Summary and Recommendations

Indian Ecological Society: International Conference 2016

Natural Resource Management Ecological Perspectives

18-20 February 2016

Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, India


Direct effect on crop growth
Physiology
Morphology
Soil fertility
Human inter
Adaptation s
Mitigation st
Agricultural prod
vulnerabil


Sustainability : Maximum for the pr
without compromis
Livelihood & Nutrition :
Eco-system Services: : Pollinators, natural e
conservation, checki


Polycentric Perspectiv
Dinesh K Marothia
President , National Institute of Ecolo
Member, State Planning Commission,G
(Ex- Chairman, CACP, GOI)
Email: dkmarothia@gmail.com
Keynote Address
Indian Ecology Society Conference
Sher-e-Kashmir University of Agricultural Sciences and
Jammu, Feb 18-20 2016

Summary and Recommendations

Natural Resource Management Ecological Perspectives

Indian Ecological Society International Conference 2016

(IESIC 2016)

Partners

Sponsors

Homepage URL: http://indianecologicalsociety.com/

Correct citation: Dhawan, A.K., Peshin, R., Chauhan, S. and Risam, K.S. (2016). Summary and Recommendations of the Indian Ecological Society International Conference on Natural Resource Managemnet: Ecological Prespectives, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, India 18-20 February, 2016.

Printed by:
Bytes & Bytes
(M) 94127 38797; sandybly@gmail.com

INTRODUCTION

Natural resource management issues are inherently complex as they involve the ecological cycles, hydrological cycles, climate, animals, plants and geography etc. All these are dynamic and inter-related. In addition to the natural systems, natural resource management also has to manage various stakeholders and their interests, policies, politics, geographical boundaries, economic implications and so on. It is very difficult to deal with all aspects at the same time. The emphasis on sustainability attempts to understand the ecological nature of the agriculture and allied areas.

An integrated approach is needed for recognising and implementing the intertwined social, cultural, economic and political aspects of resource management. A more holistic global perspective evolved from the Brundtland Commission and the advocacy of sustainable development. Most nations subscribed to new principles for the integrated management of land, water and forests in the United Nations Conference for the Environment and Development (UNCED) held in Rio de Janeiro in 1992.

The Indian Ecological Society International Conference (IESIC) 2016 on "Natural Resource Management: Ecological Perspectives" was held at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, India from February 18-20, 2016. The conference provided a forum for review of new information concerning natural resource management in the areas of land and water resources, crop environment interactions, forestry tree plantations, horticulture crops, integrated nutrient management, integrated pest management, eco-responsive livestock and fisheries production, and policies for sustainable development of agriculture. New information and recommendations relating to each of these major topics are summarized in the report that follows.

Six hundred eight delegates from eight countries attended the international conference. In total, 708 papers were contributed under different themes. There were five main sessions where 15 keynote speakers presented their expert views. In addition, there were eight concurrent sessions on the themes, where 22 lead lectures on various themes were presented, and one panel discussion. There were 15–23 oral presentations in each concurrent session on different themes.

The issues regarding strategies for natural resource management were reviewed and discussed in detail. Developing location specific, cost effective, eco-friendly conservation and management technologies for higher input use efficiency, agricultural productivity and profitability without deteriorating natural resource base is vital for sustainable management of natural resources to ensure agricultural development. The invited lectures, topical discussions, oral and posters presented at the international conference and the invited and contributed manuscripts that appear in two volumes of extended summaries (*Natural Resource Management : Ecological Perspectives*, Vol.1 and Vol.2,

ISBN numbered and CAB indexed) and the *Indian Journal of Ecology,* Vol. 43 (Special Issue 1 and 2: 2016) formed the basis for the following summary and recommendations.

SUMMARY AND RECOMMENDATIONS

1. Land and Water Resources

Water and water saving technologies pose the challenge due to climate change. About four to five decades ago, heavy snowfall used to strengthen the glacier but climate change has put havoc on this process in many areas, like Ladakh region of India.

How to manage wetlands is another challenge that we need to address? The multiple use water bodies (MUWBs) are important and valuable to meet various needs. The issues relating to management are complex due to various characteristics and categories. Wetland ecosystems are multipurpose and multiuse in nature with technical socioeconomic- cultural-political and environmental interdependencies. As a result wetlands suffer with spatial and temporal externalities due to pollution, congestion, in-fillings, encroachment, natural and created use conflicts, and misspecification of property rights regimes, entitlement systems, institutional hierarchy and mechanism for adjusting allocation of wetlands water resources.

The issue concerning water logging and poor quality water available for irrigation pose problems for crop cultivation in many areas. The problems of over-exploitation of ground water, water-logging and salinization in command areas are looming large in several states. Water quality indexing developed by using nine water quality parameters, turbidity of water is an important parameter while indexing quality of water. Presences of aquatic insects are an important indicator for monitoring the quality of surface water.

Long term option for groundwater sustainability in Indian agriculture is another pressing issue. The overdependence on groundwater under irrigated cropping system has led to its overexploitation, which resulted in decline in water table. Sprinkler irrigation is found to be effective for efficient water management and sustainable crop productivity. Growing high value crops with sprinkle irrigation is beneficial for enhanced economics. The watershed management approach has emerged as a unique integrated model. Empirical models for effective estimation of sediment yield in micro-watersheds should be employed.

Some of the states are switching over to free supply of irrigation water and electricity to the farmers. This policy needs reconsideration so as to avoid misuse of the resource, which is likely to aggravate the problem of degradation of land, and water resources, and the environment.

