

ICRISAT and CGIAR 35th Anniversary Symposium
"Climate-Proofing Innovation for Poverty Reduction and Food Security"
22-24 November 2007

Day 1: Thursday, 22 November 2007

Keynote Address on
Climate Change in next 50 years Dr Martin Parry

**“The Implications of Climate Change for Crop Yields,
Global Food Supply and Risk of Hunger”**

Day 2: Friday, 23 November 2007

Chair: Dr Dyno Keatinge (ICRISAT)
Rapporteur : Dr P Parthasarathy Rao (ICRISAT)

IFPRI

“Agriculture and Food Security in Asia: The Role of Agricultural Research and Knowledge in a Changing Environment”
Drs M Rosegrant, C Ringler, S Msangi, T Zhu, T Sulser,
R Valmonte-Santos and S Wood
----**Presented by Dr Katharine Raabe**

BIOVERSITY

“Changes in Climate will modify the Geography of Crop Suitability: Agricultural Biodiversity can help with Adaptation”
Drs Annie Lane and A Jarvis
----**Presented by Dr Kwesi Atta-Krah**

CIP

“Implications for a Warmer, Wetter World on the Late Blight Pathogen: How CIP Efforts can Reduce Risk for Low-Input Potato Farmers”
Drs Gregory Forbes, R Simon and C Crissman
----**Presented by Dr Gregory Forbes**

Discussions:

1st paper by IFPRI presented by Dr Katharine Raabe

The discussion was on:

- **Crop improvement and yields in marginal areas**
The rationale for stagnant yields in marginal areas was questioned since yield improvements in favorable areas have had substantive spillover effects. Improved

varieties were seen as not the only answer. Fertilizer and water use were also other critical components of productivity. It was claimed that in marginal areas, it was management and not breeding that had failed. It was suggested that land availability is not the only limiting factor to agricultural growth and that cropping intensity, crop diversification and market opportunities also play an important role. Further investment in infrastructure was claimed to be needed to meet the future challenges of climate change.

It was agreed that the relative failure of extension efforts in India represents an institutional bottleneck and that there was a strong need to integrate marketing issues to ensure the value addition of basic agricultural products.

- **Use of the IMPACT model**

Questions were raised on whether the IMPACT Model takes into account large-scale irrigation projects, incorporates environmental externalities sufficiently, assumes that water shortages are exacerbated by climate change, that sea levels will rise in Asia, makes any assessment of the competition for land and water and accounted for labor issues

- **Different scenarios and the main message of the paper**

The speaker was asked to reiterate the three main scenarios discussed in the paper and to underline the paper's main message. The response was:

Scenario 1: Business as usual.

Scenario 2: Step up investment in agriculture.

Scenario 3: Besides agriculture, invest in governance, social structures and education.

Investment in agricultural research has to increase hand in hand with investment in infrastructure, extension, education and health. Agricultural research must reach farmers through more rural investment. It will be necessary to shift the supply curve to the right in order to ameliorate the likely impacts of climate change.

2nd paper by Bioversity International presented by Dr Kwesi Atta-Krah

Questions were raised on the impact of climate change on biodiversity, its possible loss and the shifts in potential cropping patterns that might occur. What are the likely implications for pests, diseases and livestock? The responses were:

- **Biodiversity**

A community level approach for the poor is best as they gain the most from using available biodiversity. Use of the maximum amount of genetic diversity in biotechnology and breeding was a sensible policy if robust improved varieties are required. Yet, the monitoring of biodiversity is a relatively new discipline using modern science tools and remains a fledgling endeavor. Genetic conservation for livestock is much less well developed than for crops.

- **Shifts in crop suitability**

Regarding crop shifts, we should be able to suggest a climate analogue. For example, to which other states in India might further sustained high temperature days in Punjab

be compared? Andhra Pradesh? We may also have to think of how one crop might replace another due to its better environmental adaptation. The implication of such a replacement will also be likely to have significant effects on the maintenance of biodiversity. The System's resilience will be a key element and diversity will play an important role in ensuring this as we believe there are no silver bullet solutions to the problems likely to confront us.

Further research on the socio-economic aspects of the shift in cropping areas must be undertaken. One participant noted a crop isn't necessarily grown in an area where it is best suited but rather it is grown where no other crop is suitable!

