambia in the rainy season of 2000 as part of the Ph. D. thesis of Mustapha M. Ceesay in Crop and Soil Sciences at Cornell University in the United States. Farmers were invited to visit the first SRI trial site at the Sapu station of the National Agricultural Research Institute (NARI) in The Gambia before they enrolled voluntarily in the research programme.

During the first year of experimentation, three different plant population densities were investigated with several varieties. Yields ranged from 5.4 to 8.3t/ha. In 2001, plant population densities were investigated alongside fertilizer treatments, and on-farm trials involving 10 farmer households. The on-station SRI trials were conducted under pump irrigation, and on-farm trials under tidal irrigation.

Plant population densities investigated were 20cm x 20cm, 30cm x 30 cm and 40cm x 40 cm. Two rice varieties were used, and instead of compost, three fertilizer treatment rates were assessed: NKP in the following proportions: 70-30-30 (national recommended), 140-30-30 and 280-30-30. All trials took place in the lowland.

The on-station trials indicated that 30cm x 30cm spacing did not decrease yield over the 20cm x 20cm, and was hence recommended to the farmers for the on-farm trial. Fertilizer treatments indicated that under SRI, the nationally recommended lowest rate was as effective as doubling the rate, while tripling the rate gave higher yields, but it was not economically profitable.

The on-farm trials, conducted in a communal tidal irrigation scheme, gave "exciting" results, "*a tripling of yield*" on average, 7.4t/ha compared with 2.5t/ha obtained with farmers' current practices. Some farmers experienced more than five-fold increases, from 1.6 to 9.0t/ha in one case, and 1.4 to 8.0t/ha in another.

But there are problems facing the farmers in land preparation. Farmers in The Gambia still do not have a well-developed culture of water control. Fields are simply kept flooded after transplanting until the rice plants mature, and fertilizer application and weeding are done under submerged conditions. These practices will conflict with the adoption of SRI, but the yield increases may be a sufficient incentive for farmers to overcome these problems.

SRI in other countries

Many countries reported remarkable increases in yield. Salinda Dissanayake, Member of Parliament in Sri Lanka, personally tested SRI in his own rice field of a little more than 2 acres for four seasons, using seeds of various varieties. He got the highest yield of 17t/ha with BG358, a variety developed by the Sri Lankan rice researchers. Even with local varieties such as Rathhel and Pachdhaiperumal, usually much lower yielding at ~2t/ha, impressive yields of 8t/ha and 13t/ha were obtained.

Dissanayake formed a small group to inform farmers of SRI; and farmers who took up SRI from 18 districts have doubled their yields on average.

"These yields were obtained with less water, less seed, less chemical fertilizer, and less cost of production per kilogram … among SRI users, we find people of many different income and educational levels and different social standing, including many poor farmers having only small plots of land, farmers with moderate income, some agricultural scientists, and a few administrators, businessmen and political leaders who practice it with their own convictions." Dissanayake said.

H. M. Premaratna, a farmer from the Ecological Farming Centre, Mellawalana, Sri Lanka, backed up the enthusiasm of his Member of Parliament, and has personally provided training on SRI to more than 3 000 farmers by 2002. "From my experience, I have observed that the rice plant becomes a healthier plant once the basic SRI practices are adopted," he said.

Reports from 17 countries in 2002 showed that three-quarters of the cases gave a significant yield advantage of at least 20 to 50% increase, and although the super-yields reported from Madagascar have not been obtained elsewhere, some farmers in Cambodia and Sri Lanka have come close. Overall, the conventional systems yielded 3.9t/ha, very close to the world average for rice production. The average for all the SRI yields reported was 6.8t/ha.

A report from the Philippines not only documented yield increases over several successive growing seasons since 1999, but also a reduction of crop pests such as rats and brown and green leafhoppers, carriers of the dreaded rice tungro virus disease. This was attributed to the increased spacing of plants, allowing more sunlight to penetrate even the base of the plant, exposing the hoppers, which detest and avoid sunlight.

In Cambodia, SRI is spreading very rapidly. Only 28 farmers were willing to try SRI in 2000, by 2003, this number had grown to almost 10 000 and in 2004, 50 000 farmers are expected to adopt it.

Perhaps the greatest testament that SRI works is the increasing number of farmers that have adopted the practice.

Sources

Assessment of the System of Rice Intensification (SRI), Proceedings of an International conference held in Sanya, China, April 1-4, 2002, Cornell International Institute for Food, Agriculture and Development http://ciifad.cornell.edu/sri/

Uphoff N. Facts and fallacies regarding "Fantastic yields in the system of rice intensification". *Field Crop Research* (in press).

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Rice wars

Rice, the staple food crop for more than half the world's population, among them the poorest, is the current target of genetic modification, an activity that has greatly intensified after the rice genome was announced two years ago (see "Rice is life" series, SiS 15, Summer 2002). Since then, all major biotech giants are investing in rice research.

At the same time, a low-input cultivation system that really benefits small farmers worldwide has been spreading, but is dismissed by the scientific establishment as "unscientific". This is one among several recent innovations that increase yields and ward off disease without costly and harmful inputs, all enthusiastically and widely adopted by farmers.

A war is building up between the corporate establishment and the peoples of the world for the possession of rice. The food security of billions is at stake, as is their right to grow the varieties of rice they have created and continue to create, and in the manner they choose.

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ISIS Report 08/07/04

Corporate Patents *vs* People in GM Rice

Dr. Mae-Wan Ho and Lim Li Ching get to the bottom of current attempts by corporations to usurp rice varieties through genetic modification

Has the International Treaty sufficient bite to protect Farmer's Rights?

In 1998, masses of angry Indian and Thai farmers took to the streets of their capitals to denounce US company RiceTec Inc's claim of monopoly rights over their basmati and jasmine varieties of rice. US breeders had acquired samples from Philippines-based IRRI (International Rice Research Institute), which holds a large seed bank of Asian farmers' varieties. That was among the first warnings of a corporate agenda to usurp and control rice varieties created and used by local communities for thousands of years.

The International Treaty on Plant Genetic Resources for Food and Agriculture, which came into force on 29 June 2004, facilitates "the free flow of genetic material to plant breeders" as well as to farmers and research institutions. This is achieved through a Multilateral System for Access and Benefit Sharing, which covers a list of 35 food crops and 29 forage crops, among them rice.

The Treaty clearly acknowledges the contribution of farmers to

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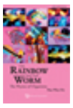
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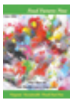
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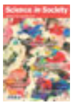
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agricultural biodiversity and recognises Farmers' Rights to save, use, exchange and sell seeds. This is an important milestone in international law. However, it falls short of unambiguously banning patents on plant genetic resources, leaving farmers' varieties in international Gene Banks under the CGIAR (Consultative Group on International Agricultural Research), which come under the Treaty, just as vulnerable as before [1]. The text clearly states that no intellectual property rights (IPRs) may be taken out on the plant genetic resources and their components that are exchanged and as covered in the Treaty; but this is qualified by limiting the condition to resources "in the form received".

