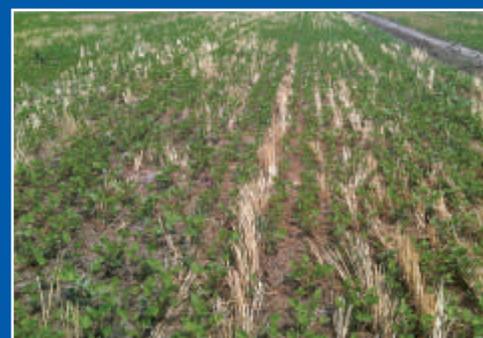


# REGIONAL DIALOGUE ON CONSERVATION AGRICULTURE IN SOUTH ASIA

NASC Complex, Pusa, New Delhi, India  
1-2 November, 2011

## PROCEEDINGS AND RECOMMENDATIONS



**Organized Jointly by**

Asia-Pacific Association of Agricultural Research Institutions (APAARI)  
International Maize and Wheat Improvement Centre (CIMMYT)  
Indian Council of Agricultural Research (ICAR)



# Regional Dialogue on Conservation Agriculture in South Asia

NASC Complex, Pusa, New Delhi

1-2 November, 2011

## Proceedings & Recommendations

### *Editors*

ML Jat, RK Malik, YS Saharawat, Raj Gupta, Bhag Mal and Raj Paroda



### *Organizers*

Asia Pacific Association of Agricultural Research Institutions (APAARI)

International Maize and Wheat Improvement Center (CIMMYT)

Indian Council of Agricultural Research (ICAR)

## The Organizers

**APAARI** (Asia-Pacific Association of Agricultural Research Institutions) is a regional association that aims to promote the development of NARS in the Asia-Pacific region through inter-regional and inter-institutional cooperation. The overall objectives of the Association are to foster the development of agricultural research in the Asia-Pacific region so as to : promote the exchange of scientific and technical information, encourage collaborative research, promote human resource development, build up organizational and management capabilities of member institutions and strengthen cross-linkages and networking among diverse stakeholders. To meet these needs, the Association: i) convenes General Assembly once in two years, holds regular Executive meetings yearly and organizes consultations, workshops, trainings etc, ii) collects, collates and disseminates research findings, iii) maintains links with other fora in the region and outside through meetings/participation and information exchange, and iv) promotes need based collaboration in research projects among member institutions, analyzing priorities and focusing on regional agricultural development. For details, please visit: [//www.apaari.org/](http://www.apaari.org/)

**CIMMYT** (International Maize and Wheat Improvement Centre) The International Maize and Wheat Improvement Centre, CIMMYT ([www.cimmyt.org](http://www.cimmyt.org)) is an international, not-for-profit organization that conducts research and training related to maize and wheat improvement and systems research in more than 100 countries across the developing world. The centre develops and applies new science to increase food security, improve the productivity and profitability of maize and wheat farming systems while sustaining natural resources. CIMMYT has an annual budget of approximately US\$100 million. The centre employs 140 internationally recruited professionals with staff located at headquarters in Mexico and another 18 locations around the world. Genetic improvement of maize and wheat is CIMMYT's core business; CIMMYT-derived varieties of maize and wheat are grown in developing countries on more than 20 million hectares and 60 million hectares, respectively. The impact of CIMMYT's work with maize and wheat germplasm improvement and cropping systems management especially Conservation Agriculture has been profound and the centre continues to be highly relevant for developing-country farmers, including South Asian smallholders. CIMMYT has a long history of implementing multi-donor, multi-stakeholder projects nationally and regionally. Since 2011, CIMMYT's research strategy is primarily implemented through new CGIAR Research Programs (CRPs) on MAIZE and WHEAT led by CIMMYT and implemented in collaboration with more than 500 research and development partners worldwide (over 200 in South Asia alone).

**ICAR** (Indian Council of Agricultural Research) The Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. Formerly known as Imperial Council of Agricultural Research, it was established on 16 July 1929 as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture. The ICAR has its headquarters at New Delhi. The Council is the apex body for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With 97 ICAR institutes and 47 agricultural universities spread across the country this is one of the largest national agricultural systems in the world. The ICAR has played a pioneering role in ushering Green Revolution and subsequent developments in agriculture in India through its research and technology development that has enabled the country to increase the production of foodgrains by 4 times, horticultural crops by 6 times, fish by 9 times (marine 5 times and inland 17 times), milk 6 times and eggs 27 times since 1950-51, thus making a visible impact on the national food and nutritional security. It has played a major role in promoting excellence in higher education in agriculture. It is engaged in cutting edge areas of science and technology development and its scientists are internationally acknowledged in their fields. For details, please visit: [www.icar.org.in](http://www.icar.org.in)

**Citation:** ML Jat, Rk Malik, YS Saharawat, Raj Gupta, Bhag Mal and Raj Paroda, editors. 2012. Regional Dialogue on Conservation Agricultural in South Asia, New Delhi, India, 1-2 November, 2011.

# Contents

<b>Foreword</b>	v
<b>Acronyms and Abbreviations</b>	vii
<b>Introduction</b>	1
<b>Inaugural Session</b>	3
<b>Technical Session I : Status of Conservation Agriculture</b>	4
Global Overview of Conservation Agriculture	4
Country reports	6
India	6
Nepal	6
Bangladesh	8
<b>Technical Session II : Initiatives of CG Centers on CA in South Asia</b>	8
CIMMYT - Sustainable Maize and Wheat System	8
IRRI - Intensive Rice Production Systems for the Future	9
ICRISAT - CA in Vertisols	10
ILRI-Crop - Livestock Interaction in CA	11
The Potential of Conservation Agricultural Practices in Central Asia	12
<b>Technical Session IIIA : Scaling out Strategy for CA Break-out Groups</b>	14
Working Group I : Out-scaling for Impact	14
Working Group II : Partnerships for Regional Cooperation	14
Working Group III : Capacity Building	15
<b>Technical Session IIIB : Reports of the Break-out Groups</b>	15
<b>Technical Session IV : Research and Development Needs on CA in South Asia</b>	16
Research and Development Gaps	16
Conservation Agriculture in Haryana : From Issues to Actions- An Example	16
Accelerating Pace of Conservation Agriculture-Role of Policies and Public-Private Linkages	17
Climate Resilient Agriculture: Outcomes of ACIAR Scoping Mission	18
<b>Plenary Session</b>	19
<b>Key Recommendations</b>	19
<b>Technical Program</b>	22
<b>List of Participants</b>	26



## Foreword

Conservation Agriculture (CA) based crop management technologies being practiced over 116 m ha globally have helped millions of farmers through arresting land degradation, improve input use efficiency, adapt and mitigate climatic extremes, and improve farm profitability in diverse ecologies across the world. Realizing the potential impacts of CA, since mid 1990's, significant efforts have been made by the National Agricultural Research and Extension Systems (NARES), in close collaboration with CGIAR institutions under the umbrella of Rice –Wheat Consortium (RWC), that resulted in adoption of these practices on more than 2.5 million ha area in South Asia. In India alone, this has led to an overall saving of USD 164 million with an investment of only USD 3.5 million on zero tillage technology with internal rate of return of 66%. In addition to the saving on production inputs, the CA based management practices have other potential benefits such as natural resource conservation, reduced emission of greenhouse gases and better resilience to climatic extremes. However, moving from conventional to CA based technologies involve paradigm shift not only in key elements but also in approaches to develop component technologies of cultivar choices, nutrient, water, weed and pest management while optimizing cropping systems. Therefore, efforts on 'Basic-strategic-applied research-extension-capacity building-knowledge sharing' continuum should henceforth form the foundation of conservation agriculture research for inclusive growth and development.

It gives me immense pleasure that the "Regional Dialogue on Conservation Agriculture in South Asia" was organized by the Asia-Pacific Association Agricultural Research Institutions (APAARI), in collaboration with International Maize and Wheat Improvement Center (CIMMYT) and Indian Council of Agricultural Research (ICAR) at National Agriculture Science Center, New Delhi on 1-2 November, 2011. The dialogue has provided a neutral platform to all stakeholders to deliberate and define future strategy on CA. The in-depth deliberations had helped in framing key recommendations that are likely to be of immense uses in promoting CA under diverse production systems in different agro-ecologies in South Asia.

I am sure the National Agricultural Research and Extension Systems (NARES) in South Asia, in partnership with all stakeholders (CGIAR, IARCs, CSOs, NGOs, private sector organizations and farmer associations), will take full advantage of these recommendations emerging from the dialogue. It is our expectation that conservation agriculture will receive high priority in future AR4D agenda. It is also expected that this publication will be of immense use to the planners, administrators, scientists, farmers, and other stakeholders for sustainable natural resource management in South Asia.



Raj Paroda



# Acronyms and Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADH	Animal Drawn Harrow
AIRC	Agricultural Input Research Centre
APAARI	Asia-Pacific Association of Agricultural Research Institutions
AP	Agricultural Production
AR4D	Agricultural Research for Development
ASEAN	Association of South East Asian Nations
ASRB	Agricultural Scientist Recruitment Board
BARI	Bangladesh Agricultural Research Institute
BAU	Bihar Agricultural University
CAADP	Comprehensive Africa Agriculture Development Program
CAC	Central Asian Countries
CA	Conservation Agriculture
CAN	Conservation Agriculture Network
CANSA	Conservation Agriculture Network of South Asia
CAR4D	Conservation Agricultural Research for Development
CAR	Conservation Agriculture Research
CAREC	Central Asia Regional Economic Cooperation
CASA	Centre for Advancement of Sustainable Agriculture
CCSHAU	Chaudhary Charan Singh Haryana Agricultural University
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CRPs	CGIAR Research Programs
CSI	Carbon Sustainability Index
CSISA	Cereal Systems Initiative for South Asia
CSOs	Civil Society Organizations
CTR	Conventional Transplanted Rice
DARE	Department of Agricultural Research and Education
DDG	Deputy Director General

DG	Director General
DSR	Direct Seeded Rice
DSS	Decision Support System
DWR	Directorate of Wheat Research
ED	Executive Director
EIGP	Eastern Indo-Gangetic Plain
EUP	Eastern Uttar Pradesh
FAO	Food and Agriculture Organization of the United Nations
GCARD	Global Conference on Agricultural Research for Development
GDP	Gross Domestic Product
GIS	Geographic Information System
GOI	Government of India
GR	Green Revolution
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi Arid Tropics
ICTs	Information Communication Tools
IFPRI	International Food Policy Research Institute
IGP	Indo-Gangetic plains
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ITIs	Industrial Training Institutions
LLL	Laser Land Leveling
M&E	Monitoring and Evaluation
MasAgro	Sustainable Modernization of Traditional Agriculture
MDGs	Millennium Development Goals
Mha	Million Hectare
NAIP	National Agricultural Innovation Project
NARC	Nepal Agricultural Research Council
NARES	National Agricultural Research & Extension Systems
NARS	National Agricultural Research Systems
NASC	National Agricultural Science Centre
NFSM	National Food Security Mission

NGOs	Non-Government Organizations
NIANP	National Institute of Animal Nutrition and Physiology
NICRA	National Initiative on Climate Resilient Agriculture
N	Nitrogen
NRM	Natural Resource Management
PPP	Public Private Partnership
PTD	Power Till Drill
R&D	Research and Development
R4D	Research for Development
RCTs	Resource Conservation Technologies
RDRS	Rangpur Dinajpur Rural Services
RKVY	Rashtriya Krishi Vikash Yojna
RWC	Rice-Wheat Consortium for the Indo-Gangetic Plains
SAARC	South Asian Association for Regional Cooperation
SAT	Semi-Arid Tropics
SAUs	State Agricultural Universities
SIMLESA	Sustainable Intensification of Maize & Legume Systems in Eastern and Southern Africa
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SRI	System of Rice Intensification
SWI	System of Wheat Intensification
SWOT	Strengths, Weaknesses, Opportunities & Threats
TFP	Total Factor Productivity
UFI	Unique Farmer Identity
UPTPR	Unpuddled Transplanted Rice
USAID	United States Agency for International Development
WGP	Western Gangetic Plain
ZT	Zero Tillage
ZTD	Zero Till Drill



# Regional Dialogue on Conservation Agriculture in South Asia

## Introduction

South Asia accounts for less than 2% of the world's total land area and 14 % of the global agricultural land. However, about 94% of the agriculturally suitable area is already under cultivation with almost no scope for further horizontal expansion of agriculture. There has been a tremendous shift in the production variables of modern farming over traditional farming. Even then, most of the agronomic works revolved around tillage and labour intensive farming. Declining soil organic carbon (SOC) status of soils has been the main shift in agriculture from 'traditional animal based subsistence' to 'intensive chemical and tractor based' agriculture that multiplied problems associated with sustainability of natural resources. The SOC concentration in most cultivated soils of South Asia is less than 5 g/ kg compared with 15-20 g/kg in uncultivated virgin soils, attributed to intensive tillage, removal/burning of crop residue and mining of soil fertility. Large acreage of cultivated lands shows fertility fatigue and multiple nutrients deficiency in many intensively cropped areas. This adds to our challenge of making farming more profitable and sustainable. Hence, the current and future food security of South Asian countries has twin challenges of resource fatigue and decelerating productivity growth of food grain crops. These challenges are being further exacerbated with the sharp rise in the cost of food and energy, depleting water resources, vulnerability of soil to degradation, indiscriminate and imbalanced use of external production inputs and overarching effects of changing climate. This has and will further lead to lower farm profit, making farming unattractive and unsustainable.

