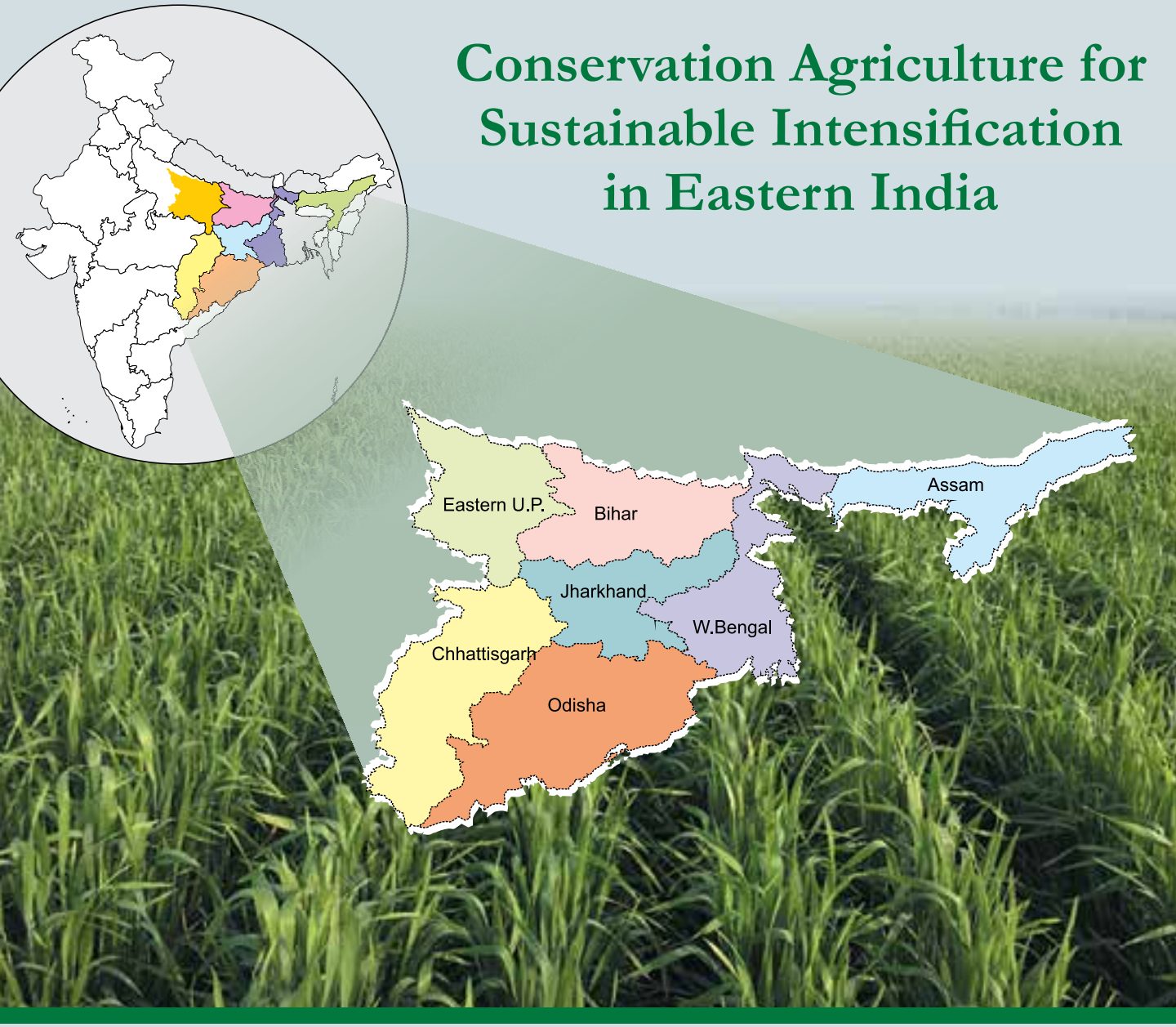
POLICY BRIEF

Conservation Agriculture for Sustainable Intensification in Eastern India



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The Context

The eastern region of India comprising seven states (Assam, Bihar, Chhattisgarh, Eastern Uttar Pradesh, Jharkhand, Odisha and West Bengal) occupies 21.85% geographical area and is an agriculturally important region that currently supports 34% human and 32 % livestock population of India. This is one of the world's densely populated regions with 1.91 fold higher population density compared to the India's national average. Of the total geographical area of 71.84 m ha, net sown area is 29.69 m ha with a cropping intensity of 140%.

Agriculture; by and large, a complex, diverse and risk prone profession, is the mainstay of economy in eastern India. The region has majority (81.24%) of marginal farmers with per capita income of Rs. 62,631/- per annum much lower than the national average of Rs. 94,130/-.