3rd paper by CIP presented by Dr Gregory Forbes

Discussion was on

- **Technico-physiological dimensions**

The difference in the resistance of the two pathogen populations was raised as an issue. While the spread of potato blight in hotter and wetter climates was acknowledged, would it now be possible to grow potatoes there at all given the changed environmental conditions? Are new diseases and pathogens likely?

The presenter indicated that the newer late blight population is more aggressive and tends to replace the older one. He recommended quantitative resistance to counter the spread but indicated there was presently a need to know more about variability in major genes. The attempts to use quantitative resistance as a strategy had been successful in test fields but when tried in the real world were less effective than expected. It was acknowledged that as the climate got hotter and wetter, the cultivation of potatoes was apt to shift to greater elevations and while there were attempts to breed low altitude, high temperature potatoes, these efforts haven't been very successful to date.

- **Further research and alternative methods of controlling the spread of the blight**

The use of bio-control to restrict the spread of blight was raised as a question concerning its feasibility. It was also pointed out that gene resistance has returned as a strategy in place of quantitative or horizontal resistance (due to transgenics) and the prospect of using gene pyramiding to increase resistance was good. The presenter responded that there had been moderate success in controlling blight using bio-controls in tomatoes under greenhouse conditions, but the presenter was unaware of any that had been successful on a large scale. He indicated that resistant gene pyramiding is a major focus of much research now.

- **Breeding for market requirements**

A question was raised as to whether there were attempts to blend breeding for market preferred traits such as potatoes for frying with resistance to blight.

The presenter acknowledged that it was a current focus of research and indicated that it was viewed as a very knowledge intensive problem.

Chair: Dr J Hughes (AVRDC)

Rapporteurs : Drs M Chadha (AVRDC)/M Samad (IWMI)

ILRI

“Vulnerability, Climate Change and Livestock – Research Opportunities and Challenges for Poverty Alleviation”

Drs P Thornton, M Herrero, A Freeman, O Mwai, E Rege,
P Jones and J McDermott

---- **Presented by Dr J McDermott**

CIFOR

“Using Tropical Forest Ecosystem Goods and Services for Planning Climate Change Adaptation with Implications for Food Security and Poverty Reduction”

Drs J Nkem, H Santoso, D Murdyarso, M Brockhaus and M Kanninen

---- **Presented by Dr H Santoso**

Discussions:

4th paper by ILRI presented by Dr J McDermott

The discussions centered primarily on the adaptation of livestock and livestock systems to harsh environments. The need to breed animals, especially cattle, which were adapted to hot climates like those in Rajasthan and CWANA, was raised. The presenter stated that much work had been done on this aspect.

The need for early warning systems was also highlighted. Assessing future scenarios is important especially those capable of including the social and poverty aspects of development. One way to get a better understanding is to examine what is happening in a prevailing extreme environment. The need to get reliable spatial indicators was also highlighted. The role of livestock in future-needed adaptations to climate change, especially in Africa, was discussed.

While there is growing recognition of climate changes and a need to provide communities with evidence of climate change, the benefits of various diversification strategies need to be assessed. Finally, the issue of tradeoffs between various management options was discussed, especially the need to look at options from different perspectives, from farm to System-wide. This then has a chance of coping with the expected complexity of the development challenge.

5th paper by CIFOR presented by Dr H Santoso

The issues of degradation of forest cover and of the increasing incidence of forest fires were discussed. It was pointed out that in many instances forest fires were largely due to human action, especially burning of forests for agriculture by poor farming communities. The need to offer them an alternative to this practice was discussed. In many countries, current adaptations to deal with climate change may, it was thought, change over the next decade. Knowledge of community vulnerability to climate change challenges is low and local governments need to look at regulations that can help local communities to take on the better informed management of forest fires. The prospects of using formal and informal networks,

especially womens' groups, to enhance the capacity of local communities to deal with climate change was highlighted. It was suggested that the emphasis on increasing awareness of the problem is also an excuse for effectively doing nothing. It was pointed out that in the case of trans-national boundary forests as in Africa, those who benefit from the goods and services from forestry should also be those who have the management responsibility. Therefore, it is important to ensure that local communities are well empowered to manage their forests. The need to work with NGOs also to conduct policy network analysis both at the national and local levels was highlighted.