Recommendations

- For managing wet lands, policies of state departments and *panchayats* need to be examined critically in view of the fact that many departments are loosely linked. A synthesis between traditional institutional mechanism and components of current policies can appropriately be put into operation for distributed or polycentric governance for MUWBs. Environmental costs in addition to management cost of the produce, which otherwise are not accounted, must be accounted for.
- Urgent efforts are required for research, training and capacity building on wetlands and its integration with the overall water resources management, in consonance with the National Water Framework Law. It may be desirable to set up an independent Centre for the purpose.
- The Ministry of Environment, Forests and Climate Change has circulated Draft Wetland Conservation and Management Rules 2016 which will replace the 2010 Rules. While there are many shortcomings in these Rules, the states are empowered to make their own rules and identify wetlands within the state. For the purpose of regulation of activities, a state level policy has to be formulated, followed by the rules and regulations. Many states do not have a state level Wetland Authority even under the 2010 Rules. The 2016 Rules provide that: All state governments shall set up a State Level Wetland Authority entrusted with affairs related to wetland conservation, regulation and management under the relevant state bye-laws.
- The adaptation strategies of rain water harvesting, land degradation management, development of salt and water logging tolerant rice (*Oryza sativa* L.) varieties, suitable water and soil conservation measures and agricultural diversification, which all have benefited the farmers, must be promoted. Subsurface drainage system using perforated PVC pipes is effective in drainage of agricultural land. Eco-friendly bio-amelioration populus based agroforestry systems for saline and alkali soils are needed for problematic areas for optimizing tree-intercrop combinations.
- Irrigation scheduling using sensors, mulching, drip and sprinkle irrigation, laser land leveling etc. should be popularized. The incentives for water saving technologies may help in long term ground water sustainability. Recharging shaft with filtration arrangement is more effective for ground water recharging and improving the quality of water from water harvesting storage like pond, nullah, bund, etc. Roller-compacted concrete (RCC) check dams are very useful for water conservation and ground water recharging. The vertical drainage through shallow tube wells on a large scale should be encouraged including rainwater harvesting.

- There is a need for research on methods of implementation of conservational approach and their judicious use. Remote sensing and Geographical Information System (GIS) tools should be widely used for land and water management.
- The concept of "Watershed Management Society at Local Level" needs to be strengthened for proper implementation. The concept needs to be defined with a view to clarify basic principles of land and water management and linkages with biomass production and ecological safeguards. The empirical models are more effective for the estimation of sediment yield in microwatersheds.
- Information on the wasteland development through biological means and approaches needs to be reviewed, consolidated and made available for general use.
- The proven technology for development of wasteland, including salt-affected/waterlogged soils needs to be introduced, with required modifications, in the areas lying abandoned.
- Water resource development in the hill areas and microlevels has emerged as the most potent tool not only at the experimental level but also at field level. Replication of proven examples is important for developing sustainable ecosystems.
- The only way the water can be conserved in the cold deserts is by creating artificial glaciers in cold regions. This can be achieved by diverting the melting water to the northern facing slopes where shade is there and winter sun is blocked. These artificial glaciers can augment social, economic and environmental benefits not only in Ladakh region but also in areas falling in down-stream.
- The financial support should be provided to farmers for adopting water conserving technologies and equipments.
- Presences of aquatic insects is an important indicator for monitoring the quality of surface water.
- Shifting the dynamics and timings of providing canal irrigation for mitigating the negative effects of climate change on productivity need critical evaluation.
- It is essential to use the available technology and evolve new technology wherever required for efficient and rational use of normal, brackish (saline/sodic) and sewage water for irrigation to achieve sustainable water use.

2. Integrated Nutrient Management

The role of soil as a living medium and the importance of categorization of

organic matter and conservation of agriculture, integrated use of inorganic fertilizers, organic materials like animal manure, piggery manure, poultry manure, biogas slurry, green manure and crop residues should be promoted for sustaining chemical, physical and biological fertility of soils. Also, the balanced fertilizer use should be ensured to avoid negative balance among nutrients in the soil. Indiscriminate use of untreated industrial waste water for irrigation of soils and crops must be discouraged to maintain soil health and sustain yield and quality of the crop produce. Make use of the available technology and evolve newer ones wherever required for the efficient and rational use of normal, brackish (saline/sodic) and sewage waters for irrigation to achieve sustainable water use. Optimum levels of soil organic matter for obtaining desirable crop yields under varying soil situations need to be defined.

Recommendations

- Integrated and optimum use of inorganic fertilizers and organic materials should be promoted for sustaining chemical, physical and biological fertility of soils. Organic cultivation practices need to be developed for different crops and for varied agro-ecological situations.
- Inoculation of legumes with efficient strains of *Rhizobium* needs to be promoted to increase the use of atmospheric nitrogen by the crops and to save on nitrogenous fertilizers as well as reducing the pollution hazards. Efficient *Rhizobium* strains need to be identified for solublizing sparingly soluble phosphorous compounds in order to increase phosphorus use for efficiency in soils.
- Indiscriminate use of untreated industrial waste water for irrigation must be discouraged to maintain soil health and sustain yield and quality of the crop produce.
- Fertilizer application based on “Soil Health Cards” recommendations though initiated,requires proper application.
- Native beneficial soil microorganisms should be isolated, multiplied and applied for better crop growth and soil health.
- Optimum levels of soil organic matter for obtaining desirable crop yields under varying soil situations need to be defined. Change in cropping pattern in places where resources are depleting and are in high risk zone of unsustainability need priority.
- Half of the recommended dose (10:20:20 N, P O , K O kg/ ha) along with FYM at the rate of 4 tonnes /ha could be the best option that will not only give sustainable yield but also improve soil health.
- Application of 241.6 g N + 711.6 g P + 592.42 g K /plant/ year in split doses is a good approach for high production and yield in pomegranate orchard.
- N-application can be done by using land capability classification (LCC) index of 4 when inorganic fertilizers are combined with organic manure in

rice (*Oryza sativa* L.).

- CP-2013 potato (*Solanum tuberosum* L.) acc. was found superior than earlier identified best variety Kufri Gaurav at low doses of N. Hyper accumulator accumulates heavy metals in roots/leaves and can be used to clean the environment.

