Symposium on Global Climate Change: Imperatives for Agricultural Research in the Asia-Pacific

Technical Session III: Panel Discussion on Adaptation and Mitigation Options

Transcript

Chairman M. Harun-Ur-Rashid, BARC, Bangladesh: Good afternoon. Friends, let us start Technical Session Three. Yesterday and this morning, we had some useful presentations and discussions on different aspects of global climate change, its impact on agriculture and livelihoods, its adaptation and mitigation options and strategies, research and action needs and city centers activities related to climate change.

Now let us hear from six panelists their opinion and view on adaptation and mitigation options and strategies, and also how to put them into action and practices. The panelists are renowned experts and specialists in their respective fields. The six presentations will be on crops, paddy, soil and fertilizers, capacity building, policy and social sciences, regional and international cooperations. May I now request the first panelist on crops, Dr. Masa Iwanaga. To introduce, Masa Iwanaga holds a PhD degree from the University of Wisconsin, USA. He is currently the Director General of the National Institute of Crop Science, NARO, Japan. He was the director of the Biological Resources Division of JIRCAS and he worked 25 years for four CG centers CIP, CIAT, IPIGRI and CIMMYT. Dr. Masa, please. May I request the panelist, you are allotted only 10 minutes each.

Dr. Iwanaga, NARO, Japan: Thank you Mr. Chairman, and good afternoon. Last week I prepared a set of PowerPoint slides, however I decided not to use them for three reasons. First of all, what I previously prepared is the subject of what my institute is doing in terms of crop management, adaptation to climate change. That part was covered by a presentation by Dr. Horie and Dr. Yagi yesterday, so that is one of the reasons why I am not going to show the same slides. Second, as a communication method, I tend to over-utilize PowerPoint so sometimes for a change I would like to speak without PowerPoint. Third, what I am going to say is based on my observation of our meeting over the last one and a half days instead of what I prepared previously. I think that it is a better way to stimulate our panel discussion. So, I am not going to use PowerPoint and I hope that in that way my talk can be more natural and spontaneous.

During the presentation yesterday and this morning I was wondering who would be most affected by climate change. Obviously, it is the farmer. And for adaptation to climate change who is going to take a decision? It is the farmer. The farmer is a unit of decision on the practical level. Of course, our government makes a decision at a higher level, but day-to-day decisions will be done by farmers.

So, I was analyzing what we were discussing yesterday and today. Is it very relevant to farmers' needs? And because farmers have to make a decision, we say that the time to act is now, it is for a scientist or

a policy maker's sake, but from farmers' point of view, they are already taking decisions even before acting because they have to manage their cropping system for sources of food and income. So that is my first submission to you. Are we addressing a farmer's needs?

On this I would like to give some simple examples. Rice farmers in the southern part of Japan are suffering from high temperature or hot summer for rice production in terms of yield and the quality of what they produce. So what kind of options do they have? They know that my institute produced a new variety which is more heat tolerant, so by planting them yield reduction and quality reduction can be avoided. But the market price is not as high as the current variety because of branding. So he or she better stick to the current variety instead of adapting a new variety. And then what option do they have? Planting earlier or later than the normal planting date to avoid heat stress during flooding time. By planting later, say two weeks later than normal, you can avoid heat stress but there is more risk of exposing your crop to a typhoon, so there is major risk. So, let us plant earlier. They cannot plant earlier because they still have a wheat crop up to the first week of June, so you cannot so easily move your planting date. So all these options you might think are not easy. The final decision is probably a simple one, but the whole process they have to think about is not that simple because they have to manage their own cropping system and financial return.

The presentations yesterday and today were both highly interesting and stimulating, yet most of them perhaps are technology supply oriented by nature of the research organization. It is not much of an implementation or a demand aspect from a farmer's point of view. So I thought that if we have next opportunity for this kind of occasion, probably I would like to see case studies from a farmer level, how they look at different adaptation strategies and they try to implement them. By doing that, we can do two things. First, granted, to do listening of what we are producing as a technological option. Crop implementation, management, crop protection or information service, and we can check whether what we are providing is really useful for farmers' day to day management of a cropping system. Second, by looking at a climate change adaptation from the farmer's point of view, we are probably going to see a different set of priorities. Again, I would say that the current approach we are taking is technology supplied and that is not bad, it is just that we need to do things from another angle to make sure that what we do is relevant and practical for the farmers' decision-making.

So that is my contribution as a panelist for further discussion. Thank you very much.

Chairman: Dr. Masa, I think you can come over here. Our next presentation on paddy is by Dr. Wassmann, I think he has already been introduced. He is from IRRI.

Dr. Reiner Wassmann, IRRI: I also do not have any slides. I have been going into the technicalities of adaptation and mitigation as far as I see it for rice this morning so I just want to have a different view at the topic now. And if I understand it correctly, the question that is posed to all panelists now is what

is actually needed to bring us further to implementing adaptation and mitigation? And I have a very simple answer to that. Maybe not a simple solution, but at least a simple answer.

What are needed now are success stories. I think we have to translate all that we have been investigating over the years into some tangible case studies which could be maybe a county, maybe a village, not too big in the beginning just starting to do some work on the ground. I am getting asked quite often by journalists when they come to me, “So you worked on mitigation for such a long time; can you just show us a field where it is done?” I said, “Sorry it is really not possible at this point, and I think it will not happen unless somebody really takes the initiative at bringing this kind of climate change study to some kind of tangible output, some units, and some regional case studies.”

I think this is something in which we should also see the role of international research and national research agencies as complementary. From an international research agency point of view we can provide some generic tools, we can work on generic options but as we all know in agriculture there is always a site-specific aspect to anything. There is no such thing as the blanket strategy that would work all over the place. We know that we can reduce methane emissions by water management, but it won't work all over the place and clearly there are some places in India where it does not make sense to change water management because the emissions are already very low. But then we can say the same thing also about adaptation. It is still very much a question what is needed in which specific situation and I think we could really have a complementary relationship between international institutions as well as national institutions.

And also I think an aspect that is often missed is that the national institutions could coordinate better amongst themselves. I do not want to point at you and say that you have to do that, of course it is just so obvious that I think that we can always improve by having more concerted efforts in that. That may not even require huge projects, but in many countries there are already some experiments going on in terms of adaptation—not case studies but experiments—but at least at that level we could get more coordination work and more harmonizing and more streamlining.

That is what I would like to say. I think we had plenty of discussions on the ins and outs of rice and I think we had really addressed that already through the day so I felt I just do not want to go into that specific part of it anymore.

Chairman: Thank you, Dr. Wassmann. Our third panelist is Dr. Lal from Ohio State University; he will speak on soil and fertilizers.

Dr. Rattan Lal, Ohio State University, United States: In contrast to those who know the subject very well and therefore do not require any audio visual, I am afraid I am one of those who do not have very good preparation and therefore I need audio visuals.

I am going to talk on soil and fertilizers, give you some examples, specific reference to India, and also on carbon sequestration and how do you do the trading, which has become an issue of discussion here. First of all I want to mention that when carbon is being sequestered, it has several components before it is sequestered. You need carbon to residue; you need nitrogen, phosphorous, and sulfur as well. To sequester 1,000 kilograms of carbon in soil you require eight kilograms of nitrogen additional to what plants need, you require two kilograms of phosphorous and you require 1.5 kilograms of sulfur. If you do not have these ingredients carbon will not get sequestered.

When you talk about the pricing, it is very important that somebody paid the price for carbon, which could have been sold in the market; they pay the price for nitrogen to fertilize or whatever, phosphorous and sulfur. That is how the carbon got sequestered. I did experiments in Africa many, many years ago and I was only putting crop residue up to 32 tonnes and it did not get sequestered. I learned later on I also needed nitrogen, phosphorous and sulfur. Unless you have those, you will not get sequestering. Here is the data from India of the total fertilizer used and the total cereal production over the period from 1961 to 1978. Obviously there is a good correlation between the two, but the carbon in soil decreased, not increased, over that period of time, especially in Punjab and UP. Why? Because the carbon and residue was taken away for wheat and they were burnt for rice and so the ingredients by which carbon will be sequestered in soil were not there even though the yield increased. Here is the data which shows, I mentioned to Dr. Foronda yesterday the nitrogen, phosphorous and production depletion rate in India. A indicates more than 20 kilograms of depletion per hectare per year. B shows 40 to 80, C shows greater than 80. We are mining nutrients even when we are applying fertilizers at a higher rate, and when we mine nutrients, let us say that we are mining 10 kilograms of nitrogen from soil, which really means 150 kilograms of carbon goes into the atmosphere as CO2, for that is where it is coming from.

