

Feast or famine?

Proponents call it a miracle. Detractors call it smoke and mirrors. Will the System of Rice Intensification feed the hungry third world or needlessly divert farmers from tried and true techniques? Christopher Surridge investigates.

Rice feeds more than half the people in the world; but not well and not for much longer. As the population rises, so does the demand for rice, yet yields of the crop are levelling out. Already, more than 400 million people endure chronic hunger in rice-producing areas of Asia, Africa and South America. And demand is expected to rise by a further 38% within 30 years, according to the United Nations. To call attention to the problem, the UN has declared 2004 the International Year of Rice. "Rice is on the front line in the fight against world hunger and poverty," says Jacques Diouf, director-general of the Food and Agriculture Organization of the UN.

But no amount of fanfare can alter the disheartening conclusion drawn by a growing number of agronomists — rice yields are approaching their limit. Despite efforts on a variety of fronts, including genetic engineering of rice strains for improved nutrition and growth¹, no solution has been found.

So it is no surprise that a simple method that claims to boost yields at lower cost to farmers is being hailed by many as that solution. The System of Rice Intensification (SRI), developed in the late 1980s in Madagascar, has since been adopted in countries from Sri Lanka to Sierra Leone. In Cambodia, SRI was unheard of in 2000, but by last year nearly 10,000 farms had converted to it, a figure that may reach 50,000 this year.

But although advocates of SRI routinely report yields up to twice those achieved by conventional agriculture, many eminent agronomists dismiss such achievements as the result of poor record keeping and unscientific thinking. A new set of field trials published this month² seems to support this view



Wonder rice? The System of Rice Intensification involves more sparsely planted, drier fields than is normal. Its supporters believe it gives more than double the yields of conventional farming.

unequivocally. Yet proponents are standing firm, and the dispute over how best to grow rice seems set to continue.

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 agriculture, the plants spend most of the season partially submerged. During a 1983 drought, which prevented many farmers from flooding their paddies, de Laulanié noticed that the rice plants — particularly their roots — showed unusually vigorous growth.

Intensive care

From this and other observations, de Laulanié developed the three main tenets of SRI: that rice seedlings should be transplanted quickly when young; that rice plants should be spaced widely apart; and, most importantly, that the rice fields should be kept moist but not flooded. Flooding, he believed, stunted the plants' roots by preventing proper soil aeration. In addition to these principles, de Laulanié took a page from organic agriculture, emphasizing plant husbandry over the use of chemical fertilizers, so that poor and rich farmers alike could practise SRI. To help promote his method, in 1990 de Laulanié established a non-governmental organization called Association Tefy Saina, which means "to improve the mind".

Despite de Laulanié's successes, SRI would have remained a Madagascan curiosity but for Norman Uphoff, a political scien-

tist and director of the International Institute for Food, Agriculture and Development at Cornell University in Ithaca, New York. In 1993, Uphoff was part of a team attempting to find alternatives to the slash and burn agriculture that was destroying Madagascar's rain forests. It was clear to Uphoff that finding a way to increase rice yields in the area, then about 2 tonnes per hectare, would greatly slow the clearing of the forests.

Then he met representatives of Association Tefy Saina. "I was hoping for a yield of 4 tonnes per hectare, so when they said they could get 15 or more, I frankly didn't believe them," Uphoff says. Such doubts evaporated once farmers in the rainforest regions started using SRI. The results, says Uphoff, were stunning. "By the end of the second growing season we were getting over 8 tonnes per hectare." In 1997, Uphoff began promoting SRI throughout Asia. It is largely through his efforts that the practice has become so widespread.

But some observers say SRI's proponents do not have the evidence to back up their claims. John Sheehy, an agronomist at the International Rice Research Institute (IRRI) in Manila, the Philippines, points out that most SRI field studies have appeared in conference proceedings and other publications not subject to peer review. Although there are exceptions³, such reports, Sheehy says, are little more than anecdotes without details of data collection methods, nitrogen inputs or other measures that a critical reader would need to judge the success of a trial.