3. Crop Environment Interactions

Crop genetic diversity, crop residue management, increased biomass production, identification of crops/trees (medicinal, aromatic, petro, edible, cactus, etc.) with high commercial/industrial value and compatibility with the prevailing environment, weather forecasting, crop residue management, climate change and biodiversity, impact of climate change on insect pests and diseases of the crops, vegetation tolerating high temperature, salinity, high CO_2 use efficiency, strategies to mitigate the impact of climate change on productivity, and pest outbreak were covered by the delegates and deliberated upon.

Main source of carbon emission is from energy generation followed by land use change and agriculture. Among the top 10 countries from carbon emission point, India contributes a substantial share but least on per capita basis (1.2 tons/year/head). Climate change in India represents an additional stress and is likely to impact Indian agriculture adversely. Due to likelihood of rise in temperature by 2°C, the coastal areas and North Eastern region of the country face the danger of erosion of native genotypes or wild types. Thus by taking adaptive measures, coping as well as resilience range will improve. Deleterious effect of global environment due to rise in temperature, depletion of ozone layer, loss of biodiversity, degradation of air and water quality, which resulted in upsurge of infectious and non infectious diseases in humans were also discussed. About 23 per cent of global diseases and 24 per cent of deaths are attributed to environmental problems. Heart diseases, cancer, reparatory disorders and many vector borne diseases are also increasing due to change in climate.

Close associations between scientists, public health professionals and administrators is required to attain harmony between man and nature. We should not work in silos but there should be intra-disciplinary and inter-disciplinary integration in research to find answers to crop, human and environment interaction, and emerging researchable issues. Impact of climate change on ecology from farmers' perspectives was also discussed.

Recommendations

- Need for developing climate resilient technology for management of natural resources, which impacts the sustainability of agriculture.
- Consider all the biotic stresses under the changing pattern of climate change.
- Strategies to mitigate the effect of climate with special reference to pest

outbreak need special attention.

- Emphasis must shift from impact assessment to developing adaptation and mitigation strategies. In order to realize the increased production while avoiding the extreme adverse effects, there is a need to reintegrate traditional knowledge into new ecological knowledge for sustainable and intensive crop production. More importance should be given to conservation technologies rather than consumptive technologies.
- Revisit efficacy of current, physical, chemical and biocontrol methods including pest resistant cultivars under changing climate. The vegetation tolerating high temperature, salinity and high CO_2 use efficiency could be better than other species.
- Some of the mitigation options for reducing carbon emissions recommended are: reducing the food wastage, adopting agroforestry and reducing area under crops like rice.
- The biomass production should be increased through varieties with early seedling vigour and more leaf area without further addition of agro-chemicals and other inputs.
- Crop residue [rice (*Oryza sativa* L.), maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), sugarcane (*Saccharum officinarum* L.) etc.] management needs special attention keeping in view the associated environmental issues. Crop rotations can be framed keeping in view the negative impacts of crops residues on subsequent crops.
- Unique pulse biodiversity of Andaman and Nicobar islands harbour needs to be conserved and promoted for development of pulse varieties.
- Endophytes have the potential to revolutionize the process of introduction of new traits in plants.
- DNA markers are important tools in establishing the genetic diversity and discrete identity of Kashmiri Nakh (*Pyrus pyrifolia* Nakai)**.**
- *Aprostocetus* has become a key pest in the lac ecosystem in the changing scenario of climate and there is urgent need to develop strategies for its management.
- From the farmers' perspective (farmer delegate) sustained effort is needed to weed out or neutralize deleterious internal and external influences on critical agricultural issues.
- Transfer of technology from laboratory to the farms has taken shape and increased the productivity but pace is very slow to realize the required benefits.

4. Horticulture Crops

Horticulture offers not only a wide range of options to the farmers for crop diversification, but also provides ample scope for sustaining large number of agro-industries, which generate huge employment opportunities. The government initiatives like Horticulture Mission for North East and Himalayan

States which is a part of Integrated Development of Horticulture (MIDH) have gone a long way in helping diversification. The various constraints impeding growth and productivity include the large area under old/senile plantation, poor quality of seeds/planting material and low rate of replacement of cultivars, lack of irrigation, inadequate storage and cold chain, inadequate processing and marketing infrastructure, and less awareness of balanced and judicious use of agricultural inputs.

Natural resource management for the sustainable development of horticulture sector depends upon exploitation of high yielding varieties, production of quality seeds and planting materials, high density plantation, technology for rejuvenation of old orchards, pollination management, integrated pest management (IPM), organic fruit production and post harvest management. Judicious and sustainable utilization of natural resources and genetic wealth would be the priority in future.

In different presentations, the genetic variations in horticulture crop, nutrients and water management, insect pests, diseases and weed management and value addition to horticulture crop were discussed. The technologies for apple (*Malus domestica*), peach (*Prunus persica* (L) Batsch), pear (*Pyrus pyrifolia* Nakai.), pomegranate (*Punica granatum* L), mango (*Mangifera indica* L.), litchi (*Litchi chinensis* Sonn.), guava (*Psidium guajava* L.), aonla (Emblica officinalis Gaertn.) kiwifruit (Actinida deliciosa), citrus (Citrus spp.) were presented. The scientists shared their views on technologies for fruits and vegetable crops.

Recommendations

- To increase the production and productivity sincere efforts are needed to develop and popularize the high yielding varieties, hybrids, high planting densities, cost effective production and protection technology, and post harvest value addition that will provided momentum for the growth of temperate horticulture.
- New crops/varieties need evaluation for substitution and intensification of existing cropping systems. Increased availability of quality planting material for horticultural crops is essential for enhanced productivity.
- There is an urgent need for certification and registration of nurseries to ensure adequate production of quality planting material.
- Increased coverage of crops under improved/high yielding cultivars and dissemination of improved production technologies as per agro-climatic zones is utmostly required.
- Promotion of integrated approach for nutrient, insect pest and disease management and hi-technology interventions for improving production of horticultural crops (e.g. drip irrigation, greenhouse, mulching, etc.).
- Crop diversification in horticulture crops.