In short, this could leave the door open for unscrupulous patenting of plant genetic resources that are not "in the form received", for example, if, after they have been freely exchanged within the Multilateral System, they are genetically modified.

As the Treaty has just entered into force, its continuing interpretation and how it is implemented will need to be monitored closely, to prevent powerful countries (and their corporations) getting rights to extract and privatise genetic resources covered by the Treaty [2]. It is also crucial to strengthen the primacy of Farmers' Rights over IPRs.

Gene-patenting and corporate rice research

This fight will be critical as biotech companies are increasingly muscling in on rice research. "The advent of biotechnology has caused a spurt in patents on gene products associated with rice," said Ronald Cantrell, director of IRRI [3]. The sequencing of the rice genome has not only opened up largely untapped commercial possibilities but has also set the pace for potential IPR disputes between corporations and governments. "I'm really concerned that we should have enough public sector research that would generate knowledge, putting it in the public arena, and we should make sure that the private sector is properly regulated," he added.

The Syngenta Foundation for Sustainable Agriculture, despite its honourable name is part of the biotech multinational Syngenta, and is now a member of the CGIAR. In one fell swoop, the private sector has become part of *the* network of international agricultural research centres, paving the way for it to participate in policy making and determining the kind of research that gets funded. This, critics say, turns the once publicly funded research body into "an agricultural research outsource for the multinational corporations" [4]. Although the Syngenta Foundation doesn't currently contribute to IRRI, there's no doubting the interest of the corporation in rice research.

An article published in the *New Internationalist* in September 2002 commented [5]: "The multinational biotechnology industry has global rice production in its gunsights. It is manoeuvring for control through intellectual property rights (IPRs), such as patents, and legislation is quickly being pushed into place in Asia and around the world to satisfy industry's demands."

GM rice versus people's sustainable agriculture

All this is coming at a sensitive time, as farmer-led movements for sustainable agriculture are also in ascendancy. For example, MASIPAG, the farmer-scientist network, is a farmer-led community-managed breeding and conservation effort on rice and vegetables throughout the Philippines. It started in 1986 and now involves 50 trial farms. Some 543 farmer-bred lines and 75 varieties of rice are grown and further improved by well over 10 000 farmers throughout the country. The Nayakrishi or 'New Agriculture' Movement in Bangladesh, where farmers typically use hundreds of varieties of rice, and have little trouble surpassing the productivity of the industrial model.

Asia produces over 90 percent of world's rice supply, and an estimated 140 000 different varieties of rice have been created by small farmers in Asia.

In the 1950s, the US put rice production at the centre of a strategy to address food insecurity and political unrest. The resulting campaign led by the Rockefeller and Ford Foundations, known as the Green Revolution, transformed rice production dramatically. Traditional farming systems and varieties were replaced by a package of credit, chemicals and high input varieties. By the early 1990s, just five super-varieties accounted for 90 per cent of the rice-growing area of Malaysia and Pakistan, and nearly half the rice lands of Thailand and Burma.

Several major transnational seed corporations – Aventis, Dupont, Monsanto, Syngenta – now have rice programmes. Rice is self-pollinated, making hybrid rice seed production costly and difficult, and nearly all rice in Asia is still grown with farmer-saved seed. The seed industry believes that the combination of genetic engineering and patents can overcome this hurdle.

"Through patents and contractual agreements, seed companies will seek to prohibit farmers from sharing or saving seed, control what pesticides are used and even assert ownership rights over the harvest."

In October 2001, an ActionAid study found that of the 250 patents on rice, 61 percent are controlled by just 6 seed companies, three of them also the world's largest pesticide corporations.

After the rice genome sequence was announced. Dr. Steven Briggs, head of genomics for Syngenta, told the *New York Times* that while the companies would not seek to patent the entire genome, they would patent individual valuable genes. He indicated that Syngenta and Myriad were well on their way to finding many of those.

China a major player

Meanwhile, the Chinese government, which has invested considerable public money into the sequencing of the rice genome, thereby breaking the 'knowledge monopoly' hitherto held by the developed countries in the West [6], is reported to be ramping up efforts to commercialise GM rice [7].

Chinese researchers have developed several GM rice varieties resistant to the country's major rice pests and diseases, such as the lepidopteran insect stem borer, bacteria blight, rice blast fungus and rice dwarf virus (see "Promises and perils of GM rice", this series). "Significant progress" was also reported for drought- and salt-tolerance. Zhen Zhu, a leading rice scientist and deputy director of the Bureau of Life Science and Biotechnology of the Chinese Academy of Sciences, told *Nature Biotechnology* that "China [is] technically mature [enough] to commercialise several varieties of its GM rice".

China's biotech budget for 2001-2005 is $1.2 billion, a 400% increase compared with 1996-2000, and about $120 million out of the current budget is devoted to GM rice programmes, Zhu estimates, and more will be allocated to field trials of GM rice. At least 10 new field trials for GM rice are expected this year, keeping the planting level comparable to 2003 of at least 53 hectares.

In the United States, USDA authorized 10 GM rice field trials over 11 hectares in 2003 and 12 trials over 45 hectares in the first quarter of 2004, 90% of which done by Monsanto.

China will be closely watched by both the developed and the developing world. China's activities in GM rice have gone on simultaneously with extensive trials in sustainable, low input rice-growing systems that benefit small farmers (see "Fantastic rice yields fact or fallacy" and "Does SRI work?" this series).

Huanming Yang, Director of the Beijing Genomics Institute in China, the lead author of a paper on the rice genome sequence published side by side with Syngenta's in the journal *Science* two years ago [6], told ISIS recently that he is "strongly opposed" to patenting the rice genome.

"As one of the important sequencing centres [of the rice genome], we think it should be covered by Bermuda Rules and should [be] made freely available. That is the reason that we have released the rice genome sequences," Yang said.

The 'Bermuda Rules' refers to guidelines for releasing human sequence data established in February 1996 at a Bermuda meeting of heads of the biggest labs in the publicly funded human genome project [8]. The rules require the labs to share the results of sequencing "as soon as possible", releasing all stretches of DNA longer than 1 000 units, and to submit the data within 24 hours to the public database known as GenBank. The goal, as stated in a memo released at the time, was to prevent the sequencing centres from "establishing a privileged position in the exploitation and control of human sequence information."

References

1. Ho MW. Science for the poor, or procurer for the rich? *Science in Society* 2002, 15, 8.

2. "International Seed Treaty comes into force today but will it undermine farmers efforts to conserve diversity? UK Agricultural Biodiversity Coalition, 29 June 2004, http://www.ukabc.org/itpgrfa29june2004.htm

3. "Patents worry in rice research", *Agence France Press / New Straits Times Malaysia,* 8 December 2003, http://www.mmail.com.my/Current_News/NST/Monday/World/

4. "CGIAR turns to outsourcing", by Devinder Sharma, via GM Watch List, 26 April 2004.

