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Agroecosystems Specialist Group

AGROECOSYSTEMS

A Quarterly Newsletter from IUCN-CEM Agroecosystems Specialist Group

In this issue

EDITORIAL

Dear Readers,

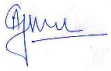
It is my great pleasure to bring out the first issue of 'Agroeocystems', the official newsletter of the newly created 'Agroecosystem Specialist Group' of IUCN Commission on Ecosystem Management (CEM) for your kind reading. This Specialist Group is aims to promote sustainable agricultural practices and agrobiodiversity management under changing climatic conditions and encourage ecosystem based approaches and resource conservation technologies for transforming agriculture as a sustainable enterprise. It will act as a platform for bringing together various stakeholders in the field to share their knowledge and experience. Also, this group is envisioned to support IUCN for framing suitable strategies for the adaptive management of agroecosystems under changing climate.

The major objectives of this SG are

- Understand complex and interconnected linkages between agriculture, biodiversity and ecosystem management
- Conduct ecological risk assessment of agroecosystems under changing climatic conditions
- Integrate landscape ecology and ecosystem based approaches to support agrobiodiversity and ecosystem services of agricultural systems
- Manage wetlands for sustainable agriculture, aquaculture and other ecosystem services
- Foster sustainable and resource conservation technologies (i.e. organic agriculture, low external input system agriculture (LEISA), integrated crop management (ICM) and ecological agriculture etc.) to enhance the productivity of existing farmlands and reduce the environmental trade-offs
- Popularize information technology for precision farming and sustainable agroecosystem management
- Encourage adaptive and climate resilient agricultural practices to enhance the food production and nutritional quality under changing climatic conditions
- Recommend sustainable use of agro-residues for multipurpose environmental benefits
- Formulate sustainable strategies to restore degraded system for agricultural extensification
- Support IUCN for preparing policy briefs, status reports and action plans on above themes for various governmental and intergovernmental agencies

We encourage IUCN-CEM members and other professionals interested in above objectives to join this specialist group on 'Agroecosystems' and participate in activities of this group, exchange ideas, contribute their opinions and apply their expertise for sustainable management of agricultural ecosystems, or simply share updates about their projects and programs on sustainable and climate resilient agricultural activities and resource conservation technologies to agriculture.iucn.cem@gmail.com. All shared news will be published in our quarterly Newsletter 'Agro-ecosystems'.

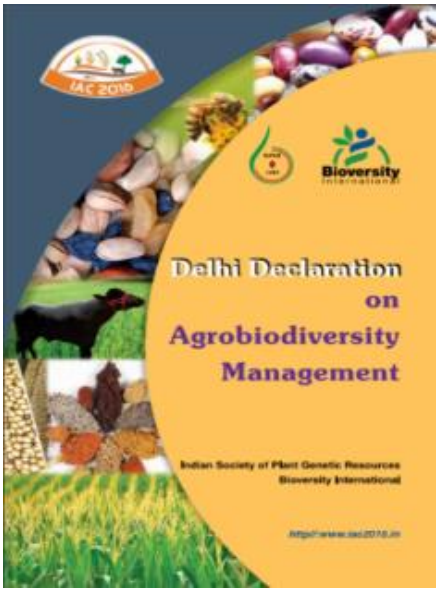
Sincerely yours



(P.C. Abhilash)
Chair, Agroecosystem Specialist Group

CONTENTS

Delhi Declaration on Agrobiodiversity Management adopted



The 1st International Agrobiodiversity Congress held in New Delhi, India, from 6-9 November, 2016 was attended by over 900 participants from 60 countries. Congress delegates discussed various aspects of conservation, management, access and use of agrobiodiversity in 16 technical sessions, four satellite sessions, a gene bank roundtable, a public forum, a farmers' forum and poster sessions. Based on detailed deliberations, the delegates unanimously adopted the following declaration in the concluding session on November 9, 2016:

PREAMBLE

- Agrobiodiversity includes crop varieties, livestock and fish breeds, and agriculturally useful insect and microbial species. Significant progress has been made towards the documentation, collection, conservation and use of agrobiodiversity related genetic resources, yet much more needs to be done towards their sustainable use, greater exchange and knowledge and technology transfer.
- If conserved and used sustainably, agrobiodiversity could make an important contribution towards resolving problems of hunger, food insecurity, malnutrition and

climate change, thus help in attaining the Sustainable Development Goals (SDGs) and the Aichi Targets of the Convention on Biological Diversity.

- Limitations in policies, investment, infrastructure, technical capacity as well as cross-sectoral coordination and partnerships have often prevented efficient use of agrobiodiversity. This is particularly alarming since it is projected that the world, where almost 795 million people go hungry today, will need 70% more food to feed 9.6 billion people by 2050 (FAO, 2015). Hence, high priority and policy support by world leaders and organizations is warranted for enhanced use of agrobiodiversity.
- The world is also facing rapid loss and extinction of biodiversity. It is estimated that species are being lost at 1,000 to 10,000 times the rate at which natural extinction took place at any time during the past 66 million years mainly due to explosive population growth and overexploitation of natural resources. Extinction of agrobiodiversity and associated traditional knowledge is an irreversible process and hence must receive priority attention. In fact, loss of a gene is a major loss for our future generations.

DECLARATION

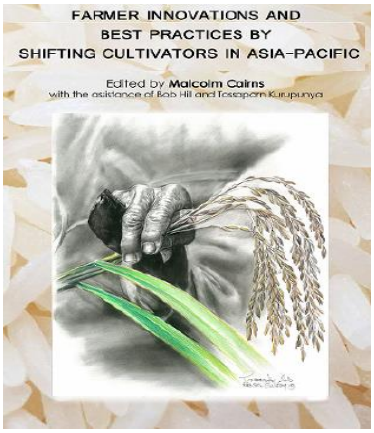
1. We call upon nations to accord top priority to the shared vision of agrobiodiversity conservation and sustainable use towards achieving the Sustainable Development Goals (SDGs) and the Aichi Targets of the Convention on Biological Diversity addressing poverty alleviation, food, nutritional and health security, gender equity and global partnership.
2. We recognize the importance of traditional agrobiodiversity knowledge available with farm men and women, pastoralists, tribal and rural communities and its central role in the conservation and use for a food secure and climate resilient world. We, therefore, call upon countries to develop the necessary legal, institutional and funding mechanisms to catalyze their active participation.
3. We urge researchers and the policymakers to initiate, strengthen and promote complementary strategies to conserve agrobiodiversity through use, including greater emphasis on using crop wild relatives. We call for them to ensure a continuum between ex situ, in situ, on-farm, community-based and other conservation methods with much greater and equal emphasis on each.