The efficiency and sustainability of a production system depends on system-based management optimization of crop yields, economic benefits, and environmental impacts. Therefore, vertical improvement through development and deployment of tools and techniques aiming at increasing agricultural production and arresting degradation of soil, water and environment and their rational use are essential to satisfy future food demand in the region and to meet the Millennium Development Goals (MDGs).

To bring a paradigm shift in agriculture, National Agricultural Research Systems (NARS), the FAO of the United Nations and CGIAR Centers have accepted conservation agriculture (CA) as a vehicle for change. No-till agriculture together with other associated management practices such as direct seeding into loose crop residues to provide soil cover and to conserve soil moisture, judicious choice of crop rotations and agroforestry tree species constitutes conservation agriculture (CA). CA based crop management practices have proved to be effective to produce more at less costs, reduce environmental pollution, promote conjunctive use of organics (avoids residue burning), improve soil health and promote timeliness of planting and other farm operations to address issues relating to terminal heat stress in the region. Like any other tillage and crop establishment technology, it may not be a panacea for all present day ills, but has proven to bring out south American Agriculture out of its stagnant state almost 20 years ago, skyrocketing the cereals and oilseed production system. Same

is the case for regional CA networks in different continents/sub-continent. CA is being widely accepted as an important component of the overall strategy for enhancing productivity, improving the environment and conserving natural resources for food security and alleviating poverty in such areas. Thus, for addressing the issues of resource fatigue and bridging management yield gaps, in South Asia, Conservation agriculture based management solutions can prove to be the cornerstone.

In South Asia, no-till systems were introduced during mid 1990s by the International Maize and Wheat Improvement Center (CIMMYT) in close collaboration with regional NARES primarily to grow wheat in rice-wheat system. The CA program was later facilitated by the strong presence of Rice-Wheat Consortium (RWC) for the Indo-Gangetic Plains led by the regional NARS and convened by CIMMYT. It led to a steady rise in the acreage of CA based resource conserving technologies in India, Pakistan, and Nepal and to some extent in Bangladesh. RWC reported a total coverage of nearly 3 m ha under CA based resource conserving technologies in South Asia by 2007 benefiting hundreds of thousand farmers directly to the extent of nearly US\$ 150 million. This has been possible through regional learnings and information sharing for development of light weight, low cost multi-crop ferti-seed planters through building capacity of local manufacturers.

However, in the past few years, there has been a slowdown in the adoption of zero-till systems in the region. This has been due to several reasons including blanket and commodity crop based recommendations, farmers' access to location specific and timely information and policy mismatches in prioritization of investments but the most important one is the lack of common platform for regional learnings and information sharing. It is fairly well understood that dissemination or extension of new technologies in general and CA in particular is a complex issue. Very often than not the scientists, having developed and tested the technologies, are not able to transfer these to the farmers widely. Why farmer is not ready to adopt the new technologies is an issue that haunts the planners and scientists alike. Farmers today need

value chain information (production, protection, inputs and services) on region-specific technologies. These region specific technologies and innovations are in advanced stages of experimentation in farmers' fields. However, the lack of a regional common platform for sharing this information and capacity building are the major deterrent in accelerating the pace of adoption of CA in South Asia.

Therefore, the agricultural science, extension and development leaders, key researchers of South Asian National Agricultural Research and Extension System (NARES), CGIAR Centers in the region, Food and Agriculture Organization of the United Nations (FAO), United States Agency for International Development (USAID), innovators, Non-Government Organizations (NGOs), and farmer associations met on 1-2 November, 2011 at New Delhi, India for a dialogue on 'Conservation Agriculture in South Asia'. The dialogue focused on Conservation Agricultural Research for Development (CAR4D) through innovations for greater impacts on small-holder farmers in the region was organized jointly by Asia-Pacific Association of Agricultural Research Institutions (APAARI), International Maize and Wheat Improvement Center (CIMMYT) and Indian Council of Agricultural Research (ICAR).

The dialogue was structured in four sessions: i) status of conservation agriculture in the region, ii) initiatives of CG Centers on CA in South Asia, iii) focused discussion through break-out groups on (a) out-scaling for impact, (b) partnerships for regional cooperation, (c) capacity building, and (iv) research and development needs on CA in South Asia. The status reports of different countries were presented by the respective RW coordinators of regional NARS and the progress of CA initiatives by the key CG Centers in the region (CIMMYT, IRRI, IFPRI, ILRI, ICRISAT) as well as other international programs in Central Asia were presented by the respective lead scientists of these organizations. All presentations were followed by in-depth discussions. This report provides the outcomes of deliberations and key recommendations for implementation by the scientific community and policy planners.

## Inaugural Session

Dr A.K. Singh, Deputy Director General, Natural Resource Management (NRM), ICAR while welcoming the participants, emphasized that CA is one of the important themes under NRM and accordingly, the Govt of India has planned to launch 'National Initiative on Conservation Agriculture' during XIIth Five Year Plan.

Outlining the importance and necessity of the dialogue, Dr Raj Paroda, Executive Secretary, APAARI highlighted that food security in South Asian region poses a serious challenge. These challenges are being further exacerbated with the sharp rise in the cost of food and energy, depleting water resources, diversion of human capital from agriculture, vulnerability of soil to degradation, indiscriminate and imbalanced use of external production inputs and overarching effects of changing climates. This has and will lead to lower farm profit, making farming unattractive and unsustainable in the region. Dr Paroda further emphasized that natural resources, climate change, water, food and energy are the focused themes prioritized by the agricultural think tanks that brings to fore the need for fresh infusion of new technologies to tap new sources of productivity growth. In this direction, the 'GCARD Road Map' which has recently been created through interactions and contributions of thousands of stakeholders highlights the urgent changes required in Agricultural Research for Development (AR4D) systems globally, to address worldwide goals of reducing hunger and poverty, while ensuring environmental sustainability and meeting the needs of resource-poor farmers and consumers and hence puts major thrust on "Innovations for greater impacts on small-farm holder". In order to meet future food demand in the region and to attain the Millennium Development Goals (MDGs), improving efficiency and sustainability through system-based management optimization of crop yields, economic benefits, and environmental impacts for which FAO and other organizations have accepted CA as one of the important strategies and a vehicle of change. Dr Paroda further added that CA has steadily increased worldwide (116 m ha) to cover

about 8% of the world arable land area. But, the pace of adoption of CA in South Asia which picked up during late 1990's through the collaborative efforts of NARS led and CIMMYT convened Rice-Wheat Consortium (RWC) for the Indo-Gangetic Plains has slowed down later in the absence of regional synergy and a common platform for sharing information and catalyzing change. In view of the above, this regional dialogue was organized with the following objectives:

- ❖ To provide a common platform for policy makers, R&D managers, researchers, private sector representatives, NGOs, CGIAR institutions, CSOs and the farmers to assess local/national and regional needs, exchange information, and accordingly define priorities for the deployment of CA with a focus on small holder resource poor farmers
- ❖ To help in developing common strategies for resolving the common problems in the region
- ❖ To develop mechanisms for facilitating the exchange of knowledge and products and learn from each other's successes and failures
- ❖ To evolve future Road Map for CA in South Asia

Dr Peter Kenmore, an Integrated Pest Management (IPM) expert at FAO, Rome in his remarks mentioned that globally, it took few decades for the farming community to shift away from the common belief that summer-fallow/ploughing was the only way to improve farm productivity to a belief that drastically reduced or minimum/zero tillage was more advantageous. CA has steadily increased worldwide (116 m ha) to cover about 8% of the world arable land area but the pace of adoption of CA in South Asia is still slow. Emphasizing the book "Save and Grow", he mentioned that we must save natural resources, biodiversity, land ecosystem and improve water quality. To achieve this, incentives need to be changed so that farmers make better choice on tillage which leads to carbon dioxide loss. He cited example as to how silting of rivers is happening and how rivers are disappearing. To find solution for such eventualities and also for burning, soil erosion and grazing, CA is important in 21st century. He also

cited the example of Brazil where the CA is driven by farmers and how mechanical tillage is replaced by biological tillage.

Dr Thomas A Lumpkin, Director General, CIMMYT in his inaugural address emphasised the changing agricultural scenario across the world. He pointed out that there will be higher futuristic cost of management of soil, emergence of new pest problems, high cost of fuel and more use of biofuel, growing ground water problem coupled with changing diet of growing population leading to diversion of grains to animal feed. We have had large gains in crop yields using improved and high yielding crop varieties coupled with appropriate management practices. But, under the growing challenges of resource degradation, escalating input crisis and costs with overarching effects of global climate change effects, the major future gains will come from management practices. The management practices based on the principles of conservation agriculture have shown tremendous potential in addressing these challenges. However, we need to have more systematic basic and strategic research for making synergy between different players and sectors and taking these research outputs to large number of farmers. For example, the biochemists are exploring the possibility of alternate use of residue which may have conflict for residue retention in CA. Therefore, there is a need to make higher investment in new technologies like CA with value chain research. Small holders have to play key role in future productivity growth and food security. South Asia, the most populous, dominated by small holders and the most impacted region of climate change and therefore, complacency has to be avoided. There is no new land for cultivation to produce more; the only option is vertical growth through productivity enhancement on a long-term and sustainable basis. Therefore, our focus should be to produce more with less land, water, energy cost, etc. through 'real time and location specific technologies/information reach to small and marginal farmers'. We have to focus on small holder precision and use of Information Communication Tools (ICTs) and techniques like cell phone based

text messages. Dr Lumpkin further highlighted that it is time for more holistic and system based approach for agricultural R&D and in this direction, the CG system has entered in to new era by launching the CRPs (the mega programs for rice, maize, wheat, climate change, etc.) across center and systems involving large partnerships. All these mega programs are based on the consultations and feedback mechanism from each region and farming. Conservation agriculture (CA) is an important component in most of these CRPs and adds value in the context that as system approach is integral part of CA and hence brings together different crops and associated component research for greater impact.

## Technical Session I: Status of Conservation Agriculture

**Chair** : Dr Mangala Rai, Advisor to Chief Minister, Bihar, India

**Co-Chair** : Dr Dinesh Periyar, Executive Director, NARC, Nepal

**Rapporteur** : Mr MG Neogi, RDRS, Bangladesh

## Global Overview of Conservation Agriculture

Dr ML Jat, Senior Cropping Systems Agronomist of Global Conservation Agriculture Program of CIMMYT presented global overview of CA. While highlighting the global issues, he mentioned that soil degradation is a major problem globally and 550 and 1100 m ha land is affected by one or other kind of wind and water erosion, respectively. The soil degradation is mainly taking place on agricultural lands of Central America (74%), Africa (65%), South America (45%) and Asia (38%). The other issues of shrinking water availability for agriculture, biomass burning and carbon emissions, declining productivity growth rates, labour and energy shortages, ever escalating production input costs etc are making agriculture unsustainable and unattractive. He emphasized that there are three principal indicators of non-sustainability of agricultural systems; soil erosion, soil organic matter decline and salinization. These problems are mainly caused by (i) tillage induced soil

organic matter decline, soil structural degradation, water and wind erosion, reduced water infiltration rates, surface sealing and crusting, soil compaction, (ii) insufficient return of organic material and (iii) mono cropping in addition to other factors indicated above. Therefore, we need to stop doing the unsustainable parts of conventional agriculture; ploughing/tilling the soil, removing all organic material, monoculture and once we do that it results in to CA. The conservation agriculture is a resource-saving agricultural production system that aims to achieve production intensification and high yields while enhancing the natural resource base through compliance with three interrelated principles, along with other good production practices of plant nutrition and pest management. He mentioned that CA systems with location-specific adjustments have worked in all kind of environments/ecologies; from the Equator, e.g. Kenya, Uganda to 50°S, e.g. Argentina, to 65° N, e.g. Finland, sea level to 3000 m, e.g. Bolivia, soils from 90% sand, e.g. Australia, Brazil, to 85% clay, e.g. Brazil (Oxisols, Alfisols) and from 250 mm of rain, e.g. Western Australia to 2000 mm, e.g. Brazil, or 3000 mm, e.g. Chile. But, it is spreading widely on large mechanized farms, rainfed systems, maize, wheat and soybean systems, through farmer led process. He further added that it represents a shift in production paradigm and scientists working on CA struggled till pre-seeding herbicides were made available but there after there is no looking back. Therefore, it is increasingly catching the attention of governments and NGOs. The global adoption of CA during 2011 is estimated at 116 m ha (Table 1)

of which nearly half exists in South America. The adoption in Asia, Europe and Africa are still very low and slow.