5. Kyuyek D. Rice is life. *New Internationalist* 2002, 349 http://www.newint.org/issue349/rice.htm

http://www.cgiar.org/members/index.html

6. Ho MW. Breaching the knowledge monopoly. *Science in Society* 2002, 15, 6-19.

7. "China ramps up efforts to commercialise GM rice" by Hepeng Jia, KS Jayaraman and Sabine Louët, *Nature Biotechnology* News 2004, 22, 642.

8. "Bermuda Rules: community spirit, with teeth" by Flint Marshall, *Science* 2001, 291, 1192.

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Rice wars

Rice, the staple food crop for more than half the world's population, among them the poorest, is the current target of genetic modification, an activity that has greatly intensified after the rice genome was announced two years ago (see "Rice is life" series, SiS 15, Summer 2002). Since then, all major biotech giants are investing in rice research.

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ISIS Report 09/07/04

Promises & Perils of GM Rice

Rice, the food crop for half the world's population is the current target of genetic modification. What are the health and environmental consequences? Prof. Joe Cummins reviews

Rice a target for corporate control?

Rice is the primary food for half the people in the world, providing more calories than any other single food. It supplies an average of 889 calories per day per person in China, as opposed to only 82 calories in the United States. Rice is a nutritious food, providing about 90 percent of calories from carbohydrates and as much as 13 percent of calories from protein [1]. Such a crop of immense global importance is a certain target for control by multinational corporations, especially since the rice genome was announced two years ago (see "Rice is life" series, *SiS* 15, 2002).

Only one GM rice trait – tolerance to the herbicide glufosinate - is currently available on the market [2]. The rice varieties under development include resistance to insects, microbial pests and tolerance to high salt levels. Pharmaceutical products and multiple transgenic traits are being pyramided into a single strain of rice. It is likely that the next GM rice to be approved for commercial release will contain an insect toxin gene from the bacterium, *Bacillus thuringiensis* (Bt), but that will be followed by a range of modifications, including insect resistance based on lectins and protease inhibitors. Because rice has a huge impact on the world's food supply, we should at least make sure it is

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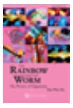
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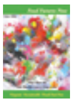
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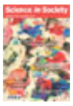
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Herbicide tolerance and insect resistance

Two glufosinate-tolerant GM rice events, LLRICE06 and LLRICE62, have been approved for commercial production. They have been inserted into the rice varieties M202 and Bengal, consisting of the *bar* gene encoding the phosphoinothricin-N-acetyltransferase (PAT) enzyme - a highly altered copy of a gene from the soil bacterium *S. hygroscopicus* genes for herbicide tolerance – driven by the CaMV 35S promoter and the CaMV transcription terminator.

Safety testing of the *bar* gene and PAT enzyme was done using the bacterial gene and protein, not the synthetic gene and its product in the rice crop. Despite this obvious flaw, the United States Department of Agriculture determined that the GM rice strains were suitable for commercial release, and these are marketed by Bayer as Liberty Link rice [2]. In 2002, Aventis (later purchased by Bayer) destroyed 5 million pounds of Liberty Link rice because they feared rejection by the international market [3], but efforts are continuing to promote and disseminate the transgenic crop. Bayer is currently seeking approval for the import of LLRICE62 for food, feed and industrial uses into Europe.

Synthetic analogues of the Bt *Cry* toxin genes have been used extensively to construct experimental rice varieties. *Indica* Basmati rice was transformed by a synthetic *Cry1Ab* gene driven by the constitutive rice ubiquitin promoter, or a *Brassica* seed-specific promoter, and terminated with the CaMV 35S terminator or *nos* terminator. These transgenic rice plants contained up to 0.15% of their total protein as synthetic toxin. Such high levels of toxin are preferred because it discourages insect resistance, but it also means that the synthetic toxin protein makes a significant contribution to people’s diet and to the rice straw fed to animals [4].

Rice lines containing *Cry1Ab* and *Cry1Ab/Cry1Ac* fusion protein genes were reported to have no effect on the fitness of non-target insects. These transgenes were used with different promoters in different rice strains: CaMV 35S, rice actin, rice ubiquitin and a maize pith-specific promoter (specifically works in the pith of the stem, to target stem borer insects) [5]. A comparison of *Indica* rice bearing constitutive and pith-specific promoters and the Cry1Ab toxin showed that the pith-specific promoter provided protection from stem borer insects while reportedly producing reduced levels of Cry toxin protein in seeds [6].

Rice with *Cry1Ab* toxin gene driven by a maize ubiquitin promoter and resistance genes for the antibiotics hygromycin and neomycin was resistant to rice leafhopper insects [7]. However, elite *Indica* rice with a synthetic *Cry1Ac* toxin gene in the same construct, although resistant to the yellow stem borer insect, had high toxin levels in all of the plant tissues [8]. European rice cultivars were transformed with synthetic *Cry1Aa* or synthetic *Cry1B* toxin genes under a constitutive ubiquitin promoter, or synthetic *Cry1B* gene under a wound inducible maize promoter (responding to stresses such as insect predation). The constitutive promoter-driven toxin genes produced high toxin levels that prevented striped stem borer predation but left toxin in all the rice tissues and seeds, while the wound inducible strain produced toxin mainly at the site of insect attack [9].

Research has established that Bt toxin was introduced into soil by root exudates of transgenic rice. The toxin released into the soil affected the enzymes of soil microbes, increasing soil acid phosphatase and decreasing soil urease [10].

The benefit of insect protection from Bt rice is offset by the potential harmful effects of high levels of toxin protein in the rice grain. As rice is such an important food crop, the safety of Bt rice must be concretely established. It has been found that food irradiation improved the "quality" of GM rice modified with the Cry1Ab toxin, by selectively removing the toxin protein [11]. However, study of the radiation products and adducts created during destruction of the toxin is essential. Furthermore, it is clear that food irradiation may be used to disguise GM rice.

A number of projects have studied the use of snowdrop lectin, *Galanthus nivalis* agglutinin (GNA) alone or in conjunction with other genes to control rice pests. Lectins are proteins that interact with human blood cells (agglutinin) and also act as anti-predator chemicals in plants or microbes. A *GNA* gene was driven by a phloem specific promoter accompanied by a hygromycin antibiotic resistance gene and was used to transform japonica rice strains. The modified rice controlled sap-sucking insects that spread rice viruses [12]. However, Ewen and Pusztai [13] showed that potatoes modified with GNA affected different parts of the rat digestive system. Similar research on the *in vivo* effects of rice genetically engineered with GNA has not been reported.