Chair: Dr D Hoisington (ICRISAT)

Rapporteurs : Drs CLL Gowda/KK Sharma (ICRISAT)

CIMMYT

“Overview on Crop Genetic Engineering for Drought-prone Environments”

Drs R Ortiz, M Iwanaga, MP Reynolds, H Wu and JH Crouch

--- **Presented by Dr R Ortiz**

AVRDC

Improving Vegetable Productivity in a Variable and Changing Climate

Drs R de la Pena and J Hughes

---- **Presented by Dr J Hughes**

Discussions:

6th paper by CIMMYT presented by Dr R Ortiz

- There is a need to develop better screening methods to identify traits that contribute to drought tolerance in crop plants. It is important to characterize the various components that might contribute to drought tolerance and final grain yield. At CIMMYT, while detailed yield evaluations of the transgenic wheat with *DREB1A* gene have not been carried out as yet, the initial trials distinctly showed better growth under drought conditions.
- Since drought is a polygenic trait, any single strategy based on transgenics or MAS may not be sufficient and we need to look at a holistic approach incorporating these tools with plant breeding. So far, molecular markers have not contributed significantly towards this goal except in the generation of new knowledge. DREB being a transcription factor, it can control many native genes in a plant and induce them to provide drought tolerance, and seems like a very promising approach when compared to a single gene approach for imparting drought tolerance to a crop. Many CGIAR centers including CIMMYT, IRRI and ICRISAT have been using DREB with very encouraging results.
- To overcome the problem of low expression in a dicot of the DREB gene in wheat, new collaborations have been initiated between CIMMYT and JIRCAS, Japan to use various drought inducible promoters and enhancers to increase gene expression.
- In the case of self-pollinating crops where sufficient variability for drought tolerance is not observed, association mapping could be useful to find specific chromosomal regions contributing towards drought tolerance.
- It will also be useful to look into new traits that could contribute to drought tolerance, especially in cases like maize that are vulnerable to drought stress during flowering.

- At CIMMYT, while there has been a lot of work and progress on documenting various traits like QPM and disease resistance, a lot still needs to be done on establishing the efficiencies of QTLs for drought tolerance. Efforts are ongoing to enhance the genetic base by developing synthetic wheat, which can be very useful for genetic enhancement of wheat following proper characterization.
- There is also a need to look at the fact that many times, the plants that are drought tolerant also tend to have more yield penalty.
- Regarding the question on how far away we are from having a breakthrough in drought work based in transgenics, it seems that one private sector company has already announced that they are likely to introduce drought tolerant maize across the globe within the next 10 years. There could be some opportunities to work with such private companies to better use the technology, especially for the developing countries.

7th paper by AVRDC presented by Dr J Hughes

Improving Vegetable Productivity for drought-prone environments

- In addition to crop improvement, future efforts should also concentrate on crop management (agronomy, etc) aspects of improved productivity.
- Drip irrigation for vegetable production to increase water-use efficiency is becoming popular. Cost effective drip systems are now available. However, the technical backstopping for maintenance of drip-irrigation system is essential in many areas especially in sub-Saharan Africa.
- Apart from tomato (which was taken as an example), there are other high-value vegetables that need to be addressed vis-à-vis climate change. These need identification and prioritization of constraints to be addressed effectively (for example, heat stress is important for leafy vegetables).
- Global warming has a considerable effect on pests and diseases. We need to ensure safe transfer of germplasm (across countries) to ensure that new pests/diseases are not introduced. Although effective seed health and quarantine systems are operational at IARC headquarters, support is needed for regional and country offices.
- Although drip systems enhance WUE, we need to consider the total use of water, as water will be a limiting factor in future. We need to consider payment for use of water more comprehensively.
- Producing safe vegetables (reduced use of pesticides) should be emphasized, in addition to crop breeding and agronomic management.