The regional CA networks, farmer innovations and policy support on machinery and herbicides have played major roles in accelerated adoption of CA in different continents/countries. Highlighting the 'Hubs'- a new concept for technology adaptation and scaling out he stressed that there is need to establish benchmark sites for research on the impacts of CA, focal point for regional (agro-ecological) capacity-building and scaling out of research and innovation systems and regional CA networks to facilitate and foment research and extension of CA innovation systems and technologies. He cited such examples as Cereal Systems Initiative for South Asia (CSISA), MasAgro in Mexico, and Sustainable intensification of Maize & Legume Systems in Eastern and Southern Africa (SIMLESA).

Highlighting the CA experiences across production systems and ecologies, Dr Jat mentioned that the principles of conservation agriculture appear to have extremely wide application; the actual formulae and technologies for applying these principles are very site-specific. While concluding, he highlighted the remarks of Franke Dijkstra, Pioneer Brazilian zero tillage farmer who started zero tillage 30 years ago that "There are a lot of changes necessary to adopt conservation agriculture, but the biggest change is in the mindset". He further emphasized that "CA is the agriculture of the future and the future of agriculture".

**Table 1 Global adoption of conservation agriculture**

Continent	Area (000 ha)	% of global total	% of arable crop land
South America	55,630	47.6	57.5
North America	39,981	34.1	15.4
Australia & New Zealand	17,162	14.7	69
Asia	26,30	2.2	0.5
Europe	1,150	1.0	0.4
Africa	368	0.3	0.1
<b>Global total</b>	<b>1,16,921</b>	<b>100</b>	<b>8.5</b>

## Country Reports

### India

Dr Indu Sharma, Project Director, Directorate of Wheat Research, Karnal, Haryana, India while presenting the country report on conservation agriculture mentioned that agriculture till recently was focused on achieving food security through increased area under high yielding varieties, expansion of irrigation and increased use of external inputs i.e. fertilizers and pesticides.

Dr Sharma emphasized that laser land levelling is the most important, rather a pre-requisite for enhancing the benefits of other conservation agriculture practices. The benefits of laser levelling resulted in 3-4 per cent more cropped area and 20-25 per cent water saving leading 10-15 per cent yield enhancement. She informed the house that surface seeding is being practised in diara lands of eastern Indo-Gangetic Plains where the soil remains wet for longer time and drilling of wheat is a problem and most of these areas remain single cropped. There is a possibility to bring this area under cropping by following zero tillage for growing wheat, the widely adopted conservation agriculture practice in the Indo-Gangetic Plains under rice-wheat system covering an area of about 0.8 million hectares and there is a need to extend this practice to cover more area and also to other cropping systems. This practice provides an opportunity to reduce the cost of cultivation by about Rs. 3,000-5,000 per hectare thereby increasing the profit margin of the farmers. It also reduces the turn-around time for seeding wheat after rice harvesting and also decreases the *Phalaris minor* incidence. The other conservation agriculture practices are direct seeded rice, bed planting and strip tillage system. She further, emphasized that for extending zero tillage/direct seeding of rice, there is a need to have suitable machinery, varieties and appropriate weed management strategies particularly to control *makara* grass in DSR system. At present, in direct seeded rice (DSR) system, some hybrids and scented *basmati* rice cultivars are giving grain yield equal to that obtained in transplanting method. However, there is a great need to explore the potential of more varieties for this situation.

She emphasized that there is a need to move forward from zero tillage to other conservation agriculture technologies. For CA to be a reality in Indo-Gangetic plains, fine tuning of the existing CA technologies and proper residue management coupled with intensive studies to quantify the residue load, and its long term effect on soil properties, standardizing fertilization practices, insect-pest and disease and weed dynamics is a must. She emphasized that about 80 million tonnes of rice and wheat residue is being burnt at present, having a fertilizer replacement value of 0.8 million tonnes. Managing this residue by adopting conservation agriculture will go a long way to improve the soil health and water resources in addition to enormous environmental benefits. By adopting triple no-till system under CA, farmers can diversify the cereal-cereal cropping system by including a short duration *moong* bean in RW system and also enhance their profit margins in addition to improvement of natural resources leading to systems sustainability.

To conclude, she emphasized to extend the CA practices to other cropping systems including rainfed areas, and benefit of carbon sequestration to the farmers.

### Nepal

Dr Niranjan Adhikari, Director Crops, NARC highlighted the importance of conservation agriculture (CA) to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs in Nepal. It contributes to improvement of environment as well as to enhanced and sustained agricultural production. Conservation agriculture in the form of resource conservation technologies (RCTs) has been started in rice-wheat system in terai region of Nepal.

Majority of the area in Nepal i.e. 0.67 million ha under rice-wheat system mostly lies in terai plains and meets about 75% of the country's total food demand. Productivity of rice-wheat system is low compared to other South Asian countries. Yield decline due to gradual decline and deterioration of soil health, low carbon content and more infestation of pests and diseases. High cost of land preparation and tillage

operations, excessive moisture at the time of sowing, low efficiency of nitrogen in rice field and poor crop establishment are the other associated constraints in rice-wheat system. Resource conservation technologies (RCTs) were extensively evaluated after the introduction of farm machineries in Agricultural Input Research Center (AIRC) command districts of Nepal. Similarly, Cereal System Initiatives in South Asia (CSISA) project has launched RCTs in rice, wheat and lentil crops in terai area of Nepal. The direct seeded rice (DSR) and unpuddled transplanted rice (UPTPR) technologies have spread in 247 and 443 ha of land, respectively in 2010. Power till drill- direct seeded rice (PTD-DSR) has been found profitable (23% more net benefit) over conventional transplanted rice (CTR). DSR gave similar yield of rice to puddle transplanted rice with less labour, water and input costs. Buckwheat cover crop with DSR resulted in minimum weed infestation and higher yield under Khumaltar conditions. Nepal Agricultural Research Council (NARC) also tried ZTD on lentil, peas, and kidney bean that produced higher yields compared to farmers practices. As a result, zero till wheat and lentil area has gone up substantially. CO<sub>2</sub> Flux from ZT-wheat field was also found low (61 mg/m<sup>2</sup>/hr) compared to normal seeding (90 mg/m<sup>2</sup>/hr). Bed planting of rice and wheat resulted in saving of irrigation water by 38% and 28% compared to flat method, respectively. laser land leveling (LLL) was initiated in Nepal and covered about 100 ha in 2011.

### **Problems faced by farmers in adopting RCTs**

- ❖ Lack of appropriate cultivars of wheat for RCTs
- ❖ Major problem of weeds on minimum/zero tilled wheat and DSR
- ❖ Persistency of herbicides in soil on reduced tilled rice and wheat field.
- ❖ Sheath blight and brown leaf spots are major disease problems in DSR system
- ❖ Broadcast seedling method enhanced *Curvularia* spp and rice rot
- ❖ Greater infestation of *Helminthosporium* leaf blight (HLB) disease under surface seeding wheat

### **Reasons for slow dissemination of RCTs in Nepal**

- ❖ Available machineries for RCTs are expensive and not available locally
- ❖ Poor policy support from the government
- ❖ Lack of aggressive extension program focused on RCTs
- ❖ Poor coordination between research, extension and private sector
- ❖ Inadequate and timely supply of inputs
- ❖ Lack of awareness to climate change: mitigation and adaptation strategies.

### **Recommendations and future strategies**

- ❖ Direct seeding of rice and wheat in light to medium light soil is recommended for higher nitrogen use efficiency, enhanced soil physical health and reduced cost of cultivation.
- ❖ For timely planting using recommended ZT wheat varieties such as Bhrikuti, Gautam and Achut should be used and Bhrikuti and BL 1473 for late planting.
- ❖ Intercropping of lentil+ linseed or lentil+ rapeseed mustard (2:1) is recommended for *Stemphylium* blight management.
- ❖ Long term impact of CA based technologies should be studied/reviewed on diseases, insects and weed incidence and soil properties.
- ❖ Farm machinery manufacturer should be given credit at low interest rate and without custom duties on raw materials.
- ❖ Provision should be made for subsidies on machinery purchase by the farmers.
- ❖ Government should give priority to promote agricultural mechanization to address the high production cost and labor scarcity.
- ❖ Farm mechanization with power tiller for small land holders should be promoted.
- ❖ Laser land leveling should be promoted on a large scale.
- ❖ Large plot demonstrations should be conducted on conservation agriculture are needed in terai region.

## Bangladesh

Mr MG Neogi, RDRS on behalf of Sirazul Islam, Director Research, BARI presented the status report of Bangladesh. Bangladesh is one of the most densely populated countries in the world and with reduction in the agriculture land area at the rate of 1% per year, the scope to expand the area under cultivation is extremely limited. Furthermore, Bangladesh having a network of 320 rivers, soil erosion in their command catchments represents a threat to food security. In this direction, Mr Neogi mentioned that CA is one of the most important way forward to address the emerging issues and future challenge of climate change and resultant effects of floods, droughts, salinity and acidity.

Mr Neogi highlighted that CA is now practiced in Bangladesh on a small scale and farmers are getting benefit to this end. However, there is no policy support available for scaling out of CA in the country. The major constraints include, small land holdings, low crop diversity (74% rice), poor extension systems and weak public-private partnership, poor access to inputs, machineries, market, information, lack of quality seeds and lack of availability of credits.

To address the challenges, he suggested the following technical solutions that are proven and hold merit for the farmers in Bangladesh :

- ❖ Using zero-tillage, surface seeding, residue management and relay cropping for improving wheat productivity
- ❖ Using dry seeded rice to address the issue of labor scarcity and timely planting
- ❖ Integrated use of laser land leveling, DSR, bed-planting and zero-tillage in order to address the issue of water scarcity and cost of production
- ❖ Optimization of cropping systems for crop diversity and ecological intensification
- ❖ Use of the new stress tolerant varieties and multi-enterprise farming system to address the issue of vulnerability to natural calamities
- ❖ Farmer's participatory research approach through strengthening and developing new public-private partnership (PPP)

- ❖ Partnership with public and private sector, NGOs and ICTs for timely access to quality inputs, machinery bank and seed cooperatives
- ❖ Establishing and strengthening farmer's participatory seed bank/seed village
- ❖ Promotion of partnership with banks/credit societies/cooperatives for timely availability of credits
- ❖ Regional network in south Asia for knowledge sharing, exposure visit of all stakeholders including policy planners for greater uptake of CA technologies.

In his chairman's remarks, Dr Mangla Rai, Advisor to Govt of Bihar said that conservation agriculture is important and a lot of progress has been made but at the end of spectrum, it is the efficiency which matters. The debate on the definition of CA reveals that some scientists pushing to ensure that techniques and tools that allow for best performance of crops at less input use should be part of CA. We need to work on efficiency mediated production systems. Let us think of farming system approach mediated by all elements of agriculture. He also added that CA has to be site-specific because pressure on land is more in South Asia as compared to Brazil. He also emphasized that our breeding strategies should have a new focus to tailor genotypes that suit to diverse production systems, management practices and ecologies.