4. We propose that researchers employ modern technologies including, but not limited to, genomics, biotechnology, space, computational, and nano-technologies for genetic resources characterization, evaluation and trait discovery. The aim must be to achieve efficiency, equity, economy and environmental security through diversified agricultural production systems and landscapes.
5. We reemphasize the necessity of global exchange of plant, animal, aquatic, microbial and insect genetic resources to diversify agriculture as well as our food basket and to meet the ever-growing food and nutritional needs of all countries. To ensure this, nations need to be catalyzed to adopt both multi-lateral (as envisaged in the International Treaty on Plant Genetic Resources for Food and Agriculture) and bilateral (as per the Nagoya Protocol) instruments to facilitate the exchange of genetic resources, while ensuring equitable access and benefit sharing opportunities.
6. Countries are also expected to harmonize their existing biosecurity systems, including phytosanitary and quarantine, and enhance their capacities to facilitate safe trans-boundary movement of germplasm.
7. We also expect that the governments and civil societies lay much greater emphasis on public awareness and capacity enhancement programs on agrobiodiversity conservation in order to accelerate its effective and efficient use.
8. We recommend the development and implementation of an Agrobiodiversity Index to help monitor on-going genetic resource conservation and management efforts, with particular emphasis on agrobiodiversity hot spots.
9. It is also urged that public and private sectors and civil societies henceforth actively invest in and incentivize the utilization of agrobiodiversity to mitigate malnutrition, increase the resilience and productivity of farms and farming households and enhance ecosystem services. Such efforts should lead to equitable benefits and opportunities, with particular emphasis on women and youth.
10. We urge countries to reprioritize their research and extension with increased investments to support the conservation and use of agrobiodiversity. Furthermore, we strongly recommend to create an International Agrobiodiversity Fund as a mechanism to assist countries and communities in scientific in situ and ex situ conservation and enhanced use of agrobiodiversity.
11. We urge the United Nations to consider declaring a 'Year of Agrobiodiversity' in order to draw worldwide attention and catalyze urgent actions for effective management of genetic resources by the global community.
12. Finally, we recommend that the International Agrobiodiversity Congress be held every four years, with Bioversity International playing the facilitator's role, to maintain the momentum gained in 2016 and continue emphasizing the need to implement the 'Delhi Declaration on Agrobiodiversity Management' and monitor the progress so made by the different stakeholders and countries.

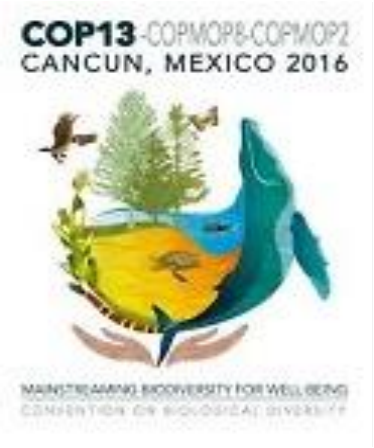
The PDF version of this publication can be downloaded at the following web link:
http://www.bioversityinternational.org/fileadmin/user_upload/campaigns/ABD_Congress_India/Delhi_Declaration_8-12-2016_4.pdf

Brain storming session held on "Future Climate Change Research in Agriculture" at NASC, New Delhi, India (February 23, 2017). The network project of ICAR, a National innovation on climate resilient agriculture (NICRA) that has been launched in India in view of transforming villages toward climate resilience was the principal theme of discussion in this session. Dr K Alagusundaram, DDG (NRM & AE), ICAR; Dr. Ch. Srinivasa Rao, Director, CRIDA; Dr SM Virmani, Chairman, NICRA Expert Committee; Dr. T. Mohapatra, Secretary, DARE & DG, ICAR were the main invitees who gave presentations regarding adaptation and mitigation of climate change in agriculture sector in India. Output of NICRA project was being appreciated and was further emphasized to expand their work through collaborations. Suggestions were made to highlight the work of this network projects at global levels.

Call for papers to contribute in a book entitled "Farmers Innovation and Best Practices By shifting cultivators in Asia-pacific. Trilogy of books about shifting cultivation in the Asia-Pacific region has been launched. Its first volume is available online and second volume is expected off-press in early to mid- 2017.



Its third and final volume invites to contribute papers related to innovations and adjustments done by shifting cultivators to adapt modern challenges of overgrowing population, market economies, land shortages and threat of mono-cropping. For example, innovation in Khonoma villages of Nagaland where farmers manages alder trees in their jhum fields are type of novelty this volume is looking to document. Submission of papers can be done directly to mfcairns@gmail.com by December 31st, 2017.

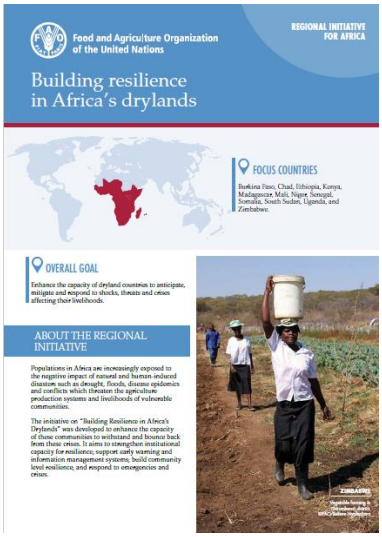


The Cancun Declaration on the main theme of COP – Mainstreaming biodiversity for well-being (2016). Prior to The 13th Conference of the Parties (COP) of the Convention on Biological Diversity to be held in Cancun, Mexico, the Cancun Declaration on the main theme of COP – mainstreaming biodiversity for well-being have been made.

The PDF version of this publication can be downloaded at the following web link:

https://www.cbd.int/cop/cop-13/hls/in-session/cancun-declaration-draft-dec-03-2016-pm-en.pdf

Regional initiatives to make agricultural system more resilient in Africa. Sustainable production intensification and value chain development in Africa: See Booklet and factsheet published for year 2016.



This initiative aims to improve institutional capacity for agricultural resilience and responding to disasters and crisis at regional, national and community level.

Asia and the Pacific's Blue Growth Initiative. This regional initiative has been launched keeping in view the estimated 30% rise in demand for fish consumption in entire Asia by year 2030. Initiative target to enhance Asian Aquaculture sustainably and make it attractive and resilient livelihood which in total can contribute to food and nutrition security by meeting increased demands for fish and also alleviate poverty and boost up the regional economy. *The details of the initiative can be found from the following link:* **http://www.fao.org/asiapacific/perspectives/blue-growth/en/**

An agreement signed between IRRI and FAO for joint efforts to globally bolster sustainable rice production. Two organizations have signed this agreement to work together for sustainable rice production while safeguarding critical natural resources, particularly for developing countries. Matthew K. Morell (IRRI Director-General) and Maria Helena Semedo, (FAO Deputy Director-General, Climate and Natural Resources) jointly showed concern for future rice production under the threat of overgrowing human population. They aimed to bring new implementations at policy level to enhance small holding farms and small farmers, especially the women farmers across globe. Their target is to make rice value chain more sustainable through different means such as varietal improvements or knowledge sharing and transfer. *The details of the initiative can be found from the following link:* **http://www.fao.org/asiapacific/news/detail-events/en/c/876570/**

ipbes
Science and Policy for People and Nature

Media release from secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and ecosystem services – IPBES (March 28, 2017).
Six pollination experts delivered message regarding theme "Agriculture is part of the pollinator solution: Intensive farming can harm or help pollination". Ecological intensification of agricultural system to support pollinator communities was highlighted.
The PDF version of this publication can be downloaded at the following web link:
http://www.ipbes.net/sites/default/files/downloads/pdf/20170328_media_release_article_ecology_letters_pollination_final.pdf

New releases by National Agricultural Statistics Service (NASS), US Department of Agriculture (USDA)

1) Census Of US Agriculture (March 28, 2017)

By taking part in this census which is conducted after every 5 years, America's farmers and ranchers will be able to represent their agricultural systems. Information of agriculture of US will be also obtained federal, state and local governments, agribusinesses, trade associations, extension educators and researchers who serve farmers and rural communities in any from. This census will highlight the insights of land use, ownership, agricultural practices and economy.

The PDF version of this publication can be downloaded at the following web link:

http://www.agcensus.usda.gov/

2) *First-Ever Local Foods Survey in US (April 07, 2016)*

Data is been collected on locally grown and sold foods in order to understand the benefits of local/ regional food systems.

The PDF version of this publication can be downloaded at the following web link:

https://www.agcensus.usda.gov/Newsroom/printable/04_07_16.pdf

3) Documentation of new data on Organic Agricultural Production in US (January 30, 2017)

Effort is made for evaluation of crop insurance coverage to help in determining the economic impacts of certified organic agriculture production which can ultimately help in sustaining industry growth. Report will be released in September 2017.