Chair: Dr Kwesi Atta-Krah (Bioversity)

Rapporteurs : Drs S Twomlow/ SP Wani (ICRISAT)

IWMI

“Facing Climate Change by Securing Water for Food, Livelihoods and Ecosystems”

Drs C de Fraiture, V Smakhtin, D Bossio, P McCornick, C Hoanh, A Noble, D Molden, F Gichuki, M Giordano, M Finlayson and H Turrall

---- **Presented by Dr C Chartres**

Discussion:

8th paper by IWMI presented by Dr C Chartres

There is increasing evidence that certain areas of the world are experiencing increased incidence of drought – a clear signal of the impact of GHG emissions, eg, the last six years of drought experienced in south-eastern Australia. The IPCC is in the final stages of drafting a briefing document for governments that clearly outlines the impacts of future climatic change on water resources. Unfortunately due to a lack of quality data it is still not possible to, as yet, predict with any confidence future weather patterns that enable robust planning. However, we must not lose sight of the fact that climate change is already impacting upon today’s weather, and we cannot wait for tomorrow. Consequently, it is not a waste of resources to plan for worst case scenarios now and invest in water harvesting structures in the rainfed areas for both supplemental irrigation and potable water sources. Already, farms in Australia are investing in water harvesting tanks for supplemental irrigation, etc.

In summary, the emphasis for all future activities must be a more crop (plant/animal) per drop strategy. The challenge is to see how resources/incentives can be made available to vulnerable communities most at risk in the developing world to make use of the plethora of existing interventions that can enhance water productivity for them. One major activity planned for the next 5 to 10 years is Phase II of the Water and Food Challenge Program that will prioritize the transfer/promotion of the best bet practices to selected basins (6-8 sites). Many of these proof of concept studies and promotional activities that will be facilitated/catalysed by the CGIAR will provide the necessary inputs into national, regional and global policies on mitigation.

Day 3: Saturday, 24 November 2007

Chair: Dr R Ortiz (CIMMYT)

Rapporteur : Dr HD Upadhyaya (ICRISAT)

ICRISAT

“Exploiting the Functionality of Root Systems for Dry, Saline, and Nutrient Deficient Environments in a Changing Climate”

Drs V Vadez, L Krishnamurthy, J Kashiwagi, J Kholova, JM Devi, KK Sharma, P Bhatnagar-Mathur, DA Hoisington, CT Hash, FR Bidinger and JDH Keatinge

---- **Presented by Dr V Vadez**

ICARDA

“Increasing the Resilience of Dryland Agro-ecosystems to Climate change”

Drs RJ Thomas, E de Pauw, M Qadir, A Amri, M Pala, A Yahyaoui,

M El-Bouhssini, M Baum, L Iñiguez and K Shideed

--- **Presented by Dr Raj Paroda**

ICRAF

“Adaptation to Climate Change through Sustainable Management and Development of Agroforestry Systems.”

Drs KPC Rao, LV Verchot and J Laarman

---- **Presented by Dr. KPC Rao**

Discussions:

9th paper by ICRISAT presented by Dr V Vadez

Nutrients and water interaction with respect to root trait efficiency and variation in root traits associated with drought tolerance; how to breed for such root traits is an issue that needs further research. The new approaches being developed at ICRISAT have potential to use fewer resources, thus possibility now exists to use selected root traits in breeding programs on a limited scale. It was argued that trait-based selection coupled with use of marker-assisted selection could minimize any yield penalties associated with drought tolerance. Transgenic groundnuts with the DREB gene were showing profuse rooting under pot conditions at ICRISAT.

It was suggested that further effort be placed on assessing the role of soil microorganisms in promoting water extraction and utilization and that exemplar species with high root biomass such as some grasses might be used as models in root studies especially under elevated CO₂ conditions.

10th paper by ICARDA presented by Dr Raj Paroda

The presenter was asked whether the Regional Coordinated Program model through NARS, that suits ICARDA very well, is or is not particularly appropriate for adoption by other CG Centers given the need for region-specific models of agricultural research. Likewise, whether he thought ICARDA's model would permit close interaction with the private sector and NGOs?

The presenter responded that there was an obvious need to work with natural systems that occur in regions particularly under farmer conditions in order to ensure significant research impact. For example, research on supplemental irrigation and the judicious use of water in the Nile Valley Regional Program has helped to raise crop production in the countries associated with this ICARDA Regional program.