## Technical Session II: Initiatives of CG Centers on CA in South Asia

**Chair** : Dr Thomas A Lumpkin, Director General, CIMMYT

**Co-Chair** : Dr HS Gupta, Director IARI

**Rapporteur** : Dr RK Malik, Senior Research Manager, CSISA (EUP)

### CIMMYT - Sustainable Maize and Wheat Systems

Dr ML Jat, Senior Cropping System Agronomist, CIMMYT provided details regarding work of CIMMYT in South Asia. Highlighting the major challenges being faced by the South Asian agriculture, he mentioned that water, labour and energy shortages, plateauing crop yields, large management yield

gaps, resource fatigues, climate change, weak public-private partnerships and policy mismatches are the major ones and need immediate attention. To address these, CIMMYT's strategy and focus in the region is on "CA as vehicle for change for sustainable natural resource and crop management to produce more at less cost". He further stressed that the additional food has to come from eastern Gangetic Plains and rainfed mixed farming systems through bridging management yield gaps, use of rice fallows, and intensification and diversification. The CA has got focus with geographical priorities, for example, in irrigated intensive production systems, the focus is to sustain food bowl whereas in rainfed fragile and low biomass ecologies, the focus is to improve biomass, arrest land degradation and improve livelihoods of the farmers. Highlighting the CIMMYT's approach, Dr Jat emphasized on geographically differentiated technology adaptation and acceleration, farmers participatory adaptation, multi-stakeholder partnerships, use of ICTs (CIMMYT Agriplex) and networks for last mile delivery and advocacy on suitable policies. He informed how CIMMYT in association with its national and international partners including manufacturers made 75 modifications in the first Pantnagar zero tillage machine and how multi-utility and multi-crop planters, the new version of turbo-seeders were developed and how the improvements in the laser land levelers were made. The results show that absolute gains in the productivity are more in the EIGP than WGP. Also, there is a strong need to have component technology research for local specific adjustment and fine tuning of the CA based production systems. Highlighting results of the long-term trials, he shared that crop and resource productivity as well as carbon sustainability index (CSI) of maize and wheat systems improved over time using CA based management practices. He also highlighted the results to show that residue retention is necessary for long term sustainability of CA in South Asia. He shared the results of genotype x tillage x cropping systems interactions and emphasized that there is a need to focus on breeding strategies to tailor crop varieties for specific management perspective. The ongoing work by

CIMMYT is focused on the carbon sustainability index, climate change related issues, effect of temperature variation on the yield potential, interactions of CA systems with genetics, nutrient management, green house gas emissions, and development of decision support system (DSS) based on these variations. He further highlighted that benefit of CA programs in India has led to cost benefit ratio of 1:19 (investments of US\$ 3.5 million led to an output equivalent to US\$ 64 million). To further build the strong foundations, long-term strategic research and farmer participatory technology adoption in different ecologies and production systems, knowledge sharing and capacity building in frontier areas are most important. The CIMMYT has initiated a Regional Course on Conservation Agriculture for the South Asian Researchers and Extension Agents. For building capacity of research scholars in frontier areas of CA, they should be deployed in long-term trials on CA. He cited an example of Haryana on innovative pathways for technology adaptation and dissemination through young farmer cooperatives and establishing CA learning modules and service centres which is gaining popularity among the farmers not only in Haryana but in other states as well.

### **IRRI- Intensive Rice Production Systems for the Future**

Dr J.K. Ladha, IRRI Representative in India while presenting IRRI's efforts on "Intensive Rice Production Systems for the Future" mentioned that among the various cereals, rice is the most, important followed by wheat and maize, in terms of area, production, and yield. Rice and wheat are grown for grain, whereas maize is grown for grain, green cobs, or fodder for animals. In South Asia, rice, wheat, and maize are cultivated either as a mono-crop in irrigated areas or as a mixed crop in drylands, mostly in fixed sequences. In the northwestern part of the Indo-Gangetic Plains (IGP), rice and wheat are the major source of calories and protein requirements. Similarly, in the eastern part of the IGP, rice is the major source of calories and is a protein source either alone or in combination with pulses.

To meet the rapidly increasing food demand to support the fast-growing population during and after the 20th century, it was necessary to intensify agriculture with new crop varieties, fertilizers and pesticides, and irrigation—collectively called the Green Revolution (GR). Unlike traditional agriculture, such intensive agriculture was more energy consuming with open-ended nutrient cycles and several adverse ecological effects. In the next 40 years, demand for food and non-food products is projected to increase further by 35-100%. With a similar demand scenario in South Asia coupled with limiting land and water resources, sustainable intensification of existing cereal production systems is inevitable. There is an urgent need for a new form of intensive but eco-efficient agriculture that encompasses both the ecological and economic dimensions of sustainable agriculture by combining the goal of maximizing both yield and input use efficiency. Although the need to continue to produce an increasing amount of grain to feed the burgeoning billions exists, efforts are being reoriented to reduce the negative environmental impacts of intensive cereal production systems on the ecosystem per se for overall harmony between production systems and the ecology.

Therefore, intensive eco-efficient farming should be an integral part of the regional strategy to address existing and emerging problems of intensive cereal production systems in the Indo-Gangetic Plains. This is possible by integrating all the best management practices following the principles of conservation agriculture, ecological intensification, and eco-efficient agriculture. Overall, improving farm-scale eco-efficient agricultural practices to the level of research plots would reduce gaps in yield and nutrient use efficiency between farmers' fields and experimental plots and tighten nitrogen cycling within farms, thereby minimizing the leakage of nitrogen from farms to the environment. However, extending the complex and knowledge-intensive principles and practices of intensive eco-efficient farming to millions of smallholder farmers of South Asia will be a challenge to all, including scientists, extension staff, and policy makers. This will require massive concerted efforts in six areas: (i) organizing

large-scale training or technical mentoring programs in eco-efficient agriculture for different levels of agricultural scientists, extension workers, and farmers; (ii) supporting the development of appropriate machinery and farm-machine rental services for on-farm adaptation of conservation agriculture and integrated soil, water, and crop management technologies in both large and scattered small fields; (iii) the development of an active farmers' feedback-based R&D system to solve practical problems in the adoption of conservation agriculture and related integrated crop management technologies; (iv) the development of local champions to showcase and promote the best management practices and other technologies to farmers in their respective areas; (v) the development of price support and markets for new agricultural products produced in integrated farming systems; and (vi) focused institutional and policy support, including appropriate incentives and crop insurance to reduce risks for widespread dissemination and adoption by farmers of intensive eco-efficient agricultural practices in the IGP of South Asia.

### **ICRISAT- CA in Vertisols**

Dr S.P. Wani presented CA based work of ICRISAT in vertisols of rainfed ecologies. ICRISAT is concentrating its CA efforts to address the issues of land degradation, water scarcity and management yield gaps through Integrated water shed management. He stated that efforts made on "integrated watershed management" till 2008 did not produce any tangible outcome because the approach was not holistic with no backstopping and no gender issues. However, when it was integrated with the Rural Ministry with well defined role of Self Help Groups and youth clubs, it was highly successful. The work done at ICRISAT indicated that improved water use efficiency with minimum tillage was found better than other CA practices. He also highlighted that with residue management, the run-off was reduced but no yield gain, though it helped in enhancing water use efficiency. While concluding, he mentioned that:

- ❖ Minimum tillage with residue application reduced runoff and soil loss in vertisols.

- ❖ During the first two years, no significant effects on crop yields were observed due to minimum tillage and residue application but later, the yield was improved.
- ❖ There is a need to study long-term effects of minimum tillage and residue application on crop yields and soil health parameters.
- ❖ Soil and water conservation measures along with enhancing water use efficiency in watersheds do increase system productivity in the SAT.

### ILRI-Crop-Livestock Interaction in CA

Dr Iain Wright, South Asia Coordinator, presented ILRI's efforts on "Crop-Livestock Interaction in Conservation Agriculture". He mentioned that livestock play a crucial role in food security and the livelihoods of almost a billion of the world's 1.4 billion poor people. Livestock contributes about 25-30% of agricultural GDP in developing countries and this figure is expected to rise to almost 50% in the next 20 years as a consequence of increased demand for livestock products (milk, meat and eggs), driven by population growth, rising incomes and urbanization. For example, India is currently producing about 110 million tons of milk annually but demand for milk is expected to reach

180 million tons by 2021-22. This rapidly increasing demand is not confined to large cities, but can also be seen in rural areas and across income groups.

In most of South Asia, crop residues (e.g. rice straw, wheat straw, maize stover, pulse haulm, etc.) are important sources of animal feed. In India, for example, almost half of all livestock feed comes from crop residues and this is forecast to rise to almost 70% by 2020 (Table 2).

As demand for livestock products increases so does demand for livestock feed which in turn increases prices. Also, crop residues vary in nutritive value (principally energy and protein content) both across and within crop species, a feature well reflected in the price. The price of rice straw in the fodder markets of Kolkata was influenced by the digestibility with the highest digestibility straws fetching Rs 4/kg compared to Rs 3/kg for the lowest digestibility. Thus, crop residues have considerable market value as livestock feed.

A recent study on utilization of crop biomass across the Indo-Gangetic Plains has highlighted the importance of crop residues as a source of feed for animals. Depending on farm size and geographical location,

**Table 2. Key feed sources in India**

Feed resource	Percentage	
	2003	2020
Crop residues	44.2	69.0
Planted fodder crops	34.1	?
Greens	17.8	?
Concentrates	3.9	7.3

Source: NIANP, 2005 and Ramachandra et al., 2007.

**Table 3. Information needed to identify optimal use of crop residues and its availability**

Use	Value	Opportunity cost
Feed	✓	✓
Fuel	✓	✓
Sale	✓	–
Mulch	?	?
Burn	–	✓

57-91% of households kept ruminant livestock, 11-66% fed wheat straw and 36-62% fed rice straw, with rice straw being more important further east.

Crop residues clearly have an important economic value, based on various uses. Currently, feeding straw to animals has a very important use in many systems in the Indo-Gangetic Plains. However, other uses such as household fuel or sale to urban centres are also common. In addition, burning of crop residues is common where the pressure to quickly establish the subsequent crop is high. On the other hand, retaining crop residues in the field for mulch has long been proven to sustainably improve long-term soil fertility and thereby crop productivity. This raises the question of how to optimize the allocation of crop residues for various uses in different systems. To answer this question from an economic perspective requires information on the values that can be placed on the different uses of crop residues and the opportunity cost of not using the residues for these purposes. Table 3 summarizes the current availability of information on these values and opportunity costs. For example, the values of crop residues as animal feed can be obtained from market prices, while the opportunity cost can be obtained from the prices of alternative feeds. However, the economic value of using crop residues as mulch has not been systematically assessed nor has the opportunity cost of not using mulch. It is difficult to identify the optimal balance of use because it is currently not possible to ascribe values and opportunity costs to all the multiple uses of crop residues. This is a major knowledge gap which needs to be addressed. In particular, long-term studies need to be conducted in the South Asian context to ascertain the benefits (economic and environmental) of retaining different proportions of crop residues on the soil.

### **The Potential of Conservation Agriculture Practices in Central Asia**

Dr John Lamers in his presentation, mentioned that rainfed and irrigated agricultural systems have supported livelihoods in the five countries in Central Asian and Caracas (CAC) region, namely, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, which comprise around 397 million hectares (m ha).

Of this, around 20 m ha are cultivated rainfed areas, primarily in northern Kazakhstan, while less than 10 m ha are currently used for irrigated crop production. During the last five decades, resource-conserving technologies were introduced in large parts of the rainfed areas while the irrigated areas were expanded largely without considering resource conservation. In more recent years, the use of conservation agriculture (CA) practices has been reported for the different agricultural production (AP) zones in CAC region.

Research findings on CA are available for the rainfed systems in the North and the irrigated systems in the South of Central Asia, but only a few studies have been conducted on CA in the rainfed foothills in the South. One hurdle that restricts reviews is the inconsistent use of standards and terminology internationally as well as in the CAC region for describing CA based systems and other resource conserving production technologies. Part of the confusion on terminology has been caused by inaccurate translations into Russian and local languages.

The rainfed AP zone in Northern Kazakhstan is relatively flat, receives scarce rainfall and suffers with high soil erosion and is, therefore, well-suited for CA practices. Various resource-conserving practices are common the 1960s. Owing to large-scale Governmental support, more than 1 m ha spring wheat is annually planted under CA-based management in this AP but forecasts indicate that the area under CA will continue to increase.

