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19 June 1990

Dear Bob,

With this I enclose a report of the Advisory Committee's deliberations at the Fourth Annual Meeting of the Foundation's International Program on Rice Biotechnology. It has not been seen by Sam Dryden, Lloyd Evans, Emil Javier, Fowden Maxwell or Peter Quail so please could you circulate to them seeking comments.

GHT OK Done

The meeting in Los Banos was a tremendous success. These Annual Meetings hold the Program together and enable all to maintain their commitments to our overall aims. The calibre of many of the developing country scientists who are involved is encouraging. As I have written in the report the explosion of knowledge about rice is amazing. From the Foundation's point of view as a co-founder of IRRI it would be interesting for a comparison to be made of the relative returns on investment in the creation of a fixed installation compared with the present more flexible approach.

I attach a note of my expenses.

With best wishes,

Yours sincerely,

J Riley

cc Dr. R.W. Herdt
Director of Agricultural Sciences
The Rockefeller Foundation
1133 Avenue of the Americas
New York
N.Y. 10036
U.S.A.

→ with accounting statements c/f for payment

GTB

	~~RWH~~	JUN 27 '90		
	~~GHT~~	- please circulate as requested also copies to SCO, LAS		
	~~PG~~	PCG JUN 2 '90		
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GHT

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REPORT OF THE ADVISORY COMMITTEE ON THE

ROCKEFELLER FOUNDATION'S INTERNATIONAL PROGRAM ON RICE BIOTECHNOLOGY

FOURTH ANNUAL MEETING, LOS BANOS, THE PHILIPPINES, MAY 9-12, 1990

Representatives of all the research groups participating in the Rockefeller Foundation's Program on Rice Biotechnology met at the International Rice Research Institute (IRRI) in the Philippines over the period May 9-12, 1990. Some groups had more than one representative at the meeting and in addition sessions were attended be relevant IRRI scientists, staff and students of the University of the Philippines, Los Banos and by numbers of observers. Also present were staff of the Rockefeller Foundation Agricultural Sciences Division and consultants associated with the Rice Biotechnology Program. More than 200 people were involved in the meeting overall.

This report arises from the deliberations of the Advisory Committee to the Program which were reported briefly to the final plenary session of the meeting. Members of the Advisory Committee present were Sam (R.M.) Dryden, Lloyd Evans, Emil Javier, Fowden Maxwell, Peter H. Quail and Ralph Riley.

The meeting was structured so that the progress of the work of each participating group could be reported and discussed in a very open way. Uncertainties and technical problems were carefully considered and assessments made of the way forward. Opportunities for co-operation and for the exchange of materials and techniques were the subject of much informal discussion in the halls and over meals and coffee. The dozen or so small group workshops on the final afternoon also contributed to a more detailed understanding of recent results and to assessments of the state of the art.

For the first time at an annual meeting it was necessary to have two simultaneous sessions for part of the time. This is a manifestation of the large amount of material that needed consideration over three very full days. It also enabled more specialist discussion but was to some degree disappointing in not enabling the entire Program to be comprehended by all of those involved.

The remainder of this report consists of the reflections of the Advisory Committee on the state of the Program, a brief assessment of its achievements and some comments on the way forward. Immediately it should be made clear that the Advisory Committee was profoundly impressed by the enormous progress that has been made in establishing a firm knowledge-base on the molecular biology and molecular genetics of rice. It is remarkable that, since the Program was approved in December 1984, we have advanced from a state of almost total ignorance to the situation of;

(i) being able to comprehend many processes in rice in terms of

molecular interactions
(ii) having established many of the methodologies necessary for biotechnological intervention in rice production
(iii) having in sight technologies that can be used to help rice farmers.

It is probably appropriate to start with factors that have been assessed as high among the priorities in rice agriculture. These include the need to control damage caused by the rice tungro viruses and by other virus diseases. As a result of work at St. Louis and at Norwich we now know the genomic structure of the two tungro viruses and how to test for virus resistance in the rice plant by agroinfection. So for the first time resistance to the virus can be separated from resistance to the insect vector with which it is normally confounded. Plant breeders will thus now be able to select for virus resistance. In addition, as far as the spherical tungro virus is concerned, knowledge of the coat-protein gene begins to open up the possibilty of genetically engineering rice to possess in-built virus resistance. Rapid progress is also being made on the investigation of the genome structure of the rice dwarf virus, the rice stripe virus and the rice yellow stunt virus in Beijing and the rice ragged stunt virus in Bangkok.