- Boosting the productivity by intensive cultivation.
- Improvement in water harvesting and distribution system, moisture management and soil conservation measures.

5. Integrated Pest Management

Pest management has thrown new challenges to plant protection scientists, extension workers and farmers. Worldwide, integrated pest management (IPM) is the policy decision for pest management. It has been five decades since the development of threshold theory and harmonious control strategies were the domain of pest management research in the USA, Canada, and some parts of Europe. In the 1970s the work on development and validation of IPM technologies started in developing countries. The implementation of IPM and pesticide reduction programmes has been in place in the developed and developing countries for the last three to four decades. There are plausible questions raised about the objectives of IPM, adoption of IPM practices, and pesticide use. Low volume pesticides and insect-resistant transgenic crops both decreased and stabilized pesticide use in the 1990s and early 2000s. Since then, pesticide sales regained an upward trajectory, and their use in agriculture has increased. Besides in 2015 there was an outbreak of pink bollworm (*Pectinophora gossypiella* Saunders) (Gujarat, Maharashtra) and whitefly (*Bemisia tabaci* Gennadius) (Punjab and Haryana) in Bt cotton in India. Thus, transgenic crops alone did not prove to be a perfect technique to save crops from ravages caused by pests.

Pesticides alone or in conjunction with transgenic cannot be the sole pest management tactics therefore, IPM is the way forward to manage the pests. Pesticides have deleterious effects on humans. There are a number of parameters of study that are relevant for testing the deleterious effects of chemical pesticides. The main ones include toxicity, mutagenicity, tumorigenicity and/or carcinogenicity, reproductive disruption, endocrine disruption, DNA damage, necrosis, apoptosis (cell death), and teratoginicity (birth defects). Generally, the most of these categories have a chemical profile that fits them and there is greater likelihood that it is potentially dangerous and carcinogenic. The greater number of species are affected by the chemicals adversely, it is more likely to have a negative impact on living organisms as a whole.

Recommendations

- Pest monitoring and surveillance should be undertaken at district, state and country level. To minimize dependence on hazardous chemicals, central and state governments should adopt integrated pest management. Use of information and communication technology (ICT) for pest surveillance and monitoring should be given impetus for database on pests over time and space, and also quickly processes data to facilitate decisions on pest management.

- Eco-friendly methods of pest management with appropriate and need based interventions are highly effective as they enhance natural enemy activity, reduce insect pest damage and help in sustainable production of quality produce.
- Data on insect resistant management available in India is rudimentary and we need to generate information on genetic and molecular aspects of bollworm resistance to Bt cotton in India that can result in formulation of effective resistance management strategy.
- Micro-organisms can be used for management of diseases, insect pests and phyto-phagous nematodes. Microorganism can also be used for bioremediation (heavy metal degradation), organic carbon recycling and waste management.
- Consortia of effective micro-organism with differential properties is ideal way for the replenishment of soil biota and helps in sustainability of agriculture.
- Concomitant with the development of new, less harmful bio-pesticides, there should be implementation of IPM educational programmes for farmers about proper pesticide use and their application practices.
- A reduction in the excessive use of certain suspect pesticides at plant growth stages and on fruits that they are not recommended for may also result in the decrease of chemicalrelated cancer incidence. Some of the insect pest namely whitefly, mealy bugs, thrips, jassids, etc. have become serious problem in different agro-ecosystems. Studies on the ecofriendly and bio-intensive management of these pests have shown better results.
- Bioi-intensive pest management (BIPM) modules involving yellow sticky traps at the rate of 12/ha for monitoring, release of *Chrysoperla zastrowi* at the rate of 1 lakh first instar grub per hectare, release of *Cryptolaemus montrouzieri* at the rate of 10,000/ha, application of entomopathogen *Lecanicillium lecanii* at the rate of 2 X 10 Conidia ml , application of neem (*Azadirachta indica* A. Juss) seed kernel extracts (NSKEs) 5% are effective in suppressing the spiraling whitefly.
- The DNA barcoding generated at BOLD systems based on 28S rDNA nucleotide sequences of thirty dipteran insects are available for providing valuable information for insect taxonomist to ease identification.
- The beneficial potential of *L. lecanii* can be increased with adoption of some useful technologies such as mass multiplication and proper delivery methods that are highly effective as they enhance natural enemy activity, reduce insect pest damage and help in sustainable production.
- The clear understanding of the functioning of agroecosystem under different environmental conditions needs intensive research to manipulate the ecosystem to the detriment of the pests and/or in favour of natural enemies.

- Bioagents like parasitoids, predators and pathogens should be thoroughly evaluated in the laboratory and screen house conditions for their adaptability to micro- and macro-environment. These can be used as bioresidual pest management with use of safe chemistry.
- The modern techniques like genetic engineering have a place in IPM, this should not be considered a panacea for solving all pest problems in future. The best of traditional techniques should be exploited to maintain biodiversity in agroecosystems.
- The use of resistant varieties has many ecological advantages over those of insecticidal control. It conserves the population of beneficial insects and micro- organisms thus strengthening natural control of pests in the agroecosystem. Many resistance sources are identified but not used in breeding programme to develop insect resistant crop cultivars. This should be given priority.
- Most IPM projects today focus on insects, and insufficient attention is given to diseases, weeds and other organisms that damage the crops. Also, much IPM technology still applies to single pest/crop. A more holistic or ecosystem approach is necessary in future programmes. Impact evaluation of IPM at farm level should be part and parcel of all IPM programmes. The evaluation indicators should include: i) adoption of non-chemical pest management practices , ii) pesticide use by weight (a.i) iii) pesticide use frequency, iv) farmers knowledge about safe use and handling of pesticides, and v) environmental impact.
- Molecular phylogenetic analysis and barcoding of insects can also provide valuable information for insect taxonomist to ease identification.
- Recommendations for use of insecticides as component of IPM lack insecticide resistance management strategies. The lack of effective spray technology may result in low efficacy of insecticide. Label claim of insecticides approved long back are not effective and need policy for review. Surveillance procedure for many insect pests needs standardization to represent actual population in field.