The annual rainfall in the region varies from 1091 to 2477 mm with a regional average of 1526 mm, which is sufficient and substantial for growing a variety of crops. However, it has erratic and uncertain spatial and temporal distribution. The region constitutes about 18% of country's utilizable water resources (10% of surface water and 30% of groundwater). Likewise, net annual groundwater availability and draft is estimated to be 143.6 and 58.6 billion cubic meter (BCM), respectively. In spite of high rainfall zone, water productivity for cereal production ranges from 0.21 to 0.61 kg/m^3 in the eastern Indian States, with an average of 0.37 kg/m^3 of water, which could be attributed to low yield as well as poor agronomic management practices specially very poor on-farm water management.

Conservation Agriculture (CA) based management paradigm adopted over 3.0 million hectares in South Asia have shown promise to provide solution to many emerging challenges being faced by the farmers such as declining factor productivity, deteriorating soil health, water scarcity, labour shortages, climate change, farm profitability, human health, etc., while ensuring future food security on a sustainable basis. Of late, in order to ensure food security of the Nation, eastern India has been targeted for ushering second Green Revolution through Government of India's investment programs powered by research outputs from various national (ICAR), sub-national (SAUs) and other agencies including CGIAR Centres and implemented by extension functionaries, progressive farmers, NGO's etc. However, learning from the second-generation problems of Green Revolution in north-west India, there is a need for clear strategies to achieve the second Green Revolution in eastern India on a sustainable basis. To these efforts, in addition to improved crop varieties and seeds, the modern agronomic management practices especially minimum soil disturbance and new crop establishment practices, for example, CA with appropriate mechanization are critical. However, CA practices and cropping systems being followed elsewhere are

Conservation agriculture practices adopted in eastern India

Key Stakeholder Consultations Organized

- Agri-Summit, 2013-A Step Towards Second Green Revolution, 8-9th April, 2013, ICAR RCER, Patna
- Workshop for Identifying the Production and Technological Gaps in Middle IGP Regions, 7th October, 2015, ICAR RCER, Patna
- Inter-state Travelling Seminar for Participatory Learning on Climate Smart Agriculture, 24 -27th February 2018 (Bihar-Haryana-Punjab)
- Zero tillage-Happy Seeder Summit Workshop on "Value chain and policy interventions to accelerate adoption of zero tillage in the rice-wheat Farming systems across the Indo-Gangetic Plains" 27th June 2018, ICAR RCER, Patna
- Launching Workshop on Scaling up Climate Smart Agriculture through mainstreaming Climate Smart Villages in Bihar, 7th August, 2018, BAMETI, Patna
- Sensitization Workshop on Conservation Agriculture,19th November 2018, ICAR RCER, Patna
- International Conference of Crop Residue Management, 14-15th October, 2019, Patna
- Launching of Climate Resilient Agriculture Programme, 20th November, 2019, Patna




Stakeholder consultations on conservation agriculture systems in eastern India

diverse than those adopted in eastern Indo-Gangetic Plains (EIGP). While puddling is quite common in *Kharif*, zero tillage (ZT) with or without residue retention is practiced in *Rabi* crops indicating that the protocols of CA are partly adopted in the EIGP.

To foster the adoption of CA based sustainable intensification in eastern India, ICAR Research Complex for Eastern Region in collaboration of various CGIAR Centres, National Academy of Agricultural Sciences (NAAS) and other partners have organized a series of stakeholder consultations to take the stock of status of conservation agriculture in eastern India along with limitations associated with its adoption and a way forward. The science evidence and learnings used in this document are also based on the implementation of various collaborative research programs *viz.* Cereal Systems Initiatives for South Asia (CSISA); Developing and Defining Climate Smart Agriculture Practices Portfolios in South Asia under CGIAR Research program on Climate Change, Agriculture and Food Security (CCAFS); ICAR-Consortium Research Platform on Conservation Agriculture in rice-fallows; Consortium Research Platform on Farm Mechanization; Improved Rice-based Rainfed Agricultural Systems (IRRAS); Sustainable Resilient Farming System Intensification (SRFSI) in the EIGP; Scaling up Climate Smart Agriculture through mainstreaming Climate Smart Villages and Climate Resilient Agriculture Programme (CRAP) *etc*. Based on the deliberations by the stakeholders in different meetings/seminars/workshops organized in the region in the recent past as well as specific discussions held with the key resource persons listed in the document, the key recommendations emerged as way forward through suitable action for their implementation by the State Governments, Krishi Vigyan Kendras (KVKs) and public and private developmental organizations in the eastern region. Moreover, CA being a mechanized system of farming will also be highly effective in addressing some of the unforeseen challenges such labour availability and access due to COVID-19 mediated lockdown, social distancing and anticipated reluctance of agricultural workforce due to COVID fear. Under such situation, CA will be highly helpful in timeliness of operations specially the planting of crops while ensuring social distancing.