After the Second Annual Meeting of the Program, the Advisory Committee pointed out that although insect resistance came high in the priorities list, in practice there was very litle commitment in this area. It is a pleasure now to acknowledge the vigorous research on insect resistance which is part of the Program. Research is well underway on the identification of *Bacillus thuringiensis* genotypes carrying genes for crystal proteins that are toxic to insects that are pests of rice. Such genes could be engineered into rice or used in endophytes. In addition joint work between Kansas State and Durham Universities and the International Center for Genetic Engineering and Biotechnology, New Delhi, is progressing towards the identification inhibitors of insect enzymes in rice and its relatives. These inhibitors could contribute towards resistance to insects when incorporated in rice varieties.

Finally, in discussion on the use of novel forms of insect resistance that will be introduced into rice, concern was expressed that this resistance should be deployed in farmers' fields in ways that will allow for the maximum sustainability of its effectiveness. This will require knowledge of insect ecology and the Advisory Committee recommends that within the next two years the Rockefeller Foundation should arrange a conference in which molecular biologists concerned with transgenic insect resistance should be brought together with insect agro-ecologists so that the most effective strategies can be devised for the deployment of varieties with new forms of resistance.

In the bacterial and fungal diseases of rice impressive progress is also being achieved in molecular studies. This is particularly true of the work at Kansas State University in which a gene for

avirulence in the rice blight bacterium has been cloned and sequenced. This and related work at IRRI will lead to the identification of new strategies for the control of the bacterial blight disease of rice.

Novel approaches are emerging in Hangzhou and Los Banos through the search for organisms, principally bacteria, that produce substances that are antibiotic to the bacteria and fungi that cause diseases of rice. While antibiotics have long been part of the therapeutic portfolio for the treatment of infections in man and other mammals, little attention has been paid to similar methods for the control of plant diseases. This work should be encouraged as part of the Rockefeller Foundation Program. There are suggestions that some developing country scientists and laboratories display particular talents in this field and have access to relevant antagonistic organisms from their indigenous rice agriculture.

Numbers of laboratories are now using anther culture in practical breeding programs so that this is now less a research activity and more an exploitable technology. However, there seems little doubt that the process could be used in more breeding programs than at present and this implies that a new phase has been entered more concerned with technology transfer than technology development. Clearly scientists in developing countries who are not yet availing themselves of the anther culture approach need training in its use. Possibly this could be achieved by the Rockefeller Foundation organising short (two weeks or so) courses in the laboratories with real expertise in anther culture in China or Korea, or, if it is required in Latin America, at CIAT.

Some of the products of wide hybridization are already in multilocation testing as candidate varieties. However, this work continues to make excellent progress using as parents a greater diversity of wild-species relatives of rice. It will provide to breeders a continual flow of rice genotypes into which wild genes of economic importance have been introgressed and work to validate the nature of this material, by the use of DNA markers, will require continuing research.

The DNA restriction fragment length polymorphism (RFLP) map being developed at Cornell University by Steve Tansley and his colleagues is already being used for pratical purposes. It now has about 300 markers, spaced on average about 10 map units apart. Molecular markers can be used to follow such genes as those giving resistance to the white-backed plant hopper or giving grains with culinary attractive aromas. Such findings increase the simplicity and also the precision with which selection can be practised in plant breeding. Currently work has turned to attempts to find markers for drought resistance and salt tolerance. The longer term aim is to obtain a map with up to 1000 RFLP markers using a cDNA library instead of genomic DNA as hitherto. The amalgamation of the RFLP map and the conventional map must be an immediate objective so that breeders can get the best value from all kinds of chromosome mapping in rice.