CA research findings from the irrigated zones in the warm regions of Southern Kazakhstan, Kyrgyzstan, and Southern Tajikistan, Turkmenistan and Uzbekistan have a short history. Yet, evidence illustrates a favourable impact of CA on physical and chemical soil properties. A rapid increase in soil organic matter (SOM) is consistently reported leading to improvements in soil structure and greater soil moisture holding capacity. But, experimental evidence also reveals that significant increases in SOM are not surprising given the low initial SOM values. Moreover, the SOM increases observed in the arid and semi-arid agro-climatic conditions in CAC region were roughly proportional to the annual amount of SOM added.

Crop residue management practices still need further refinements due to the present high dependence of farmers on crop residues as fodder for livestock and income generation. Therefore, more knowledge is needed on critical residue return rates since the retention of all residues from the previous crops is not needed under permanent raised beds. Also options to expand fodder crops are needed as to reduce farmers' dependence on crop residues for feed.

CA practices increased irrigation water use efficiency with, for instance, permanent raised-bed, which also proved promising for salt-salinity management although CA alone will have to be combined with other best practices to resolve this important and damaging problem in the irrigated areas of CAC region. Nitrogen use efficiency also increased with permanent raised beds for crops such as wheat and maize but not for cotton.

Crop yields with different resource conserving practices are inconsistent: some evidence indicated that immediately after the conversion from conventional systems to permanent raised beds or zero till, yields do not exceed the levels obtained from conventional practices and in some cases were even lower. Cotton production seems not to be zero-till although clearly caused by insufficient land preparations, inadequate seeders and lack of knowledge about the most suitable management of crop residue retention. The short history of CA experiments points also to potentially high yield gains with permanent raised-bed plantings for irrigated winter wheat but not for zero-till.

Seeders (with or without simultaneous fertilizer applications) suitable for CA practices in the irrigated AP zone were tested and successfully developed for untilled soils and for raised-bed planting. Yet they are not commercially available in contrast to the situation in the rainfed areas of Kazakhstan where efforts have been made to make adequate CA equipment accessible to farmers.

The few financial assessments support the promotion of certain CA practices because of similar yield levels for CA and conventional practices but with lower production costs for CA, but any new crop

management that bears the risk of potential yield reductions and particularly of strategic crops is unlikely to find spontaneous support at the higher administration levels in the CAC region.

Agricultural policies greatly influence the adoption and dissemination rate of CA practices. Although it has been suggested that, in the absence of private land tenure, farmers in Uzbekistan and Turkmenistan are reluctant to invest in any conservation-related practices, the lack of adoption of CA practices in Kyrgyzstan for instance, where farmers have gained private ownership about a decade ago, suggests that land tenure by itself does not automatically lead to an adoption of new cropping practices including CA. Government subsidies and support in Kazakhstan has facilitated the adoption of CA and Kazakhstan is already among the top 10 countries with the largest areas under no-tillage in the world.

Since research has not been conducted yet over several cropping cycles, more research is needed before a final conclusion can be drawn. For the time being, the evidence base is too limited to justify a broad-scale promotion of CA based crop management. Additional efforts should focus on a validation of promising CA based systems and fine tuning through adaptive research. This fine tuning is needed to account not only for the biophysical conditions, but also for farmer circumstances, availability of machines and production factors that govern the success of new approaches.

Particularly critical in CAC are enabling agricultural policies backed by national administration and centering on providing incentives or alleviating bottlenecks that will encourage farmers to adopt CA practices. Increased land tenure security, more liberalized input and output markets, more optimal pricing of scarce water resources, and targeted subsidies may help, but still are insufficient when implemented as isolated measures. To achieve adoption of CA practices would need an increased information dissemination, awareness, and learning among farmers and policy makers about the benefits of CA. This demands the support of extension services for awareness creation among agricultural producers and improving links among farmers, markets and service organizations which however are not yet available.

## Technical Session IIIA: Scaling out Strategy for CA- Break-out Groups

### Working Group I : Out-scaling for Impact

**Chair** : Mr Ashok Yadav, Director General (Agriculture), Haryana

**Co-Chair** : Mr Ravi Gopal, Director Research, BAU, Bihar

The group brain stormed on the key constraints in adoption and proposed strategies for scaling out of CA based crop management technologies. The group identified following constraints in the adoption of CA based technologies:

- ❖ Top down approach for technology delivery
- ❖ Lack of value chain basic and strategic-adaptive research-scaling out continuum for situation specific adaptation of component technologies
- ❖ Conflicting messages and policies, for example, organic farming v/s CA, zero-tillage v/s rotavator, zero tillage v/s system of rice intensification (SRI) and system of wheat intensification (SWI), etc. that misleads the farmers
- ❖ Lack of conceptual clarity and conflicting opinions among scientists/ extension agents.
- ❖ Limited capacity of extension system on CA
- ❖ Lack of trained human resources due to lack to structured CA course curriculum at SAUs
- ❖ Regional disparities for CA machineries, services, spares due to lack of capacity of local manufacturers
- ❖ Lack of incentives for green agriculture

The group recommended the following strategies for scaling out of CA based crop management technologies:

- ❖ Sub-regional and regional platforms need to be created for technology development, adaptation and knowledge sharing.
- ❖ Multi-stakeholder functional partnerships with common goal and shared vision should be strengthened among different players of agricultural research for development.
- ❖ Conservation agriculture being an important strategy for addressing the emerging challenges should get high priority with suitable policy support.

- ❖ There is a need to develop the technology banks using different sources of information and knowledge and define their recommendation domains catering location specific needs and farmer circumstances for scaling-out by the local extension functionaries.
- ❖ Appropriate mechanism for load shedding of CA based machinery and also service centers, spare parts, repairs, etc. locally should be developed through deployment of ICTs, etc.
- ❖ Develop database of network of service providers and build their capacity.
- ❖ Use of ICTs, media and networks for knowledge sharing should be strengthened and a special programs on CA based technologies should be broadcasted on a dedicated channel on agriculture.
- ❖ Collective efforts of different stakeholders need to be made on demonstration of proven technologies in a cluster approach and use these clusters as learning as well as information sharing centers by organizing local and regional travelling seminars, field days, etc.
- ❖ A mechanism should be developed to provide incentives to CA adopters.

### Working Group II: Partnerships for Regional Cooperation

**Chair** : Dr Suzanne Ross, Senior Development Advisor, USAID-India

**Co-Chair** : Dr D.P. Singh, Consultant, Haryana Kisan Ayog, India

The group had detailed discussion on partnerships for regional cooperation and had consensus that partnerships for regional learnings, information and technology sharing is a must for potential benefits of the technologies in the homologous ecologies. There is a strong need for creation of regional CA networks and for that regional organizations/programs like APAARI, RWC, CSISA, SAARC, ASEAN, CAADP, CAREC along with CGIAR institutions can play important role. As capacity building on CA is very important and for convergence of practices, there is a need for capstone or curriculum for CA, collaborative platforms for knowledge sharing, SWOT analysis policies/

consequences for regional cooperation and develop analytic and communication tools to help policy makers understand economic, social and political implications of various alternatives. The group also emphasized convergence on international standards of production system certification and making inventory of trade impediments through regional fora like CAR, SAARC, ASEAN. They also advocated having a mechanism for farmer level carbon credit trading and linking them with systems, equipments and to international trade agreements.

### Working Group III: Capacity Building

**Chair** : Dr John Lamers, Uzbekistan

**Co-Chair** : Dr RP Narwal, Director Research, CCSHAU, Hisar, Haryana, India

The deliberations of the working group on “Capacity Building” revolved around that capacity building on all aspects of farming is very important but as CA is knowledge intensive and new introduction in the region, it should have more focus at all levels and for all the stakeholders. The group had an opinion that innovations with the highest chance of being adopted are, (i) simple, (ii) possibly based on existing knowhow, (iii) inexpensive with a few external inputs, (iv) produce immediate as well as long-term benefits and (v) require a minimum of community organization so that individual farmers can implement them on their own fields. The group identified the potential gaps in capacity building on CA and suggested that there exists gaps at all levels and among all stakeholders. The academic community have their own understanding of CA and sustainable agriculture with insufficient openness and awareness of CA. The extension agents/institutions are not updated and insufficiently informed about the latest developments on CA. Private sector players have lack of demand awareness (particularly in countries other than India), farmers/producers are insufficiently aware of the benefits of CA. The strategies on capacity building that group suggested for different stakeholders are:

- ❖ **Academic community**: There is a need to prepare and disseminate a standardized curriculum as well as modules for training for different target

groups. The experience shows that it is easier to bring different messages to one community than it is to bring different communities to one message. The recommendations on CA must be sufficiently flexible to deal with the diversity and variability of the farming communities.

- ❖ **Agriculture extension providers** : An update is needed on the latest developments through trainings and courses. More demonstrations should be conducted and these should be exploited for awareness creation. The extension agents need capacity building on processing and presentation of results, interpretation of results and analyses, communications and e-learning, extension material.
- ❖ **CA machinery manufacturers** : For quality standards of the CA machinery, the new and small scale manufacturers need skills development. In South Asia, most of the manufacturers do not provide operational manuals with CA machinery and hence there is need to build their capacity on this. The capacity building of local artisans for repair and maintenance should also form integral part of the program for local access to farmers for these services. The traders/dealers should receive updated information and training on calibration, operation and maintenance of CA machinery so that they provide right services to the farmers.
- ❖ **Farmers and service providers** : The farmers and service providers need back-up support on component technologies even if the basic idea is right.

### Technical Session IIIB: Reports of the Break-out Groups

**Chair** : Dr IP Abrol, Director CASA, India

**Co-Chair** : Dr Niranjana Adhikari, Director Crops & Horticulture, NARC, Nepal

**Rapporteur** : Dr Andrew McDonald, CIMMYT, Nepal

The recommendations of the three working groups as reported in preceding section were presented by the respective rapporteurs for discussion among all the participants. Several of these recommendations were agreed by the house, and are given in the recommendation section.

## Technical Session IV: Research and Development Needs on CA in South Asia

**Chair** : Dr Gurbachan Singh, Chairman, ASRB, India

**Co-Chair** : Dr John Dixon, ACIAR, Australia

**Rapporteur** : Dr Sonali Bisht, INHERE, India

### Research and Development Gaps

Dr Gurbachan Singh, Chairman, ASRB shared the R&D gaps. He mentioned that the most important change that we have to make is on our approach which should be R4D rather than R&D. There exists large gaps between research and development and hence we need to effectively translate research into appropriate technology packages that are adaptable to local situations and production systems. There is huge gap in effective communication, extension and capacity building for greater uptake and impact of technologies as farmers have already adopted many technologies but there lacks a consensus among the scientific community. Therefore, we need to align programmes and policies to provide incentives and award to the adopters for potential technologies. We also need to develop mechanism for farmer feedback and action systems for inclusive research and create platforms for knowledge exchange and support for such technologies. He also emphasized establishing long-term research platforms on CA to monitor the dynamics and productivity trends, soil health and economical as well as environmental benefits. As we move in the direction of CA, our breeding strategies should have focus on tailoring genotypes under those situations. Integrated CA technology based cropping systems for smallholders through integrating food and nutrition and employment security, livestock, horticulture, etc. should form the priority for future research agenda for integrated farming system.

### Conservation Agriculture in Haryana: From Issues to Actions- An Example

Dr Raj Gupta, CIMMYT presented the report of the 'Working Group on Conservation Agriculture' constituted by the Haryana Kisan Ayog. The report was released by Dr Bhupendra Singh Hooda, Hon'ble

Chief Minister of Haryana. While highlighting the "From Issues to Actions: Conservation Agriculture for Sustainable Crop Production in Haryana", Dr Gupta mentioned the significant contributions of CCSHAU on Conservation Agriculture in close collaboration with ICAR, State Department of Agriculture and CIMMYT. In his presentation, he emphasized on CA as a vehicle of change in production and sustainability of agriculture in the Haryana for which the State has agreed in principle to undertake the following activities and actions:

- ❖ Using the funds placed with department of agriculture, the laser assisted land leveling should be undertaken to cover at least 3.0 m ha of irrigated and dry lands by promoting custom services. Also, at least 50 % of the cultivated area (~ 1.5 m ha) could be brought under CA based crop management practices.
- ❖ Direct seeded rice (DSR) should be promoted in 50% of the *basmati* rice areas and all of the rice-potato/vegetable systems. No-till mechanical transplanting can be promoted on atleast 10 % of the rice area.
- ❖ 'Single Window Services' for zero-till planting with residue retention in wheat and other crops need to be promoted to avoid residue burning in 50% of the wheat / sugarcane areas using the turbo happy seeder and double disk planters through creation of CA machinery banks.
- ❖ The Department of Agriculture should mount a baseline survey on tube well water quality, and manage the database in GIS framework, to delineate problematic areas and link this with soil health cards/ soil testing service. Water quality, tillage and crop establishment and residue management practices and crop and cultivar choices be considered to make fertilizer recommendations in cropping system perspectives.
- ❖ Problem soils (saline, alkaline, water-logged) should be mapped using remote sensing and GIS tools,
- ❖ Dual purpose wheat for green fodder should be linked to program meant for improving productivity of livestock. Dual purpose wheat may specially be promoted on peri-urban interface where dairies are located.