The PDF version of this publication can be downloaded at the following web link:

https://www.agcensus.usda.gov/Newsroom/printable/01_30_17.pdf

APN ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

Press release from APN 22nd Inter Governmental meeting and scientific planning group meeting held at New Delhi, India (May 03, 2017). Challenges, gaps and solutions for climate change adaptation in water and agriculture sectors" was the major theme of APN meeting that was held from April 24–27, 2017. Decisions regarding new initiatives and action in context to Asia- Pacific region were taken. Workshop on Climate resilient Agriculture is decided to be held jointly by Sub-regional Committee for South Asia, SAARC Agriculture Centre and Government of India in latter half of fiscal year 2017 in Hyderabad, India. In workshop, exchange of knowledge related to response of agriculture sectors to the implementation of Paris Agreement is looked for.

The details of the meeting can be found from the following link:

http://www.apn-gcr.org/2017/05/03/apn-22nd-joint-inter-governmental-meeting-and-scientific-planning-group-meeting-held-in-new-delhi-india-26-27-april-2017/

Innovations in Agroecology – a case study from the Netherlands

Authors: Govert van Dis and his wife Phily Brooijmans

Govert and Phily at the farm

Noord-Brabant is a region in South-West Netherlands, where both the authors successively runs their own 100 hectare organic arable farmland successively. They actively follow innovations in agroecology such as crop rotation, intercropping, use of machine for early stage weeding, use of green manure, use of special eco-plough for ploughing etc. which is published by FAO.

Margin of Flower around the field

Hand weeding done in carrot field

Use of GPS for Weed management

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-bs181e.pdf

Farmers improve food and nutritional security through agroecology in Mozambique

Authors: M. Mulima, T. Zangada, G. Fayela, E. Muianga, C. Marcatto, P. Murphy

Inspite of having numerous water bodies and many rivers including Zambeze and Limpopo crossing in central and south of Mozambique respectively, the nation is yet affected with devastating drought events leading to long lasting hunger since past 15 years. This case study highlights how based on ecological concepts and principals conservation of critical natural resources such as water, soil, forests and cultivated plants and animals sustainable agriculture could be achieved. In context to this, Action Aid Mozambique (AAMoz) has been working with 80 farmers association each having agricultural land area of ~100 hectare

Agroecology Knowledge Exchange in Marracuene,

and total covering >8000 farmers in this initiative.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-bs180e.pdf

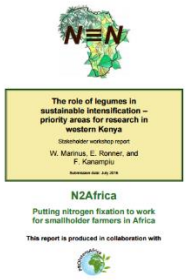
Role of legume crops in sustainable intensification: Case studies of Western Kenya

Authors: W. Marinus, E. Ronner and F. Kanampiu

This report is an outcome of stakeholder workshop, June 21, 2016 (held in Kiumu, Western Kenya). Drivers of change, sustainable agriculture and legume intensification in Western Kenya were major priority areas discussed in the workshop. This report is published in collaboration with Prointense Africa.

The PDF version of this publication can be downloaded at the following web link:

http://www.n2africa.org/sites/n2africa.org/files/N2Africa%20PROIntensAfrica%20stakeholder%20meeting%20western%20Kenya_0.pdf



Adaptive agricultural practices for Rice-wheat cropping system in Indo Gangetic Plain of India

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Indo Gangetic Plain (IGP) in Asia has >13.5 million-hectares agricultural land which is predominantly used for rice-wheat cropping system since time of green revolution i.e. since 1960s (Gupta and Seth 2007). Both rice and wheat are important food crops for Asia. Primarily rice is one of the chief staple food crops, 90% of which is produced (over 40-46% of the irrigated cropland) and consumed in Asian Sub-continent (Ladha et al. 2016). Agriculture in IGP of India over preceding decades was highly tillage, inorganic fertilizers, labor, water, capital and energy intensive in order to meet growing food demand of rapidly overgrowing population. As a result, alongwith increased agricultural produce, the depletion of natural resource base viz. salinization of agricultural land, reduced soil fertility and sequestered carbon, overexploitation of groundwater etc. has occurred in these regions (Tilman et al. 2002). Besides this, agricultural system in these regions has an added pressure of climate change, variability and frequent erratic weather events. Rationale of following discussion is to deliberate the mounting challenges that are being faced by agrobiodiversity, rice and wheat crop production/ productivity, tangible and intangible ecosystem services offered by rice/wheat agroecosystems in the IGP region of India. Moreover, since rice (relatively major) and wheat agroecosystems are both subject to and responsible for global warming/ climate change. Therefore,

sustainable management of these agroecosystems is highly timely and is of greater concern. It can play a major role in solving challenges pertaining to changing climate, crop pests and disease occurrence, weed prevalence and regional food insecurity. To meet this, integration of location specific, resource conserving, climate resilient and adaptive agricultural practices for rice-wheat cropping system in IGP is of urgent need.

Eastern Uttar Pradesh of India that lies in eastern part of IGP is among the most afflicted places due to aforementioned challenges and threats faced by agriculture sector. Local and indigenous farmers are steered to adopt various adaptive, climate resilient and resource conserving practices or approach that enhances the crop yield, improve soil fertility and health, and attain maximum net economic returns/ profitability into rice–wheat cropping systems. For instance, most local farmers of the place shifts from using conventional to hybrid varieties, make changes in date of sowing/ transplanting, follow varietal transition viz. use of drought tolerant crop variety, or increases irrigation as an adaptation to delayed onset of monsoon during rice crop season. Also, permutation of different tillage, crop establishment and residue retention options is also explored.

Fig 1. Field visits and agricultural surveys in rural parts of Mirzapur district (lies in eastern Uttar Pradesh in IGP) to document adaptive practices employed for rice-wheat cropping system by local farmers of the place.

Documentation of such adaptive practices for rice-wheat cropping system in eastern U.P. through questionnaire based agricultural surveys highlights, how significant is the role of indigenous farmer's knowledge in meeting local, regional as well as global food security along with maintenance of soil health and reduced environmental externalities. Field level experimental validation of promising adaptive practices and in-situ or ex-situ ways of conserving critical natural resource such as water (required for irrigation purposes as flooded/ rainfed agricultural system predominates in the entire IGP stretch, see figure 1), adopted by local farmers can be up scaled to larger landscape depending upon the likeness in agro-climatic/ agro-ecological zones.

Fig 2. Rainfed and flooded irrigation system predominates in Indo gangetic plain of India. Nearly 80% of farmers are resource poor, marginal and have agricultural landholding of <0.5 hectare. Agriculture is the major source of income for most of the farmer's family. Therefore whole family joins hand to do agricultural activities (Rao et al. 2016).

In lieu of these, sites and experimental plots from different agroecosystems in Mirzapur district of eastern Uttar Pradesh is selected for field level experimental validation of adaptive practices employed by local farmers (Fig 3). Favorable reasons to choose Mirzapur district for experimental validation are:

(a) It is largest district of most populated state of India i.e. Uttar Pradesh where >70% of farmers lives in rural areas each having land holding of size <1 hectare.

(b) 30% - 40% part of district lies in middle indo gangetic plain having plentiful of resources for agriculture purposes and alluvium rich fertile soil (plain sandy loam and black soil). Though deterioration of soil health due to overuse of inorganic chemical fertilizers and pesticides in last couple of decades have taken place;

(c) While remaining 60-70% of district lies in the Vindhyan zone which is water scarce region having rocky, sandy loam and red lateritic soils.

Markedly, on one hand a part of district is endowed with rich natural resources (specifically soil and water) for agricultural purposes while on the other hand its major part is devoid of similar natural resources such as water. This highlights that site specific recommendation is very important to procure agriculture system as a sustainable enterprise for any nation of the world (Fig 4).

Fig 3. Experimental plots and fields selected for validation of adaptive practices

Canals | Terrace/ Contours | Pitting's | Check dams

Fig 4. Site specific water saving techniques adopted in Indo gangetic plain of India. Canals, check dams and pitting's are built in areas having good rainfall for better water harvestings. While terrace are built in hilly region which is water scarce.

