AGROCLIMATIC ATLAS OF BIHAR

Abdus Sattar, Mithilesh Kumar, N.K. Singh,
R.K. Jha, Gulab Singh and S.K. Bal

AICRP ON AGROMETEOROLOY, CENTER FOR ADVANCE STUDIES ON CLIMATE CHANGE
DR. RAJENDRA PRASAD CENTRAL AGRICULTURAL UNIVERSITY, BIHAR
PUSA (SAMASTIPUR) - 848 125

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सत्यमेव जयते

कृषि एवं किसान कल्याण,
ग्रामीण विकास और पंचायती राज मंत्री
भारत सरकार
कृषि भवन, नई दिल्ली
**MINISTER OF AGRICULTURE & FARMERS WELFARE,
RURAL DEVELOPMENT AND PANCHAYATI RAJ
GOVERNMENT OF INDIA
KRISHI BHAWAN, NEW DELHI**

11 MAR 2021

संदेश

डॉ. राजेन्द्र प्रसाद केन्द्रीय कृषि विश्वविद्यालय, पूसा, समस्तीपुर बिहार का सेंटर फॉर एडवांस स्टडीज ऑन क्लाइमेट चेंज जलवायु परिवर्तन से उत्पन्न विषम परिस्थितियों के निवारण हेतु काम कर रहा है। इसी कड़ी में वहां के वैज्ञानिकों ने बिहार राज्य की स्थानीय परिस्थितियों एवं वहां की मौसमीय घटनाओं का विश्लेषण करने के उपरान्त "**Agroclimatic Atlas of Bihar**" नामक पुस्तक तैयार की है, जिसमें भौगोलिक सूचना प्रणाली (जीआईएस) मानचित्रों के माध्यम से कृषि-मौसमीय संबंधी संसाधनों को वर्गीकृत किया गया है।

यह पुस्तक बिहार की कृषि के नीति निर्धारण, कृषि वैज्ञानिकों और प्रसार कार्यकर्ताओं के लिए उपयोगी साबित होगी। इस पुस्तक से बिहार के किसानों को मौसम आधारित खेती करने से अत्यधिक लाभ होगा तथा जलवायु परिवर्तन से होने वाले नुकसान को कम करने में सहायता मिलेगी।

मैं इस पुस्तक को तैयार करने में महत्वपूर्ण भूमिका निभाने वाले डॉ. राजेन्द्र प्रसाद केन्द्रीय कृषि विश्वविद्यालय, पूसा, समस्तीपुर बिहार के वैज्ञानिकों को इस प्रकाशन के लिए बधाई देता हूं। मुझे पूरा विश्वास है कि यह **Agroclimatic Atlas** बिहार के कृषि उत्पादन के लक्ष्य को बढ़ाने में हमारे चल रहे प्रयासों में मददगार साबित होगा।

(नरेन्द्र सिंह तोमर)

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।। संदेश ।।

विगत वर्षो से मौसम में बदलाव तथा जलवायु परिवर्तन बिहार राज्य में देखने को मिल रहा है। कभी ज्यादा बारिश होना, कभी कम बारिश होना जलवायु परिवर्तन का परिणाम है। बदलते मौसम एवं जलवायु में खेती को कैसे करें तथा राज्य के किसानो की आमदनी बढ़ाने के लिए आधुनिक एवं उन्नत तकनीक से खेती किया जाना आवश्यक है। हाल के दिनों में, चरम मौसमीय घटनाओं की प्रवृत्ति बिहार में कई गुना बढ़ गई है और जिसके कारण कृषि के विकास में नकारात्मक प्रभाव पड़ रहा है। मानसून की वर्षा में बड़े अंतर और जलवायु परिवर्तनशीलता की पृष्ठभूमि में, विशेष रूप से रबी मौसम के दौरान अत्यधिक तापमान की घटना, बाढ़ तथा सुखाड़ की घटनायें, राज्य की जलवायु संवेदनशील भौगोलिक वातावरण और विशाल ग्रामीण आबादी, राज्य में कृषि पर जलवायु परिवर्तन से उत्पन्न चुनौतियों का समाधान करने की तत्काल आवश्यकता है।

मुझे खुशी है कि डॉ0 राजेन्द्र प्रसाद केन्द्रीय कृषि विश्वविद्यालय, पूसा ने जलवायु परिवर्तन के कृषि पर पड़ने वाले प्रभाव के लिए एक "सेन्टर फॉर एडवांस स्टडीज ऑन क्लाइमेट चेन्ज" स्थापित किया है। हमारी सरकार ने जलवायु परिवर्तन अनुकूल कृषि पर एक बहुत बड़ा शोध कार्यक्रम शुरु किया है। यह प्रकाशन इस शोध कार्यक्रम के लिए बहुत उपयोगी सिद्ध होगा।