Rice plants containing both the *GNA* gene and the unlinked *Cry1Ac* gene were reported to be resistant to the major rice insect pests, striped stem borer and brown leaf hopper (rice with only Cry1Ac resisted striped stem borer while rice with GNA resisted brown leaf hopper) [14]. Rice transformed with a single vector containing *Cry1Ab* driven by the maize ubiquitin promoter, along with *GNA* driven by sucrose synthetase promoter and the *bar* gene for herbicide tolerance driven by the CaMV promoter was intended to be resistant to yellow stem borer and three sap sucking insects, along with the herbicide glufosinate. This huge package of genes was integrated at a single chromosomal site [15]. No account has been taken of the interaction of the various toxins in the human food supply and in the environment.

Basmati rice was co-transformed with three plasmids carrying four genes including *GNA*, synthetic *Cry1Ac*, synthetic *Cry2A* and resistance to the antibiotic hygromycin. The promoters used in these constructions included maize ubiquitin and CaMV 35S while the transcription terminators were nos [16]. As in the previous construction, care must be taken to evaluate the toxicity of the toxin products and their interaction in the human diet and in the environment.

Elite Chinese rice cultivars were transformed with a gene for bacterial blight and a *GNA* gene, along with a hygromycin antibiotic resistance gene in constructions employing promoters, including rice sucrose synthetase promoter, maize ubiquitin promoter and the CaMV promoter. Transcription was terminated using the *nos* terminator in every case. The transformed rice was resistant to sap sucking insects and to bacterial blight [17].

Insect and bacterial disease resistant lines have been pyramided (pyramiding is combining transgenes by genetic crosses). A strain with a fused *Cry1Ab/Cry1Ac* gene was combined with a gene derived from a wild rice for resistance to bacterial blight, in a male sterile restorer line of rice. The pyramided line was resistant to bacterial blight and to stem borer insects [18]. In the pyramided lines, regulators must consider and evaluate the toxicity of each transgenic toxin and the combination of toxins brought about by crossing.

Resistance to the rice stem borer was produced using a synthetic trypsin inhibitor that interferes with insect food digestion. The synthetic gene was roughly based on a winged bean chymotrypsin inhibitor. The genetic construction included the CaMV promoter and was enhanced with an omega sequence from tobacco mosaic virus and the first intron of a gene for phaseolin [19]. A synthetic copy of a gene product that interferes with digestion surely requires extensive safety testing!

Salt tolerance & enhancement of biomass

Increasing the transcription level of a rice sodium antiporter (a pump that moves sodium ion into a vacuole) gene, called *OsNHX1*, is reported to improve the salt tolerance of rice [20], with the potential of opening large tracks of land to rice cultivation. Over expression of barley aquaporin gene in rice led to increased carbon dioxide conductance and assimilation [21]. Such modifications are potentially able to enhance biomass production in rice.

Nutritional enhancement

Rice has also been the target of genetic modifications that nutritionally enrich food crops. 'Golden Rice' genetically engineered to produce pro-vitamin A has been discussed extensively elsewhere [22]. Although much touted as a cure for vitamin A deficiency in developing countries, it has yet to be commercialized and its effectiveness in addressing vitamin A deficiency has been called into question.

Pharm rice

Production of pharmaceutical proteins in rice crops poses potent threats to the food supply. Recent efforts to test and produce rice modified to produce the human gene products lactoferrin and lysozyme have been temporarily thwarted [23]. However, rice producing human growth hormone has been developed despite the likelihood that the GM rice could cause cancer in those consuming it [24]. Rice is not a suitable cross for producing pharmaceutical products because of the high likelihood that the products will pollute the food supply.

Environmental impacts

The genetic modifications being used or promoted for rice pose a significant threat to the environment if they contaminate conventional rice fields or spread transgenes to weedy relatives such as red rice. Pollen mediated gene flow was substantial from Mediterranean GM rice bearing a gene for herbicide tolerance to conventional rice and to the weed, red rice [25]. Gene flow from herbicide tolerant to cultivated rice was also substantial in another study of Mediterranean rice [26]. Rice pollen was spread from a test plot up to 110 meters from the boundary of the test plot [27]. It is very clear that transgenic rice will pollute any nearby conventional rice.

Health impacts

GM rice may soon be approved for commercial production in a number of countries. Safety testing of the currently described products has not yet been published. GM rice cannot be presumed to be substantially equivalent to conventional rice, but that may not hamper approval in the United States of many such constructions. For the most part, GM rice is formed from synthetic genes that should require much fuller safety testing than has been done in the past.

In North America, regulators have allowed substitution of genes and proteins produced in bacterial surrogates for the actual genes and proteins produced in crop plants in toxicity tests of human and environmental safety. The use of the bacterial surrogates is allowed, to save corporations the cost of preparing genes and proteins from the crop plants, even though the genes and proteins tested differ significantly from the genes and proteins produced in the crop plants [28]. The public should insist that the actual genes and proteins produced in the crops be tested.

The world's leading food crop should be treated with more care than has been done with maize, soy and canola.

References

1. Encarta Encyclopedia Article Rice 2004, 9pp, http://encarta.msn.com/encyclopedia_761569224/Rice.html
2. USDA/APHIS AgEvo USA Company Petition 98-329-01p, 1998, 25pp, http://www.aphis.usda.gov/brs/de_reg.htm
3. Jack A. GE Rice Update: Organic rice surges while GE rice falters, 2002, 5pp http://www.amberwaves.org/web_articles/gericeupdate.html
4. Husnain T, Asad J, Maqbool S, Datta S and Riazuddin S. Variability in expression of insecticidal Cry1Ab gene in Indica Basmati rice *Euphytica* 2002, 128, 121–8.
5. Bernal C, Aguda R and Cohen M. Effect of rice lines transformed with *Bacillus thuringiensis* toxin genes on the brown planthopper and its predator *Cyrtorhinus lividipennis, Entomologia Experimentalis et Applicata* 2002, 102, 21–8.
6. Datta K, Vasquez A, Tu J, Torrizo L, Alam M, Oliva N, Abrigo E, Khush G and Datta S. Constitutive and tissue-

specific differential expression of the cryIA(b)gene in transgenic rice plants conferring resistance to rice insect pest *Theor. Appl. Genet*. 1998, 97, 20-30.