Farm Yard Manure | Composts derived manure | Vermicomposts

Fig 5. Organic agro-inputs used by local farmers into their farm fields to improve soil fertility and crop yield.

Adaptive practices involving sustainable use of organic and inorganic amendment's and their mixtures are majorly followed by local farmers of place. Specially the use of composts, vermicomposts, farm yard manure (FYM), biologically derived products from sea weed extracts and dung of cow, sheep, goat and duck are few common organic input used for agricultural farm field at every alternate years to maintain soil integrity and health over past few years (Fig 5).

Crop residue (particularly of rice, wheat and mustard) retention and incorporation of green manure viz. Sesbania in agricultural fields are also the common organic inputs used by local farmers. Experimental observations clearly indicates that these practices played a key role in improving the soil quality (viz. microbial population diversity, soil organic carbon and NPK content), diversity of sentinel species, grain yield and its nutritional value. Preliminary results showcase the importance and timeliness of study and suggest identification, field level experimental validation, large scale field utilization and location specific (based on soil type, climate, crop and varietal demands of place and people) recommendation of promising agricultural practices to be crucial in terms of meeting global food security thereby providing societal benefits and human well-being worldwide.

References:

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Gupta R and Seth A (2007) A review of resource conserving technologies for sustainable management of the rice–wheat

cropping systems of the Indo-Gangetic plains. Crop Prot. 26, 436–447

Ladha JK et al. (2016) Agronomic improvements can make future cereal systems in South Asia far more productive and result in a lower environmental footprint. Global Chan. Biol. 22, 1054–1074

Rao CS et al. (2016) Chapter Four - Climate Resilient Villages for Sustainable Food Security in Tropical India: Concept, Process, Technologies, Institutions, and Impacts. Advances in Agron. 140, 101-214

Tilman D et al. (2002) Agricultural sustainability and intensive production practices. Nature 418, 671-677

Other Recent Researches

Osterberg, JT, Xiang W, Olsen LI, Edenbrandt AK, Vedel SE, Christiansen A, Landes X, Andersen MM, Pagh P, Sandøe P, Nielsen J. Christensen SB, Thorsen BJ, Kappel K, Gamborg C, Palmgren M (2017) Accelerating the domestication of new crops: feasibility and approaches. Trend Plant Sci. http://dx.doi.org/10.1016/j.tplants.2017.01.004

Abstract: The domestication of new crops would promote agricultural diversity and could provide a solution to many of the problems associated with intensive agriculture. We suggest here that genome editing can be used as a new tool by breeders to accelerate the domestication of semi-domesticated or even wild plants, building a more varied foundation for the sustainable provision of food and fodder in the future. We examine the feasibility of such plants from biological, social, ethical, economic, and legal perspectives.

Faucon MP, Houben D, Lambers H. (2017) Plant functional traits: soil and ecosystem services. Trend Plant Sci 22: 385-394

Abstract: Decline of ecosystem services has triggered numerous studies aiming at developing more sustainable agricultural management practices. Some agricultural practices may improve soil properties by expanding plant biodiversity. However, sustainable management of agroecosystems should be performed from a functional plant trait perspective. Advances in functional ecology, especially plant functional trait effects on ecosystem processes and services, provide pivotal knowledge for ecological intensification of agriculture; this approach acknowledges that a crop field is an agroecosystem whose ecological processes influence soil properties. We highlight the links between plant functional traits and soil properties in relation to four major ecosystem processes involved in vital ecosystem services: food production, crop protection, climate change mitigation, and soil and water conservation, aiming towards ecological intensification of sustainable agricultural and soil management.

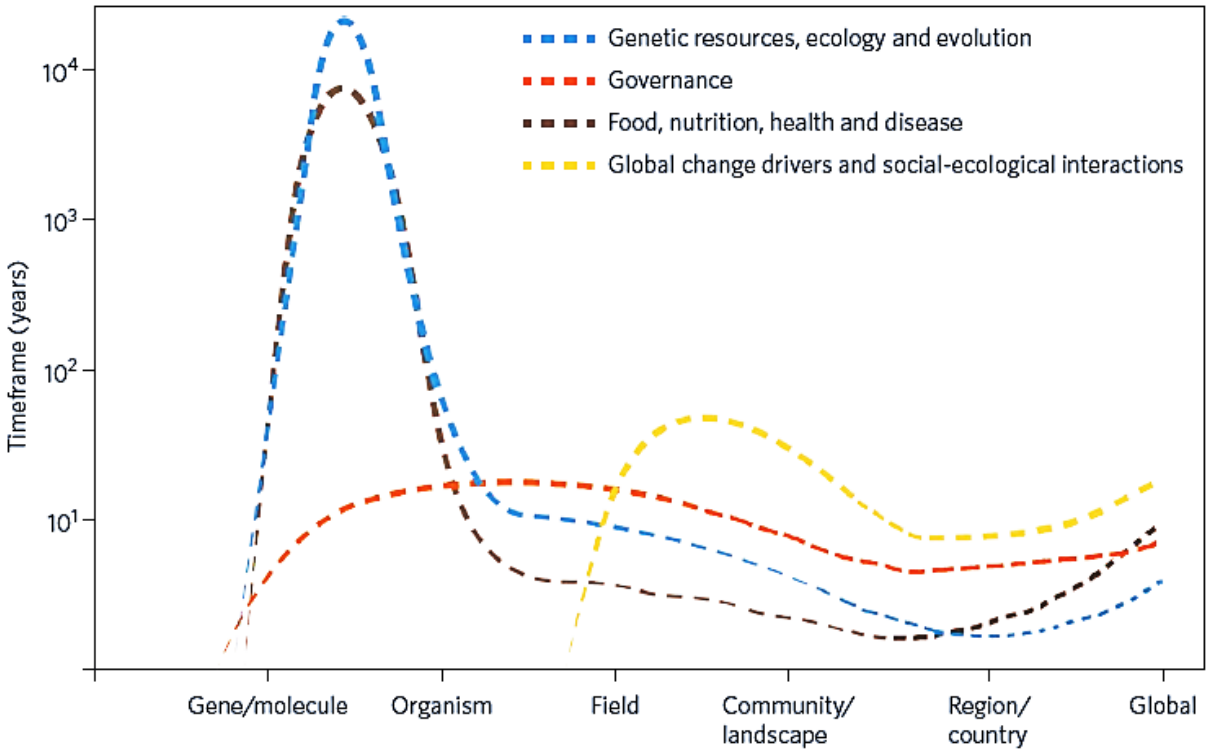
Schmidt JE, Gaudin ACM (2017) Toward an integrated root ideotype for irrigated systems. Trends Pla Sci 22:433-443

Abstract: Breeding towards root-centric ideotypes can be a relatively quick trait-based strategy to improve crop resource use efficiency. Irrigated agriculture represents a crucial and expanding sector, but its unique parameters require traits distinct from previously

proposed rainfed ideotypes. We propose a novel irrigated ideotype that integrates traits across multiple scales to enhance resource use efficiency in irrigated agroecosystems, where resources are concentrated in a relatively shallow 'critical zone'. Unique components of this ideotype include rapid transplant recovery and establishment, enhanced exploitation of localized resource hotspots, adaptive physiological regulation and maintenance of hydraulic conductivity, beneficial rhizosphere interactions, and salinity/water logging avoidance. If augmented by future research, this target could help to enhance agricultural sustainability in irrigated agroecosystems by guiding the creation of resource-efficient cultivars.