Here is the data on the mining of potassium in Indian soils. Twenty, 20 to 40, 40 to 80, so we have a negative nutrient budget. When you have a negative nutrient budget you cannot have a positive carbon budget. Carbon, nitrogen, phosphorous, sulfur, water, they all go together and you cannot separate them and therefore we have a problem of mining.

The other part from the trading point of view is importantly is that there is a hidden carbon cost. When you apply input you have cost of carbon to pay for that input. Diesel, by conventional tillers is when you plow, it requires 60 to 70 kilograms of carbon per hectare for plowing. If you do minimum tilling like disking it requires 40 to 45 kilograms, if you do no till it requires about 20 to 23 kilograms of carbon in diesel and farm operations. Therefore if you are sequestering carbon you must deduct those in those parts. Nitrogen is very expensive in terms of carbon. One kilogram of nitrogen fertilizer in manufacture requires 0.9 kilograms of carbon into the atmosphere from fossil fuel, phosphorous about 0.2, potassium about 0.1, lime about 0.4. And the most expensive part is pumping irrigation water. When you are pumping by electricity and if electricity is being used by not hydro-electric but by fossil fuel like

it is done by coal in China and in the United States and other places, it costs about 150 kilograms of carbon per hectare per year. Herbicides are the most expensive, and pesticides. About 5 kilograms of carbon is emitted into the atmosphere to provide one kilogram of herbicide. Fungicides are very expensive.

Now, the residue, this is a rice-based cropping system, the amount of residue produced in Asia: almost 1.5 billion tonnes, and very little of that goes into the soil to put to increase carbon into the soil. The amount of nutrients contained in that residue is about 12 to 15 kilograms of nitrogen, about one to four kilograms of phosphorous, about one to two kilograms of sulfur. Now, most of the nutrients contained in the residue in India are as much as eight million tonnes. Eight millions tonnes of nutrients are taken away from the land when the residue is not returned. Once again we cannot sequester carbon if the residue and the nutrients are not beside.

Another challenge to trading carbon credits, in addition to what I just mentioned of carbon about nitrogen, phosphorous, sulfur and residue which are being taken, is aggregating small landholders at a district level. If you require 100,000 tonnes of minimum transaction cost, how are you going to aggregate 200,000 to 250,000 farmers to do that? Assessing the increase in carbon pool, it is not a carbon pool at one farm, or at one soil sample; it is for the entire district. How do you assess that for a one year period? How do you pay a farmer $2 a tonne, which the Chicago Climate Exchange has now, rather than $250 a tonne with the real prices as I mentioned. It requires all those ingredients which have a price. What are the transaction costs? Right now 20 to 30 percent of the actual cost goes to the dealer not the farmer. And assessing that rather than the gross carbon pool because of those hidden carbon costs I mentioned.

The last thing I want to mention is the challenges to reducing footprint. Ken Fischer mentioned this morning we set up no-till experiments in Nigeria in 1969. Some of the most cited papers I have ever published in the no-till farming were printed in 1973. Yet nobody is doing it. Why? Because the crop residue, which in an essential ingredient, is taken away. Therefore nobody follows no-till farming. Why? Because the fertilizer and the herbicide which are required are not available; therefore nobody does it. Using residue mulch, which has not been the case. Even in the no-till system this morning the graph showing 1.5 million hectares Indo-Gangetic Plain, nobody uses crop residue in the no-till. I will not call that no-till. No-till means leaving the residue on the surface. If the residue is taken, it is not called no-till. I do not know what else you want to call it. And forced controlled grazing. Even when you have a crop harvested, even the neighbors bring their own cattle to graze on whatever is left. As long as controlled grazing cannot be done the idea of keeping the residue mulch on the ground and improving soil carbon just does not arise.

Increasing fertilizer use efficiency through precision farming; using slow release formulation. this morning it was mentioned about putting clay; how about putting zeolites? Zeolites are very essential. How about using nano-enhanced fertilizers so that the leeching losses are much less. Right now the

fertilizer use efficiency for nitrogen is hardly 30 percent. Enhancing irrigation use efficiency which is hardly 30 percent—we have to do that. Reducing losses by erosion, leeching and volatilization, especially N2O with 310 times more global warming potential. And increasing the soil carbon. The critical level of organic matter for soil is one percent to improve the efficiency use of all those inputs. If the fertilizer is less we have a very difficult problem maintaining high yield.

How do you assess sustainability? Well, if your goal is carbon sequestration this is one way you assess the sustainability. The net carbon productivity, net primary productivity divided by all the inputs converted into carbon. And if this relationship is non-negative, positive, over time the system is sustainable from an ecological point of view. Otherwise it is not. Thank you.

Chairman: Our next presentation is on capacity building. Dr. Kobayashi, from the University of Tokyo, Japan. Everybody is taking less time than required. He is not introduced. Dr. Kobayashi has a doctorate degree in Agriculture from the University of Tokyo and is professor of the Graduate School of Agriculture and Life Science, University of Tokyo. So his interest area is atmospheric and climatic impacts on agricultural production. He worked at the National Institute for Agro-Environmental Sciences, Tsukuba, Japan, before moving to Tokyo in 2003. Currently, he serves as the chief editor of the *Journal of Agricultural Meteorology*.

Dr. Kazuhiko Kobayashi, University of Tokyo, Japan: Thank you Mr. Chairman. Let me show some examples which may be interesting or may not be interesting, I am not very sure but there should be a story. I talk about system-wide adaptation, not just farmers or scientists.

I borrowed this very beautiful picture from my colleague Dr. Hasegawa who is not here, now he is in Australia. As you see here, this is the rice seed plotted against temperature in summer in Hokkaido and the message is clear. In the past in the late 19th century to the mid 20th century the rice seed in Hokkaido was strongly constrained by low temperature. But as the efforts of many people like the farmers, agronomists and breeders pushed up the curve, what is more interesting is that now the optimum looks like lower than it was before. So I just wonder if we could do the same thing at the other end of the optimum temperature. So that we can generate this kind of the phenomena to the adaptation or the maintenance or even increase of livelihood against temperature by the adaptations.

I would say that there are many actors which could contribute to this adaptation, not just the scientists, nor farmers, although they may play major roles. I will just show one example from each and there is no need for me to mention this anymore but there are a lot of possibilities of utilizing the mechanism of the heat-stressed fertility in rice because we now know one of the mechanisms which are responsible for this heat tolerance. It looks like we should pick up a variety with the longer “L” in this picture to make them more tolerant. Let me show you an example, a very beautiful example of farmers’ adaptation to change in climate, not necessarily to do with warming but the different kind of climate change in Hokkaido again. My colleagues have found that the soil freezing depth has declined recently as you can

see the “Y” axis depth so that the soil freezing has been becoming shallower and shallower as the year goes. Why is that? They looked up the temperature; no significant trend at all. But when they looked at the earliness of snowfall, there is the significant trend. Essentially this means that they are now having snowfall earlier than before. That can easily explain—indeed that corresponds with the trend of maximum freezing depths. If you just flip over, these trends overlap very beautifully. Having snow earlier and heavier, the soil is blanketed earlier so that the soil freezing has been reduced. That is the mechanism they think and I am very sure. Then, what have the farmers observed? On the left panel, they have found that potato, the previous crop, turned into a pest against their next crop, in this case maize. In this part of Japan the farmer owns a very large area so even this kind of small amount of the previous crop make annoyance or extra cost for them. And then, farmers found the way to get rid of this pest by plowing snow in winter. You see how it works. Now the soil surface is exposed to the air so that they can kill the pest which can survive now under the snow blanket. So essentially the farmers now have got control over the soil freezing so as you can see from—it might not be very clear—some part of their field is here plowed but not all the field so I suppose that the farmers want to have this field killed and frozen and the other part, not frozen and they can do it with plowing snow in winter. So that is a very beautiful example of adaptation to the changing climate by farmers.

The other example—you have already seen this picture—there is a prediction that apple growing areas will be moved to other higher altitudes. But you know that apple trees will not migrate at all; it is the farmer that makes the changes. If you look at the temperature record, we have seen the warming trend in some of these apple-growing areas in Japan. Correspondingly there is a change in varieties or change in choice of varieties by farmers. Originally the Fuji was the major leading variety here in apple, on your left, but some farmers found that the coloring has gotten poorer these days, possibly because of the warmer climate. And some farmers found the mutation which bears much redder fruits. So these red Fuji have become more popular, although the original one still remains for the reason that I mention just next. So you could consider this a kind of adaptation by farmers to the warming trend, but I would say that the coloring is important in some markets. As you see on the left, the apple is probably the biggest export in agricultural product outside Japan. In Taipei of course the apple must be red but in Beijing, the Chinese also make Fuji apples, and it looks like they do not care about the color too much. Indeed, even in Japan some consumers know that the original Fuji, although the color is not as good as the new one, tastes better so their market has no problem with this warming effect. So in a sense the market makes matters and the other way around. The problem of poorer color due to warming is made by the market or by the consumer. That is the point.