Peer review is particularly important for



Against the grain: Henri de Laulanié (above) invented the System of Rice Intensification. John Sheehy (left) has found it wanting.

living-room-sized plots in the same fields. Weeds were suppressed with herbicides on the conventional plots but pulled by hand in SRI plots. SRI plots received extra rapeseed cake fertilizer. Conventional plots were flooded; SRI plots were not. Yet overall, no significant differences were found between the two cropping systems. SRI yielded slightly higher in Jiangsu, but fared slightly worse in Hunan.

On trial

Dobermann is not surprised. Every component of SRI has been studied before and found to have little effect, he says. The results also fit Sheehy's theoretical calculation of how much rice a field can produce. He believes the upper limit is set by the amount of sunlight that falls on it. Based on weather data for Madagascar, Sheehy has calculated theoretical maximum outputs for areas that have reported the most impressive yields under SRI. By his estimates, the reported yields are as much as 10 tonnes more than is possible². "You can't get out more than gets put in," he says.

So what accounts for SRI's growing popularity? Dobermann suspects practitioners have been lulled by the apparently greater vigour of their plants. When rice plants are grown close together, as in conventional practice, they produce fewer tillers, the side branches upon which the grains are formed. With the wider spacing of SRI, the individual plants produce more tillers and so more grain. But this merely compensates for hav-

ing fewer plants per hectare, and the yield is not significantly affected.

Others suspect that SRI may perform better in some regions than others. John Angus, a crop scientist with the CSIRO, Australia's national research agency in Canberra, thinks SRI could increase yields only under specific conditions. The soils in the highlands of Madagascar are highly reducing — they are acidic and low in oxygen. Reducing conditions also occur in parts of Japan and the Australian rice belt where Angus says it has proved helpful to drain paddies in the middle of the growing season to allow more oxygen into the soil.

Proponents contend that SRI owes its popularity to impressive yields. T. M. Thiagarajan, 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." Thiagarajan helped convince the Tamil Nadu state government to spend US\$50,000 on promoting SRI to local farmers.

Roots of farming

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

Nor will single-season field trials reveal the full potential of SRI, he argues, 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 — the case in Thailand, for instance — further seasons will see it come into its own.

In some ways, the debate resembles that currently raging over organic agriculture. For advocates, SRI is a grassroots movement to resist the influence of global agribusiness by reducing dependence on chemical inputs. Detractors call it a waste of time that is diverting resources from more promising approaches such as genetic engineering.

One thing both sides agree on is that meeting the UN's goal of halving hunger and poverty by 2015 will require radical changes in agriculture. Whether this will come from the uplands of Madagascar or the modern agronomy laboratory remains an open question. ■

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1. Surridge, C. *Nature* 416, 576–578 (2002).
2. Sheehy, J. E. *et al.* *Field Crops Res.* doi:10.1016/j.fcr.2003.12.006 (2004).
3. Stoop, W. A., Uphoff, N. & Kassam, A. *Agric. Syst.* 71, 249–274 (2002).
4. Dobermann, A. *Agric. Syst.* 79, 261–281 (2004).

field studies, because of the pitfalls involved in assessing yields, says Achim Dobermann, a soil scientist at the University of Nebraska, Lincoln, who has attempted a critical assessment of SRI⁴. One concern is the rice's water content. Under SRI, rice takes about two weeks longer to mature for harvest than rice grown in conventional systems, by which time the grain has taken up much more water. Unless the grain is carefully dried, the SRI field will seem to have yielded more rice, when in fact the increase could be water.

This month, Sheehy, Dobermann and IRRI researcher Shaobing Peng have published their own trials of SRI². At three experimental stations in Hunan, Guangdong and Jiangsu provinces of China, they grew rice using SRI and conventional best practice on