7. Ye G, Yao H, Shu Q, Cheng X, Hu C, Xia Y, Gao M and Altosaar I. High levels of stable resistance in transgenic rice with a cry1Ab gene from *Bacillus thuringiensis* Berliner to rice leaffolder, *Cnaphalocrocis medinalis* (Guenée) under field conditions *Crop Protection* 2003, 22, 171–8.
8. Khanna H and Raina S. Elite Indica transgenic rice plants expressing modified Cry1Ac endotoxin of *Bacillus thuringiensis* show enhanced resistance to yellow stem borer (*Scirpophaga incertulas*) *Transgenic Research* 2002, 11, 411–423.
9. Breitler J, Vassal J, del Mar Catala M, Meynard D, Marfà V, Melé E, Royer M, Murillo I, San Segundo B, Guiderdoni E and Messeguer J. Bt rice harbouring cry genes controlled by a constitutive or wound-inducible promoter: protection and transgene expression under Mediterranean field conditions *Plant Biotechnology Journal* 2004, 2, in press, 14pp.
10. Sun C, Chen L, Wu Z, Zhang Y and Zhang L. Effect of transgenic Bt rice planting on soil enzyme activities [Article in Chinese] *Ying Yong Sheng Tai Xue Bao* 2003, 14, 2261-4.
11. Wu D, Ye Q, Wang Z and Xia Y. Effect of gamma irradiation on nutritionalcomponents and Cry1Ab protein in the transgenic rice with a synthetic cry1Ab gene from *Bacillus thuringiensis, Radiation Physics and Chemistry* 2004, 69, 79–83.
12. Wu A, Sun X, Pang Y and Tang K. Homozygous transgenic rice lines expressing GNA with enhanced resistance to the rice sap-sucking pest *Laodelphax striatellus, Plant Breeding* 2002, 121, 93-5.
13. Ewen S and Pusztai A. Effect of diets containing genetically modified potatoes expressing *Galanthus nivalis* lectin on rat small intestine *The Lancet* 1999, 354, 1353-4.
14. Loc N, Tinjuangjun P, Gatehouse A, Christou P, Gatehouse J. Linear transgene constructs lacking vector backbone sequences generate transgenic rice plants which accumulate higher levels of proteins conferring insect resistance *Molecular Breeding* 2002, 9, 231-44.
15. Ramesh S, Nagadhara D, Reddy V and Rao K. Production of transgenic indica rice resistant to yellow stem borer and sap-sucking insects, using super-binary vectors of *Agrobacterium tumefaciens*, *Plant Science* 2004, 166, 1077–85.
16. Maqbool S and Christou P. Multiple traits of agronomic importance in transgenic indica rice plants: analysis of transgene integration patterns, expression levels and stability *Molecular Breeding* 1999, 5, 471–80.
17. Tang K, Tinjuangjun P, Xu Y, Sun X, Gatehouse J, Ronald P, Qi H, Lu X, Christou P and Kohli A. Particle-bombardment-mediated co-transformation of elite Chinese rice cultivars with genes conferring resistance to bacterial blight and sap-sucking insect pests *Planta* 1999, 208, 552-63.
18. Jiang G, Xu C, Tu J, Li X, He Y and Zhang Q. Pyramiding of insect- and disease-resistance genes into an elite indica, cytoplasm male sterile restorer line of rice, 'Minghui 63' *Plant Breeding* 2004, 123, 112-6.
19. Mochizuki A, Nishizawa Y, Onodera H, Tabei Y, Toki S, Habu Y, Ugak M and Ohashi Y. Transgenic rice plants expressing a trypsin inhibitor are resistant against rice stem borers, *Chilo suppressalis, Entomologia Experimentalis et Applicata* 1999, 93, 173–8.
20. Fukuda A, Nakamur A, Tagiri A, Tanaka H, Miyao A, Hirochika H and Tanaka Y. Function, Intracellular Localization and the Importance in Salt Tolerance of a Vacuolar Na+/H+ Antiporter from Rice *Plant and Cell Physiology*, 2004, 45, 146-59/
21. Hanba Y, Shibasaka M, Hayashi Y, Hayakawa T, Kasamo K, Terashima I and Katsuhara M. Overexpression of the Barley Aquaporin HvPIP2;1 Increases Internal CO2 Conductance and CO2 Assimilation in the Leaves of Transgenic Rice Plants *Plant Cell Physiol*. 2004, 45, 521–9.
22. Ho MW. 2002. 'Golden Rice' – An exercise in how not to do science. TWN Biotechnology & Biosafety Series 6, Third World Network, Penang.
23. Cummins J. Pharm Crop Stalled for Now *Science in Society 2004, 22*, 28-9.

24. Cummins J. Cancer Promoting Transgenic *Science in Society* 2003, 22, 31.
25. Messeguer J, Marfà V,Català M, Guiderdoni E and Melé E. A field study of pollen-mediated gene flow from Mediterranean GM rice to conventional rice and the red rice weed *Molecular Breeding* 2004, 13, 103–12.
26. Messeguer J, Fogher C, Guiderdoni E, Marfà V, Català M, Baldi G and Melé E. Field assessments of gene flow from transgenic to cultivated rice (*Oryza sativa* L.) using a herbicide resistance gene as tracer marker *Theor. Appl. Genet.* 2001, 103, 1151–9.
27. Song Z, Lu B and Che J. Pollen flow of cultivated rice measured under experimental conditions *Biodiversity and Conservation* 2004, 13, 579–90.
28. Cummins J. Bt toxins in genetically modified crops: Regulation by deceit *Science in Society* 2004, 22, 31-2.

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Rice wars

Rice, the staple food crop for more than half the world's population, among them the poorest, is the current target of genetic modification, an activity that has greatly intensified after the rice genome was announced two years ago (see "Rice is life" series, SiS 15, Summer 2002). Since then, all major biotech giants are investing in rice research.

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A war is building up between the corporate establishment and the peoples of the world for the possession of rice. The food security of billions is at stake, as is their right to grow the varieties of rice they have created and continue to create, and in the manner they choose.

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- One Bird - Ten Thousand Treasures
- New Rice For Africa

ISIS Report 12/07/04

Two Rice Better than One

Lim Li Ching reports on remarkable results from a simple experiment in China that combats rice disease and increases yields

Planting a diversity of crops instead of monocultures can do wonders. Thousands of Chinese rice farmers have increased yields and nearly eliminated the most devastating disease - rice blast fungus - without using chemical fungicides or spending more money.

These farmers and extension workers in Yunnan Province collaborated with a team of scientists from Yunnan Agricultural University, the Plant Protection Stations of Honghe Prefecture, Jianshui County and Shiping County in Yunnan Province, the International Rice Research Institute and Oregon State University in the United States to implement a simple change in cultivation practice in order to control rice blast, a disease that destroys millions of tonnes of rice and costs farmers several billion dollars in losses each year.

The area is prone to rice blast epidemics because of its cool, wet climate. The fungus that causes blast disease, *Magnaporthe grisea*, spreads through multiple cycles of asexual spore production during the cropping season, causing necrotic spots on leaves and necrosis (death) of the rice panicles.

Instead of planting large stands of a single type of rice, as had been their usual practice, the farmers planted a mixture of two

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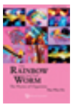

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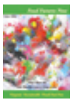

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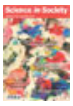

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different kinds of rice: a standard hybrid rice that does not usually succumb to rice blast, and a much more valuable but lower-yielding glutinous or 'sticky' rice known to be very susceptible to the disease. Before 1998, 98% of rice fields in the area were monocultures of the hybrid rice varieties Shanyuo22 and Shanyuo63. The glutinous varieties, although highly valued, were planted in small amounts due to their low yields and vulnerability to rice blast.