पुस्तक में भौगोलिक सूचना प्रणाली (GIS) मानचित्रों के माध्यम से राज्य के कृषि संबंधी संसाधनों के विवरण वर्गीकृत किया गया है, जो राज्य में फसल उत्पादन को बढ़ावा देने के लिए वैज्ञानिकों, नीति–निर्माताओं और विस्तार कार्यकर्ताओं को उनके प्रयासों में मदद करेगा।

मैं सभी लेखकों को इस तरह के एक महत्वपूर्ण दस्तावेज के साथ आने के लिए बधाई देता हूँ और मुझे उम्मीद है कि यह Agroclimatic Atlas बिहार के कृषि उत्पादन को बढ़ाने में हमारे चल रहे प्रयासों में मददगार साबित होगा।

(अमरेन्द्र प्रताप सिंह)

सत्यमेव जयते
त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

भारत सरकार
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भारतीय कृषि अनुसंधान परिषद
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Foreword

Climate change is considered to be the biggest challenge posing threat to food security vis-à-vis sustainability and profitability of agriculture in our country. It is now a global reality that India is one of the most vulnerable countries to climate change and at present climate change is seriously affecting agricultural production through causing climate variability and increased extensive events like drought, floods, cyclones, etc. The overall strategy shall be to transform agricultural production systems into a climate smart vibrant production system. Under such a situation, it is necessary that climatic information down to micro-level is made available for effective planning and to fine tune agricultural operations. Options like introducing weather linked farming practices suitable to local agroclimatic resources and length of growing periods could be seriously explored apart from utilizing actionable weather forecast based agro-met advisories.

Bihar is one of the most climate sensitive states of India on account of its unique geo-climatic conditions and high population. Drought, flood, heat wave, cold wave, extreme rainfall events and hailstorm are common occurrences in Bihar. In this context, it is essential that agro-climatic resources of the state are evaluated properly at micro-level for chalking out tactical and strategic action plans to address the serious issues concerning climate change.

I am happy that All India Coordinated Research Project on Agrometeorology (AICRPAM) operating at Centre for Advance Studies on Climate Change, Dr. Rajendra Prasad Central Agricultural University is bringing out an important publication entitled "Agroclimatic Atlas of Bihar" encompassing different agroclimatic products in the form of thematic maps. The products of this atlas would help the farmers, policy makers and researchers in a long way to mitigate the negative impact of climatic change and sustain the agricultural production on a sustainable basis.

I compliment the authors of this Atlas and hope that it would be of immense use to the researchers in planning their future line of research, for policy makers to execute their action plan on Bihar agriculture for the benefit of the farming community.

(T. Mohapatra)

Date: 12th February 2021
Place: New Delhi-110 001

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डॉ. सुरेश कुमार चौधरी / Dr. Suresh Kumar Chaudhari
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Deputy Director General (Natural Resource Management)

15.02.2021

Message

The importance of weather in agriculture has become more pronounced in recent years due to climate change. The success and failure of agricultural enterprises is strongly dependent on the variability of weather and climate. Since more than 50 per cent of the cultivated land in Bihar is rainfed and agricultural production is heavily dependent on the monsoon rainfall, crop production in the state is highly sensitive to climatic variability. The need of the hour is, therefore, to adopt weather-wise farming practices. In the context of climate change, it is also necessary to understand potential and constraints of the agroclimatic resources of the state.

I am happy to note that All India Coordinated Research Project on Agrometeorology (AICRPAM) operating at Centre for Advance Studies on Climate Change of Dr. Rajendra Prasad Central Agricultural University has developed *Agroclimatic Atlas of Bihar* for taking rational decisions on future agricultural programmes in the light of climate change impact on agricultural production. This would serve as a reference book for chalking out climate change related policy matters for the entire state.

I wish to record my appreciation and congratulate all the authors of the book, which will serve many purposes in agricultural research and help in boosting agricultural production of Bihar under changing climatic scenario.

(S. K. Chaudhari)

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Date :_____

Message

The economy of Bihar like rest of the country is heavily dependent on agriculture and almost 85-90 percent people of the state are directly or indirectly engaged in agricultural activities. As crops remain exposed to the whims of weather right from germination to harvesting, it is essential that we adopt weather based farming practices to impart resilience to agricultural production against extreme weather condition in the wake of climate change. This could be achieved by utilizing weather as an input in agriculture. Under such situation, agroclimatic resources of a state need to be properly characterized and categorized in terms of its potential and constraints for successful agricultural planning.