6. Forestry Tree Plantations

Agriculture and industrial agro-forestry : a model for food, fuel and wood security, impact of climate change on forest management and adaptive strategies in future with main emphasis on forests, researchable gaps in short rotation forestry, digitization of forest data, integration of poplar improvement programme with its end-use and thrust areas for future research in forestry were discussed by the delegates. There must be holistic approach in improvement, production and end use in industry based on field experience and farmers perspective. Agro-forestry (AF) is adopted by small and marginal farmers, which provides better economic returns than pure block tree plantation and can reduce pressure on natural forest for wood, effective option for diversification, and food

and wood security. Industrial agroforestry can make large scale reforestation more practical and economical. The grain yield of wheat intercrop under poplar based agroforestry systems was higher (3 tonnes/ha) in pair row spacing of 18m x 2m x 2m as compared to block plantation of spacing of 10m x 2m and 5m x 4m, respectively under semi-arid ecosystem of India. In biosaline agroforestry model at The Central Soil Salinity Research Institute (CSSRI), Karnal, the pearl millet (*Pennisetum glaucum*) yield was 11q/ha under *Eucalyptus* and 13.1q/ha under *Melia* plantation planted in 2014 against 6.7 q/ha in open plot. For propagation of *Gloriosa superba*, tubers of >20 g weight were found better to obtain flowering and fruiting in the same year. Highest seed yield (221.95 kg/ha) was obtained in Nauni source followed by Nandani (211.45 kg/ha) and Giripul (187.08 kg/ha). Treatment of wood of *Bombax ceiba, Pinus roxburghii* and *Celti saustralis* with methanolic extract of *Acoruscalamus* considerably enhanced their dimensional stability. *Simarouba glauca* at the age of 10 years and spacing 6 m x 6m meter had carbon sequestration potential of 374.1 t/ha of CO_2 equivalents under dryland conditions. *Toona ciliata* was found to have excellent tolerance to air pollution compared to *Ficus carica, Melia azedarach* and *Morus alba*, respectively under mid hill conditions.

Recommendations

- Management of natural forests should be directed in accordance with scientific principles of forest management.
- Need to set up value addition cottage units at village/panchayat levels to enhance marketability of the tree/agroforestry produce, besides employment generation.
- Stakeholder's (Farmer–Industry-Scientist-Financial institution) coordination to attract the adopters and incentives for biomass based renewable energy are the attractive areas of interest.
- The potential of agroforestry and niche area for agroforestry practices on marginal land need to be exploited to meet the targets of tree cover, basic needs and mitigation of climate change.
- Setting up of the region specific working groups of experts including progressive adopters for development and promotion of agroforestry as a viable land use.
- Registration of certified sources ensuring the availability of quality planting material of elite genotypes preferable to indigenous species.
- Sustainable development strategies for plantations to strengthen India's cause and contribution to committed restrictions of COP-21 (The Paris Climate Conference is officially known as the 21st Conference of the Parties or COP-21).
- Public and private sector involvement through financial support to the plantation forestry.
- Quantification of ecosystems services on long term basis and provision of

incentives to industry as well as growers would definitely help in adoption of plantations.

- Promotion of export potential for on-farm timber.
- Interface with private and public sector for R&D and forest enterprise development should be promoted. Forestry research is not able to meet the needs with more specialization, rather coordination of research institutions with state forest departments is essential.
- Man-wildlife conflict is increasing and needs consideration to protect human life and livelihood.

7. Policies for Sustainable Agriculture and Success Stories

A three-pronged strategy may be required to deal with the ecological and other problems created by the monoculture of crop rotations:

(i) Searching solutions within the prevalent production pattern,

(ii) Evolving equally or more remunerative alternatives to natural resource exploiting rotations, and

(iii) A medium and long term development plan should be formulated covering relevant aspects. Such a plan should also include appropriate policies, programmes and projects for implementation.

"Sustainability of Himalayan Environment: Issues and Policies" were discussed in the current scenario and steps required for sustainability of this region. In order to promote sustainable farming, achieve sustainable livelihood, the need to judiciously access natural resources is essential. Hill agroecosystem has vast potential of exportable commodities. In addition, this region is a vast source of water and biodiversity but requires more efforts for their perseverance, sustenance and also fast response to changes.

Ecological and socio-economic impacts of transplanted and direct wet seeded rice cultivation were discussed by the industry that is supporting this programme in collaboration with the public sector research system. By using holistic lifecycle assessment, the options to improve the socio-economic and ecological performance can be identified. The approaches adopted by various segments within private extension and key elements involved in extension also came up for discussion. One of the main reasons for success is direct and frequent contact with farmers. The increasing use of information and communication tools in private sector has built in dynamic system of information sharing and feedback from users. Six success stories were presented involving directed seed rice technology, aquaculture in inland salt affected waterlogged areas, efficient on and off-farm resource management, sustainable agriculture through integrated farming system, role model for scientific dairying, and crop diversification.

Recommendations

- Introduction of multidimensional changes in terms of knowledge, attitude and skill development, intensive extension approaches for sustainable development of farmers and agriculture in the Himalayas are required.
- Emphasis on shifting from traditional cereal crops to niche crops for higher profits in agriculture.
- Increased investment in infrastructure in rural areas especially on input and product markets.
- Formation of producer companies to mitigate the reduction in size of holdings and scattered marketed surplus.
- Effective integration of public-private partnership in extension system is the need of the hour.
- Documentation and publication of success stories of farmers for replication and up-scaling of innovations. Highlighting the positive side of successes in agriculture in mass media needs more emphasis.
- All development strategies/efforts should focus on natural resource management with effective involvement through empowerment of all stakeholders keeping them farmers centric.
- In order to have rational use of valuable water resources and power, a proper pricing policy may be evolved. "Competitive populism" needs to be avoided by all the political parties in the country.
- The input testing laboratories particularly for fertilizers and pesticides should be strengthened. Strict enforcement measures may also be undertaken to follow the quality standards of these inputs. Users of the inputs should also have the right to get the samples tested. Fertilizer usage based on soil testing be made mandatory.
- Farmers, particularly women, must be involved at various stages of development, evaluation and implementation of technologies regarding sustainable development.
- Key contact fellow in each village should be encouraged for business powers outsourcing and mobile learning module should be encouraged.
- Integrated organic farming system (IOFS) for improving of farming, organic inputs availability and profit. IOFS comprising of cropping system involving cereals, pulses, oilseeds, fruits and fodder with dairy, fisheries, vermincompost can reduce the cost of market dependency for organic inputs.
- The spending on agricultural developmental programmes has increased and with this the demand for "All India Coordinated Research Project for Evaluation".