Zimmerer KS, de Haan S (2017) Agrobiodiversity and a sustainable food future. Nature Plants 3:1704. DOI: 10.1038/nplants.2017.47

Abstract: The biodiversity of food plants is vital for humanity's capacity to meet sustainability challenges. This goal requires the rigorous integration of plant, environmental, social and health sciences. It is coalescing around four thematic cornerstones that are both interdisciplinary and policy relevant.



Weng ZH, Zwieten LV, Singh BP, Tavakkoli E, Joseph S, Macdonald LM, Rose TJ, Rose MT, Kimber SWL, Morris S, Cozzolino D, Araujo JR, Archanjo BS, Cowie A (2017) Biochar built soil carbon over a decade by stabilizing rhizodeposits. Nat Clim Change 7:371-376

Abstract: Biochar can increase the stable C content of soil. However, studies on the longer-term role of plant–soil–biochar interactions and the consequent changes to native soil organic carbon (SOC) are lacking. Periodic 13CO2 pulse labelling of ryegrass was used to monitor belowground C allocation, SOC priming, and

stabilization of root-derived C for a 15-month period—commencing 8.2 years after biochar (Eucalyptus saligna, 550 _C) was amended into a subtropical ferralsol. We found that field-aged biochar enhanced the belowground recovery of new root-derived C (13C) by 20%, and facilitated negative rhizosphere priming (it slowed SOC mineralization by 5.5%, that is, 46 g CO2-Cm□2 yr□1). Retention of root-derived 13C in the stable organo-mineral fraction (<53 _m) was also increased (6%, P < 0.05). Through synchrotron-based spectroscopic analysis of bulk soil, fieldaged biochar and microaggregates (<250 _m), we demonstrate that biochar accelerates the formation of microaggregates via organo-mineral interactions, resulting in the stabilization and accumulation of SOC in a rhodic ferralsol.

Paustian K, Lehmann J, Ogle S, Reay D, Robertson GP, Smith P (2016) Climate-smart soils. Nature, 532: 49-57.

Abstract: Soils are integral to the function of all terrestrial ecosystems and to food and fibre production. An overlooked aspect of soils is their potential to mitigate greenhouse gas emissions. Although proven practices exist, the implementation of soil-based greenhouse gas mitigation activities are at an early stage and accurately quantifying emissions and reductions remains a substantial challenge. Emerging research and information technology developments provide the potential for a broader inclusion of soils in greenhouse gas policies. Here we highlight 'state of the art' soil greenhouse gas research, summarize mitigation practices and potentials, identify gaps in data and understanding and suggest ways to close such gaps through new research, technology and collaboration.

Potts SG, Imperatriz-Fonseca V, Ngo HT, Aizen MA, Biesmeijer JC, Breeze TD, Dicks LV, Garibaldi LA, Hill R, Settele J, Vanbergen AJ (2016) Safeguarding pollinators and their values to human well-being. Nature, 540: 220-229

Abstract: Wild and managed pollinators provide a wide range of benefits to society in terms of contributions to food security, farmer and beekeeper livelihoods, social and cultural values, as well as the maintenance of wider biodiversity and ecosystem stability. Pollinators face numerous threats, including changes in land-use and management intensity, climate change, pesticides and genetically modified crops, pollinator management and pathogens, and invasive alien species. There are well-documented declines in some wild and managed pollinators in several regions of the world. However, many effective policy and management responses can be implemented to safeguard pollinators and sustain pollination services.

Powlson DS, Stirling CM, Thierfelder C, White RP, Jat ML (2016) Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems? Agric, Ecosyst Environ 220:164-174

Abstract: Conservation agriculture (CA), comprising minimum soil disturbance, retention of crop residues and crop diversification, is widely promoted for reducing soil degradation and improving agricultural sustainability. It is also claimed to mitigate climate change through soil carbon sequestration: we conducted a meta-analysis of soil organic carbon (SOC) stock changes under CA practices in two tropical regions, the Indo-Gangetic

Plains (IGP) and Sub-Saharan Africa (SSA), to quantify this. In IGP annual increases in SOC stock compared to conventional practice were between 0.16 and 0.49 Mg C ha _1 yr _1. In SSA increases were between 0.28 and 0.96 Mg C ha _1 yr _1, but with much greater variation and a significant number of cases with no measurable increase. Most reported SOC stock increases under CA are overestimates because of errors introduced by inappropriate soil sampling methodology. SOC increases require careful interpretation to assess whether or not they represent genuine climate change mitigation as opposed to redistribution of organic C within the landscape or soil profile. In smallholder farming in tropical regions social and economic barriers can greatly limit adoption of CA, further decreasing realistic mitigation potential. Comparison with the decreases in greenhouse gas emissions possible through improved management of nitrogen (N) fertilizer in regions such as IGP where N use is already high, suggests that this is a more effective and sustainable means of mitigating climate change. However the mitigation potential, and other benefits, from crop diversification are frequently overlooked when considering CA and warrant greater attention. Increases in SOC concentration (as opposed to stock) in near-surface soil from CA cause improvements in soil physical conditions; these are expected to contribute to increased sustainability and climate change adaptation, though not necessarily leading to consistently increased crop yields. CA should be promoted on the basis of these factors and any climate change mitigation regarded as an additional benefit, not a major policy driver for its adoption.

Mueller ND, Lassaletta L, Runck B, Billen G, Garnier J, Gerber JS (2017) Declining spatial efficiency of global cropland nitrogen allocation. Glob Biogeochem Cycles http://dx.doi.org/10.1002/2016GB005515

Abstract: Efficiently allocating nitrogen (N) across space maximizes crop productivity for a given amount of N input and reduces N losses to the environment. Here we quantify changes in the global spatial efficiency of cropland N use by calculating historical tradeoff frontiers relating N inputs to possible N yield assuming efficient allocation. Time-series cropland N budgets from 1961 to 2009 characterize the evolution of N input-yield response functions across 12 regions and are the basis for constructing tradeoff frontiers. Improvements in agronomic technology have substantially increased cropping system yield potentials and expanded N-driven crop production possibilities. However, we find these gains are compromised by the declining spatial efficiency of N use across regions. Since the start of the Green Revolution, N inputs and yields have moved farther from the optimal frontier over time; in recent years (1994–2009), global N surplus has grown to a value that is 69% greater than what is possible with efficient N allocation between regions. To reflect regional pollution and agricultural development goals, we construct scenarios that restrict reallocation, finding that these changes only slightly decrease potential gains in nitrogen use efficiency. Our results are inherently conservative due to the regional unit of analysis, meaning a larger potential exists than is quantified here for cross-scale policies to promote spatially efficient N use.

Yamaji N, Takemoto1 Y, Miyaji T, Mitani-Ueno N, Yoshida KT, Ma JF (2017) Reducing phosphorus accumulation in rice grains with an impaired transporter in the node. Nature 541: 92-136

Abstract: Phosphorus is an important nutrient for crop productivity. More than 60% of the total phosphorus in cereal crops is finally allocated into the grains and is therefore removed at harvest. This removal accounts for 85% of the phosphorus fertilizers applied to the field each year1,2. However, because humans and non-ruminants such as poultry, swine and fish cannot digest phytate, the major form of phosphorus in the grains, the excreted phosphorus causes eutrophication of waterways. A reduction in phosphorus accumulation in the grain would contribute to sustainable and environmentally friendly agriculture. Here we describe a rice transporter, SULTR-like phosphorus distribution transporter (SPDT) that controls the allocation of phosphorus to the grain. SPDT is expressed in the xylem region of both enlarged- and diffuse-vascular bundles of the nodes, and encodes a plasma membrane-localized transporter for phosphorus. Knockout of this gene in rice (Oryza sativa) altered the distribution of phosphorus, with decreased phosphorus in the grains but increased levels in the leaves. Total phosphorus and phytate in the brown de-husked rice were 20–30% lower in the knockout lines, whereas yield, seed germination and seedling vigour were not affected. These results indicate that SPDT functions in the rice node as a switch to allocate phosphorus preferentially to the grains. This finding provides a potential strategy to reduce the removal of phosphorus from the field and lower the risk of eutrophication of waterways.