Road Map for Accelerated Adoption of Conservation Agriculture in Eastern India

Establish database repository on conservation agriculture for eastern India

Currently, there is no structured mechanism for tracking the adoption and maintaining database on CA/resource conservation technologies (RCTs) in different crops/cropping systems/ecologies of the region. Quality data on availability of CA machinery/Custom-hiring centres, area under combine harvesting machinery, amount of crop residues left in field in different crops and cropping systems, farmers practice for management of these crop residues, etc. is also lacking. ICAR Research Complex for Eastern Region in collaboration with CGIAR Centres, SAUs and other institutions should initiate focused programme on data base creation along with collection and collation of statistical information on land use pattern, area under rice-fallow, CA machineries available, important distributers of CA machineries including repair and maintenance centres. A systematic study on constraints in adoption of CA technologies in different crops and ecologies of the region also need to be prepared. An urgent action is therefore needed to map the CA research under all initiatives in eastern India to define recommendation domains considering soil, climate, cropping systems as well as socio-economic conditions of the stakeholders.

Setting-up common learning platform and sites of science-based evidence generation on CA

The most important limiting factor in adoption of CA is lack of synthesized knowledge on locally adapted CA practices which leads to perceived risks among the farmers who feel that puddling/intensive tillage is essential for cultivation of crops. In eastern India, large chunk of the farmers are even unaware of the resource conservation technologies. Some of them even have not heard about the Zero-till seed drill/Happy seeder. There is a need to create mass awareness of the CA technologies and demonstration of their benefits through creating a common platform of learning and knowledge sharing. All stakeholders need to be involved for creating the awareness and providing opportunities for sharing

On-site consultations CA with international experts

successes and failure with the technologies and innovations. There is also strong need to establish long-term field experiments on CA for generating science based evidence on key performance indicators of CA in diverse ecologies and cropping systems which can also serves as sites of learning and capacity development of range of stakeholders. The platform can also facilitate organizing inter-state travelling seminars for participatory learning on CA technologies to expose the farmers of eastern India to understand the climate smart agriculture/CA interventions going on especially in Haryana, Punjab and in other states.

Development of effective and productive supply chain system for CA machinery

Eastern India has negligible presence of manufactures dealing with CA machineries. Even for spare parts and repair & maintenance of existing machineries, the stakeholders have to depend on the markets available elsewhere in India, especially Punjab. Even for operating combine harvester, the farmers of eastern India rely on the trained manpower, available in Punjab, Haryana and Western UP. Agricultural Mechanization Development Centres (AMDC) needs to be established in each eastern Indian state, particularly for strengthening the small farm mechanization including rigorous multistake capacity building.

Though Custom-hiring Centres (CHCs) are being established in eastern Indian states, limited repair or maintenance support services and lack of spare parts are major limitations for potential use of CHCs. These issues create tangible barriers to adoption and wider acceptance of the benefits of CA practices. Manufacturers and dealers must be provided the required incentives to stock machines as well as spare parts within the region. Similar to Small Farm Mechanization Mission (SFMM) at the Centre, states of the region should also create SFMM.

Workshop on ZT-Happy seeder summit

Addressing subsidies for CA machinery as incentives to the farmers

The slow pace of adoption of CA based practices in the eastern India may be due to earlier subsidies which have distorted the market price. High empanelment costs created disincentives for manufacturers to engage more widely in the programme.

Inauguration of scaling up climate smart agriculture through mainstreaming climate smart villages in Bihar by Hon'ble Agriculture Minister, Govt. of Bihar

Subsidies have resulted in mal practices, and access has been limited to certain sections of society. The farmers are not financially positioned to purchase ZT drills/Happy seeders, and will access the technology primarily through CHCs. In order to promote CA on large scale, subsidy/incentives needs to be extended to the farmers. However, subsidy should be released based on ground compliance monitoring and assessment. It is also envisaged that there is a need to incentivize the purchase of happy seeder/ turbo seeder / and zero-till seed-cum-fertilizer drill to facilitate *in-situ* management of crop residue and retaining the straw as surface mulching. Refinement is needed in current prototypes of CA machineries (ZT drills, Happy seeders, etc.) in accordance with the farmers' need in eastern India besides cost reduction without compromising the quality of machine. Zero-till multi-crop and multi-utility planters need to be developed and popularized.