The experiment with mixed varieties dispersed single rows of glutinous rice between groups of four rows of hybrid rice, but at a rate sufficient to meet the local demand for glutinous rice. As rice is hand-harvested in Yunnan, farmers can easily separate the hybrid and glutinous grains, which are used for different purposes.

In 1998, the first year of the trial, four different mixtures of varieties were planted over 812 hectares, comprising all the rice fields in five townships of Shiping County, Yunnan Province. The mixtures gave excellent blast control, such that only one foliar fungicide spray was applied. The study expanded to 3 342 hectares in 1999, encompassing all the rice fields in 10 townships of Jianshui and Shiping Counties. No fungicidal spray was needed that year. Farmers were so convinced of the benefits of the rice diversification program that the practice expanded to more than 40 000 hectares in 2000.

The mixed rice fields were compared with control monoculture plots. The overall results showed that disease-susceptible rice varieties planted in mixtures with resistant varieties had 89% greater yield and blast was 94% less severe than when they were grown in monoculture. Both glutinous and hybrid rice showed decreased infection.

Specifically, in 1998, panicle blast severity on the glutinous rice averaged 20% in monocultures, but was reduced to 1% when dispersed within the mixed populations. Meanwhile, panicle blast severity on the hybrid varieties averaged 1.2% in monocultures, but was reduced to varying degrees in the mixed plots. Results from 1999 were very similar to the 1998 season for panicle blast severity on susceptible glutinous varieties, showing that the effect of mixed planting was very robust. Panicle blast severity on the less-susceptible hybrid varieties averaged 2.3% in monoculture in 1999, and was reduced to 1.0% in mixed plantings. This despite the fact that the hybrids were planted at the same density in mixed and monoculture plots.

The hypothesis for the reduced severity of blast attack is fairly clear for the disease-susceptible glutinous rice. If one variety of a crop is susceptible to a disease, the more concentrated those susceptible types, the more easily the disease will spread. The disease is less likely to spread if susceptible plants are separated by other plants that do not succumb to the disease and the distance between the susceptible plants increased (a dilution effect). In addition, the glutinous rice plants, which are taller and rise above the shorter hybrid rice, enjoyed sunnier, warmer and drier conditions that discouraged the growth of rice blast.

Disease reduction in the hybrid variety is more difficult to explain, but is possibly due to the taller glutinous rice physically blocking the airborne spores of rice blast and/or altering wind patterns. It is also likely that there was greater 'induced resistance' playing a part in disease suppression. Induced resistance occurs when non-virulent pathogens induce a plant defence response that is effective against other pathogens that would normally be virulent on the plant. Indeed, preliminary analysis of the genetic composition of pathogenic populations indicated that mixed fields supported diverse pathogen populations with no single dominant strain. By contrast, pathogen populations in monocultures were dominated by one or a few strains. Hence, the more diverse pathogen population of the mixed stands may have contributed to greater induced resistance in the plants, and in the longer term this increased pathogen diversity may also slow down the adaptation of pathogens to the resistant genes functioning within a given mixed plant population.

Grain production per hill of glutinous varieties in mixtures averaged 89% more than when planted in monoculture. As a result, although glutinous rice in mixtures was planted at rates of only 9.2 and 9.7% that of monoculture in 1998 and 1999, respectively, it produced an average 18.2% of monoculture yield. The higher yields are certainly due to the reduced severity of rice blast fungus, though other factors (for example, improved light interception) may also have contributed. Hybrids planted in mixtures, despite facing an increased overall plant density, experienced grain yields per hectare that were nearly equal to the hybrid monocultures. Thus, mixed populations produced more total grain per hectare than their corresponding monocultures in all cases.

The mixed varieties of rice were also more ecologically efficient. It was estimated that an average of 1.18 hectares of monoculture cropland would be needed to provide the same amounts of hybrid and glutinous rice as were produced in one hectare of a mixture. Additionally, after accounting for the different market values of the two rice types, the gross value per hectare of the mixtures was 14% greater than hybrid monocultures and 40% greater than glutinous monocultures.

The scientists concluded that intra-specific crop diversification is a simple, ecological approach to disease control, which can be extremely effective over a large area and can contribute to sustainable crop production.

Sources

Zhu Y, Chen H, Fan J, Wang Y, Li Y, Chen J, Fan JX, Yang S, Hu S, Leung H, Mew TW, Teng PS, Wang Z and Mundt CC. Genetic diversity and disease control in rice. *Nature* 2000, 406, 718-722.

"Simple method found to vastly increase crop yields", by Carol Kaesuk Yoon, *New York Times*, 22 August 2000.

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ISIS Report 14/07/04

One Bird - Ten Thousand Treasures

Dr. Mae-Wan Ho *reports on how ducklings in the paddy fields turned weeds to resources and increases yield and leisure for farmers*

During the last leg of a six-day lecture tour in Japan 1999, I was fortunate enough to have visited an organic farmer not far from Fukuoka, who was reputed to have done wonders introducing ducks into the rice paddy field.

The train ride from Tokyo lasted five and a half hours, speeding through a most unusual landscape, which repeats itself in endless variations for the entire duration. It consists of large and small clusters of houses and the occasional single abode, all floating, it seems, on a sea of paddy-fields. Paddy fields fill every available inch of land that is not built upon, and most of the plots are tiny. That was a real surprise for me, who, like most people, imagine Japan to be a fully industrialized developed nation.

Our hosts from the Green Co-op in Fukuoka met us at the station, and after the usual polite exchange of bows, we were taken to another platform for the local train to Keisen, where the famous organic farmer Mr. Takao Furuno had kindly invited all three of us: Tony Boys, my interpreter for the occasion and Mr. Watanabe, a fellow speaker, to stay the night with his family.

It was getting dark by the time we arrived in Keisen. Tony

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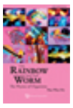

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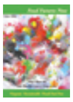

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telephoned from a booth outside the station, and some minutes later, Mr. Furuno himself came to pick us up in his mini-van. We drove a short distance and stopped in front of a largish but modestly built and modestly furnished bungalow. Mrs. Furuno opened the door and gave us a warm traditional Japanese welcome. We were invited to sit down around the dinner table where all the children came to greet us. Five healthy, suntanned and smiling children, two boys and three girls between the ages of 16 and 8, introduced themselves, then retreated next-door to the kitchen where they were served supper. Grandma and Grandpa were busy with food preparation, and appeared only later to say hello.