Varshney RK , Saxena RK, Upadhyaya HD, Khan AW, Yu Y, Kim C , Rathore A, Kim D, Kim J, An S, Kumar V, AnuradhaG, Yamini KN, Zhang W, Muniswamy **S**, Kim J-S, Penmetsa RV, von Wettberg E, Datta SK. Whole-genome resequencing of 292 pigeonpea accessions identifies genomic regions associated with domestication and agronomic traits.

Abstract: Pigeonpea (*Cajanus cajan*), a tropical grain legume with low input requirements, is expected to continue to have an important role in supplying food and nutritional security in developing countries in Asia, Africa and the tropical Americas. From whole-genome resequencing of 292 *Cajanus* accessions encompassing breeding lines, landraces and wild species, we characterize genome-wide variation. On the basis of a scan for selective sweeps, we find several genomic regions that were likely targets of domestication and breeding. Using genome-wide association analysis, we identify associations between several candidate genes and agronomically important traits. Candidate genes for these traits in pigeonpea have sequence similarity to genes functionally characterized in other plants for flowering time control, seed development and pod dehiscence. Our findings will allow acceleration of genetic gains for key traits to improve yield and sustainability in pigeonpea.

INVITED ARTICLE

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Climate Resilient Villages in India

Written by: Dr. Cherukumalli Srinivasa Rao

Climate change has become an important area of concern for India to ensure food and nutritional security for a growing population. To meet the challenges of sustaining domestic food production in the face of changing climate and generate information on adaptation and mitigation in agriculture to contribute to global fora like UNFCCC, it is important to have concerted research on this important subject. With this background, ICAR launched a major project 'National Initiative on Climate Resilient Agriculture' (NICRA) during XI Plan in February 2011 and now during XII Plan it is referred as 'National Innovations in Climate Resilient Agriculture' (NICRA). The project had an overall outlay of Rs. 350 crores for the XI Plan period and now is with Rs.600 Crores allocation during XII Plan period.

Objectives

The Major objective of NICRA is to enhance the resilience of Indian agriculture, covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies; to demonstrate the site specific technology packages on farmers' fields for adapting to current climate risks; and to

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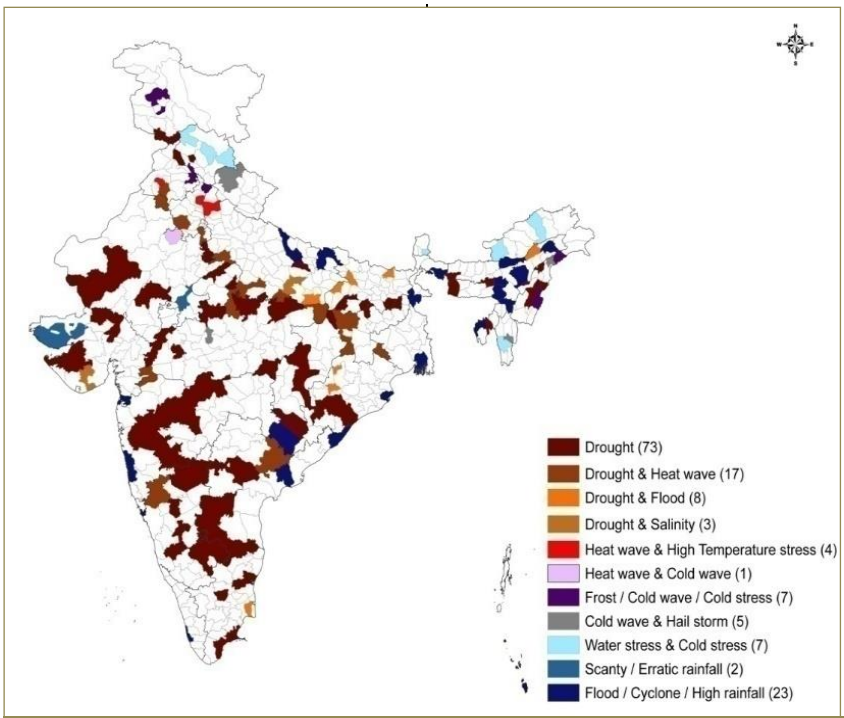


Climate Resilient Villages established in different districts of India

enhance the capacity of scientists and other stakeholders in climate resilient agricultural research and its application.

Components

During XII Plan, the scheme involves 4 major components, viz., Strategic Research (40 ICAR Institutes), Sponsored and Competitive Grants, Technology Demonstration, Capacity Building and Knowledge Management.

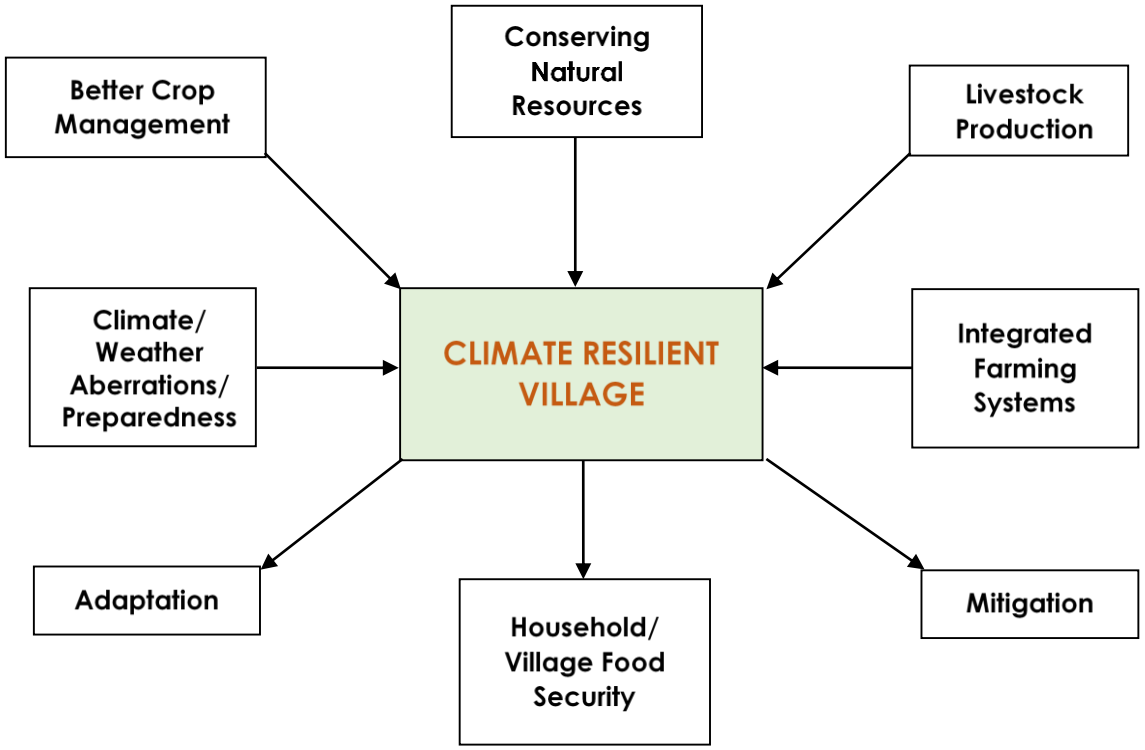
Under Technology Demonstration Component (TDC), 151 climate resilient villages were established in 151 climatically vulnerable districts of India in a farmer participatory mode through 121 Krishi Vigyan Kendras (KVKs), ICAR Institutes and AICRP centers, spread across the country in 28 States & one Union Territory. TDC aims at demonstration of proven technologies to enhance the adaptive capacity and to enable farmers cope with current climatic variability. Location specific technologies which are developed by the national agricultural research system which can impart resilience against climatic vulnerability are being demonstrated. A representative village in each climatically vulnerable district was selected for implementation. The interventions are broadly divided in to four modules, natural resource management, crop production, livestock and fisheries and the creation of institutional structures for sustaining the activities envisaged and scaling up of interventions. NRM interventions included site

Community participation is a key in Climate resilient villages

specific rainwater harvesting structures in drought affected areas; recycling of harvested water through supplemental irrigation to alleviate moisture stress during midseason dry spells; improved drainage in flood-prone areas; artificial groundwater recharge and water saving micro-irrigation methods. In-situ moisture conservation through ridge and furrow and raised bed planting in soybean, cotton, maize, pigeonpea, short duration pulses, vegetables, wheat, mustard, sugarcane, potato and vegetables resulted in higher benefit: cost ratios (2.6 to 4.7).

