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Biosafety of Transgenic Rice

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Rice, wheat and maize, members of the grass family, are the major grains that sustain humanity. Of these three, rice is the most important since it is the staple food for over half of the world's population. Most rice farmers and consumers are in Asia, where approximately 70 per cent of the world's 1.3 billion poor people live. Of the 840 million people suffering from chronic hunger, more than 50 per cent live in areas dependent on rice for food, income and employment.

While the world population is continuing to grow, rice growth rate has decelerated from 2.3 per cent during the 1980s to 1.1 per cent during the 1990s. A major worrying aspect is the productivity decline witnessed in the favourable irrigated rice growing regions from where major part of rice production is derived. Yield stagnation in many Asian countries, limited possibilities of expanding arable land due to rapid industrialisation and urbanisation, depleting water resources and elevated wages of farm labour, are the main constraints for increasing rice production. In addition to these constraints, decline in native soil productivity, increase in salinity, alkalinity and waterlogging are further adding to productivity decline. The canopy structure of the new rices encourages pests and pathogens, which further inflict serious damage. Recognising the pending crisis in the state of rice production, the FAO, on November 3, 2003 declared, 2004 as the International Year of Rice.

Developing new rice varieties with higher yield potential and innate genetic capacity to stabilise production are vital to bridging the yield gap between favourable irrigated and the unfavourable rainfed environments. It is also a major challenge. The pace and extent of achieving this objective is constrained by limited availability of suitable germplasm. Therefore, conventional breeding is handicapped in gathering the necessary ingredients for meeting the dimensions of the task. Newer approaches, tools and technologies are needed to overcome these constraints, which conventional crop improvement programmes are finding difficult to overcome. The newer technologies will also have to be seed embedded if they are to meet the demand of the vast majority of resource-poor farmers, holding less than a hectare of land, so that more rice can be produced from lesser land, using lesser water, labour and chemicals.

During the last two decades or so, spectacular developments in modern biology have ushered in the era of biotechnology, bioinformatics and genomics. The power of these technologies enables us to discover genes of importance for human welfare from anywhere in the plant or animal kingdom. Genetic engineering enables us to move genes of interest between organisms, including those that are nor crossable. Transgenics, carrying novel traits for disease and pest resistance, are already proving to be a boon for even the resource-poor farmers in China. While these new tools and technologies are poised to lend a major impetus to war on poverty, hunger and disease, indeed, there are concerns in respect of any potential harm to human health and environment. To address all such concerns, genetically modified crops (GM crops) are going through an intensive testing for toxicity and allergenicity that is unprecedented in the history of agriculture. Even though, individual products of genetic engineering may pose more risk, less risk, or the same risk as anyone or another of the products of conventional breeding, deployment of GM rice in major rice growing areas of Asia, merits a comprehensive evaluation in view of the fact that these regions happen to be the centres of diversity for rice. The merit and demerit of not using GM technology in developing new crop cultivars need to be weighed against any possible risks associated with using it.

To discuss issues of development and deployment of GM rice in rice growing areas of Asia, Africa and Latin America, NAAS convened a meeting at Chennai. The meeting was attended by concerned subject matter specialists including, rice breeders, molecular biologists, entomologists, economists, nutritionists, social scientists, NGOs and a farmer representative.*

The areas of scientific discussions were:

- The biology and ecology of rice crop and its wild, weedy relatives and land races.
- Transgenic rice for commercialisation.
- Potential impacts of transgenic rice on human- and animalhealth.
- Developing a risk assessment model and methodology for transgenic rice.
- Societal, economic and ethical issues affecting transgenic rice Given below are the major recommendations, which emerged from deliberations at this meeting.

Recommendations

1. The importance of conventional plant breeding was recognised and its further strengthening through incorporation of new scientific and technological tools, including biotechnology was strongly recommended.

2. There are real benefits to be had, by all sections of the society, from the application of biotechnology, in particular the recombinant-DNA (rDNA) technology. A broad-based consultative process must be conducted to rank priorities for transgenic rice development suited to national needs on an ongoing basis.

3. Developing rice varieties having greater tolerance to drought, submergence and salinity, better resistance to pests and disease, and rich in micronutrients, appear to be achievable goals through rDNA engineering and should be pursued actively.

4. A comprehensive science-based risk assessment system must be practised for genetically engineered crops—including rice—that takes into account issues relating to centres of diversity and unique social and economic aspects.

5. Currently, genetically enhanced transgenic rice conferring high level of resistance to stem borers and leaf folders are in advanced stage of development in some countries. Transgenes encoding δ-endotoxins of *Bacillus thuringiensis* (Bt) are the commonly used insecticidal genes in view of their good record of specificity and efficacy against target pests, and its nontoxicity to humans, other mammals and birds. The workshop recommended that to enhance its efficacy, wherever possible such transgenes must be put under the control of target tissue- or stage-specific regulatory elements rather than the constitutive ones.

6. Importance of resistance management through integrated pest management was stressed in the workshop, as also the imperative to extend the usefulness of Bt and

* *NAAS convened a meeting in Chennai, (Oct. 27 to Oct. 30, 2002), in collaboration with Syngenta International to critically examine all the pertinent issues comprehensively.*

such other transgenes. Resistance management strategies for the predominantly tiny rice farms of Asia need to be fine-tuned in keeping with the local practices. The aspect of refugia, in particular, would merit special attention. The workshop recommended that studies be undertaken to assess efficacy of refuges and refugia provided by non-transgenic rice crops. Given the scenario of greater vulnerability to resistance breakdown in Asian rice farming systems, deployment of twogenes (having dissimilar mode of action) transgenics may be required to prolong resistance.

7. The potential of gene flow in rice exists and its occurrence has been scientifically established. This phenomenon must be addressed for transgenic rice through appropriate regulatory oversight, on a case-by-case basis. Given the importance of rice as a staple crop, regulatory agencies must develop and put in place a comprehensive monitoring mechanism to assess longterm environmental/ecological impacts from the release of transgenic rice.

8. The regulatory process relating to genetically engineered crops needs to be made transparent, participatory (involving all stakeholders), effective and efficient. Appropriate regulatory oversight based on sound scientific information should be an essential requirement for the approval and release of crops derived from rDNA technology.

9. International experience garnered across different species must be used to make appropriate case-by-case study of biosafety assessment and regulatory oversight while taking into account current difficulties experienced internationally in interpreting and applying concepts, such as the precautionary principle and substantial equivalence.

10. No credible scientific evidence is available indicating horizontal transfer of antibiotic-marker genes under natural conditions, and chances of such transfer are far greater from other microbes in the environment. The workshop recommended use of alternative systems of selection where feasible. The workshop also recommended use of ‘clean DNA’ (minus the vector background) technology for transformation.

11. The technological application of micronutrient-enhanced rice must be reviewed through the regulatory process, keeping in view the social, political and cultural implications.

12. Prior to commercialising herbicide resistant rice, issues relating to the potential development of resistance in the genetically modified crop, besides the ecological, social and cultural factors from such an introduction to the society, must be addressed.

13. The workshop recommended that transgenic rice producing pharmaceuticals and drugs must be assessed carefully for their impact on food and feed chain. It was strongly felt that rice crop must be avoided to produce such compounds as far as possible. However, if there was critical need to develop such transgenic rice, a distinct set of biocontainment protocols must be developed under rigorous oversight.

14. No scientifically valid environmental or ecological impact issue was identified with respect to releasing transgenic rice varieties in centre(s) of origin and centres of diversity.

15. Basic research relating to transgenic rice should be encouraged even as effective regulatory systems are put in place.