Pricing strategies to achieve market demand driven approaches for long-term sustained adoption of CA

It has also been deliberated that subsidy extended on purchase of machineries should be based on quality of the machines. In general, bids for the supply of machines invited are generic in nature. Detailed specifications along with brand/mark need to be mentioned in the bid itself, in order to ensure the supply of quality machines. Similar is the case with spares. National and State GST charges also need to be waved off on CA machineries to reduce price barriers to adoption.

Sustainable intensification of rice-fallows with suitable crops and crop establishment techniques

Eastern India has ~9.2 million ha area under rice-fallow due to lack of irrigation, late harvesting of long-duration high yielding rice varieties, moisture stress at the sowing time, water logging and/ or excessive moistures in November/December *etc*. Adoption of CA based resource conservation technologies (RCTs) involving suitable crop varieties would offer opportunities to cultivate at least 50% of rice-fallow area. Pulses such as chickpea, lentil, lathyrus and blackgram, and oilseeds such as safflower, mustard and linseed through rotation or relay with rice are the candidate crops for efficient utilization of conserved and scarce resources including soil moisture. Conservation agriculture-based crop establishment of these crops has a potential for sustainable intensification of rice-fallows in eastern India which not only will have economic benefits to farmers but also can help country to achieve self sufficiency in pulses and oil seeds. A systemic future research on nutrient management, crop/cultivar combination, and farm mechanization is warranted that may further help to upscale system productivity potential in rice-fallow agro-ecosystem.

Cropping system approach to CA and pest dynamics

Soil biology and pest (including insects, pathogens, nematodes and weeds) dynamics under CA is the subject matter of a thorough investigation due to change in hydrothermal regime of the soil in presence of crop residue cover and non-disturbance of soil. Changes in community structure of microbes, microbial dynamics (beneficial *vs.* pathogenic) and microbial mediated processes under CA need to be studied. Intensive research programmes also need to be initiated on sustainable use of crop residues, use of micro-organisms for faster degradation of crop residues, quantification of crop residues suitable for mulching in different crops and cropping systems, development of climate smart crop varieties, crop diversification, *etc*.

Crop residue management

About 650 million tons of crop residue is generated every year in India (NPMCR, 2014). Large portion of crop residue is burnt 'on-farm' primarily

to clean the field for sowing of the next crop. Rice, wheat and sugarcane are prone to crop residue burning. There is need to develop, disseminate and incorporate technological options for sustainable management of crop residues; and to formulate and implement suitable law and legislations/policy measures to curb burning of crop residue. Diversified uses of crop residue for various purposes primarily for *in-situ* recycling and also other purposes *viz.,* animal fodder, power generation, as industrial raw material for production of bioethanol, packing material for fruits and vegetables, and glassware, utilization for paper/board/panel industry, biogas generation/composting and mushroom cultivation in Public Private Partnership (PPP) mode need to be promoted.

Developing synergies among institutional landscapes

Keeping in view the fact that large numbers of research for development projects are being implemented in the eastern region by the CGIAR Centres including donors besides ICAR & SAUs, and state Governments, effective coordination between NARS and CGIAR Centres at regional level would greatly help in accelerated adoption of CA through bringing more synergies and complementarity and bridging knowledge gaps. Therefore, there is a need to develop a mechanism for regular meetings and interactions at the regional level in different locations involving CGIAR partners, SAUs, ICAR institutions, State Govt. functionaries and other stakeholders. While strengthening the long-term CA research platforms as sites of learning as well as new scientific insights and evidence generations, the on-farm research-cum-demonstration with farmers' participation involving KVKs is the key for its upscaling/out scaling and promotion on large areas. Duplication in research across the institutions/organization also needs to be avoided.

Capacity building of stakeholders

Multistake capacity building of stakeholders on CA is essentially required. Training programs to address the skill-gap could be based on existing arrangements elsewhere (e.g. NABARD, Skills Council, Agri-clinics *etc*.). Frequent demonstrations of machines (ZT seed drills/Happy seeder/Tractors/ Laser land levelers etc.) also needs to be arranged in order to increase awareness among stakeholders. Therefore, different training modules targeted to diverse stakeholders need to be developed. Based on the strengths on various aspects of CA-based practices, key institutions should be identified to lead and facilitate the capacity development programs in areas of their expertise in different geographies. Different agricultural universities and institutions in the region should introduce a course on CA as a part of course curriculum and also more students and young researchers should be trained through mainstreaming CA in the programmes like Rural Agricultural Work Experience (RAWE) and practical crop production course at under-graduate level and increased post-graduate research on CA.