Adoption of in-situ moisture conservation measures in crops was helpful to improve the soil moisture availability at the root zone (30-40 days) and eventually increased the productivity of crops by 15-20% in dry regions of the country in comparison to the traditional practices of farmers. Large number of Rain Water Harvesting structures were constructed/renovated/repaired, while 80000 m3 additional rainwater storage capacity was created through farm ponds alone and the cropping intensity was increased by about 20% in several NICRA villages.

Under the crop production module, demonstrations consists of drought and flood tolerant varieties, community nurseries for delayed monsoon, water saving paddy cultivation methods (SRI, aerobic, direct seeding), advancement of planting dates of rabi crops in areas with terminal heat stress, frost management in horticulture through fumigation, popularization of location-specific & risk-reducing intercropping systems with high sustainable yield index. Under the livestock & fishery module demonstrations on fodder production, especially



Climate Resilient Village (CRV) Framework and Impacts

under drought/flood situations, improved shelter for reducing heat stress in livestock, silage making methods for storage of green fodder and feeding during the dry season, breed selection and stocking ratios for fish production in farm ponds and monitoring of water quality in aquaculture and Integrated farming system models in diverse agro ecosystems are being taken up. Interventions such as soil health, water management along with tolerant crops or varieties contributed in overcoming the droughts (particularly mid-season or inter droughts).

Residue recycling, avoiding or minimizing crop residue burning, agro-forestry interventions, GPS based soil sampling, site specific nutrient management, village level organic resource inventory, tank silt addition, better feed, breed and shelter management in livestock, location specific integrated farming system models were unique features of these climate resilient villages. Establishment of rain gauge and automatic weather stations, data recording, agro advisories contributed to risk minimizations and input cost saving. Village level carbon balance studies revealed that various climate resilient villages contributed to positive carbon balance and reducing Green House Gas (GHG) emissions.

Village level institutional mechanisms such as Village Level Climate Risk Management Committees (VCRMC), custom hiring centers for farm machinary are created for managing infrastructure created and to improve the timeliness of operations during the limited window periods of moisture availability in rainfed areas and to promote small farm mechanization for adoption of climate resilient practices. Similarly village seed banks and fodder back established resulted in efficient seed and fodder systems. These interventions helped farmers to reduce the yield losses and enhanced their adaptive capacity against climatic variability.

Custom hiring centre in Climate Resilient village

Source: *Srinivasarao et al Climate Resilient Villages for Sustainable Food Security in Tropical India: Concept, Process, Technologies, Institutions and Impacts. Advances in Agronomy (2016)*

New Publications

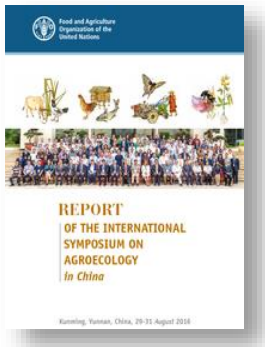
FAO. 2016

Sustainable Agriculture for Biodiversity: Biodiversity for Sustainable Agriculture. Published by FAO (2016).

This report highlights the work of FAO relating to agrobiodiversity, forestry and fisheries sectors. It also showcase how managing agroecosystems and maintenance of agrobiodiversity benefits in terms of offering countless number of ecosystem services viz. food, feed, clean water etc. and functions viz. maintenance of water quality, biological pest control, erosion control and pollination etc. To derive all these benefits holistic approach is needed by valuing all sectors equally.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i6602e.pdf



FAO. 2017

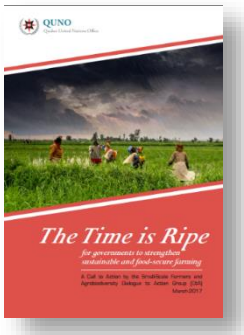
Report of the International Symposium on Agroecology in China

Kunming, Yunnan, China, 29–31 August 2016. Food and Agriculture Organization Report No. 6884. Rome, Italy

Symposium was held in Kunming, Yunnan, China from 29–31 August 2016 jointly by Chinese Academy of Agricultural Sciences (CAAS), FAO, Yunnan Academy of Agricultural Sciences (YAAS) and supported by the Government of France. 221 participants from 25 countries gathered in symposium. **Symposium was followed by further meetings held in** Brazil, Senegal and Thailand. Major outcome of symposium highlighted that approach of agroecology must be site specific and consider 3 different pillars of sustainability i.e. social, economic and environment.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i6884e.pdf



QUNO. 2017

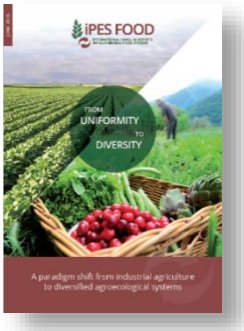
The Time is Ripe – for Governments to Strengthen Sustainable and Food-Secure Farming

March 2017. Small-Scale Farmers and Agrobiodiversity Dialogue to Action Group (DtA)

QUNO's (Quaker United Nations Office) Food & Sustainability Program was held in November, 2016. As an outcome of it, a call from Dialogue to Action Group (DtA) for international community to mobilize resources for providing proactive support to small scale farmers, their seed system and agrobiodiversity by public sectors was made. Key affirmation of call is that governments must come forward in supporting small farmers in achieving sustainable agriculture and secured livelihoods.

The PDF version of this publication can be downloaded at the following web link:

http://agrobiodiversityplatform.org/files/2017/04/FINAL-QUNO-Time-is-Ripe_23-March.pdf



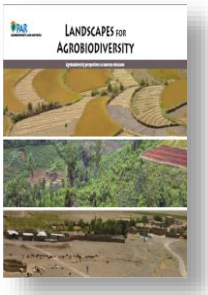
IPES-Food. 2016

From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agro-ecological systems.

This report talks about potential of shifting from industrial mode of agricultural system to diversified agro ecological systems and there benefits over current agricultural system that are yet not a complete success in meeting food and nutritional security, social equity and environmental harmony.

The PDF version of this publication can be downloaded at the following web link:

http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf



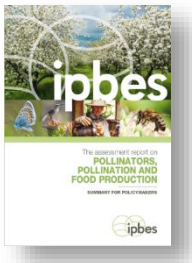
PAR. 2016

Landscape for Agrobiodiversity

This booklet describes work undertaken by the Platform for Agrobiodiversity Research (PAR) within the project "Supporting Agrobiodiversity Maintenance and Use in the Context of Land Management Decisions". Key issue highlighted in report was that conservation debates often ignore agrobiodiversity. Steps for adaptive management of agrobiodiversity have also been discussed in the report.