8. Promoting Resource Efficient Agriculture System through Public – Private Partnership

World Wide Fund for Nature-India and Centers for International Project Trust (CIPT) organized a panel discussion on 'Promoting resource efficient agriculture system through public-private partnerships (PPP)' as a part of Indian Ecological Society-International Conference. The discussions pointed out that the current levels of PPP lie in need based requirements and work in service providing mode. For an efficient agriculture system, the complementary strengths of public and private sectors need to be harnessed to add context for a sustainable environment.

Government should be proactive and urge partners to start PPPs in agriculture. This will ensure more serious participation of private sector.

In order to improve agriculture production and enhance accessibility of food crops by the consumer, a huge opportunity exists that presents a strategic point in which the private sector, in collaboration with the public sector can pull out the resources to address the issue. No one individual sector can do it all alone. The sooner one starts, the better is the chance of getting there.

Recommendations

- The Indian research institutes, particularly, in dealing issues like impact of climate change in agriculture should enhance accessibility so that the private sectors or non-governmental organizations can reap benefit and percolate the knowledge down to the growers.
- In case of the voluntary global sustainable standards, government role will be important to enforce regulations.
- Research findings as an output from the research institutions should not be restricted to only peer reviewed journals but must also benefit all sectors including private and farmers.
- For states like Punjab which have been aiming towards crop diversification because of the alarming groundwater conditions, there lies an opportunity to shift farmers towards high value crops and integrating them with better market linkages.
- PPPs can make a difference in bringing technology innovation to the highly resource intensive agriculture system. However, installation of devices and digitization of data is a challenge. Public institution like Department of Science and Technology (DST) can play a big role in scaling up projects and providing the technical and financial support.

10. New Initiative

The Indian Ecological Society (IES) will like to be associated with research institutes for more scientific interaction among scientists from India and abroad. To achieve this objective IES will shortly initiate following activities:

- Lecture Series: Lectures by eminent scientist from India and abroad at various state agricultural universities/ institutes,
- Initiative for young scientist for documentation of work in theme area of ecology to be presented at conferences of the Indian Ecological Society,
- The Indian Ecological Society travel grant for post graduate students for participation in conferences of the Indian Ecological Society,
- Constitution of consultative group on theme area for more interaction, and
- Formulation of state/institutional chapters of the Indian Ecological Society.

ACKNOWLEDGEMENTS

We are sincerely grateful to Prof. Dinesh Marothia and Dr. Keshav R. Kranthi for their critical comments on the draft recommendations and their valuable inputs for improving the draft.

SESSION DETAILS

Chief Guest	
Dr Jitendra Singh	Minister of State for Development of North Eastern Region (Independent charge) and Minister of State for Prime Minister Office Personnel, Public Grievances & Pensions Department of Atomic Energy and Department of Space, Government of India
Guests of Honour	
Dr Pradeep K. Sharma	Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu
Dr Nazeer Ahmed	Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir
Dr K.K. Katoch	Vice Chancellor Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya Palampur
Technical Session I	
Chairperson: Dr Narayana Gowda	Former Vice Chancellor University of Agricultural Sciences Bangalore
Co-chairperson: Dr B.L. Jalali	Professor Plant Pathology and Former Director of Research – Haryana Agricultural University
Session in Charge/Rapporteur: Dr D.P.Abrol	Dean Faculty of Agriculture Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu
Keynote Speakers	
Padma Shri Chewang Norphel *Ice Man of Ladakh*	Artificial Glacier: A High Altitude Water Conservation and Harvesting Technique
Dr Birgit Wilhelm Consultant for Sustainable Agriculture and Resource Management at the Agriculture Department of WWF (World Wide Fund for Nature) Germany	Integrated Nutrient Management - The Important Role of Organic Matter in Living Soil as Common Ground for Agriculture and Nature Conservation

Dr Abiona Michael Petu Ibikunle National Open University of Nigeria	The Role of Agricultural Biotechnology in Food Security, Poverty Eradication (Youth Empowerment) and Mitigation against Vices of Climate Change
Dr Narayana Gowda Former Vice Chancellor University of Agricultural Sciences Bangalore	Sustainable Development of Farmers: A Success Story
Dr U.C. Sharma Former National Coordinator National Agriculture Technology Project	GHG Emissions: Impact on Agriculture and Mitigation Strategies with Special Reference to Jammu & Kashmir
Dr Chanda Siddoo-Atwal Primary Biochemist for Moondust Cosmetics Ltd. Formerly Post-doctoral Fellow at Medical College Wisconsin, USA	An Approach to Cancer Risk Assessment and Carcinogenic Potential for Three Classes of Agricultural Pesticides

Technical Session II

Chairperson: **Dr N.K. Krishan Kumar**	Deputy Director General (Horticulture Science), Indian Council of Agricultural Research, New Delhi
Co-chairperson : Dr Nazeer Ahmed	Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir
Session in Charge/Rapporteur: **Dr D.P. Abrol**	Dean Faculty of Agriculture Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