I am happy to note that All India Coordinated Research Project on Agrometeorology operating under Centre for Advance Studies on Climate Change, RPCAU, Pusa has made an attempt in bringing out the Agroclimatic Atlas of Bihar, which contains numerous valuable information viz. different value added agroclimatic products derived from rainfall, temperature, relative humidity, wind and potential evapotranspiration depicted through GIS maps. I am sure that these would help our ongoing efforts in achieving desired goal of sustaining agricultural productivity and profitability under changing climatic scenario. I wish that the information generated in the Atlas would serve as an important guideline and reference material for chalking out future course of action and designing location specific agricultural projects Bihar.

I congratulate Dr. Sattar and his team for bringing out this very useful document and wish that it will help scientists, researchers, policy makers and farmers in boosting agricultural production in the state of Bihar.

Srivastava

(R.C. Srivastava)

PREFACE

Bihar's economy is highly dominated by agriculture and allied sectors. Around 85 to 90 percent of the population still lives in rural areas, where agriculture along with animal husbandry, is the main source of their livelihood. Climate change is now a reality in Bihar and could be felt in terms of abnormal temperature, erratic rainfall pattern leading to frequent dry spell/ drought and related extreme weather events impacting agricultural production system in the state. There is an urgent need to address the challenges posed by climate change on agriculture and its allied sectors in the state. The overall strategy would be to transform agricultural production systems into a climate resilient and climate smart vibrant production system through various interventions in order to achieve sustainable food security amidst land degradation and over exploitation of natural resources.

The issue of climate change and erratic nature of weather has forced the scientists, farmers and policy makers to pay attention to agricultural meteorology. Under such situation, it is necessary that climatic information down to micro-level is made available for effective planning and to fine tune agricultural operations. Hence, there is an urgent need for compilation of weather information in respect of crop production. In this agroclimatic atlas, greater focus has been given to generate agroclimatic products related to rainfall, temperature, potential evapo-transpiration based on agroclimatic analyses. Accordingly, lots of GIS maps based on these products have been generated in this atlas, which will help the farmers, policy makers and researches to undertake strategic researches and policy making under changing climatic condition. Apart from these, information on cropping trend and climate change in Bihar has been included. The Atlas gives a very broad picture of the status of available agroclimatic resources of the state. Hence, it could be used as reference material to further go ahead in terms of designing future projects related to Bihar agriculture under changing climatic condition. The Atlas is the outcome of research activities carried out under All India Coordinated Project on Agrometeorology.

We take this opportunity to express our sincere thanks and gratitude to Dr. R.C. Srivastava, Hon'ble Vice Chancellor, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar for his keen interest, encouragement and valuable guidance, and for providing necessary facilities for carrying out this work. Hon'ble Vice Chancellor has been a great motivator and mentor right from initiation to final completion of this important work.

We are very thankful to Dr. K.M. Singh, Dean (Agriculture) and Dr M.S. Kundu, Director of Extension Education for their support and guidance.

Information collated from different sources of literature cited in this Atlas is duly acknowledged. Weather data available at Agrometeorology Division, Center for Advance Studies on Climate Change, RPCAU, Pusa and data received from IMD, Govt. of India have been used in analysis for developing the Atlas.

Thanks are due to the Publication Division, RPCAU, Pusa for facilitating the publication of the Agroclimatic Atlas of Bihar.

Authors

Authors...

Dr. Abdus Sattar Associate Professor cum Senior Scientist (Agrometeorology) and Principal Investigator (PI) of All India Coordinated Research Project on Agrometeorology, RPCAU, Pusa (Samastipur) Bihar. He did his M.Sc and Ph.D in Agrometeorology. As Principal Investigator, he is also handling several other agrometeorological projects viz. National Innovations on Climate Resilient Agriculture (NICRA); Forecasting Agricultural Output using Space, Agrometeorology and Land based Observations (FASAL); Gramin Krishi Mausam Sewa (GKMS) and Characterization of Radiative and CO_2 fluxes over Rice-wheat system (SAC, ISRO). As Co-PI, also contributing to five other projects in the university. He has published more than 35 research papers in peer reviewed national and international journals, technical bulletins and book. He contributed significantly to agrometeorological research, and enhanced farm productivity and farmers' income through climate services and risk management. In recognition of his contributions, Rajendra Agricultural University, Pusa, Bihar (Now Dr. RPCAU, Pusa) gave him "Best Teacher/Scientist Award" in 2011. He is the recipient of "Best Ph.D Thesis Award" from the Association of Agrometeorologist in India. He optimized and modeled rice-wheat cropping system for potential productivity and adaptation under changing climatic scenario. He developed Climate Smart Irrigation Software/App for Kharif Rice. He is a life member of the Association of Agrometeorologists and Indian Meteorological Society. He is also Zonal Member for Eastern Region of the Association of Agrometeorologists and founding Chairman of Bihar Chapter of the Association of Agrometeorologists.