Going to a much larger scale, this is a picture I copied from the paper which was used to predict the climate change impacts on the world's under-nourished population. You can see a very beautiful relationship between the amount of food produced and the food required and the percentage of under-nourished. But, I would say that you should not assume the same in relationship holds 50 years from now. Indeed, we have to reduce the curve downwards as I show you here, for better distribution

of food amongst the population. Otherwise we have too many crops here and too little food there. We should be able to solve this problem by not just increasing the production but realizing a better distribution system.

So my recommendation here may be too arrogant for you leading scientists but is simply this: think globally and act locally. I would interpret those two phrases in this way. Consider all major challenges you would face for the coming decades. As I mentioned here yesterday it is not really wise to concentrate only on climate change. And I would just mention the next two slides would be just the example I will show you. But act locally. I mean connect with wealth, connect better with the farmers and other actors in the food systems so that it is not just the scientists who can play a role in the adaptation of the food system to climate change. But other actors could be even more efficient in making adaptation. Just one of the major challenges we are going to face especially in Asia is that Asia is now the world's number one in terms of nitrogen oxide emission. And as you see, in North America and Europe, the amount of nitrogen oxide emitted from fossil fuel combustion has been stable or even declining. But in Asia, it is going up further and I do not think it would stop in 10 or 20 years. The consequence is that it increases surface ozone concentration. Two years ago I managed to scare the Indian colleagues by showing this picture of the dark spot on the Indian sub-continent. I am very sure that the reference climate or reference atmosphere for you in 2020 will be quite different from what your simulations assume. By the way, the ozone is one of the most damaging air pollutants at a large scale now and in the future, and I would say that the impact of ozone would be much larger in the impact of climate change than CO2 increase, at least on a regional scale, not a local scale. That is all I can show you.

Chairman: Thank you, Dr. Kobayashi. Our next presentation is on policy and social sciences. Our panelist is Osamu Koyama. I can introduce Osamu Koyama. He has graduated from the faculty of liberal arts, University of Tokyo and joined the Ministry of Agriculture, Forestry and Fisheries. Then he served as an econometrician at the Food and Agriculture Organization in Rome. His expertise is in the area of food supply and demand analysis. Currently he is the director of the Research Strategy Office, JIRCAS. Dr. Koyama, please.

Dr. Osamu Koyama, JIRCAS, Japan: Thank you very much, chairman. My talk will be limited within my duty, which is policies in social science. Here we are talking about the Asia Pacific region so we must know what the differences are between the Asia Pacific and other regions. As you know, we have a dynamic economy and diverse stages of development; various kinds of countries exist and we have diverse cultures and social backgrounds and highly populated. This means–this expression is very peculiar–we are very much advanced in finding problems. We have plenty of problems because we are highly populated. As you know, in agriculture we have small-scale farming and monsoon rice-based farming and diverse farming systems based on rice and various crops, and many other constraints in agriculture because of resource constraints and population pressure. So, the Asia Pacific needs its own

framework against climate change. We, as Asia-Pacific people must think about our own type of options that must be flexible and dynamic because our economies change and it must cover diverse players because we have various kinds of advanced countries, developing countries, and various countries. And we are small farmer-based, so collective actions are fully utilized. We must promote cooperatives and community-based actions.

So, the role of social scientists is very critical but research has not been very active as you know in social science. I would like to explain the reason. From the famous reference in the area of economics, from the Stern Review, the main message is as follows: the benefits of strong, early action on climate change outweigh the cost. I do not want to argue about this message, but the importance is the middle. The methods they used are aggregated techniques and economic models and marginal cost benefit analysis. Because, for example, the cost benefit analysis—the benefit we expect is in the long term future and on a global basis. But cost incurred is very local and we have to pay for it at this moment in time. So there must be long distance, so we have big challenges in doing upgrading, disaggregating, aggregating or we have to think about the discount rate, interest rate and so on. That creates various kinds of problems in research. Huge challenges. Not only for the cost benefit analysis, but also for assessment models. There are many uncertainties, as Prof. Wheeler already explained, between crop models and aggregated yield, or temperature precipitation change and planted area. All unknown. Besides that, we do not know the relationship between supply demand and malnutrition, or poverty reduction and so on. That cannot be modeled exactly at this moment.

So one solution we are facing is a sophistication of modeling. In JIRCAS, we are doing very sophisticated modeling work, stochastic models, done by Dr. Furuya my colleague is doing risk assessment using probability type modeling. But that is not enough. At the local level, we must introduce economic incentives as many previous speakers mentioned. For example, to promote good agricultural practice or water pricing policy I know that giving incentives to players such as farmers, consumers and so on. For example, if we introduce such mechanisms as carbon sequestration in soil or methane emission reduction that can be a promoter. Fortunately, in this area, the Asia Pacific, multi-functionality, these economic incentives means–it is very difficult to explain but externality, you know we must create market for other intangible things; that is what we call internalization of externalities. So this kind of study has already been done heavily in this area, so we have some experience. And the introduction of the business mind by introducing carbon trading as Prof. Lal already explained, or carbon tax, not only climate change tax or climate change subsidies and so on.

So we must also study the third option. We must study the new mechanisms such as emission trading systems which is already done in the EU because it is a relatively homogeneous country, it can be easily introduced. But in Asia how we can introduce this kind of emission trading system? And again a clean development mechanism which is a very powerful tool now. But unfortunately, 50 percent credit goes to China and India now. Instead of clean development they call CDM a “China development mechanism,”

because in the future more than 50 percent of credits will go to China only. So we must think about the utilization of this mechanism in other countries in this area. For getting credit we have lots of potential areas in agriculture. And also climate insurance or regional stock reserves, we should also study these kinds of policy setting. We are proud to say that we are about to obtain credit by introducing a small-scale agro policy project in Paraguay. The detail is written, introduced in this newsletter but this is the first case in the world of organizing small scale farmers and then accumulating the effect of afforestation, so this is a very epoch-making thing.

I would like to raise one other question to all of you. This is a famous graph of grain price the future grain price with temperature rise. Some researchers say it will cause a decline in the future. Some say if temperature rises by 5 degrees it will rise by 40 percent or 50 percent. But as you know we have recently experienced a price soar, a price hike of more than 300 percent, so the 40 percent in 2050 does not mean much. An 800 million malnourished population exists now at this moment. They are suffering. And then analysts say there will be additional several millions of malnourished people in 2050. That is not so meaningful. An Asian diet and crop have been and are being diversified significantly. We stopped eating costly grains and we are moving towards a western style. Diet has completely changed. So a several percent reduction in 2050 does not mean much. I do not want to say climate change is not so important. I would like to say something is wrong. Some expression is wrong from the current assessment. There must be a more severe thing in local phenomena like sea level rise or denudation and salinization and so on.

So in concluding my talk, the research priority for global and local contributions: our Asian researchers must also contribute globally. One is custom-made incentives suitable for the Asia and Pacific region. The second is global—this is very important because we must assist to get the agreement globally, then we will benefit. So instead of interfering with the global commitment, we should create credit which can be used and traded. And we can get this from the advanced countries, so this is the point. The third point is since we have tremendous amounts of problems in agriculture, global warming, like Prof. Kobayashi said, or climate change is not the only problem, so which mitigation adaptation measure should be done with mainstream research. For development we must tackle what mitigation is for. And finally, researchers must actively participate in policy formulation. Thank you very much.

Chairman: Thank you Dr Koyama. Our next and last presentation on regional and international cooperation and the panelist is Mark Holderness. Mark is a plant pathologist and has a doctorate degree from the University of Reading, United Kingdom. He worked for many years in plant pathology at IPM. Then became increasingly involved in bio-diversity research, learning and institutional reforms. He worked for PMG, Cocoa and Coconut Research Institute and then for CAB International, working in a wide range of tropical agricultural systems. He is now the executive secretary of GFAR. Mark please.