Keynote Speakers

Dr N.K. Krishan Kumar Deputy Director General (Horticulture Science), Indian Council of Agricultural Research, New Delhi	Utilizing Horticultural Technologies for Ecological Sustainability
Dr Nazeer Ahmed Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir	Natural Resource Management for Sustainable Development of Temperate Horticulture
Padma Shri Dr Randeep Guleria Head of the Department of Pulmonology and Sleep Disorders at the All India Institute of Medical Sciences New Delhi	Health Effects of Changing Environment
Dr Dinesh Marothia Member Planning Commission Chattisgarh and President, National	Managing Wetland Ecosystems: A Polycentric Perspective

Institute of Ecology	
Dr Krishan Bir Choudhary President of Bharatiya Krishak Samaj (Indian Farmers Organization)	Impact of Climate Change on Ecology from Farmers' Perspective
Dr Bushan L. Jalali Professor Plant Pathology and former Director of Research – Haryana Agricultural University	Climate Change: Impact on Biotic Stresses Afflicting Crop Plants
Dr J.P. Singh Joint Director Department of Plant Protection Quarantine and Storage Government of India	Emerging Issues of Plant Protection in India

Technical Session III

Chairperson: Dr U.C. Sharma	Former National Coordinator, National Agriculture Technology Project
Co-chairperson : Dr B. Gangwar	Former Director Indian Institute of Farming System Research, Meerut
Session in Charge/Rapporteur: **Dr S.K. Gupta**	Professor Plant Breeding and Genetics, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

Keynote Speakers

Dr B. Gangwar Former Director, ICAR-Indian Institute of Farming System Research, Meerut	Natural Resource Management through Farming System Approach
Dr S. Dam Roy Director Central Island Research Institute Port Blair	Natural Resource Management for Ecological Sustainability of Islands
Dr Kamal Vatta Director, Centers for International Projects Trust (Columbia Water Center), India	Long Term Options for Groundwater Sustainability in Indian Agriculture

Technical Session IV

Theme Area: Land and Water Resources

Chairperson: Dr Dinesh Marothia	Member Planning Commission Chhattisgarh and President, National Institute of Ecology
Co-chairperson: Dr U.S. Walia	Former Professor of Agronomy Punjab Agricultural University Ludhiana

Session in charge/Rapporteur: Dr Vikas Sharma

Lead Lectures

Dr S.S. Rawat	Identification and Quantification of Areas Vulnerable to Soil Erosion and Deposition in a Himalayan Watershed using Remote Sensing and GIS Water Management Structures and their role in Watershed
Dr U. S. Walia	Judicious Use of Herbicides
Dr A.K. Mishra	Water Management Structures and their Role in Watershed

Technical Session V

Theme Area: Integrated Nutrient Management

Chairperson: Dr Sushil Kumar Saxsena	Professor and Head (Entomology) Navsari Agricultural University Navsari
Co-Chairperson: Dr R.K. Nanwal	Chief Agronomist Haryana Agricultural University

Session in Charge/Rapporteur: Dr Sandeep Chopra

Lead Lectures

Dr R.K. Nanwal	Integrated Farming System for Sustainable Agriculture: An Overview
Dr Dileep Kachroo	Integrating Farming System for Livelihood Security: An Approach Towards Sustainable Agriculture
Dr Sushil Kumar Saxsena	Integrated Farming System for Sustainable Agriculture: An Overview

Technical Session VI

Theme Area: Integrated Pest Management

Chairperson: Dr A.N. Sabalpara	Director of Research and Dean Post Graduate Studies Navsari Agricultural University, Navsari
Co-Chairperson: Dr K.K. Sharma	Director Indian Institute of Natural Resins and Gums

Session in Charge/Rapporteur: Dr V. Kaul

Lead Lectures

Dr D.P. Abrol	Integrated Pest Management: An Analysis of Challenges and Future Strategies

Dr A. Sabalpara	Role of Microbes in Sustainable Agriculture
Dr K. K. Sharma	Understanding the Diversity in Lac Insects of *Kerria S*pp. in India and the Nature of Insect-host Plant Interaction

Technical Session VII

Theme Area: Crop Environment Interactions

Chairperson: Dr U.C. Sharma	Former National Coordinator National Agriculture Technology Project
Co-Chairperson: Dr S.K. Gupta	Professor Plant Breeding and Genetics Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

Session in Charge/Rapporteur: Dr Manmohan Sharma

Lead Lectures

Dr S. K. Gupta	Crop Genetic Biodiversity with Special Reference to Oilseed *Brassica* and Wild Allies-Conservation and their Utilization
Sumit Roy	Role of Better Management Practices in Reducing Carbon Emissions
Dr S.K. Bal	Managing Abiotic Stresses in Agricultural Fields: ICAR-NIASM Initiative

Technical Session VIII

Theme Area: Horticulture Crops

Chairperson: Dr V.K. Wali	Professor and Head Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu
Co-Chairperson: Dr S.C. Negi	Chief Agronomist Haryana Agricultural University

Session in Charge/Rapporteur: Dr Kiran Kour and Dr Prashant Bakshi

Lead Lectures

Dr S.C. Negi	Diversification of Existing Cropping system- An Approach towards Higher Productivity and Sustainability
Dr V.K. Wali	Status and Potential of fruit culture
Dr N.K. Leela	Antioxidant Potential of Leaf Extracts of four Myristica Species

Technical Session IX

Theme Area: Forest Tree Plantation

Chairperson:	Operations Manager Social Investments
Dr V. Vijay Vardhan	Programme ITC Limited
Co-Chairperson:	Former General Manager (Forestry)
Dr M.S. Haque	NABARD India

Session in Charge/Rapporteur:
Dr K.K.Sood

Lead Lectures

Dr V. Vijay Vardhan	Agriculture and Industrial Agro-forestry: A Model for Food, Fuel and Wood Security
Dr R.C. Dhiman	Integration of Poplar Improvement Programme with Its End-use: WIMCO's Experience
J.S. Jasrotia, IFS	Climate Change, Its impact on Forest Management and Adaptive Strategies for Future

Technical Session X

Theme Area: Policies for Sustainable Development of Agriculture and Success Stories