There was demand for more simulation studies to expected climate change in such dry regions and effort to develop strategies to replicate better the results of station trials to on-farm conditions. As an example in Kenya the speaker indicated that *Lathyrus* (grasspea) performed well under drought prone conditions but varieties with zero neurotoxin were requested for upscaling.

11th paper by ICRAF presented by Dr KPC Rao

A commentator stressed in an agroforestry context the issue of whether labor use could be sufficiently minimized to be practical and the need to ensure sufficient system profitability for small-scale landowners, especially in relation to the potential profitability of other dimensions of crop husbandry.

The speaker was asked what approaches were needed to enhance biomass production in changed climate scenarios? He indicated the need to address climate change at a mega level when considering agroforestry situations and the requirement to better define the introductory elements required by the system to address climate change with respect to agroforestry. A better understanding of the drivers of climate change and what drives the uptake of agroforestry technology (breeding and management) was also required to mitigate adverse effects of climate change.

Chair: Dr J McDermott (ILRI)

Rapporteurs: Drs Cynthia Bantilan (ICRISAT)/P Bezkorowajnyj (ILRI)

WARDA

“Exploiting Partnerships in Research and Development to help African Rice Farmers cope with Climate Variability”

Drs B Manneh, P Kiepe, M Sie, M Ndjiondjop, NK Drame, K Traore, J Rodenburg, EA Somado, L Narteh, O Youm, A Diagne and K Futakuchi

--- **Presented by Dr B Manneh**

IRRI

“Climate Change Adaptation through Rice Production in Regions with High Poverty Levels”

Drs R Wassman and A Dobermann

---- **Presented by Dr R Wassman**

Discussions:

12th paper by WARDA presented by Dr B Manneh

- Would introducing such systems, as SRI rice, be an alternative approach for drought tolerance? Should you consider different systems and the importance of using SRI to reduce water use? --- Using the SRI system still has its sceptics and people have come to different conclusions regarding the results. This usually derives from the need for high labour inputs and the intense management effort needed to implement the system. IRRI

and WARDA are both working on the potential of aerobic rice systems and some SRI rice but this is not a priority.

- How can partnerships with other IARCs help WARDA efforts in sub-Saharan Africa? --- Considering that we need support from groups working with agro-meteorology and GIS more and more, to help us disaggregate some of the big global predictions down to a regional basis, what we then also need are socio-economists to do some of the modeling to identify potential ex-ante assessment of likely future scenarios. We have to determine how to link different models such as crop simulation models, household socio-economic models, and the institutional models to come up with future scenarios for policy makers at regional levels to help them examine where future investment may be required. This is a major challenge because we are short of such skills. We have to ask ourselves “What is the capacity of the individual Centers to do that? How do we handle this in the future?”
- A commentator indicated the seriousness of the nature of work on adaptation and mitigation. The centers carrying out research on climate change proofing should set their priorities more distinctly. The question of climate proofing for adaptation is very important but neither should we forget completely about mitigation issues. However, as far as the core priorities of the CG are concerned, we need to put our first efforts into adaptation issues. In the draft proposal of the proto-challenge program on climate change it stated that mitigation was included only if it helped farmers generate income from such activities. Therefore, only if donors are willing to pay for specific carbon or methane emission studies can they be undertaken, otherwise mitigation research is not deemed to be in the current main stream. It was noted that less than 10% of rice in Africa is irrigated so methane emission from these sources is not much of an issue presently.
- The impression was given that the native African rice species flowered at a different time of the day than for *O. sativa*. What is the hypothesis as to why that is so, and is there any evidence in terms of genomics that would help in the search for these characteristics? --- Flowering time information came from WARDA’s physiologists and came from a limited range of samples. As yet they have not gone further into the study to look at such things as the genomics and controlling traits through adaptation. But it is an important area and will be looked into further.
- Partnerships with WARDA are very interesting. What were the partnership arrangements necessary to make the seed available in the development of the NERICA rice varieties?-- - Access to good quality seed has been one of the major drawbacks of the new technology. However, one of the issues of debate in the CGIAR now is defining an appropriate balance between science and development. Therefore the Centers don’t have a clear mandate to follow this path. As a result, WARDA is partnering with private institutions and NGO’s especially in Uganda and Benin to get them involved in improved seed production. We also try to partner with development networks funded by IFAD and ADB to provide access to good quality seed for farmers.