Stakeholder capacity building events

Key Discussants

- R.S. Paroda, Chairman TAAS, New Delhi
- K.M. Bujarbaruah, Former Vice Chancellor, AAU, Jorhat, Assam
- S. Pasupalak, Former Vice Chancellor, OUA&T, Bhubaneswar, Odisha
- J.C. Katyal, Former Vice Chancellor, CCSHAU, Hissar, Haryana
- A.K. Singh, Vice Chancellor, BAU, Sabour, Bihar
- R.C. Srivastava, Vice Chancellor, DRPCAU, Pusa, Samastipur, Bihar
- S.K. Patil, Vice Chancellor, IGKV, Raipur, Chhattisgarh
- D.D. Patra, Vice Chancellor, BCKV, West Bengal
- C. Chattopadhyay, Vice Chancellor, UBKV, Coochbehar, West Bengal
- J.S. Sandhu, Vice Chancellor, Sri Karan Narendra Agriculture University, Jobner, Rajasthan
- H.S. Gupta, Former DG, BISA, New Delhi, India
- S.K. Chaudhari, DDG (NRM), ICAR, New Delhi
- B.P. Bhatt, Director, ICAR-RCER, Patna, Bihar
- H. Pathak, Director, NIABM, Baramati, Maharashtra
- R.C. Agarwal, DDG (Education), ICAR, New Delhi
- P. Kumar, National Coordinator, NAHEP, ICAR, New Delhi
- S.S. Singh, Director (Extension Education), RLBCAU, Jhansi, UP
- A. Arunachalam, Principal Scientist, ICAR HQ, New Delhi
- P.K. Mahapatra, Former Dean, OUA&T, Bhubaneswar, Odisha
- K.M. Singh, Director (Extension), DRPCAU, Pusa, Samastipur, Bihar
- M.P. Thakur, Director (Extension), IGKV, Raipur, Chhattisgarh
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- D.K. Singh Dron, Director (Research), BAU, Ranchi, Jharkhand
- H.C. Bhattacharya, Former Director (Extension), AAU, Jorhat, Assam
- Himanshu Kumar Rai, Director (Agriculture), Govt. of Bihar
- J.S. Urkurkar, Director, Directorate of Research Services, IGKV, Raipur, Chhattisgarh
- J.B. Tomar, Director (Research), BAU, Sabour, Bihar
- D.P. Tripathi, Director, PPM, Govt. of Bihar
- Jay Cummins, University of Adelaide, South Australia
- Adam Loch, University of Adelaide, South Australia
- A.K. Joshi, CIMMYT Representative in India & Managing Director, Borlaug Institute for South Asia (BISA)
- M.L. Jat, Pr. Scientist/Systems Agronomist, CIMMYT, India
- P.K. Joshi, Former Director, IFPRI, South Asia
- R.K. Gupta, Former Coordinator, CIMMYT, South Asia
- R.K. Malik, Consultant, CSISA-CIMMYT, Bihar
- M.K. Gathala, Sr. Scientist, CIMMYT, Bangladesh
- D.S. Rana, Scientist, IRRI, New Delhi
- Y. Saharawat, Country Coordinator, IFDC, India Office.
- S.P. Poonia, Research Platform Coordinator, CSISA-CIMMYT, Bihar
- P. Sagwal, IRRI, South Asia Centre, Varanasi
- P. Kumar, Research Scientist CSISA-CIMMYT, Bihar
- D.K. Singh, Research Scientist CSISA-CIMMYT, Eastern UP
- R.K. Jat, Cropping System Agronomist, BISA, Pusa, Samastipur, Bihar
- U.S. Singh, Consultant, CIP, New Delhi
- Sudhanshu Singh, Senior Agronomist, IRRI, New Delhi
- Shahnawaz R. Dar, Sr Associate Scientist, IRRI, New Delhi
- A. Chowdhury, Professor & Head, Department of Plant Pathology, UBKV, Pundibari, Coochbehar, West Bengal
- J.S. Mishra, Head, Division of Crop Research, ICAR-RCER, Patna
- U. Kumar, Head, Division of Socio-economic and Extension, ICAR-RCER, Patna

The viewpoints and inputs during the deliberations in the brainstorming sessions formed the basis of the policy brief, for which the key discussants are thankfully acknowledged.

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Citation: Mishra, J.S., Bhatt, B.P., Arunachalam, A. and Jat, M.L. (2020). Conservation Agriculture for Sustainable Intensification in Eastern India. Policy Brief, 8 p. Indian Council of Agricultural Research and National Academy of Agricultural Sciences, New Delhi.