Dr. Mark Holderness, GFAR, United Kingdom: Thank you, Mr. Chair, and also thank you to Dr. Koyama for having very nicely introduced what I am about to say. I would like to try in 10 minutes to

wrap up the bigger picture, if you like, of how agricultural research for development needs to get to grips with these issues, and the sort of relationships that we need between all of us to make this happen in practice. Just as we have heard for the last two days, it has been very instructive for me and has reinforced my belief that we cannot go on as we are. Business as usual is not an option. We have heard so many very compelling and very well-argued cases that we are facing changing climates in a world where we have changing demographic pressures. We have changing food habits, changing land uses, changing agricultural water resources, losing soils, losing the best soils to the creeping advance of cities where our people are going and a loss of the local knowledge that has sustained our systems for generations.

And the bottom point there is the one I would really like to draw your attention to if anything here. The poor are the ones who are losing out most. And this is not just me saying it; this has come through from all of you in your international expertise, through the Intergovernmental Panel on Climate Change, through the high level conference held in June this year at FAO, through the international assessment on the role of agricultural science and knowledge for technology and development and the world development report. All happening this year; all having the same underlying message that we need to get to get to grips with these multiple challenges: of increasing agricultural productivity to feed the world; of increasing incomes; making agriculture a viable living. And deal with all of this in a world where there are no further certainties.

And underneath it all, we have to focus on the poor. We have to focus on insuring they are going to get the food they need, that societies are not broken down by agricultural changes, and that the environment continues to sustain agriculture for generations to come. And I would like to particularly to ask the question this afternoon of what kind of institutions do we all need to be working in to meet these challenges. And I would like to emphasize, as I think Masa said earlier, it is not just about what happens in scientific research, it is what happens in innovation in farmers' own fields. Farmers have been innovating for centuries, but they are constrained. They are constrained by the resources they have, they are aware of the risks that they face every day. These are what shape their decisions. But knowledge, the knowledge that we can generate as those working in agricultural research can empower farmers to actually make those choices; to make a difference for themselves.

And so I think very much that we have to bring together these two really contrasting knowledge systems. The knowledge from science that is reductionist, that is trying to get to the finest detail. That is trusted and validated by its own belief system, its own means of replicating results. Farmers have their own knowledge system. It is very holistic. It is trusted by what their predecessors did, what they have seen last year, validated by their own experience, their own culture and their own knowledge. And so the challenge for all of us is to link these two together to get the best of both, because if we are going to get to sustainable development—and I am really quite depressed that in the last six months the focus on sustainability of development had gone right out of the window as we focus on dealing with

the food price crisis—we have to bring it back into the frame. And to do so we have to bring together the innovation of all of these players to really make things happen on the ground and on the global scale.

Here is my first attempt at absorbing what I have been hearing the last two days in terms of what are the things we need to be thinking about in an agricultural research system that deals with climate change issues on a national level. Clearly it is shaped by the international context. If we start from the top down, it is shaped by national policies, national development processes. Public research and extension institutions have a huge role in this. But so also do those in other sectors, in industry and transport and forestry. Business plays a huge role in shaping the market, shaping the sort of practices used. And civil society organizations are always there to bring things back into a different perspective and put the society at the front. I have put the farmers in the dead centre of the process. Not just the farmers though because it is also consumers. It is also all of us in the processes we do on a daily level that can shape things and change the way that food is produced.

Out of all of that I have been hearing we need to know more about the weather prediction, not the climatic prediction, the local weather prediction to help farmers to make those informed decisions. We need to define our research priorities and actually get on and implement them. We need the knowledge systems that will make that knowledge accessible through to farmers. And we need to help farmers to be able to deal with risk, with real risk of major shocks to their systems. And those require social organization they require service providers on the ground to be really active in linking these systems together in order that those bottom five can be met. The environmental sustainability; we can produce enough food to feed people and get it around to people; we can enable food security for those that are disadvantaged; and we can make local livelihoods and national economies stronger through it.

So to turn to how does this play out on a global level, or regional level, we have again I think to put the farmers and consumers at the centre of these processes. We as agricultural researchers serve the farmers. Otherwise we have no business being in this business. We have to look at how we can mobilize all of these layers: the service delivery agents, whether they are called extension officers whether they are called input suppliers; those who support them; the knowledge generators at a national level, the national research systems; the international players, the CG and so on that we have been hearing about; and the science generators, those who are coming from way outside agriculture. Probably the biggest technological advance in agriculture in the last decade has been information technology. It has been nothing to do with anything that has come out of our laboratories. It has come out through access to knowledge and the means to mobilize information and really make it work. So we need to pull these players together. And from my perspective, keep the poor in mind in all that we do.

But this is not easy. Let us face it, is not easy. We have all of these barriers that stop us communicating with one another, which stop us from working effectively with one another. Who controls that knowledge? Who is aware of it? Is it in the right medium? Can it be read? Is it relevant to the local

context? Are there institutional barriers? Are our societies, the attitudes of our societies barriers in themselves? And this was why the global forum for agricultural research was established and indeed why APAARI within this region was established before that. To start to bring together different perspectives to bring these different voices together so that we are actually sharing and exchanging experiences and knowledge to make agriculture better for the future. And this movement—and it is a mass movement—relies on all of you because all of you are in this and can gain from it. Bringing farmers right to the centre of the process; engaging civil society in constructive argument in making sure that those perspectives of the disadvantaged are put dead centre; revitalizing national systems if they have been under funded and neglected. We have heard earlier that it has been 25 years or so since the World Bank last bothered to look at agriculture. We need to get the institutions resourced, refunded, and brought back to being valid and viable to meet these needs that I am talking about. The private sector is a huge player. We have to recognize that farmers are entrepreneurs. We are dealing with market systems in all that we do whether or not there is a cash market. The international centers, again, connecting those activities we have heard about back so they are adding value to the national systems. And the basic research is driven by real underlying needs. This is also really aimed at the funding bodies. Because unless we get them engaged in these processes, agriculture will continue to be neglected.

So how is this organized? Each region has its own representative body. They are structured slightly differently but they are all there as platforms, as inclusive, open platforms for everyone to play a role in. And those come together under GFAR, but it is important to emphasize as someone said earlier, “Think globally, act locally.” All of these processes must be driven by national needs and below that by community needs in order to then shape. A global agenda is simply the sum of all our parts.

And so in terms of objectives, these are the areas that I would say we really need to be working together in. We need to be working together to address the future needs of agriculture. To advocate for change beyond these walls, beyond this often rather cozy and introverted community of agricultural science, we need to be out there mobilizing awareness, informing people of the crucial relevance of this. Where was agricultural science when the food price crisis hit? Why were we not there a year, three years before, making people aware that this was on the horizon? We need to shape institutions that will deliver these very difficult and very complex goals. And that means opening the walls of our institutions, opening up to new partnerships, to new waves of working, where those two forms of knowledge get united. We can do a lot more in learning between regions to really short-circuit these processes, to make sure that the advances that are happening in Asia can be rapidly taken up in Africa. As we have been hearing in this international meeting, the knowledge that is being developed in institutions in Europe can feed in and enable transformation in this region. And we need to also look very much at how we are communicating. How we are sharing this knowledge around. Getting away from the scientific paper. I am not undermining the scientific paper but it is only one form of communication. We need to be really linking, using new media, and new ways of getting messages across.

My function, Raj Paroda's function, we are here to help these things happen by creating these forum platforms. But it is really down to you. If you want to see a viable agriculture, and you want to see a viable role for agricultural research within shaping that future, then you have to be the ones to take action. You are the ones who are drivers; you are the ones who understand the issues. You have got the power to shape it all and I would urge and plead with you all to use these mechanisms to really bring this argument alive in the much wider public, to inform those who we are seeking to help as intended beneficiaries of all that we do, and to really make a difference in this world. Thank you very much.

Chairman: Thank you, Mark. I may now request the panelists to take their designated seat please. And also may I know request Doctor Keatinge to please go ahead.

Dr. John D. H. Keatinge, AVRDC: Thank you to all the speakers. There were some pretty blunt statements made, some slightly shocking pictures shown, and a very nice wrap up at the end by Mark. But that is not the end of the process; we now need to hear from you. May I suggest you ask your questions if possible directed to specific individuals. If not I will try to get an individual to answer the question. Who would like the first question? Yes, sir.