- ❖ Acreage of rice needs to be decreased to release some pressure on scarce water resources. Intensification of hybrid maize (*kharif* and *rabi*) and pulses or vegetable crops are some of the possibilities. The new cropping system will also save irrigation water.
- ❖ Good quality tillage machinery prototypes (multi-crop planters, multi-purpose turbo happy seeders and multi crop double disk planter, sugarcane cutter planter) need to be subsidized to promote CA.
- ❖ There is a need to promote system based technical advisories to farmers using modern Information and Communication Technologies (ICT).
- ❖ The available database needs to be linked Unique Farmer Identity (UFI) to soil testing and other schemes of the Department.
- ❖ Department of Agriculture needs to encourage and support farmer cooperatives based on CA and to facilitate and subsidize the purchase of improved CA equipments and other inputs.

### **Accelerating Pace of Conservation Agriculture-Role of Policies and Public-Private Linkages**

Dr PK Joshi, from IFPRI in his presentation indicated that there are six broad categories of policies which are related to investments, subsidies, incentives to agribusiness, risk mitigation, reform markets and welfare. He emphasized that the carrier of CA revolves around 2 Ms, machinery and management. He mentioned that the key drivers for large scale CA adoption are primarily (i) yield improvement and unit cost reduction, (ii) reduce labour requirements, (iii) availability of various CA options, (iv) absence of livestock (for example Malawi), (v) access to credit, (vi) government support on incentives and taxes; interest rates and (vii) donor funding. indicating the roles of public, private sector organizations and CSOs, he highlighted that each sector has its own strength but the collective efforts make all the difference. The specifying roles of different sectors in promoting CA is given as under:

#### **Public sector**

- ❖ Invest in research and capacity building
- ❖ Improve infrastructure

- ❖ Strengthen institutional systems for land reform and consolidation
- ❖ Policies related to subsidies, taxes and duty relief and credit/insurance

#### **Private sector**

- ❖ Participate in R&D, share cost in R&D, machinery development, etc.
- ❖ Farmer friendly business models
- ❖ BOT for infrastructure
- ❖ Custom-hiring and services
- ❖ End-to-end value chain for example contract farming

#### **CSOs**

- ❖ Organize farmers (specially smallholders) for collective action
- ❖ Link research and development programs
- ❖ Link farmers with service delivery systems-machine, seed, fertilizers, credit, etc.
- ❖ Link farmers with markets

Highlighting the way forward, Dr Joshi mentioned that, there is immediate need for a national and regional movement for promoting CA based technologies by involving all stakeholders in the agri-value chain. CA policies should form part of a coherent national policy on agricultural development. National network (CAN) and regional network (CANSAs) of different stakeholders need to be developed to accelerate mainstreaming CA based technologies. For policy advocacy and capacity building, there should be sensitization programs on CA for different target groups like policy advisors, professionals and financial institutions. The training modules should be focused and audience specific like extension specialists, farmers, service providers, etc. The specific researchable and policy issues highlighted by Dr Joshi are as under:

#### **Researchable issues**

- ❖ R&D to expand to more crops and agro-ecologies with greater emphasis on smallholder agriculture
- ❖ Document constraints for upscaling CA technologies for example: adoption of zero tillage

- ❖ Targeting CA concept in other regions to delineate potential regions for CA practices
- ❖ Extrapolate potential benefits on eco-region basis
- ❖ Test induced innovation hypothesis on wages and energy prices, output prices
- ❖ The potential contribution of CA in TFP growth in agriculture should be analyzed and documented

### **Policy issues**

- ❖ Integration of CA technologies with existing government programs and map technology traits with government programs
- ❖ Architect new programs based on CA technologies and make synergies with mega government scheme
- ❖ Institutional innovations to link CA interventions with international programs and treaties such as carbon credit: bonus for smallholders
- ❖ Creation of favorable environment for private sector for making investment on CA

### **Climate Resilient Agriculture: Outcomes of ACIAR Scoping Mission**

Dr John Dixon, South Asia Coordinator, ACIAR shared the report of the recent scoping study on Climate Resilient Farming Systems in Eastern IGP. He emphasized that 'conservation agriculture will play an important role in bringing food security and improved livelihoods to east India and its sub-region. The scoping mission identified research on elements of conservation agriculture that have matured to the point where out-scaling can be undertaken, as well as related research that over time will improve system performance. Cutting across any specific research opportunities, however, it is important that the R&D should be further focused on key issues and adoption pathways through a systems analysis involving both biophysical components and the interacting market and socioeconomic elements. He highlighted that ACIAR in collaboration with CG systems and NARS is exploring to launch a project that focused on the following:

- ❖ Climate risk reduction through adaptation/ adoption of no-till cropping is the first leg of stool. This addresses the food security crops (rice,

wheat, maize) and may be seen as the first leg of a three-legged stool upon which future profitable agricultural systems will be based.

- ❖ Water shed management and its effective utilization under different production systems should be seen as the second leg of the productivity stool, helping to manage the 'drought' element of climate risk and enabling farmers to confidently invest in technology to raise land and water productivity.
- ❖ Crop intensification and diversification is the third leg of the stool, enabled for field crops by direct seeding (where appropriate) and accessible groundwater - diversification should not be confined to food security crops, but extend to high-value horticulture and include value-chain management to optimise risks and returns. Future sustainable and productive agriculture will draw on a diverse range of crop options in flexible (climate-responsive) farming systems. But, these will not be fixed 'models'.
- ❖ Livestock and aquaculture are important. Livestock presently make up 35% of agricultural output in Bihar, for example, and is especially important for poorer farmers. Opportunities should be sought to integrate them into the above research where possible.
- ❖ System resilience and risk are major factors in technology adoption and intensification, and research on climate and market forecasts, linking forecasts to farm decision-making, is needed. Although this has previously been attempted in India, further research may be timely given advances in modelling climate and climate change but the paucity of effort on medium-term weather forecasting and in particular weather forecasts that are linked to market forecasts and transmitted to farmers in a way that enables timely decisions to be made.
- ❖ In all our future R&D efforts, there is a strong need of integration with special reference to "Conservation Agriculture based Farming Systems Research"
- ❖ Future Road Map for Eco-Regional Program (RW Consortium)-NARS Leaders

There was a discussion on the continuation of RW consortium for harnessing its benefits. The NARS leaders repeatedly emphasized that RWC has made tremendous contributions for introduction and promoting conservation agriculture in the region. Therefore, there is a need to revive and strengthen RWC to provide a common neutral platform for policy makers, R&D managers, researchers, private sector representatives, NGOs, CGIAR institutions, CSOs and the farmers to assess local/national and regional needs, exchange information, and accordingly define priorities for the deployment of CA with a focus on small holder resource poor farmers.

## Plenary Session

**Co-Chairs** : Dr S. Ayyappan, Secretary, DARE, GOI, & Director General (ICAR)  
Thomas A Lumpkin, Director General, CIMMYT

**Rapporteur** : Dr Indu Sharma, Director DWR

Dr S. Ayyappan and Dr Thomas A Lumpkin, Director Generals of ICAR and CIMMYT, respectively in their concluding remarks during the plenary session mentioned that South Asia has been very successful in achieving breakthrough in food production through green revolution technologies of 1960s and 1970s. However, South Asia is the most populous and has the greatest number of malnourished people and food security is still an issue. As far as our priorities are concerned, investments on R&D for conservation agriculture (CA) and climate change are on top priority. Focusing on success of no-till in South Asia, he highlighted that during mid 1990's this technology was introduced by CIMMYT in close collaboration with regional NARS primarily to grow wheat in rice-wheat system. This was later evolved as eco-regional program "The Rice-Wheat Consortium for the Indo-Gangetic Plains (RWC)" led by the regional NARS and convened by CIMMYT. It led to a steady rise in the acreage of CA based resource conserving technologies (RCTs) in India, Pakistan, and Nepal and to some extent in Bangladesh. RWC reported a total coverage of nearly 3 m ha under CA based resource conserving technologies in South Asia by 2007

benefiting hundreds of thousand farmers directly to the extent of nearly US\$ 150 million. Later, recognizing the significant efforts made in the region, the RWC was awarded by prestigious 'Kind Bedouin' and CGIAR awards. This has been possible through regional learnings and information sharing for development of light weight, low cost multi-crop ferti-seed planters through building capacity of local manufacturers. For better gains through CA based technologies, efforts are needed on breeding crop varieties that suit CA. Also crops-livestock interactions need to be emphasized for future research. Highlighting the global importance of green agriculture and carbon credits, etc. Dr Ayyappan emphasized that there is a need to incentivize carbon trading. ICAR now has some mechanism in place in the form of NICRA and also prioritizing CA in 12th Five Year Plan for special programs in the form of National Initiative on Conservation Agriculture, he further added. But, the most important mechanism that we need to have in place is the common platform for sharing knowledge through cross learnings across the production systems, agro-ecologies and borders in the region like RWC, he added. As we move further in the direction of CA for its greater uptake and larger impact, capacity building and suitable policy framework is most important.

## Key Recommendations

### *Research related recommendations*

- ❖ There is a need to define existing location specific recommendation domains of different CA based crop management technologies suited to various production systems, agro-ecologies and socio-economic conditions of farmers.
- ❖ It is necessary to establish long-term basic and strategic research platforms in different production systems and ecologies for monitoring the effects in terms of resource/input use efficiency, pest dynamics, soil health, carbon sequestration, greenhouse gas emissions, etc., and link them with participatory/adaptive research modules for out-scaling of potential technologies.
- ❖ Long-term studies need to be conducted to ascertain the benefits (economic and

environmental) of CA on incorporation of crop residues in the soil and its other competitive uses as fodder, power generation, fuel, biofuel, paper industry, etc.

- ❖ Basic and strategic research on CA in relation to crop-livestock interactions on a long-term basis should be conducted to rationalize the residue needs for CA vis-à-vis livestock fodder under various production systems.
- ❖ The crop breeding programs need a renewed focus to tailor varieties suited to system's needs and for large scale adoption of conservation agriculture.
- ❖ The component technologies specifically suiting to the requirements of CA under different situations and production environments need to be developed, refined and adopted.
- ❖ Research on assessment of efforts put in by farmers for practicing CA and commensurate environmental benefits needs to be strengthened in order to ensure incentives to farmers for environmental services.
- ❖ Design and development of CA machinery, with special focus on small holder farmers should be given due attention.

### ***Development related recommendations***

- ❖ There is a large potential for adoption of CA which can easily be adopted over 20 million ha area in the South Asia region. For this, farmers need easy access to region-specific technologies with competent human resource, coupled with suitable policy support.
- ❖ Greater adoption and impact of CA will have to come from non rice-wheat systems and rainfed ecologies, an area which is untapped so far in the region.
- ❖ Efforts should be made to capture farmer innovations on CA and align them with scientific validation and refinements.
- ❖ There is a need to combine other best practices with CA, for example, permanent raised bed showed promising results in increasing irrigation and nitrogen use efficiency and better salinity management in irrigated areas in Central Asia.

- ❖ The program for developing dual purpose wheat for green fodder should be linked to program meant for improving productivity of livestock. Dual purpose wheat could be promoted in case of peri-urban agriculture where dairies are also located.
- ❖ Collective efforts of different stakeholders are needed for conducting demonstration of proven technologies in a cluster approach. Also, these knowledge sharing centers should be used for organizing local and regional travelling seminars, field days, etc.
- ❖ Analytic and communication tools need to be developed to help policy makers understand economic, social and political implications of CA based technologies vis-à-vis existing farmers' practices.
- ❖ CA is relatively knowledge intensive system. Hence, multi-disciplinary, multi-stakeholder partnerships should be developed and strengthened for further fine tuning the CA based technologies.
- ❖ There is a need to encourage use of information communication tools (ICTs) for real time access of information on location specific technologies/ inputs, services and farm advisory activities.
- ❖ The traders/dealers must receive updated information and training on calibration, operation and maintenance of CA machinery so that they provide right services to the farmers. The farmers and service providers also need technical back-up support.