To what extent has WARDA been exploiting the population material produced from the research from both WARDA and IRRI, and to what extent has this been constrained in the context of Climate Proofing and adaptation. We have a good collaboration with IRRI and have received much material already with drought tolerance – 2 varieties with important traits have already been adopted by many farmers in the dry zones. Also, a consortium of experts “the Drought Frontier Project” has been created by IRRI to discuss ways of bringing technologies together to combat drought.

13th paper by IRRI presented by Dr R Wassmann

- How is rice seed distribution handled at IRRI? – Reference was made to an ongoing project for seed distribution in Bangladesh in collaboration with IRRI.
- How is it that additional carbon dioxide could make things worse? —The issue of excess carbon dioxide is interconnected with the inherent interconnection between the plant physiology and the yield.
- Might varieties that are generated with traits to overcome so many problems such as tackling the increase of temperature finally end up without good yields? – The crop varieties are developed for specific environments, which are defined using geographical information and likely future trend projections. We have to deal directly with this issue and give it primary importance.
- Through the Rice and Climate Change Consortium (RCCC) what strategy has been devised to relate climate change with issues such as salinity, pests and resiliency? — IRRI feels there is no need to start from scratch but look only at the point of climate change proofing at this stage. An example of work in the Mekong delta was highlighted.
- The issue of rising sea levels and how to tackle these situations was raised- Utilizing the NASA's work and data would bring much needed information to bear on this issue. Experiments taking place at IRRI and its collaboration with other research institutions on the consequences of rise in sea-level were described
- A comment was offered about the importance of CO₂ enrichment research in support of climate change proofing studies, especially those that involve field trials, which now have to be given the utmost importance.

Chair: Dr Y Ramakrishna (CRIDA)

Rapporteurs : Drs P Pathak/Piara Singh (ICRISAT)

CIAT

“Climate Proofing Agricultural Research Investments”

Drs P Jones, A Jarvis, G Hyman, S Beebe and D Pachico

---- **Presented by Dr P Jones**

WORLDFISH CENTER

“Enhancing the Resilience of Inland Fisheries and Aquaculture systems to Climate Change”

Drs E Allison, NL Andrew and J Oliver

---- **Presented by Dr E Allison**

Discussions:

14th paper by CIAT presented by Dr P Jones

The discussion focused on the point that we need to develop technologies (eg, crop varieties) that will help in the short-term to solve immediate problems as well as in the long-term considering the impending climate change. This would require modifications and flexibility in policies for providing larger benefits to the poor. The proposed challenge programs on climate change will focus on key issues of climate change, but it will not cover the entire spectrum of these issues. Clearly, research in business-as-usual mode is not going to be enough. Therefore, the climate change agenda needs to be mainstreamed into the CGIAR research system and people will need further climate change research orientation. There is also the need to incorporate climate change aspects into poverty, sustainability and livelihood analyses related to population, markets and policy. As farmers do not see small gradual changes in climate, we need to help them cope with both larger episodic events and gradual changes in climate.

15th paper by World Fish Center presented by Dr E Allison

Questions were related to the need for climate-induced modeling of fish production in relation to changes that are taking place in the oceans. There is also a need to manage coastal areas in the light of climate change and variability, particularly involving the occurrence of large storms. There is also a need to update vulnerability maps for the people engaged in fisheries in order to help plan strategies for adaptation to climate change. The issue of missing data on fish production and related information for some regions was discussed. A need was felt to strengthen this activity substantially. There is also need to integrate better fish production with mainstream agricultural production systems.