Dr. Mithilesh Kumar, Professor cum Chief Scientist, Department of Agricultural Biotechnology & Molecular Biology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar did his Ph.D in Genetics from IARI, New Delhi. He is acting as Director Research. He has more than 35 years of UG and PG teaching experience. He has published many research articles in reputed national and international journals. He has supervised a large number of M.Sc and Ph.D students. His main areas of research are genetics, plant biotechnology and plant tissue culture.

Dr. N. K. Singh, who was born on 20 January, 1958 at Chapra (Saran), has been serving Dr. Rajendra Prasad Central Agricultural University, Pusa as Professor and Head, Department of Plant Breeding and Genetics. He is also acting as Associate Director Research of the university. He has served this university for more than 35 years with UG and PG teaching. He has guided more than 25 M.Sc (Ag.) and Ph.D students. He has published more than 50 research papers and popular articles in National and International Journals. During a span of more than 35 years of service, Dr. Singh has developed and released 15 rice varieties for different eco-systems of Bihar. Among them, Rajendra Bhagwati and Rajendra Saraswati are worth mentioning and popular among the farmers. Dr. Singh is most popular among the farmers for DSR technology of rice, in which rice is grown as wheat without puddling and transplanting, having yield potential near to transplanted rice. At present, he is working for getting combined rice and wheat productivity more than 100 quintals from one hectare land. Thus, he is actively involved in promoting Climate Smart Agriculture among the farmers.

Dr. Ratnesh Kumar Jha is Professor-cum-Chief Scientist (Agronomy) in Dr. Rajendra Prasad Central Agricultural University Pusa, Bihar. Presently, he is heading Centre for Advance Studies on Climate Change as Project Director. He is Principal Investigator of project "Scaling up Climate Smart Agriculture (CSA) through mainstreaming Climate Smart Villages (CSVs) in Bihar. Again, he is Principal Investigator of project entitled "Climate Resilient Agriculture Program". Dr. Jha is the Nodal Officer of National Agriculture Disaster Management Plan. He was Program Coordinator of KVK Saran from December 2006 to November 2017. He was Principal Investigator of NICRA project from February 2011 to November 2017. Several KVK awards like Best KVK award of the University in 2013 and Best KVK Zonal award for Zone II of 2014 by ICAR (awarded in 2015) go to his credit. Under his leadership, KVK Saran got "A" grade ranking by Niti Ayog. He joined as Assistant Professor in 1996, promoted to Associate Professor in 2006 and Professor in 2012. He has published more than 12 research papers in national and International journals. He is a founder member of KVK journal published exclusively by the KVKs. Apart from research activities, he is teaching core courses in M.Sc. Ag and Ph.D. students. He has guided two M. Sc. Ag students so far and presently guiding third one. He has written one book on Agriculture in Ancient India. At least 12 training manuals go to his credit.

Dr. Santanu Kumar Bal is presently posted as Project Coordinator (Agrometeorology) in All India Coordinated Research Project on Agrometeorology (AICRP-AM) as In-charge located at ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad and involved in several projects including two externally funded by ICAR-NICRA and Monsoon Mission-II. As a visiting scientist to Israel under MASHAV fellowship, he worked on Database Management in Meteorology and Hydrology. He was awarded Fellows of "Association of Agrometeorologists" and "Indian Ecological Society". In his research career, he has worked in 17 research projects, published more than 60 peer reviewed papers, 62 conference papers, 2 Books, 27 book chapters & technical bulletins, etc. He and his team developed various softwares, concepts, technologies, methodologies viz., post-hail management strategies for field and vegetable crops, prediction models for various insect-diseases, Dynamic Crop weather Calendars etc. He acted as Managing Editor of J. of Agrometeorology, editor of J. of Agricultural Physics and as reviewer in many international & national journals.

Dr. Gulab Singh has been working as Technical Officer under GKMS Project (Agrometeorology), Centre for advance Studies on Climate Change, RPCAU, Pusa since July, 2019. He did his M.Sc. in Agricultural Meteorology from the Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya–224 229 (U.P.) in 2013, and Ph.D. in Agricultural Meteorology from the Bidhan Chandra Krishi Vishwavidyalaya in 2018. He published more than 15 publications (research paper, journal articles and technical documents). He is a life member of the Association of Agrometeorologists and Indian Meteorology Society. He is also Treasurer of Bihar chapter of Association of Agrometeorologists.

