

October 15, 2004 – 10:15 p.m.

## **STRATEGIES FOR ACHIEVING A DOUBLY GREEN REVOLUTION IN AGRICULTURE**

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Thank you very much, Ambassador Quinn. It is indeed an honor to be the discussion leader on this discussion of the strategies for achieving a double Green Revolution in agriculture and to be associated with these wonderful people.

I just want to say that during the eight years I served as Director General of IRRI and another dozen years I served helping to provide some money for IRRI and for the other international centers, I learned a few things, many things as a matter of fact, but I'm just going to comment on four that have to do with our subject here today.

First, rice genomic improvement was the principal driving force for the Green Revolution. Now, that's not original with me. Of course, everybody knows this. But we have to keep in mind that it brought about an increase in the potential productivity, it determined the responsiveness of the plants, in this case, rice, to input a fertilizer, water, herbicides and so forth. It determined their resistance to stress, drought, excessive temperatures, low temperatures, soil toxicities. I used to tell my soil science friends, "You guys should go over and make friends with the plant breeders, because they can solve your soils' problems in some cases easier than you can – because for you to try to solve your soils' problems, you change the soils to fit the plants. It's much simpler if the plant breeder will change the plants to fit the soil." And that's exactly what they have been able to do.

And then last, it determines the resistance to insects and diseases, which is a very important factor. The second thing I learned was that genomic improvement was a global effort. There's sometimes a tendency for us in the more developed world to give all the credit for the Green Revolution to CIMMYT, to IRRI, to CEOT, ITA and the other international centers. I just wanted to point out from the standpoint of what happened in IRRI that indeed was not the case. It was, IRRI helped organized the effort, but the effort was truly international. The most successful international research effort of IRRI was associated with what was called the International Network for the Genetic Evaluation of Rice, INGER, where they had some 74 countries involved in this effort. Seed of the best varieties were gathered, disseminated by IRRI and then made available to the scientists in these various countries for their testing. But the thing that's interesting is that it wasn't an IRRI-dominated program.

I remember the first time one of these – they called it IRTP then, International Network for the Testing of Rice. I asked for some data coming from the trials, and the IRRI scientists didn't provide me any data. I say, "What's the matter here, fellows?" They're not trusting you. They're not sending you the data. They don't want IRRI publishing their results. And so in this meeting and other meetings, the situation was changed. A committee of scientists from the various countries was set up to govern what went on. They determined what networks were going to be run and so forth. Within a year you had data coming in right, left and middle, because it really did become a collaborative effort.

Well, just very quickly, the extent of what went on with these trials. In three decades they disseminated and distributed more than 48,000 test entries. In the history of INGER they distributed 2.6 million seed packets of elite germ plasm, some 667 varieties were released, having been tested in INGER. One study suggested the average annual value of about \$2.5 million for each of these 660 varieties that were released. So that's the second, and I think very important, thing that I learned.

Thirdly, there were some unintended negative effects of the Green Revolution and of the varieties' improvement. Some people have even been led to question whether there was a true revolution and if there was, was it any good. Excessive use of fertilizer associated with the Green Revolution brought about water pollution, particularly with nitrogen, and there's no question that did take place. Same thing with pesticides, with pesticides getting into the water, but more importantly pesticides killing non-target organisms. One other thing this system brought about was intensification of cropping, mono-cropping and a lack of genetic diversity in the materials that you're using. That's a third thing I learned.

Then the fourth, the rates of production, and rates of productive increase have declined suggesting a plateau with little chance of further increase, using traditional breeding and genetic techniques. New tools, research methodologies are needed. One of the things we're going to be talking about today are some of the new tools, particularly with respect to genomic improvement, that are available or that are being worked on, methodologies that are going to make it possible for us to move ahead.

Then lastly, to tie this together and make genomic improvements with other changes that will move toward this doubly Green Revolution.

Now, to start us out this morning, we're going to ask Dr. Swaminathan who has already been introduced to you. This show would just stop and have to be derailed, Dr. Swaminathan, if it weren't for you, because you have been able to help so many. I was afraid they were going to take him away from us, since they had him doing so many other things. But he agreed to stay with us and to sort of introduce this subject for us, and then we will have a couple of scientists focusing on the genomic improvement and related subjects, talk to us. Then finally bringing it together with other factors that are necessary, we will hear from them.

I will introduce the others later, but Dr. Swaminathan has been introduced to you already. I personally know him in three careers. First, as a breeder, as an active researcher himself, setting this stage for the Green Revolution in wheat. Second, as a research administrator, leader an inspirational leader of the Indian Council for Agricultural Research, IRRI, and recognized

around the world for that. And then thirdly, the career that he is now participating in with his own foundation, moving out to have the results of technology felt in the countryside. Dr. Swaminathan.