The Furunos were a handsome couple in their forties. He, wiry and dark, with a winsome squint and sparkle to his eyes, had the appearance of being both amused and content with life, as he had every reason to be. He spoke in an even, unhurried manner, with a gentle tone. She was of medium build, lively, good-looking and more openly ebullient about their success. Of course, they did not mean *financial* success, they meant success of the farming method, which, since its introduction ten years ago, has been spreading all over Southeast Asia. In Japan, about 10 000 farmers had taken it up by 1999; and has also been adopted by farmers in South Korea, Vietnam, The Philippines, Laos, Cambodia, Thailand and Malaysia. Farmers have increased their yield 20 to 50 percent or more in the first year. One farmer in Laos increased his income three-fold. It is obviously a boon to Third World farmers.

"We want to help", the Furunos declared, "financial success is unimportant. We did not patent the method, we just want it to be widely adopted." The method has been researched and perfected over the years in their own fields. At this point, Mr. Furuno introduced a young visitor who was working with the family in order to learn the method. "There's always someone here who wants to learn, and everyday, I get several phone calls from people needing advice." He said as a matter of fact, without either false modesty or pride.

The young man's eyes widened when he learned that I was the niece of Kyu Ei Kan's wife. Kyu Ei Kan is a writer most renowned for his books on how to make money. And to demonstrate that what he writes is sound, he proceeded to make a lot of money himself. The excited young man pushed the book he was reading in front of me. It had my uncle's photograph on the cover, and the title, *How I Became Rich- An Autobiography*. Mr. Furuno must really be a great success if a young man who dreams of becoming rich should be so eager to learn from him. I made a mental note to tell my aunt, and maybe persuade my rich uncle to go into organic farming business.

"Well, it has been called a 'one-bird revolution'", my host began, "the duck is the key to success." The secret is to release *ducklings* into the paddy fields soon after the seedlings are planted. But won't the ducklings eat the rice seedlings? No. "It is in their nature not to eat the rice seedlings." Mr. Furuno assured me, then added, "agronomists in the university say it's because rice seedlings have too much silica."

They have made a very good video, complete with English narration, which shows how the ducklings readily take to the paddy field when they are led there to be released. About 20 ducklings are released per tenth of a hectare. They genuinely seem to enjoy getting into the water, where they paddled contentedly between the rows of rice seedlings, now ducking under the surface of the water, now raising their heads to swallow something, but never harming the rice seedlings. In fact, the ducks are good for the rice plants in many ways, including the mechanical stimulation they provide, which make the plant stems thicker and stronger, as demonstrated by careful experimentation.

Mr. Furuno did attend agricultural college, but he did not learn the Aigamo method there. Aigamo is the name for the ducks, which is a crossbreed between domestic and wild ducks. He simply worked out the method by a combination of "contemplation, inspiration and experimentation". Actually, ducks have been raised in paddy fields in China and probably other parts of South East Asia since a long time ago. But the farmers never left the ducks in the fields, and were unaware of all the benefits that the ducks can bring.

The benefits the ducks give to the rice plants are numerous; again, that was worked out by Mr. Furuno's scientific experiments carefully set up in the field. The ducks eat up insect pests and the golden snail, which attack rice plants, they also eat the seeds and seedlings of weeds, using their feet to dig up the weed seedlings, thereby oxygenating the water and encouraging the roots of the rice plants to grow. You can actually see the difference between the plants in the Aigamo plots and the control plots without Aigamo.

In fact, the ducks are so good at weeding that farmers who have adopted the method now have time to sit and chat instead of spending up to 240 person-hours per hectare in manual weeding every year. Besides, 'pests and weeds' have been miraculously transformed into resources for rearing ducks. The ducks are left in the fields 24 hours a day, and do not need to be herded back to the shed. They are protected from dogs by an electric fence or some other barrier around the field. There is a patch of dry land for the ducks to rest and also for them to be fed waste grain from the rice-polishing factory, so they maintain a relationship with the farmer. But otherwise, the ducks are completely free-range until the rice plants form ears of grain in the field. At that point, the ducks have to be rounded up (otherwise they will eat the rice grains). They are then confined in a shed and fed exclusively on waste grain. There, they mature, lay eggs, and get ready for the market.

It was too early in the year to plant the rice seedlings in Furuno's own paddies. Japanese farmers time their planting according to the length of the growing season quite precisely. So, as we came south on the train, we noticed more and more dry vacant fields. Furuno's in-laws, who live some distance away, have already planted the seedlings and flooded the fields, and we were to be taken there to see the ducklings being released the next morning. The father-in-law was once a rich businessman, but had decided to give up business for organic farming. The in-laws, who look ten years younger than their age, live in a large house with a beautiful garden and a permaculture orchard where chickens roam freely to keep the ground free of weeds – another labour-saving invention - and also provide chicken manure to fertilize the trees.

The ducks are not the only inhabitants of the paddy field. The aquatic fern, *Azolla*, or duckweed, which harbours a blue-green bacterium as symbiont, is also grown on the surface of the water. The azolla is very efficient in fixing nitrogen, attracting insects for the ducks and is also food for the ducks. The plant is very prolific, doubling itself every three days, so it can be harvested for cattle-feed as well. In addition, the plants spread out to cover the surface of the water, providing hiding places for another inhabitant, the roach, and protecting them from the ducks. In fact, the roach grows so well in the paddy that Mr. Furuno has not bothered to count them. What do the fish feed on? They feed on duck feces, on daphnia and other worms, which in turn feed on the plankton. The fish and ducks provide manure to fertilize the rice plants all through the growing season. The rice plants, in return, provide shelter for the ducks.

The paddy field with ducks and all is really a complex, well-balanced, self-maintaining, self-propagating ecosystem. The only external input is the small amount of waste grain for the ducks, and the output? A delicious, nutritious harvest of organic rice, duck and roach. It is quite productive. The Furunos' farm is 2 hectares; 1.4 of which are paddy fields, while the rest is devoted to growing organic vegetables. The organic vegetables fields were full of butterflies of all kinds when we visited them the next morning. This small farm yields annually 7 tonnes of rice, 300 ducks, 4000 ducklings, and enough vegetables to supply 100 people. At that rate, no more than 2 percent of the population needs to become farmers in order to feed a nation. Tony Boys indeed believes that with proper management, Japan can become self-sufficient once more. So who needs GM crops? The choice is clear, not only for Japan, but also for all of South East Asia, and the world at large.

This Aigamo method also explodes the myth that organic farming is necessarily labour intensive. "Organic farming need not be labour intensive, it is fun!" said Mr. Furuno emphatically. The Furunos are not purists, and they use both mechanical harvesters and tractors. Their method is so simple and enjoyable, that five years ago, the two eldest boys managed their own small plot and got a bumper harvest from it. That was also documented on video. Mr. Furuno, however, will complain that they are very, very busy, and no wonder. They run their own vegetable business, process their own ducks and sell those as well. In addition, he writes books, papers, runs courses, and lectures all over S.E. Asia.