Chairperson:	Former Vice Chancellor University of
Dr Narayan Gowda	Agricultural Sciences Bangalore
Co-Chairperson:	Director, Centers for International
Dr Kamal Vatta	Projects Trust (Columbia Water Center), India

Session in Charge/Rapporteur:
Dr M.H. Wani / Dr Anil Bhat

Lead Lectures

Dr M.H. Wani	Sustainability of Himalayan Environment: Issues and Policies
Dr Jagmeet S. Bal	Study on the Ecological and Socio-Economic Impacts of Transplanted and Direct Wet-seeded Rice Cultivation in Andhra Pradesh

Technical Session XI

Theme Area: Eco-responsive Livestock and Fisheries Production

Chairperson: Dr Asha Dhawan	Dean, College of Fishery, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana
Co-Chairperson: Dr Mera D. Ansal	Senior Scientist, College of Fishery, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana

Session in Charge/Rapporteur:
Dr Akhil Gupta/ Dr. S. Dewedi

Lead Lectures

Dr Asha Dhawan	Climate Change and its Impacts on Fisheries
Dr Meera D. Ansal	Species Selection for Enhancing Productivity of Freshwater Carps in Inland Saline Water of Punjab, India- A Field Study

Panel Discussion (Public Private Partnership)

Coordinators:

Dr Kamal Vatta	Director CIPT, India
Mr. Murli Dhar	Director WWF India

Session in Charge/Rapporteur: Dr Manish Sharma

1. **Dr Birgit Wilhelm:** Consultant for sustainable agriculture and resource management at the agriculture department of WWF, Germany
2. **Mr V. Vijay Vardhan:** Operations Manager Social Investments Programme ITC Limited.
3. **Mr Prem Prakash Saboo:** Chief Finance Officer - RML Information Services P Ltd.
4. **Mr Jagmeet Bal:** Manager Government Relations, BASF India
5. **Dr Anil Kakkar:** Vice President at Excel Crop Care Ltd

Plenary Session

Keynote lectures, interactive session and brief presentation of reports

Chairperson:	Vice Chancellor Sher-e-Kashmir
Dr P.K. Sharma	University of Agricultural Sciences and Technology of Jammu
Co-chairpersons:	Director Extension Sher-e-Kashmir
Dr K.S. Risam	University of Agricultural Sciences and Technology of Jammu
Dr A.K. Dhawan	President Indian Ecological Society

Session in Charge/Rapporteur:
Dr Rajinder Peshin

Plenary Lecture

Dr K.R. Kranthi **Director Central Institute for Cotton Research, Nagpur, India**	Insecticide Resistance Management

Valedictory Session

Chief Guest

Jenab Khurshid Ahmad Ganai, IAS	Advisor to Governor of Jammu and Kashmir

Guests of Honour

Jenab Jehangir Mir	Deputy Chairman Legislative Council, J&K
Dr Pradeep K. Sharma	Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

LIFETIME ACHIEVEMENT AWARDEES

Dr A.S. Atwal (Posthumously)

Dr A.S. Atwal a renowned educationist and ecologist served as Dean, College of Agriculture for 11 years and Dean Post Graduate Studies for 4 years (1979-85) at Punjab Agricultural University, Ludhiana. Dr Atwal remained Advisor to Jammu & Kashmir Government and Vice-Chancellor (Designate) for two years and prepared the project for establishing the University. Prof. Atwal will be remembered as the 'Father of Modern Beekeeping in India' as he opened new vistas of commercial beekeeping in the country. Prof. Atwal established the Indian Ecological Society in 1974 and nurtured this society with complete devotion for nearly 25 years.

Dr G. S. Dhaliwal (Posthumously)

Dr GS Dhaliwal a renowned entomologist served Punjab Agricultural University, Ludhiana at various capacities for 31 years. Dr Dhaliwal was nominated Member of World Food Prize Nominating Academy (2003-04). He was invited on behalf of Nobel Peace Prize Laureate, Dr Norman E. Borlaug to nominate a candidate for the highest international award in food and agriculture, The World Food Prize. He was also conferred 'Life Time Achievement Award' by International Allelopathy Foundation.

AWARD OF HONOUR (EXTENSION SERVICES)

Dr Om Gouri Dutt Sharma

Dr Om Gouri Dutt Sharma, Dy. Director General at Doordarshan Kendra, Jalandhar received his higher education from Punjab Agricultural University. Dr Sharma had keen interest in theatre activities and his documentaries on Green Revolution of Punjab and Heritage Museum of Punjab Agriculture University were acclaimed at national/international level. His contributions for agriculture extension through Mass Media support were rewarded by Punjab Agriculture University, Ludhiana and State Agriculture Department of Punjab.

HONORARY CAUSA FELLOWS OF THE INDIAN ECOLOGICAL SOCIETY

Dr Kamal Vatta
Director, Centers for International Projects Trust (Columbia Water Center), India

Dr Santanu Kumar Bal
Principal Scientist School of Atmospheric Stress Management NIASM.

Dr Meera D. Ansal
Senior Scientist, College of Fishery, GADVASU.

Dr Sanjeev Kumar Chauhan
Professor Agro-forestry Punjab Agricultural University

Dr S.S. Walia
Senior Agronomist, Punjab Agricultural University

Dr Rajinder Peshin
Associate Professor Agricultural Extension Education Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu


INTERNATIONAL CONFERENCE
2016


Artificial Glacier: A High Altitude Water Conservation & Harvesting Technique
Leh Nutrition Project


factors
highest in the vulnerable popula
pollution.
COPD, CAD and lung cancer.


ological Perspectives


Sustainable Livelihood Security through Temperate Horticulture


and nature


Indian Ecological Society: International Conference 2016
Natural Resource Management
Ecological Perspectives
February 18-20, 2016
Partners
WWF
NABARD
IUFRO
Collaborative Host Organization
Sher-e-Kashmir University of Agricultural Sciences
and Technology of Jammu (J&K) India
Sponsors