### ***Policy related recommendations***

- ❖ Rice-Wheat Consortium (RWC) must be revived and strengthened to provide a neutral platform for policy makers, R&D managers, researchers, private sector representatives, NGOs, CGIAR institutions, CSOs and the farmers to assess local/national and regional needs, exchange information, and accordingly define priorities for the deployment of CA with a focus on small holder resource poor farmers.
- ❖ There is a strong need for creation of regional CA networks and for that regional organizations/ fora/programs like APAARI, RWC, CSISA, SAARC,

ASEAN, CAADP, and CAREC along with CGIAR institutions can play an important role.

- ❖ Investments by the national governments are not an issue, but the bigger issue is prioritization and making best use of the allocated resources. Large investments are being made by the national systems, for example in India, NFSM, RKVY, NAIP, national initiative on CA, climate resilient agriculture (NICRA), ICAR platform on water, etc. are operational. There is a need for integration and complementarities in such schemes with appropriate monitoring and evaluation (M&E) for mid-course correction and greater impact at the field level.
- ❖ Suitable mechanisms need to be developed for capacity building on CA for different target groups e.g. inclusion of CA in course curriculum in State Agricultural Universities, deploy M.Sc. and Ph.D. students in long-term CA trials, and train the service providers and machinery operators, etc.
- ❖ An efficient and reliable mechanism needs to be developed for documentation of CA database in the region enabling researchers and policy planners for taking further initiatives.
- ❖ A proper mechanism needs to be established for providing incentives to CA adopters including compensation for carbon credits.
- ❖ There is a need to have required mechanism in place for ensuring the minimum quality standards of CA machinery with all spare parts, after sale services and operational manuals which are lacking at present.
- ❖ Agro-Service Centers need to be developed to provide timely CA based machineries and services to the resource poor small land holders.
- ❖ It is critical to develop an active farmers' feedback-based R&D system to solve practical problems concerning adoption of conservation agriculture and related integrated crop management and farming system, including focused institutional and policy support, appropriate incentives and crop insurance to reduce risks for widespread dissemination and adoption of CA technologies by the farmers.
- ❖ There is full justification for subsidized good quality tillage machinery prototypes (multi-crop planters, multi-purpose turbo happy seeders and multi-crop double disk planters, sugarcane cutter planter) to promote CA. Also we need to address properly the conflicting messages and policies, for example, zero-tillage v/s rotavator or rotavator v/s turbo seeder, zero tillage v/s system of rice intensification (SRI) and system of wheat intensification (SWI), etc. since often these result in misleading the farmers.

# Technical Program

## Day 1: November 1, 2011

---

### **0830-0900 Registration**

#### **Inaugural Session (0900-1000 hrs)**

0900-0907	Welcome	: AK Singh, DDG (NRM), ICAR
0907-0920	About the Dialogue	: Raj Paroda, Executive Secretary, APAARI
0920-0935	Special Remarks	: Peter Kenmore, FAO
0935-0955	Inaugural address	: Thomas A Lumpkin, DG, CIMMYT
0955-1000	Vote of Thanks	: Raj Gupta, Head, CIMMYT India

### **1000-1030 Tea Break**

#### **Technical Session-I Status of Conservation Agriculture (1030-1300)**

*Chair* : Mangala Rai, Advisor to Chief Minister,  
Bihar

*Co-Chair* : Dinesh Periyar, ED Nepal

*Rapporteur* : MG Neogi, RDRS, Bangladesh

1030-1115	Global Scenario of Conservation Agriculture	: ML Jat, Senior Cropping system Agronomist, CIMMYT
1115-1145	Country Report- India	: Indu Sharma, Project Director, DWR
1145-1205	Country Report- Nepal	: Niranjana Adhikari, Director, NARC
1205-1225	Country Report- Bangladesh	: MG Neogi, Head, RDRS
1225-1300	Open Discussion	:

### **1300-1400 Lunch Break**

---

**Technical Session-II**  
**Initiatives of CG Centres on C A in South Asia (1400-1545)**

*Chair* : Thomas Lumpkin, DG, CIMMYT

*Co-Chair* : HS Gupta, Director IARI

*Rapporteur* : RK Malik, Senior Research  
Manager, CSISA, EUP

1400-1420	CIMMYT- Maize and Wheat Systems	: ML Jat, Senior Cropping System Agronomist, CIMMYT
1420-1440	IRRI- Rice Systems	: JK Ladha, IRRI Representative, India
1440-1500	ICRISAT- CA in Vertisols	: SP Wani, Principal Scientist & Head, ICRISAT
1500-1520	ILRI-Crop-Livestock Interaction in CA	: Iain Wright, South Asia Coordinator, ILRI
1520-1540	CA Practices in Central Asia	: J Lamers, GEF-UNESCO, Uzbekistan

**1540-1600 Tea Break**

**Technical Session-III**  
**Scaling out Strategy for CA- Break-out Groups (1600-1800)**

**Working Group-I : Out-scaling for Impact**

*Chair* : Ashok Yadav, Director General  
(Agriculture), Haryana

*Co-Chair* : Ravi Gopal, Director Research,  
BAU, Bihar

**Working Group-II : Partnerships for Regional Cooperation**

*Chair* : Suzanne Ross, Senior Development  
Advisor, USAID-India

*Co-chair* : Dr D. P. Singh, Consultant, Haryana  
Kisan Ayog, India

**Working Group-III : Capacity Building**

*Chair* : John Lamers

*Co-Chair* : RP Narwal, Director Research,  
CCSHAU, Hisar

**1930 Dinner**

## Day 2: November 2, 2011

### Technical Session-III (Conti) Report of the Break-out Groups (0900-1000)

*Chair* : IP Abrol, Director CASA

*Co-Chair* : Niranjan Adhikari, Director Crops  
& Hort, NARC, Nepal

*Rapporteur* : A. McDonald, CIMMYT, Nepal

0900-0915	Chair Group-I
0915-0930	Chair Group-II
0930-0945	Chair Group-III
0945-1015	Open Discussion

#### **1030-1100 Tea Break**

### Technical Session-IV Research and Development Needs on CA in South Asia (1100-1300)

*Chair* : Gurbachan Singh, Chairman, ASRB

*Co-Chair* : John Dixon, ACIAR

*Rapporteur* : Sonali Bisht, INHERE

1100-1120	Research and Development Gaps: Gurbachan Singh, Chairman, ASRB	
1120-1140	CA in Haryana- From Issues to Actions: An Example	Raj Gupta, CIMMYT
1140-1200	How to Accelerate Pace of Adoption: Policies, Public-Private Partnerships, Role of CSOs.	PK Joshi, IFPRI
1200-1220	Climate Resilient Agriculture: Outcomes of ACIAR Scoping Mission	John Dixon, ACIAR
1220-1240	Future Roadmap for Eco-Regional Program (RW Consortium)	NARS Leaders
1240-1300	Summarizing the Discussion	Chair

#### **1300-1400 Lunch Break**

---

**Plenary Session: (1400-1530)**

*Co-Chairs* : S. Ayyappan, Secretary, DARE,  
GOI & Director General (ICAR)  
Thomas A Lumpkin, Director  
General, CIMMYT

*Rapporteur* : Indu Sharma, Director DWR

1400-1450	Session Reports	: Respective Rapporteurs
1450-1505	Concluding Remarks by Co-Chair	: Thomas A Lumpkin
1505-1525	Concluding Remarks by Co-Chair	: S Ayyappan
1525-1530	Vote of Thanks	: Ajai Kumar

**1530-1600 Tea Break**

1600-1700 Visit to National Agricultural Science  
Museum, NASC Complex

**1930 Dinner**

---

## List of Participants

### **ADITYA K SINGH**

Senior Scientist  
Directorate of Maize Research (DMR)  
Pusa, New Delhi-110012  
India  
aditya\_jadon@yahoo.co.in

### **AJAI KUMAR**

Senior Administrative Country Coordinator  
International Maize and Wheat Improvement Center  
(CIMMYT), NASC Complex,  
Pusa, New Delhi-110012  
India  
ajai.kumar@cgiar.org

### **AK MEHTA**

Assistant Director General (Extension)  
Indian Council of Agricultural Research,  
Krishi Anusandhan Bhawan-I,  
Pusa, New Delhi-110012  
India  
akmehta@icar.org.in

### **AK SINGH**

Deputy Director General (NRM)  
Indian Council of Agricultural Research,  
Krishi Anusandhan Bhawan-II,  
New Delhi-110012  
India  
aksingh@icar.org.in

### **ALIM AL RAZI**

Marketing Director  
Rahman Agro Industries  
Power Generation Engineering Works  
House 375, road 6, Baridhara, Dhaka  
Bangladesh

### **ANDREW MCDONALD**

Cropping System Agronomist  
South Asia Regional Office  
International Maize and Wheat Improvement Center  
(CIMMYT)  
Singha Durbar Plaza Marg  
Kathmandu  
Nepal  
A.McDonald@cgiar.org

### **ANIL CHANDRA PRAMANIK**

Farmer  
Village- Alipur, Post office- Belghoria,  
Upazila/Police Station- Durgapur,  
District- Rajshahi  
Bangladesh

### **ANKIT AGRAWAL**

Farmer  
Village & Post Bhureka,  
District Mathura  
Uttar Pradesh  
India  
ankitag201@gmail.com

### **ANUPAMA DEORA**

Research Fellow  
Haryana Kisan Ayog,  
Chaudhary Charan Singh Haryana Agricultural  
University (CCSHAU)  
Hisar, Haryana  
India  
shiningdeora@gmail.com

**AR SHARMA**

Professor (Agronomy)  
Division of Agronomy  
Indian Agricultural Research Institute  
Pusa, New Delhi-110012  
India  
sharma.ar@rediffmail.com

**ASHOK K YADAV**

Director General (Agriculture)  
Directorate of Agriculture  
Krishi Bhawan, Panchkula, Haryana  
India  
akyadavias@yahoo.com

**ASHOK YADAV**

Professor (Agronomy)  
Department of Agronomy  
Chaudhary Charan Singh Haryana Agricultural  
University (CCSHAU)  
Hisar, Haryana  
India  
aky444@gmail.com

**ATUL JAIN**

Head, Agri Services  
Hariyali Kisan Bazar  
DCM Sriram Consolidated Limited,  
A-6, Sector-16, Noida, Noida,  
Uttar Pradesh- 201301  
India  
atuljain@dscl.com

**B GANGAIAH**

Principal Scientist (Agronomy)  
Directorate of Rice Research (DRR)  
Rajendra Nagar,  
Hyderabad, Andhra Pradesh  
India  
bandla\_gang@hotmail.com

**BALDEV SINGH**

President  
All Indian Machinery Manufacturers Association  
Amar Agro Industries  
Ludhiana, Punjab  
India  
amaragri@gmail.com

**BC VIRAKTAMATH**

Director  
Directorate of Rice Research (DRR)  
Rajendra Nagar  
Hyderabad, Andhra Pradesh  
India  
pdrice@drdicar.org

**BHAG MAL**

Consultant  
Asia Pacific Association of Agricultural Institutions  
(APAARI)  
C/o TAAS, IARI Campus  
Pusa, New Delhi-110012  
India  
b.mal@apaari.org

**BHAGWAN SHARMA**

Farmer  
Village & Post-Khayasa  
District Mathura, Uttar Pradesh  
India

**BR KAMBOJ**

Hub Coordinator,  
Cereal Systems Initiative for South Asia (CSISA), Haryana  
Hub,  
Central Soil Salinity Research Institute, Karnal, Haryana  
India  
b.kamboj@cgiar.org

**CM PARIHAR**

Scientist  
Directorate of Maize Research (DMR)  
Pusa, New Delhi - 110012,  
India  
pariharcm@gmail.com

**DEVRAJ ARYA**

Technology Development Leader  
Monsanto India Limited Ahura Centre, 5th Floor 96,  
Mahakali Caves Road Andheri (East),  
Mumbai 400 093 India  
devraj.arya@monsanto.com