Dr. Ghodake: Sorry, I think I may not have a question, but a small comment with your permission, chair? I think that we talked about a number of issues this afternoon. One important direct indication when we talk about climate change: it is related to risk and uncertainty, today and tomorrow. Now, if you look at the current prices of agricultural products and outputs worldwide, developed and developing countries, they are artificially decided. Number one is that consumption, particularly basic food items, must be cheaper. And so we talk to poor people and when we take into consideration the economies of poor people, generally we tend to say that food must be very cheap. And that is how we have under-valued agriculture in the world. Now we do not have any mechanism of correcting that. As we all know, food is not a perfectly tradable commodity unlike many other items. Now if you look at all these things, is there any possibility to really discuss this particular issue and bring the realistic price of agricultural outputs in the world? And what do we do about that? So if you talk about all the different areas that we have covered, this goes back to the right pricing of agricultural outputs. We want to really help poor people, at the same time not by reducing the prices, but there should be optimal prices by taking into consideration risk and uncertainties to which agriculture is exposed. Thank you.

Dr. Keatinge: I take that as a comment; do we have a specific question now that could deal with that subject? Is anybody willing to answer the issue of are we paying enough, or should we be paying less? I guess it is a consumer versus producer argument, but it is something that we need to get the right balance for if we are going to deal with alleviating poverty at a general level. Would you like to go? Go for it.

Dr. Koyama: Yes, I agree with you that some prices of products are not properly decided. Some are decided by the government, some are biased by the market powers, such as big companies as so on.

But I would like to raise two points. One is to increase bargaining power of farmers is very important. In Japan farmers' organizations are very strong and I think that helps to gain the proper price. The second is the proper evaluation of agricultural services, which is not taken into account in the market. We call that multi-functionality. We should include that kind of function into the market. That kind of mechanism should be created through policy setting. Thank you very much.

Dr. Pham Quang Ha: I have one comment and two questions. The first comment is about the modeling. According to my knowledge, modeling is not only for production but modeling is to understand the process. For that reason I would like to ask Reiner Wassmann how can he believe in modeling? And what is the property of the same modeling that we in scientific research can believe? The second thing: global warming comes from mankind's activities mainly. If we believe that, scientific research in agriculture sector cannot solve their questions. This maybe comes from industry. Farmers cannot manage the work, but farmers fit the work, so the question is for this period we are facing financial world crisis. What is the impact for agricultural production and for agricultural research? Thank you.

Dr. Keatinge: So, do we have a volunteer on the panel to answer those questions? Yes we have one volunteer. Go for it.

Dr. Koyama: The second one may be beyond the scope of this symposium, so I ask somebody else to answer it. This first one, I am a modeler, so the credibility of models, the robustness of the model maybe some other professionals can answer. Yes, the process is very important. The process of thinking and copying the actual market and world in computers is a good process of thinking, as well as a good process of simulation. For example, if you change the inputs of the model, then we can get a different kind of outcome. So, I think that modeling is essential too for us in order to deal with climate change. But, we must explain the limitations and assumptions to the public. That is the duty of scientists. Otherwise that outcome misleads the opinions and policy making. Thank you.

Dr. Holderness: Well, I will not attempt to answer the financial change issue, but I think it is quite salutary to look at what is actually beneath that, a loss of confidence in the markets. Fundamentally, stocks and shares are essentially a means of gambling on confidence. When we look at the issue around the food price crisis in June, I was very struck by the political reaction to that. Clearly it became an immediate political issue for many countries. I think there was something like 30 countries that had riots on the streets. Obviously the governments have acted in a reaction to that. But I am very concerned that that reaction is a very short term measure. It is one that is about "Let us get inputs bumped up very quickly, let us put in seeds, let us put in more fertilizers," and perhaps therefore increase our climate problem. There is very little indeed in providing long term sustainability and long term solutions, and that is where this community needs to be a lot more mobilized to actually getting these messages across. Because at the moment, I can tell you from the discussion I have seen in FAO, there is very little real substance in discussion beyond the immediate crisis. And I think that is where the

politicians need to be informed and not to let drop the food problem in the case of the financial problem. They are both still with us. Thank you.

Dr. Keatinge: Raj?

Dr. Paroda, APAARI: Indeed it has been a very thought-provoking session, and many useful ideas have come. We always say wisdom comes collectively. I would just like to, as chairman, for the sake of bringing up front what various speakers have mentioned, and the key messages that have come. I have my question at the end. Masa did mention that we need to have implementation at the field level. And adoption would depend on economical considerations. I think Wassmann also said we need now tangible case studies on the ground. So the message is coming that we need to do something now, quickly and immediately; the time is otherwise running out. Dr. Lal did emphasize very clearly that farmers will have to be compensated for whatever we are expecting him to do, good agriculture. And in that context whether it is incentive for carbon sequestration or whether for going for no-till farming and so on I do not have to repeat all those, but many important issues were flagged and Dr. Kobayashi said that all challenges have to be not put in isolation but be put together. And climate change should be part of the overall challenges on agriculture. So, it is not that we are looking at only climate change but as was said pricing and bio fuel agriculture, food production and so on have to be looked into in totality. And Koyama brought out many useful points. I must really compliment him for excellent analysis. But he had flagged very basic issues that there is something wrong in the assessment that we are making, whether it is the crop modeling, whether it is in the context of assessment of all these changes, emissions etc. This is my question, that if we have the concerns with regards to assessment, how do we refine them? And the main point which also came, and Mark also said, was that we need a knowledge system. It seems that we really now need to have some mechanism for exchange of knowledge. And, proper knowledge; knowledge which is evaluated, not only information for information's sake. So in this whole exercise, I would request of the panelists who are very well experienced, what is road ahead now? Could you kindly tell any concrete two, three or any issues on which we can think of future action and the road ahead? Thank you.

Dr. Keatinge: Thank you, Raj. That has made it in a very pointed fashion. Is there anybody willing to rise to the challenge in the panel to suggest one or even two things we can do over the next couple of years that is going to make a substantial difference? Go for it.

Dr. Lal: Raj, that was an excellent summary. I think one thing which obviously we have realized and repeatedly said here is that the task involves a multi-disciplinary approach and multi-institutional approach. I do not think that any single discipline or any single institution can really address the question that we have very huge question facing on a global scale. That is why, as sometimes mentioned this afternoon by at least two panelists, “Think locally and act globally,” and I was wondering really whether we need to reverse that. Think globally, because it is a global issue. It is really a global issue that we are talking about. Climate change is not a local issue; climate change is a global issue.

Whatever has been happening in one part of the world is going to affect the other part of the world. But at the same time we have to act on that global issue at a local scale, because the farmers are the ones who are going to adapt it. So I think that sometimes what was said was very nice, but I am wondering in the context of our current scenarios if we have to interchange that. So that is one philosophy I was going to suggest.

In terms of implementing that philosophy, I think the Challenge Program that Ken mentioned today, obviously no single institution can do everything, if it is a CG or a NOR. We really need to involve NOR, CG and the developed countries institutions, dealing with at least five issues. We have got climate change which we are focusing on; we have certainly soils, we have water issues, and we have vegetation, with the crops, pasture, and trees. We have livestock. Those are the basic five ingredients that we need to address. But at the same time we have got policy issues, we have got human dimensions, and we have got economics and information technology. So I think that the challenge may be a program which we have mentioned that there is funding for. Perhaps that is where some really good project involving a multi-institutional and multi-disciplinary approach needs to be developed.

Dr. Kobayashi: I think there are many things we can do, and we should do. Just to give you two examples. Say if you want to really seriously estimate the impacts of global warming, I mean temperature rise on your crop, rice crop, say for example in your own country, India or China, you must know when exactly the rice plants come to the flowering stage, which is the most sensitive stage. But surprisingly this kind of basic information, when your farmers' plants come to flowering stage across your country is often lacking. In China, I am very sure that no one has very good figures about the exact, or may not be very exact but say a few days precision. They do not know the timing of flowering across China; no one has that data. And also the other example. I am very much interested in these days the change of diet which may have a much bigger impact on agricultural production than population growth in coming decades. But, even if you look at these East Asian countries like Japan, Korea, China, no one has a very good estimate of how much food, what kind of food we eat every day. We only have our FAO food balance sheet. That is quite far from sufficient to know what people are actually taking every day. So, my suggestion is we should start with something very basic to know ourselves much better and that is basic. That is my only suggestion in this case.

Dr. Keatinge: I recognize that we have an appeal for knowledge here, but I was also thinking back 10 or 15 years when I was one of the young acolytes of the farming systems movement, where we decided that we would have to study everything before we could make any progress. And we ended studying everything and everything and we never made any progress. So I feel that we do have to take a limited knowledge set and take it forward if at all possible. Not that we may not need to know the flowering dates of particular crops in China, but we have to make sure that is the most important thing we need to know if we are going to go and have a mass effort at collecting it.

Sorry, we have other questions coming in now, so let us get more from the floor rather than the panel. Maarten is next.