The PDF version of this publication can be downloaded at the following web link:

http://agrobiodiversityplatform.org/docs/landscapes-for-agrobiodiversity-PAR.pdf



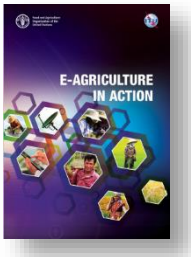
IPBES. 2016

The assessment report on Pollinators, pollination and food production: Summary for policy makers

Report tells the importance of animal pollination. It say that production, yield and quality of more than three quarters of the leading global food crop types that occupying nearly 1/3rd of all agricultural land are benefited from animal pollination. It gives that figure that 91 (fruit, seed and nut) out of 107 leading global crop type's production rely on animal pollination up to varying degrees.

The PDF version of this publication can be downloaded at the following web link:

http://www.ipbes.net/



FAO. 2017

E-agriculture in action

Food and Agriculture Organization Report No. 6972. Rome, Italy

Book talks about the importance of right information reaching at right time to farmers. It significantly decides the livelihood and well-being of farmer's, their family and communities, particularly of small and resource poor farmers. Different case studies have been showcase in book relating to how emerging technologies can be used to provide good quality of life to farming communities.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i6972e.pdf

FAO. 2017

Integrated Pest Management of major pest and diseases in Eastern Europe and Caucasus

Food and Agriculture Organization Report No. 5475. Rome, Italy

This book encourages the technical advice that is provided under Integrated Pest Management scheme to control crop pests and diseases. IPM reduces use of pesticides which can otherwise cause harm to environment, farming communities and also to the consumers. Summary of control methods of biological pests and there control can be found in this booklet.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i5475e.pdf

FAO. 2017

Punjab & Sindh Kharif Crop (Sugarcane, Rice and Cotton) Mask

This publication shows the detailed datasets (land and crop statistics) collected from Punjab and Sindh for kharif crop through manual field method as well as integrated use of remote sensing and GIS.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i6896e.pdf

Global Alliance for the Future of Food. 2016

The Future of Food: Seeds of Resilience, "A Compendium of Perspectives on Agricultural Biodiversity from Around the World"

Honolulu, 3rd September, 2016 at IUCN World conservation congress

The Future of Food: Seeds of Resilience, A Compendium of "Perspectives on Agricultural Biodiversity from Around the World" is released during IUCN World conservation congress held on 3rd September 2016 in Honolulu. The compendium (PDF) highlights the importance of preserving seed and agricultural biodiversity and recommended the ways to strengthen community based efforts in attainment of the same.

The PDF version of this publication can be downloaded at the following web link:

http://futureoffood.org/wp-content/uploads/2016/09/FoF_Print_Compendium_82616_FA.pdf

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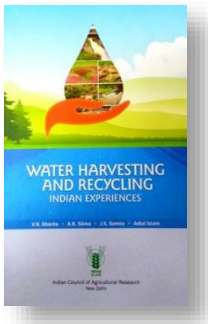


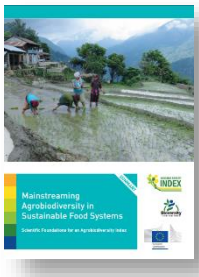
ICAR- India.

Water Harvesting and Recycling Indian Experiences

Book gathers latest knowledge on water harvesting and recycling techniques from different in situ and ex situ sources. Information of the book can be a good input for planners and policy makers. Research students working in field of conservation of water resources will also be benefitted by this book.

The PDF version of this publication can be downloaded at the following web link:

http://www.icar.org.in/en/node/11403



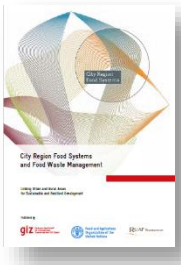
Biodiversity International. 2016

Mainstreaming agrobiodiversity in sustainable food systems

This book outlines the key message and contents of forthcoming publication entitled "Mainstreaming agrobiodiversity in sustainable food systems: Scientific foundations for agrobiodiversity index" in year 2017. Book is first step in laying foundation to creating Agrobiodiversity index to measure agricultural biodiversity at different dimensions. Publication of book is at right time as there is need to understand biodiversity in rapid and cost efficient ways that can assist in providing ease to policy/ decision makers regarding agronomic practices that can foster biodiversity

The PDF version of this publication can be downloaded at the following web link:

http://www.bioversityinternational.org/fileadmin/user_upload/Mainstreaming_Summary_2017.pdf



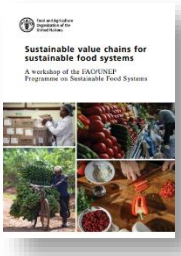
FAO. 2017

City Region Food Systems and Food Waste Management

This book compiles and collates 13 different case studies relating to urban cities food systems and food waste management have been discussed. It provides lesson regarding design of specific policies and programs for sustainable city regional food systems.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i6233e.pdf



FAO. 2016

Sustainable value chains for sustainable food systems: A workshop of the FAO/UNEP Programme on Sustainable Food Systems

Book highlights the role of multidimensional concept of sustainability that can potentially benefit the rural population, particularly the women's population. Knowledge sharing can be best vehicle in attaining that sustainability in era of overgrowing human population and market pressures.

The PDF version of this publication can be downloaded at the following web link:

http://www.fao.org/3/a-i6511e.pdf

Calendar of Events

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JUNE 2017

NINETEENTH INTERNATIONAL CONFERENCE ON AGRICULTURAL, ENVIRONMENTAL, ECOLOGICAL AND ECOSYSTEMS SCIENCES ICAEEES 2017

Paris, France, 25–26 June 2017

Information: https://www.waset.org/conference/2017/07/paris/ICAPCS/home

ISER-186TH INTERNATIONAL CONFERENCE ON AGRICULTURAL AND BIOLOGICAL SCIENCE (ICABS)

Pune, India, 25–26 June 2017

Information: http://iser.co/Conference2017/India/1/ICABS/

JULY 2017

INTERNATIONAL CONFERENCE ON EMERGING TRENDS IN INTEGRATED PESTS AND DISEASE MANAGEMENT FOR QUALITY FOOD PRODUCTION

Kuching, Malaysia, 25–27 July 2017

Information: https://www.mypadnow.com/ipm2017

WEST AFRICA FERTILIZER AGRIBUSINESS CONFERENCE

Accra, Ghana, 10–12 July 2017

Information: https://events.crugroup.com/westafrica/home

WRFER- INTERNATIONAL CONFERENCE ON FORESTRY, FOOD AND SUSTAINABLE AGRICULTURE (ICFFSA)

Puducherry, India, 30 July 2017

Information: http://wrfer.org/Conference2017/7/Pondicherry/ICFFSA/

AUGUST 2017

FOURTH INTERNATIONAL CONFERENCE ON AGRICULTURE AND FORESTRY (ICOAF)

Colombo, Sri Lanka, 25–26 August 2017

Information: http://agroconference.com/

OCTOBER 2017

ISER-240TH INTERNATIONAL CONFERENCE ON AGRICULTURAL AND BIOLOGICAL SCIENCE (ICABS)
Malacca, Malaysia, 05–06 October 2017
Information: http://iser.co/Conference2017/Malaysia/4/ICABS/

TENTH INTERNATIONAL CONFERENCE ON AGRICULTURE & HORTICULTURE
London, UK, 02-04 October 2017
Information: https://agricultureconference.wordpress.com/

INTERNATIONAL CONFERENCE & EXPO ON AGRICULTURE & VETERINARY SCIENCES: RESEARCH & TECHNOLOGY
Hyderabad, India, 23–25 October 2017
Information: http://www.agriconference.org/

NOVEMBER 2017

THIRD INTERNATIONAL CONFERENCE ON SUSTAINABLE AGRICULTURE TECHNOLOGIES
Nanhua University, Taiwan, 24-26 November 2017
Information: http://www.icsat.org/

THE INTERNATIONAL SYMPOSIUM ON ENVIRONMENT AND SUSTAINABLE AGRICULTURE DEVELOPMENT (ESAD 2017)
Sanya, China, 28-30 November 2017
Information: http://www.engii.org/conference/ESAD/940s2601.html