Transgenic plants can now be produced in both *japonica* and *indica* rices. So one of the prime objectives of the Program has been achieved. However, there is still much to be done to make transformation routine. The absolute number of plants transformed is small and we have little information about the fertility of transformed plants, about their stability or the mode of inheritance of the introduced genes in the generations derived from the propositi. The meeting made clear that the following technical improvements are necessary before rice transformation becomes accessible to all :

i) alternative selection criteria than resistance to kanamycin, since selection on kanamycin-containing medium may lead to sterility
ii) better reporter genes for assurance of the presence and expression of introduced genes, since detection of the B-glucaronidase (GUS) gene seems to be uncertain in many circumstances
iii) more effective promotor genes, since CaMV 35S promoter may not be as effective in rice as in some other plant species
iv) some knowledge of whether it is necessary to target DNA insertions to specified parts of the recipient rice genome for maximum stability in the control of expression.

The provision of answers to these very difficult questions may require a concentration of components of the Program concerned with transformation in some highly competent and specialist laboratories. Clearly they are not all issues which are solely of concern in expanding the availability of transformation in rice and answers may come from research on transformation in other species. Nevertheless they pose a significant challenge to the Rockefeller Foundation Program and consideration must be given as to the research strategy required to face the challenge.

Although we have suggested that consideration should be given to consolidating technical development on transformation to especially competent laboratories, nevertheless the field is so attractive - indeed glamorous - that it would be impossible to discourage many people from "having a go". Transformation will be especially appealing to many developing country scientists who have been taught protoplast culture and regeneration and now want to use the techniques to make new scientific advances and to be at the "cutting edge". For such people a brief handbook on the present state of the transformation art in rice could save much wasted time, excessive expectation and perhaps extravagant claims. Above all the handbook should clearly mark out what are the pitfalls for someone who is not able to pick up a telephone to talk to an experienced authority in the field. The Advisory Committee very much hopes that the Foundation will be able to find an author willing to spend a few days pulling together such a handbook.

The Advisory Committee again congratulates the Rockefeller Foundation on the success of its International Program on Rice Biotechnology. It is a unique example of what can be achieved by an

international research network with an overarching objective and members of the network making inputs according to their specialist capabilities. The whole sums to much more than if each individual piece of research had been done separately. In particular the Program has been effective in its training function. There are now scientists in several developing countries who are able to contribute to plant biotechnology, especially of rice, who would not have had such experience without the help of the Program. As such specialists are so few in developing countries the Program has added to the capabilities of such countries in significant terms both absolutely and proportionately.

In developing countries the monitoring of safety associated with the deliberate release of transformed rice will become increasingly important. Programs to deal with these issues should be developed to include;

(i) The sponsoring of workshops - wherein the appropriate officials from countries participating in the Program can share concerns and information regarding regulatory matters
(ii) Fellowship grants - to expose individuals from developing countries to the agencies in the U.S.A. and Western Europe - allowing them to take advantage of the "learning curve" of those countries.
(iii) Monitoring "model" field trials and associated regulatory procedures would provide useful information. This would also be important for measuring efficacy.

As the Program becomes increasingly successful, it may, ironically, become increasingly exposed to criticism from groups concerned with issues such as the environment, Third World development and biosafety. The Rockefeller Foundation will need to have proactive programs, like those mentioned above in place to react in a responsible fashion.

Continuing review of priorities and targets seems very necessary. Initiatives such as that described by Dr. Cristina David, which look at the demographic and economic impact of rice technology developments, are important for recalibrating the Program's strategies and re-establishing targets.

Finally the Advisory Committee wishes to commend the work of Bob Herdt as the Agricultural Sciences Director. With the support of Dr Herdt, the "product champion" of the Rice Biotechnology Program, from the outset, has been Gary Toenniessen. He has the whole Program at his finger tips - knows the strengths and weakness of all the particpants - gently but firmly steers all involved. That scientific knowledge of the rice plant has expanded enormously in the last five years is due in large measure to the prescience, perseverance, persistence and leadership of Gary Toenniessen. It is a salutary lesson that to be major achiever in science it is not necessary to work at the bench!

RALPH RILEY, Cambridge, 18 June 1990