Dr. Maarten Van Ginkel, ICARDA: May I be so presumptuous as to—I know the panel is also answering questions, but to answer your question sir, we need to invest more in agricultural research. We do not know what the solutions are going to be to the problems that we are facing. We need to enable an environment in which we pay more to agricultural research in individual governments. And the people in the panel, and many here, can contribute to that. Developing countries, on average, invest only one tenth in agricultural research what is invested by the industrialized countries. That is one. And that we can do. Second, we need to get smart minds into agricultural research. I mentioned that this morning we have a lot of smart people in other areas and they are not coming to agriculture. We need to catch young people at high schools and at universities and get them into agriculture. And those are two examples of what you can do, and the panel can provide a third one.

Dr. Keatinge: Thank you for that. Next please?

Yusoff bin Abduladin: Thank you chair and distinguished panelists. I just have two general questions. My name is Yusoff, I am from Malaysia. I would like to see the agricultural production in a different perspective. So we look at two main components. I think that people who are familiar with modeling understand this very well. We are talking about governing, we are talking about limitation and we are talking about reducing. So we talk a lot in the last two days on the governing factors of agriculture production. We are talking about temperature, we are talking about carbon dioxide, and then we also talk about limiting factors, such as water, such as nitrogen and other nutrients. But one of the things that I think the conference lacks is addressing the issues of pests and diseases. These are the factors that are reducing the agricultural production, because with the rising temperature with this more favorable environment I will see that these pests and diseases will be more prevalent. So we may have a species or a variety that has tolerance to high temperature, tolerance to these harsh environments, but we cannot escape from all of what we call pests and diseases. My question is, is there a planting mechanism or is our farming system prepared for this thing? Because some research indicates that the monoculture has the drawbacks. Maybe the mixed farming probably or we are talking about agro-forestry, a mechanism that can probably minimize this sort of what we call risk.

My second question is: The first panelist mentioned about and everybody here has mentioned about the risk, that the most risk will be with the farmers. How do farmers adapt to this climate change? It boils down to money matters. So we are talking about, for the last two days we are talking about listening to these eco-system services or multi-functionality. I think this is good as something that probably has a future and I believe in it. But there must be a lot of quantification. I do not know how much quantification has been done as far as this multi-functionality or as far as these eco-systems are concerned. And it has to be like Prof. Lal mentioned; it has to be converted into what we call the dollars and cents. Thank you very much.

Dr. Keatinge: Thank you very much indeed. Let us ask Masa and Reiner to tell us, have we paid sufficient attention to diseases, viruses and insects? Or is this one of these nasty things that is just about to jump upon us anyway?

Dr. Wassmann: Ok, whilst we acknowledge that diseases will be a problem in the future, I think it is very difficult to give any predictions on that. The nature of disease and propagation and the future climate of diseases are really more complicated to have any kind of field experiment on. Of course we can think it in terms of life cycles, of insects, there is some work on that. And it is indeed really frightening that we can expect to have three life cycles of many insects in places where the third generation will really hit the rice crop, for example at the maturity stage. But other things, for example distribution of insects, will depend on future atmospheric circulation and those kinds of things. And if we consider all the unknowns and the different level of uncertainty that we have, then it is really rather a daunting task to make predictions on that. I think what we can say is that it will be certainly a stronger problem than in the past and that we have to adjust our measures. For example, integrated pest management has to become more flexible to react to situations. So whilst we cannot predict the situation as such, I think it is fair to say that we have to see that there will be a necessity for a constant adaptation of integrated pest management.

Dr. Keatinge: Do you want to add anything to that Masa?

Dr. Iwanaga: Not really, actually I would like to respond to the question from Dr. Paroda where you had a question about giving some basic suggestions on what we can do in terms of future action. I was thinking about putting some specifics in my talk, but due to time constraints I did not. What I thought is the role of APAARI, which is a platform for information exchange among Asia-Pacific participating countries. And you produced a very nice series of brochures. It is a success story, starting with baby corn in Thailand. I was wondering if you can produce something similar by picking up some of our examples of our farmers adapting in a positive sense to new challenges about climate change. Dr. Kobayashi shared with us some very positive examples, taking the example of red Fuji, how Japanese farmers are adapting. So if you can compile those practical examples and also some analysis On what kind of information or technology was available at the time of the farmers taking some decisions. And then look at the other reflection on whether it was a good decision or not and what factors tell us that we could do better, or finding some gaps, and what the gaps which research needs to respond to. So if we can look at those things, and APAARI to compile or coordinate and submissions to be made by participating countries, in that way we can share our experience and information.

Dr. Keatinge: Thank you. We still have a second question on the table now, from Dr. Yusoff. Perhaps Dr. Koyama might like to comment. I guess the question was, never mind all this biological research, it is only dollars and cents which count. Do you feel that you can respond to that challenge or not? The question as I understood it from Dr. Yusoff was that really, in reality, all of this science and stuff does not

make much difference. It is the dollars and cents that counts to farmers, and that is what we should be paying attention to.

Dr. Koyama: Ok, farmers are concerned about income, I agree. So in the high income countries, already the governments introduced various mechanisms to compensate farmers' services though income subsidy or through environmental payment, and various mechanisms, insurance systems also. So, the farmers in developed countries are well off. That kind of system should be prevailed also amongst the other countries.

I would like to respond to Dr Paroda's question about something wrong in assessment. It was intentional that I made such a provocative message, but the same as poverty indicators or hunger indicators, the average numbers do not say much about the severity. So the severeness in global climate change is in regional, local events or extreme events. But if we merge into a global level, it does not show the severity. So, the model is ok based on the best knowledge we have now. I think modeling is ok, but the way we are expressing the result is not a good way. I think we should provide case studies at the same time. The local thing and extreme events we must include into them all eventually, but at this moment we have to show at the same time. That is my suggestion. Thank you.

Dr. Keatinge: Dr. Ghodake is next.

Dr. Ghodake, Chairman, APAARI: Thank you chair for allowing me to come back again. I think I have got a small comment as well as a suggestion. We talked about a number of issues that are related to resources available to agricultural development worldwide. And I think there was a comment made by Dr. Ginkel here also on investment in agricultural research.

If you look at global climate change, it is a big global issue. It is affecting globally, regionally, and nationally. When we talk about how we address this, there are a number of issues and a number of levels we should be addressing. At policy level, at macro level, at global level, then you come to the strategic level, then you come to the individual research and development project level.

So we are all talking about the research and development level here. We are talking to each other, but we are not possibly talking to those who are responsible for making decisions for agricultural investments in general and for agricultural research investment in particular. And I think this particular forum, when we talked about GFAR, APAARI, a number of national bodies, we should be talking to those people and that will be the immediate impact mechanism. As we know, world agricultural development has been brought to the centre of the development agenda this year, after 26 years of absence. Now, somehow people are realizing that agriculture is important. Regional, global and national programs must be talking outside of this forum, talking to other people, maybe talking to policy-level people. Ministers like the GFAR executive secretary was talking about FAO meeting, but nothing happened after that. So there needs to be some kind of canvassing. How do we attract more investment

in agricultural research and development, as well as agriculture per say. So I think we should be serious about that and take it further.

Dr. Keatinge: I think your point is legitimate; however I am not sure that it is necessarily down to us. Most of the people in this room speak to decision makers, help create policy and all the rest of it. So I think that we do our bit. I happen to know that when the British Prime minister went to the Rome meeting, he gave his people who are advising him three days notice to come up with something new. Now, if we are dealing with things at that type of rather frantic level, I do not know that the political masters really take this stuff seriously, as they should do. Masa has been advising the government of Japan, I understand, about what they might do as far as this is concerned. I believe that we are responsible for making those sorts of statements. But let us face it, it took the most powerful man in the world at the moment more than 10 to 15 years to absorb the issue that human activities were causing climate change. We all got the message very early, but the big man did not. Is that down to us, or do we have to now present our case in a different way so that in fact people start to understand what we are talking about.

Dr. Ghodake: I think that is exactly what I was trying to say. That individually efforts cannot be taken up, but collectively we can make a difference. That is why we are here. Various nations, regional programs, global forum. So collectively there must be pressure, not individually. When you go individually then you are one among a number of sectors, but when you are collectively going, then possibly you can make a difference, and that is what we are trying to say. We have to use collective bargaining power as well as collective knowledge and information. So we have a lot of information in this group, but how do we use it for somebody to understand outside of this particular chamber? That is important.

Dr. Keatinge: Now would one of the panelists like to say how we should use the information? Mark, the politician, will step forward.