Later that evening, we were treated to a delicious meal of home grown organic rice, duck, chicken and vegetables, complete with unlimited bottles of Furuno's own brand of organic sake and fragrant pine wine, both bearing the label, *One Bird, Ten Thousand Treasures*. Mr. Furuno's one ambition in life is to share these boundless treasures, this unlimited harvest, with the world.

We bathed in the warm glow of this wonderful thought, and ate and drank deep into the night, becoming more convinced by the hour that the harvest is indeed limitless and free to all who work creatively in partnership with her.

This is an edited version of an article first circulated by ISIS in 1999.

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Rice wars

Rice, the staple food crop for more than half the world's population, among them the poorest, is the current target of genetic modification, an activity that has greatly intensified after the rice genome was announced two years ago (see "Rice is life" series, SiS 15, Summer 2002). Since then, all major biotech giants are investing in rice research.

At the same time, a low-input cultivation system that really benefits small farmers worldwide has been spreading, but is dismissed by the scientific establishment as "unscientific". This is one among several recent innovations that increase yields and ward off disease without costly and harmful inputs, all enthusiastically and widely adopted by farmers.

A war is building up between the corporate establishment and the peoples of the world for the possession of rice. The food security of billions is at stake, as is their right to grow the varieties of rice they have created and continue to create, and in the manner they choose.

This extended series will not be appearing all at once, so look out for it.

- Fantastic Rice Yields Fact or Fallacy?
- Top Indian Rice Geneticist Rebuts SRI critics
- Does SRI work?
- Corporate Patents vs People in GM Rice
- Promises and Perils of GM Rice
- Two Rice Better Than One
- One Bird - Ten Thousand Treasures
- New Rice For Africa

ISIS Report 28/07/04

New Rice for Africa

A new rice variety developed by plant breeders is boosting rice yields for farmers all over Africa. Dr. Mae-Wan Ho *reports*

African rice species proliferate like weeds, but are low yielding. Asian rice species, brought to Africa 450 years ago, are high yielding, but cannot compete with weeds. Scientists at West Africa Rice Development Association (WARDA) succeeded in crossing the two to produce "new rice for Africa", or "Nerica", that combines the ruggedness of local African rice species with the high productivity of the Asian rice.

This has happened at a time when demand for rice is growing faster in West Africa than anywhere else in the world. Rice imports have increased eight-fold over the past three decades to more than 3 million tonnes a year, at a cost of almost US$1 billion.

The African species lodges, or falls over, when grain heads fill. It also shatters easily, wasting more precious grain. The higher-yielding Asian species has largely replaced its African cousin. But, West African farmers in rainfed (dryland) areas can't grow the semi-dwarf rice varieties from Asia, because they don't compete well with weeds, nor do they tolerate drought and local pests. And African farmers are too poor to buy herbicides, pesticides or fertilizers.

Dr. Monty Jones, WARDA rice breeder, initiated a biotechnology programme in 1991, making use of the 1 500 African rice

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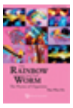

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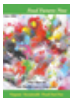

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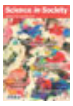

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varieties kept in gene banks, which have faced extinction as farmers abandoned them for higher-yielding Asian varieties. A number of international agricultural research institutions were partners with WARDA in the creating Nerica, plus farmers and national agricultural research programmes in 17 African countries.

The creation of "Nerica" involved crossing the African with Asian species, and ‘rescuing’ the inter-specific hybrid embryos in tissue culture. These hybrid embryos would otherwise have died if left on the plants.

The panicles of Nerica hold up to 400 grains compared to the 75-100 grains of its African parents, and can potentially double the production of rice. Nerica also matures 30-50 days earlier than traditional varieties, allowing farmers to grow extra crops of vegetables or legumes. They are taller and grow better on the fertile, acid soils that comprise 70% of the upland rice area in the region. In addition, it has 2% more protein than either the Asian or African parents. This is an instance of ‘hybrid vigour’ or heterosis.

Nerica is not just one variety; it is a family of more than 3 000 lines. Savitri Mohapatra, Communication and Information Office of the Africa Rice Center, said in reply to my enquiry, "Hundreds of Nerica lines have been developed and they are true-breeding." In other words, farmers can save and replant seeds, without having to purchase seeds every year. Poor farmers are therefore getting the benefit of hybrid rice without having to pay for it every year.

Participatory research is the key to the Nerica success story. Farmers grew several varieties and provided valuable feedback to the scientists. The scientists were able to learn about the traits most valued by farmers and incorporate those into the breeding programme. More than 1 300 farmers took part in the 1998 project to start growing the new rice varieties in Guinea. This was followed by a 1999 project to increase seed supply at national level and a farmer awareness campaign.

In Guinea, farmers increased yield by 50% without fertilizer and by more than 200% with fertilizer.

Building on the success in Guinea, WARDA and its partners joined forces to scale up dissemination of Nerica throughout Sub-Saharan Africa. This culminated in the launch of The African Rice Initiative (ARI) in March 2002.

According to ARI’s projections, by the end of the 5-year project (Phase 1), some 200 000 ha will be under Nerica cultivation with a production of nearly 750 000 tonnes per year, achieving rice import savings worth nearly US$90 million per year.

Nericas are spreading fast in Sub-Saharan Africa. In 2002, Nerica 1, 2, 3 and 4 were the top varieties selected by farmers in trials in Benin, Burkina Faso, Côte d’Ivoire, The Gambia, Ghana, Mali, Sierra Leone and Togo.

Within West Central Africa, Côte d’Ivoire released the first two Nerica varieties in 2000, and Nigeria released one in 2003. Farmers in The Gambia, Guinea, and Sierra Leone are growing several Nerica varieties. In Benin, Gabon, Mali and Togo, several Nerica varieties are under extension. Uganda has released a Nerica variety as "Naric-3". Ethiopia, Madagascar, Malawi, Mozambique, and Tanzania are evaluating several Nerica varieties.

"In trials, we’re getting yields as high as 2.5 tonnes per hectare at low inputs – and 5 tonnes or more with just minimum increase in fertilizer use," says Dr. Monty Jones, who is to receive the 2004 World Food Prize jointly with Chinese Rice Breeder, Dr. Yuan Longping, Director-General of the China National Hybrid Rice Research and Development Centre in Changsha, Hunan.

"Barring unforeseen difficulties," says Hans Binswanger, Sector Director of Rural Development and the Environment of the World Bank, "we anticipate a rapid growth of rice production, leading to self-sufficiency within three or four years. We expect improved incomes and nutrition for the rural population and more affordable domestic rice for the urban population."

Sources

"NERICA- New rice transforming agriculture for West Africa" Guy Manners, WARDA, Ivory Coast, 2001
http://www.scienceinafrica.co.za/nerica.htm

"Nerica on the move" WARDA
http://www.scienceinafrica.co.za/nerica.htm

The Africa Rice Center
http://www.warda.org/warda1/main/Achievements/nerica.htm

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