**DINESH PARIYAR**

Executive Director  
Nepal Agricultural Research Council (NARC),  
Singha Durbar Plaza,  
P.O.Box 5459, Kathmandu,  
Nepal  
ednarc@ntc.net.np

**DP SINGH**

Consultant  
Haryana Kisan Ayog  
Chaudhary Charan Singh Haryana Agricultural  
University (CCSHAU)  
Hisar, Haryana  
India  
dpsingh1943@gmail.com

**GAM BHADUR GURUNG**

Program Director  
FORWARD, (NGO) Chitwan  
Nepal  
gbigumng@yahoo.com

**GOPI GHOSH**

Assistant Country Representative  
Food and Agriculture Organization of the United  
Nations  
Lodi Estate 55 Max Muller Marg New Delhi  
PO Box 3088, New Delhi-110 003  
India  
gopi.ghosh@fao.org

**GURBACHAN SINGH**

Chairman  
Agricultural Scientists Recruitment Board (ASRB)  
Indian Council of Agricultural Research,  
Krishi Anusandhan Bhawan-I  
Pusa, New Delhi- 110001,  
India  
ag.comm@nic.in

**GURDAS MONDAL**

President,  
Seed Grower Association  
Kulgachi, Nadia,  
West Bengal  
India

**HS GUPTA**

Director  
Indian Agricultural Research Institute  
Pusa, New Delhi-110012  
India  
director@iari.res.in

**HS SIDHU**

Senior Research Manager  
Cereal Systems Initiative for South Asia (CSISA),  
Punjab Hub,  
Teri House, Punjab Agricultural University  
Ludhiana, Punjab  
India  
H.Sidhu@cgiar.org

**IAIN WRIGHT**

Regional Coordinator  
International Livestock Research Institute (ILRI) India  
NASC Complex, Pusa,  
New Delhi - 110012,  
India  
i.wright@cgiar.org

**INDU SHARMA**

Project Director  
Directorate of Wheat Research (DWR)  
Post Box 158, Kunjpura Road, Karnal-132001, Haryana  
India  
pdwheat@dwr.in

**IP ABROL**

Director  
Centre for Advancement of Sustainable Agriculture  
(CASA)  
NASC Complex, Pusa  
New Delhi-110012  
India  
abrolip@gmail.com

**JAGADISH TIMSINA**

Cropping Systems Agronomist  
International Rice Research Institute (IRRI)  
House 9, 2/2 Road, Banani, Dhaka-1213  
Bangladesh  
j.timsina@irri.org

**JK LADHA**

IRRI Representative in India  
International Rice Research Institute (IRRI)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
j.k.ladha@cgiar.org

**JL KARIHALOO**

Coordinator  
Asia Pacific Consortium on Agri Biotechnology  
(APCoAB)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
j.karihaloo@cgiar.org

**JOHN DIXON**

South Asia Coordinator  
Australian Centre for International Agricultural  
Research (ACIAR)  
38 Thynne Street Fern Hill Park BRUCE ACT 2617,  
Canberra,  
Australia  
john.dixon@aciar.gov.au

**JOHN LAMERS**

UNESCO National Office to Uzbekistan in the Central  
Asia Cluster  
Address: 9, Ergashev Street,  
100084 Tashkent  
Uzbekistan  
j.lamers@zef.uznet.net

**KS KHOKHAR**

Vice Chancellor  
Chaudhary Charan Singh Haryana Agricultural  
University (CCSHAU)  
Hisar, Haryana  
India  
vc@hau.ernet.in

**KUHU CHATTERJEE**

Regional Manager South Asia  
Australian Centre for International Agricultural  
Research (ACIAR),  
Australian Embassy, New Delhi  
India  
Kuhu.Chatterjee@dfat.gov.au

**MAHESH K GATHALA**

Cropping Systems Agronomist  
International Maize and Wheat Improvement Center  
(CIMMYT)  
House 9, 2/2 Road, Banani, Dhaka-1213,  
Bangladesh  
m.gathala@cgiar.org

**MALVIKA DADLANI**

Joint Director (Research)  
Indian Agricultural Research Institute  
Pusa, New Delhi-110012  
India jd\_research@iari.res.in

**MAMTA KAIN**

Research Associate  
International Maize and Wheat Improvement Center  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
m.kain@cgiar.org

**MANGALA RAI**

Advisor to Chief Minister Bihar  
Govt of Bihar  
48, Main Secretariat Patna – 800015  
India  
mnglrai@gmail.com

**MEENAKSHI CHANDIRAMANI**

Program Specialist  
International Maize and Wheat Improvement Center  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
m.chandiramani@cgiar.org

**MG NEOGI**

Head of Agriculture and Environment  
Rangpur Dinajpur Rural Services (RDRS),  
Rangpur  
Bangladesh  
mgneogi@gmail.com

**MICHELLE DEFRESE**

Communications Assistant to Director General  
International Maize and Wheat Improvement Center  
(CIMMYT)  
Km 45, Carretera Mex-Veracruz  
El Batan, Texcoco, Mexico CP 56130  
Mexico  
M.Defreese@cgiar.org

**ML JAT**

Senior Cropping System Agronomist  
International Maize and Wheat Improvement Center  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
m.jat@cgiar.org

**MUKUNDA BAHADUR CHHETRI**

Progressive Farmer  
Village & Post- Simara,  
District-Bara  
Nepal  
bishnu.bista@snpl.com

**NAGESHWAR SINGH**

Progressive Farmer  
District Begusarai, Bihar  
India

**NEELAM CHOUDHARY**

HCP Manager  
International Maize and Wheat Improvement Center  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
n.choudhary@cgiar.org

**NILS TEUFEL**

Scientist  
International Livestock Research Institute (ILRI) India  
NASC Complex, Pusa,  
New Delhi-110012  
India  
n.teufel@CGIAR.ORG

**NIRANJAN ADHIKARI**

Director  
Crops & Horticulture  
Nepal Agricultural Research Council  
Kathmandu  
Nepal  
chdnarc@ntc.net.np

**PETER E. KENMORE**

Principal Officer  
Plant Production and Protection Division  
Food and Agriculture Organization of United Nations  
(FAO)  
Viale delle Terme di Caracalla 00153 Rome  
Italy  
Peter.Kenmore@fao.org

**PK JOSHI**

Senior Program Manager  
International Food Policy Research Institute (IFPRI),  
NASC Complex, Pusa,  
New Delhi -110012,  
India  
p.joshi@cgiar.org

**PS CHAHAL**

Associate Director of Research  
Punjab Agricultural University (PAU),  
Ludhiana, Punjab  
India  
piarasingh1990@rediffmail.com

**R SAI KUMAR**

Project Director  
Directorate of Maize Research (DMR)  
Pusa, New Delhi – 110012  
India  
pdmaize@gmail.com

**RAJ DEEP SINGH**

Manager  
National Agro Industries,  
Chandigarh Road  
Ludhiana, Punjab  
India  
info@nationalagroinds.com

**RAJ GUPTA**

Head-CIMMYT India  
International Maize and Wheat Improvement Centre  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
rajgupta@cgiar.org

**RAJ NARAYAN SINGH**

Farmer  
Village & Post- Kesawe  
District Begusarai, Bihar  
India

**RAJ PARODA**

Executive Secretary  
Asia Pacific Association of Agricultural Institutions  
(APAARI)  
C/o TAAS, IARI Campus,  
Pusa, New Delhi-110012  
India  
raj.paroda@yahoo.com

**RAVI GOPAL SINGH**

Director Research  
Bihar Agricultural University  
Sabour, Bhagalpur, Bihar  
India  
ravigopal.singh@gmail.com

**RK JAT**

Cropping Systems Agronomist  
International Maize and Wheat Improvement Center  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi -110012,  
India  
r.jat@cgiar.org

**RK MALIK**

Senior Research Manager  
Cereal Systems Initiative for South Asia (CSISA)  
EUP Hub  
Indian Vegetable Research Institute,  
Krishi Vigyan Kendra  
Sargatia, Kushinagar, Uttar Pradesh  
India  
rk.malik@cgiar.org

**RK SHARMA**

Principal Scientist  
Directorate of Wheat Research (DWR)  
Post Box 158, Kunjpura Road, Karnal – 132001,  
Haryana  
India  
rks20037@gmail.com

**RN YADAV**

Office Secretary  
Asia Pacific Association of Agricultural Institutions  
(APAARI)  
C/o TAAS, IARI Campus, Pusa,  
New Delhi-110012  
India  
ram.niwas@apaari.org

**RP NARWAL**

Director Research  
Chaudhary Charan Singh Haryana Agricultural  
University (CCSHAU)  
Hisar, Haryana  
India  
narwalrp@gmail.com

**RS DALAL**

Member Secretary  
Haryana Kisan Ayog  
Chaudhary Charan Singh Haryana Agricultural  
University (CCSHAU)  
Hisar, Haryana  
Indiarsdalal1@gmail.com

**RS CHHONKAR**

Senior Weed Scientist  
Directorate of Wheat Research (DWR)  
Post Box 158, Kunjpura Road, Karnal-132001,  
Haryana  
India

**S AYYAPPAN**

Secretary, Department of Agricultural Research &  
Education, Govt of India &  
Director General, Indian Council of Agricultural  
Research (ICAR)  
Krishi Bhawan, New Delhi - 110001  
India  
dg.icar@nic.in

**SL JAT**

Scientist  
Directorate of Maize Research  
Pusa, New Delhi-110012  
India  
sliari@gmail.com

**S MAKHIJA**

Senior Manager  
Jain Irrigations  
New Delhi  
India  
makhija.surindr@jains.com

**SAIN DASS**

President  
Indian Maize Development Association (IMDA)  
Connaught Circus, New Delhi  
India  
sain1dass@yahoo.com

**SARBJIT SINGH**

Managing Director  
Dasmesh Mechanical Works  
Amargarh,  
Distt Sangroor, Punjab  
India  
dasmesh\_dmw@yahoo.co.in

**SONALI BISHT**

Advisor  
Institute of Himalayan Research and Education  
206, Gupta Arcade,  
Mayur Vihar, Phase-1  
Delhi-110 091  
India  
sonalibisht@yahoo.co.in

**SP WANI**

Principal Scientist & Head  
International Crops Research Institute for the Semi-  
Arid Tropics (ICRISAT)  
Patancheru P.O. 502 324, Andhra Pradesh  
India  
S.WANI@CGIAR.ORG

**SS SINGH**

National Consultant  
National Food Security Mission  
Department of Agriculture and Cooperation  
Government of India  
Krishi Bhawan, New Delhi  
India  
sssinghdac@gmail.com

**SUDHIR AGGARWAL**

Village & post Bhureka,  
District Mathura  
Uttar Pradesh  
India  
bhawaniseeds@gmail.com

**SURABHI MITTAL**

Senior Economist  
International Maize and Wheat Improvement Center  
(CIMMYT)  
NASC Complex, Pusa, New Delhi-110012  
India  
s.mittal@cgiar.org

**SUZANNE ROSS**

Senior Development Advisor  
United States Agency for International Development  
(USAID)  
India-Mission  
American Embassy,  
Chanakyapuri, New Delhi  
India  
gross@usaid.gov

**THOMAS A LUMPKIN**

Director General  
International Maize and Wheat Improvement Centre  
(CIMMYT)  
Km 45, Carretera Mex-Veracruz  
El Batan, Texcoco, Mexico CP 56130  
Mexico  
t.lumpkin@cgiar.org

**TK DAS**

Senior Scientist  
Division of Agronomy  
Indian Agricultural Research Institute  
Pusa, New Delhi-110012  
India  
tkdas64@gmail.com

**US SADANA**

Head  
Department of Soils  
Punjab Agricultural University  
Ludhiana, Punjab  
India  
hodsoil@pau.edu

**VIJESH KRISHNA**

Economist  
International Maize and Wheat Improvement Centre  
(CIMMYT)  
NASC Complex, Pusa,  
New Delhi-110012  
India  
V.Krishna@cgiar.org

**VIJOY K MALLICK**

Director General  
Department of Agriculture,  
Ministry of Agriculture and Cooperative  
Kathmandu  
Nepal  
agribusiness@moac.gov.np

**YASHPAL SAHARAWAT**

Senior Scientist  
Indian Grassland and Fodder Research Institute  
Jhansi, Uttar Pradesh  
India  
y.saharawat@cgiar.org







OFFICE BLOCK