Dr. Holderness: Well obviously enough I completely agree with what Dr. Ghodake has just said. I think the other thing that we need to be better at as a community of scientists is learning to express ourselves in a more public way. I think it is part of our handicap of being trained to always be cautious and always be conservative in what we are saying, and always having to back it by the final ultimate probability of being right. But the rest of the world does not think that way. It is again this science and society gulf, and I think we need to become a lot smarter at using new media in particular, using things like video. We did some work in Bangladesh with the Bangladesh Rice Research Institute and IRRI, which through very simple seed cleaning practices as we heard about also from ICARDA gave a 15 percent yield increase across hundreds of farmers. But by training women—and it was the women who did the seed work—to spread their message in forms that other women wanted to hear, suddenly this knowledge became established on national television. It has now gone into West Africa for use in rice there and so on.

So I believe very strongly that we get the institutions we deserve. If we do not go out there and say that there is a value in agricultural research and extension and so on institutions, then why should society value it? We have to make the case for investment through our actions and through spreading the word of what we have achieved and why it is so crucial what we do. The world will not come knocking to agricultural research.

I think the same point applies to Maarten Van Ginkel's very apt comment about why there are no young scientists coming through. It is the same problem. We have not created a world in which agricultural research is seen as a valuable occupation, that what we do is seen as relevant and crucial. And yet, so many others in related disciplines are making those cases. There are no shortage of environmental scientists, no shortage of people desperate to work in conservation. Where is the desperation to work in agriculture? I think we need to get much better at our messaging. As Dr. Ghodake said, the problem, very often, is that individual institutions are going to speak to a policy maker and are immediately tainted by that perspective that you are after money for your institution, or you are after whatever role for your institution. And I think that it is this collective issue that comes through very strongly. And it is not just research, it has got to be civil society, it has got to be farmers actually making these cases so that the investment follows the demand.

Why is agricultural research not valued in the same frame as schools or road building? Why is it that developing country budgets for agriculture are much below those in other areas? We have to get smarter. We have to use all the techniques available for people that are using to communicate in so many other industries except agriculture.

Dr. Keatinge: Thank you. We actually have a senior decision maker present and he is going to speak next. Dr. Tusneem is a member of the planning commission for Pakistan that is a very senior post. He can decide, so he is going to tell us whether he is convinced or not.

Dr. Tusneem: Thank you very much indeed. That is what I was thinking, because I wear a different hat now when I go back. I mean it had been intellectually very enriching, enlightening discussion. And I think great nourishment for our future endeavor in research. But when I go back, if my deputy chairman asks me, "What are the two or three things we can implement in climate change to make a difference over the next five years?" what should I tell him? I think that is what I would like to see in the concluding session. And then if I ask for more money from him, “This is something the research has discovered so far which is implementable at the national level or at the farmers’ level, and we can proceed with it, but at the same time there are many issues which are researchable and for that we need additional funding,” I think that would be very persuasive to seek more funds for research. But if I just say there are a number of issues raised and we need to do more research before we can come up with any solutions I think I am not going to get anything. Thank you.

Dr. Keatinge: Well you can have my list afterwards. Prof. Gowda is next.

Prof. C L Laxmipathi Gowda, ICRISAT: Thank you. I think that we are becoming more and more selfish. As researchers we are talking of doing more and more research when some people said, "Oh, we have enough research already." What it needs is how the farmer is going to be benefited. In many of the developing countries, the survival of the farmer depends on whether his field gets enough rain in a particular season. So I think that what we need to look at is, yes research is important but how that research is immediately applied to the farm level? That is going to be much more important than doing more research. I think we should be looking at that also. Research is important; we have also to have our own bellies filled. But the millions of farmers who are there, I think, need immediate attention also. I think this is what we also should be debating, rather than just talking only about research.

Dr. Keatinge: Thank you for that. I am glad Ken Fischer has left the room otherwise you would be out of a job I suspect.

Dr. Wassman: I would like to add one more aspect towards the question of communication what was already elaborated on, very eloquently I found. I think the aspect we should also keep in mind is lobbying, and lobbying the case of agriculture, agriculture research, and also generally action to be taken within the framework of climate change and all the regulations that are coming and have been set.

So, one example, we have heard a lot about carbon financing and carbon credits here. I am not sure if it is aware to everyone in the audience that the land use is explicitly excepted for being eligible for any CDM project, unless it is for forests. You know in Marrakesh there was a whole discussion on what actually constitutes a forest and there is even some definition in the Marrakesh accord, but in other words, whatever we are doing in curtailing emissions will not be eligible for any CDM project.

It is quite clear this is now the current regulation, it is not carved in stone. What people are talking about now is what some people call the post-Kyoto regulation, and others say wait a minute maybe it is even within the Kyoto protocol but then let us call it the post-2012 regulation because the current commitment period goes until 2012, and then there has to be something that will be after that.

So in other words, right now people are discussing on the regulations that will be in the period beyond 2012, and next year there will be a decisive meeting in Copenhagen where essentially these things have to be hammered out if you consider a bit of lead time in that regard. Where are now the lobbyists of agriculture? Are they in the meetings where these regulations are actually set? Are they trying to make sure? Or who are the lobbyists in fact? Who is trying to bring the cause of agriculture into that picture? And as long as we do not have that, that we do not bring these issues into the existing regulations it will be very difficult ever having mitigation projects because they simply cannot be funded, at least not through the CDM mechanism. There may be other ways of funding, there may be foundations, but this has nothing to do with this carbon financing itself.

Dr. Keatinge: Thank you. Yes, that is Rattan Lal. Then I am going to ask before you speak, I am going to ask Prof. Wheeler who is sleeping at the back a question. Can you respond, Prof. Wheeler to the issue that Prof. Kobayashi raised about ozone? Is ozone more important than climate change? That is the question at a regional level that we need you to be able to tell us in terms of modeling. Please carry on.

Dr. Lal: In article 3.3 of the Kyoto Treaty, soil is not accepted as a tradable commodity. The Hague COP-6 meeting European Community rejected soil to be included in this. Last June the European Commission had a meeting called "Can soils make a difference?" and they desperately said they changed the opinion, that yes they will now lobby for soil to be included. So far it is not.

The only mechanism for trading carbon credit is the industrial private organizations such as the Chicago Climate Exchange, such as the World Bank. The prices are very low. The European market that trades, as somebody mentioned today, it does not trade soil carbon. So right now it is a matter for discussion to lobby.

The second point I just wanted to mention: somebody said we must attract the brightest and the best in agriculture. Many land-grant universities in the United States have been faced with that problem. We have the poorest GRE scores, the poorest GPA scores. Here are the reasons, the information found: the salary of an agricultural graduate is 20,000. The salary of a computer graduate is 50,000. The salary of an engineer is 100,000. The salary of a medical doctor is 300,000. Unless you change the salary structure, which indicates the price of a graduate, you are not going to attract the brightest and the best. That is a very simple answer.

Somebody said about the research since the 1950s, 1960s and 1970s that there is an excellent body of knowledge on what to do on erosion control, conservation agriculture, farming systems. There was a Belgian report that came out of INEAC, "Can primitive farming be modernized?" An excellent report on what was done in the 1950s and 1960s. That knowledge was never adopted. We need to find out why the knowledge that has existed for the last 50 years is being ignored by farmers. In spite of all the conferences we have on conservation agriculture, we have only 100 million hectares at the moment on conservational agriculture, out of 1,500 million. Let us find out why farmers are not doing what we know so well.

Dr. Keatinge: Right, Prof. Wheeler are you ready to rise to the challenge and tell us whether the ozone effect is being properly taken into account in the big modeling?

Prof. Tim Wheeler, University of Reading, United Kingdom: Right, thank you for that. I think I was the furthest away from everyone from the microphone over there. I am not an expert on ozone, but it is something that people have drawn our attention to in the literature in the last few years. The direct effects of high daytime ozone concentrations at ground level are to cause damage to the photosynthetic apparatus. It is thought, or at least there have been a number of studies on soya bean, that suggests

that the damaging effects of ozone may be greater under elevated conditions of CO2. Now that is on the plot level, and the kind of experiments that are done to investigate these are those that use the open-top chambers like you saw in a number of talks.

The difficulty we have though is in scaling that up to a regional or country-level assessment of the effects of ozone. That is more difficult because there are much greater spatial differences in the distribution of ozone. Concentration rises during the day time; it is not there during the night time. It is a locally controlled concentration rather than a global concentration such as the concentration of CO2 within the atmosphere. I think it is right to draw attention to this as a challenge for the future. It gets mixed up within the climate change argument. But it is yet another environmental stress that we need to consider amongst other environmental stresses in that wider sense that we discussed here at this meeting.