Inauguration of Agrometeorological Observatory by

Shri Kailash Choudhary

Hon,ble Union Minister of State for Agriculture

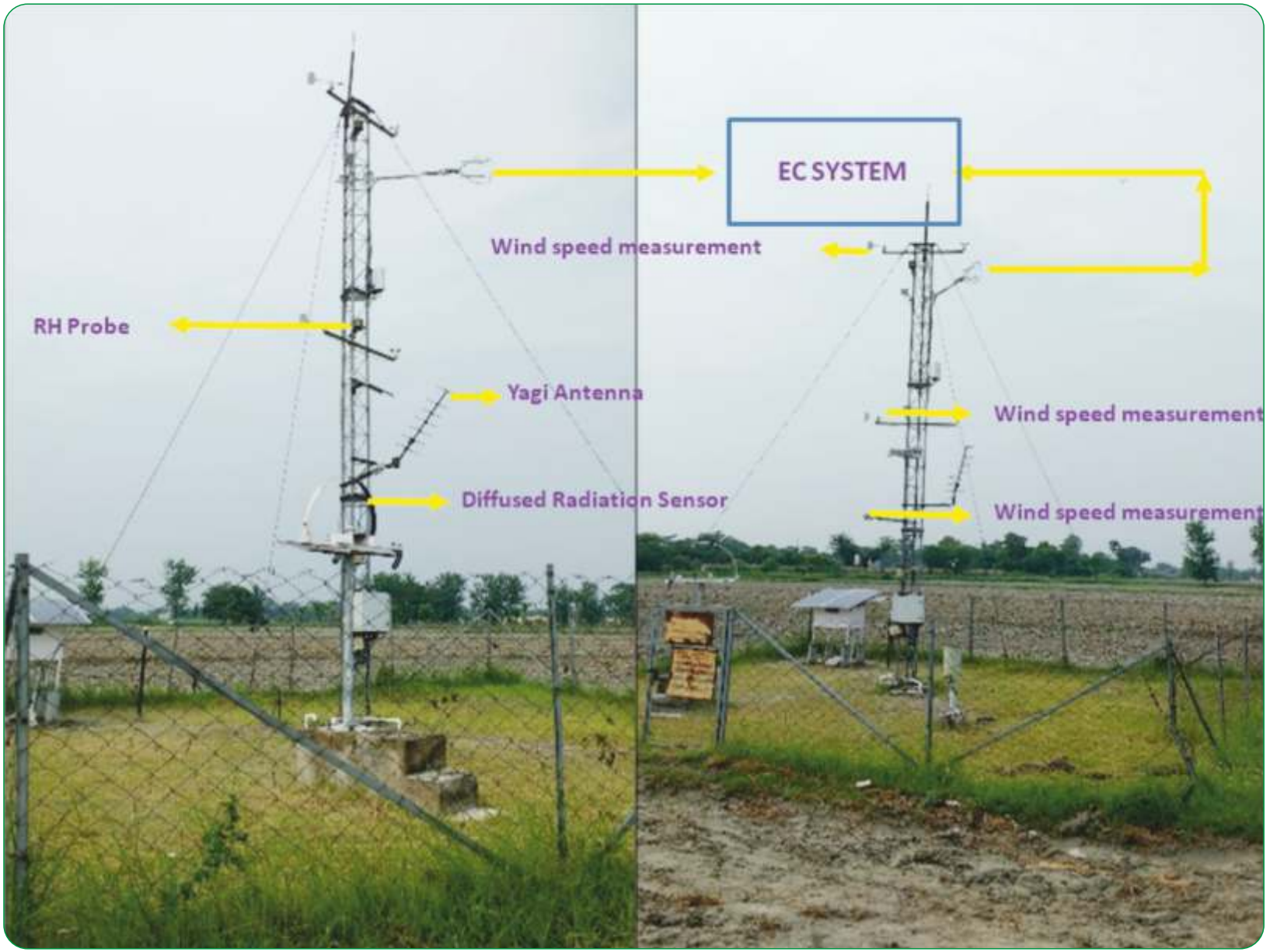
Govt. of India and

Dr. R. C. Srivastava

Hon,ble Vice Chancellor, RPCAU, Pusa

on 17 February, 2020

Agrometeorological Station Installed at RPCAU, Pusa



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Saraswati Garden, RPCAU, Pusa