Chair: Dr BI Shapiro (ICRISAT)

Rapporteurs : Drs SN Silim (ICRISAT)/ KPC Rao (ICRAF)

IRI, for Climate and Society, Columbia University

“Innovations in Climate Risk Management: Protecting and Building Rural Livelihoods in a Variable and Changing Climate”

Drs JW Hansen, W Baethgen, D Osgood, P Ceccata and RN Ngugib

---- **Presented by Dr. JW Hansen**

ICRISAT

“ICT-enabled Knowledge Sharing in Support of Extension: Addressing the Agrarian Challenges of the Developing World Threatened by Climate Change, with a Case Study from India”

Drs V Balaji, SN Meera and S Dixit

---- Presented by Dr V Balaji

Discussions:

16th paper by IRI presented by Dr JW Hansen

17th paper by ICRISAT by Dr V Balaji

Weather based agro-advisory services: Providing location specific agricultural advice based on a critical interpretation of agricultural implications of historical climate variability as well as climate forecasts is a viable option to help and guide farmers and other stakeholders make better informed decisions. Weather based agro-advisory services being implemented in India was cited as an example of such an intervention.

Operational problems with insurance: Index-based insurance has the potential to become a viable alternative to traditional approaches of insurance for agriculture with the main benefits coming from income smoothing and access to credit. However, limitations cited include lack of secure networks (within 20km) to collect the required weather data (reliably following the acceptable quality control standards), non-availability of historical climatic data (30 years or more) to quantify climate related risks in various enterprises, and the possibility of data tampering. Inadequate availability of met stations was identified as an important constraint during the gap analysis conducted by IRI and concerted efforts are required to improve this situation. Data collection through satellites was mentioned as an alternative.

Access to and availability of meteorological data: Access to climatic data is a major problem in most developing countries. Meteorological data collected by national meteorological services is not a part of the public domain and is very expensive to buy. This to some extent is constraining the use of climatic data by various user groups. Options for mainstreaming meteorological services need to be explored probably by encouraging partnerships between meteorological services and user departments.

Institutional issues for up-scaling: One major limitation in using forecasts is timely access to information. At present this is constrained by lack of institutional arrangements that facilitate sharing of information and coordination of actions among different stakeholders.

Adaptation through ICT4D: Agricultural extension is under tremendous pressure. Declining public investment in extension services are eroding their capacity to deliver effective and efficient services. ICT has the potential to transform the way extension is done by linking a broad range of institutions and stakeholders and by facilitating a two-way flow of information. ICT based extension is considered to be more effective since it contributes to the sourcing of information directly from authorized institutions and individuals. This not only reduces the number of layers involved in making the information available but also avoids the

possibility of loss or misinterpretation of information. Some successful examples of ICT based extension are available both from Africa and South Asia and the challenge is to make them work better in operational terms. Major constraints include the availability of information in digital form and access to bandwidth.

ICT enabled Data collection and dissemination: A number of sensors with a capacity to communicate data over limited areas are now available cheaply. Mobiles can be used to transmit the data to a database. This will be extremely useful especially in relation to disaster warning and management programs.

Closing Comments by Dr M Parry (Symposium Chief Guest and IPCC committee Chair)

Mainstreaming climate change: The mainstreaming of adaptation to climate change into decision-making at various levels is essential to ensure that sensitive agricultural enterprises are resilient in both today's and tomorrow's climate. Climate change research should not be seen as an add on program but as an integral part of research. A number of relevant initiatives are on going in the CGIAR system and action is required to derive synergies and to make them more effective.

Role of CG system in climate change research: CG system being the largest international agricultural research network, has the strength and comparative advantage in doing research on issues related to mitigation and adaptation to climate change. The strength of CG is on pivotal hypothesis driven research, generation of new knowledge, testing and development. The CGIAR system should continue to work with NARS in mainstreaming climate change for the benefit of farmers.

Methods for testing adaptation: There is a need to devise methods for testing adaptations before advocacy. Win-win or no regrets approaches aimed at addressing current problems while preparing for the future is worth pursuing. The science of prediction of climate change scenarios at the scale they need to be applied is evolving and the research should have the necessary flexibility to refine and make adjustments to what they are doing, as new evidence is produced. It will also be useful to establish agroclimatic analogues with the climate of today for relating to the future.

Way forward: A two-step program is suggested as a way forward. In the short term, the CGIAR should aim at developing a winnable proposal for the challenge program on climate change. This will focus on what we can do now, on adaptation than mitigation, and put equal emphasis on socioeconomic and biophysical changes. In the long-term, the group should aim at developing a vision paper (rainbow vision) with a much broader goal and a road map to achieve it. This vision paper should be fairly flexible and should not necessarily be tied to immediate deliverables.