Can I make one more point, Mr. Chairman, now that I am standing up and have gone all the way to the microphone. We use the term climate change rather loosely, and I think deliberately so in meetings such as this. Two points on that: one that I think we should always remind ourselves that we are talking about climate variability and change, and that there are natural sources of climate variability as well as those due to human activities. And perhaps more importantly we should think that there is a time dimension to climate change, and also a spatial dimension. The impacts and adaptation options to climate change will very much depend on how far we are looking ahead and what part of the world we are concentrating on. In the short term, there are parts of the world where agricultural productivity will benefit under a moderate amount of climate change, but in the longer term we will start seeing negative impacts starting to overcome those. So it is very much a time dimension to climate change, there is not just one uniform challenge that we face to agricultural productivity.

Dr Keatinge: Thank you for that. Yes, sir?

Prof. Kobayashi: Maybe some people have got the wrong notion about the size of the spatial scale impact. Just last week I joined a meeting in Hanoi, and they were talking about hemispheric transport of this air pollutant. So, this is the regional or even continental scale issue, not just urban pollution impacts. The other thing is that last year we had the very high ozone episode in spring, in May, in a very remote western island of Japan, which came clearly from China, so it is at least a trans-boundary across East Asia, and you could easily imagine that this air pollution covers the whole sub-continent of India. That is very likely, so it not just a small scale stuff.

Dr. Keatinge: No, I understood that. Prof. Aggarwal, and you are next, at the back.

Prof. Aggarwal: My comment is back to the very interesting discussion that we just had in relation to the comment that Dr. Paroda made, what exactly can we do now? Of late, we have been interacting a lot with policy makers back home. We have made several presentations to parliamentarians. The key

problem that comes when we talk of climate change we talk of scenarios of 2050, 2080, 2020, something that is distant on the horizon. Politicians by the nature of their job have a time horizon of two years, three years, a maximum of years. They really do not see what exactly they can do now. Unless we relate future climate change that we have talked about, not as a discreet event, but as a continuous event and related with current climate equilibrity, for which there are some actions possible, possibly we will not get enough attention. A key point that we believe from a work perspective is risk management. That is something that we really need to do. Indeed a lot of research is already done on that area; what is needed is implementation, and for that money is needed. For example, insurance. Time and again this issue of insurance comes up. What we need is to increase the penetration of these types of instruments like insurance. The key problem is who pays the premium. One possibility is that we can perhaps lobby for the creation of a global fund that can be used for the risk management of farmers in developing countries. Thank you.

Dr. Noble: I just wanted to make a comment, and it pertains to what Prof. Lal was alluding to. The problem of adoption of more conservation-based agricultural production systems, why has it not been adopted by farmers? I think there is a very simple answer. If you cannot show quick and tangible outcomes to a resource-poor farmer within a single growing season, the ability to adopt a new approach is effectively zero. And I think that is the fundamental problem we are facing in everything we are doing from a land and water resource perspective. If you cannot actually demonstrate a quick and tangible outcome to an individual who is going to be putting a lot more labor, possibly costing him something, there is no hope that he is going to adopt it. I think that is the challenge for us. How do we actually change this nexus? We have this huge tool box out here and really if we could, I think have significant impacts. It could solve all of the problems we are talking about. But the problem is getting it out there. And that problem is one that none of these things, except probably high wheat yielding variety or rice variety will be adopted, because it does not offer a quick response.

Dr. Keatinge: Prof. Gowda, would you like to say something about that, because ICRISAT has considerable experience in this area in water sheds and it is not as depressing a situation as has just been made out to be. I believe that there is a positive story to be related.

Prof. Gowda: Ok, there are possibilities where technologies are available, and some of these technologies can show an immediate impact. It may not be in one season but at least in two seasons. In one season also it is possible, but not as dramatic as it is. What we are looking at is in a normal watershed, farmers who are at the downside of the watershed get the most benefit because that is how the water flows, the erosion and the silt and other things flow. But if we can have technologies where we can harvest the water in smaller watersheds, but all along the top of the sequence and use that water and also ensure that the farmers get those benefits are the ones that will encourage them to use these technologies in a much faster way than otherwise. Because normally, as you have seen, any natural resource management technology to show effect takes between six to 12 years and even 20

years, and farmers cannot wait as mentioned more than one or two seasons to see the beneficial effects.

Dr. Keatinge: If I can just add from experience there are two vital things in the equation. Social empowerment and equity, and without those two things nothing took off.

Dr. Lal: In the 1980s the Mississippi River was carrying large sediments. There were very serious problems, and the only solution was taking highly erodable land out of cultivation, 40 million acres in the United States. They enacted a law called Conservation Result Program. The idea was to pay farmers $50 an acre, so they would not cultivate it. It worked. We have 1.5 billion hectares of land on which we want to have conservation agriculture adopted. Most farmers in the United States said give us $10 per acre, and we will do it. 1.5 billion hectares will take 15 billion hectares to adopt conservation agriculture. Why can we not do it? That is the only way it is going to happen. Pay up front but eventually when it works, recover the cost back. If you do not pay, it will not be adopted. CRP was exactly the same. Somebody has to pay. The farmers are putting the fertilizer, everything else, they are taking the crop residue away, and if we want them to put the residue back they want to tie up the nitrogen, phosphorous and sulfur, somebody has to pay the price. Society gains, society pays. No payment, no implementation.

Dr. Keatinge: Right, we have five minutes left before we go for our cup of tea or coffee. Please we would like individuals to make very short snappy statements towards the end. If they want to get anything of their chest, this is the moment.

That means that all the problems are solved and we can go home and not worry about it. I cannot believe that to be the case, let me get something off my chest then. I believe that if the money that is being spent in Iraq and on the War on Terror had been invested instead in a war to eliminate poverty we would not be sitting in this room today, because the poor would not exist anymore. How is it then we can generate that type of political will which in fact means that we can in fact solve these problems. I spend most of my time worrying about can I get enough money to keep the institute running. Not on, can I solve the problems of climate change or this that and the other thing. And to me that is nonsense, but that is the way life is at the moment because there is not sufficient political will out there to allow me and all the other people in this room to do their jobs effectively and get on and solve the problems. And I do not know what the answer to that is, but if anybody can tell me over coffee I would be only too happy to hear it.

Now I have got that off my chest, would anybody else like to do the same? We have a stunned silence down on the panel here, who are obviously anxious for their tea. We still have three minutes I am not letting you go until 16:00. Come on Mark; let us have a Rallentando from you then.

Dr. Holderness: Well I think you have said it yourself just now. The money is out there in the system. The problem that agriculture has is its profile and it is not seen as the issue, and that is why again it comes back to collective action; it comes back to all the voices being heard in every opportunity and in every way. I was very struck interacting with Greenpeace on the international assessment process because I asked Benny Harlin, if I can quote him, at the end of that process, "Ok, we are now taking GFAR forwards, the global forum. What do we have to do to get the level of public attention that Greenpeace gets?" His response was "Create a crisis," and frankly, sad but true, the only reason agriculture is back on the map at the moment is because of the crisis and if we let this moment slip, then we really only have ourselves to blame for not following through on all the interest that has been generated.

Dr. Keatinge: Well, let me leave you with a positive message because I am not sure that that was particularly positive. It is rational, but not positive. The one thing that I have learned from these last two days is that there is a huge number of talented people in the room. They are all working fit to bust. Whatever problems that are put in front of the agricultural research community over the next 20 years, there will be a response to that which is positive and effective. I only wish like Maarten that we could attract young, bright people with lots of good money and plenty of equipment into the industry. But if that is not the case, and we still have to fight onwards then I believe to be optimistic and to believe in ourselves and the fact that we have the capacities to solve problems is something that we should not take away, and not think that it is a very light conclusion. Because there are many more problems in other industries, the finance industry, etc. But in the agricultural research sector, we have problems, but we have the capacity to be able to rise and address those problems effectively. And that is the type of optimism that I believe that all of us need to take away from this conference.

Lots of work has already been done to solve the problems of climate change; lots of that is waiting in the wings. Bring on the problem, and I believe that we can also offer the solution. But the message also is we have to work together, we have to be clear, we have to communicate and we probably have to do things in different ways than we have done them before. But that does not mean we should leave the room in a depressed fashion. It means that we should be ready and confident to carry on this noble crusade, if I can call it that, that we have all been involved with over our career, and the fact that I may be emotional as far as this is concerned I believe is appropriate, because if you are not emotional then you will not win your crusade.

Thank you very much.