Doubling Farmers' Income: **KISAN–MITrA**

Proceedings of **National Workshop on Doubling Farmers' Income through Scaling-up:** KISAN–MITrA (Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture)

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Vivekananda International Foundation India

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Citation: Wani SP, Vijay Sandeep Jakkula and Dhirendra Singh (*eds*.) 2017. Doubling Farmers' Income: KISAN–MITrA . Proceedings of National Workshop on Doubling Farmers' Income through Scaling-up: KISAN–MITrA (Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture) Patancheru 502 324. Telangana, India: International Crops Research Institute for the Semi-Arid Tropics. 160 pp. ISBN No. 978-92-9066-594-6 Order code: CPE175.

Acknowledgment

We are extremely thankful to Vivenkananda International Foundation for enabling us to provide strategies on the topic of doubling farmers' income by the year 2022. We are also thankful to the Department of Agriculture, Government of India, National Research Institutions, State Agricultural Universities, Corporates, International Research Centres and NGO groups for their contributions towards the report.

We gratefully acknowledge the financial assistance provided by J Farm Research Centre, Tractors and Farm Equipment Limited (TAFE), we sincerely acknowledge Vivenkananda International Foundation for taking intitiatve particularly Gen. NC Vij, Gen. Ravi Sawhney, Mr Dhirendra Singh, IAS (Rtd.). We acknowledge Sri Shobhana K Pattanayak, IAS, Secretary, Department of Agriculture, Cooperation and Farmers Welfare, Government of India, and all other dignitaries from Government as well as private companies. We sincerely acknowledge the help and support of Dr Vikas Khitha, Head of Business Development, L&T Finance. We sincerely acknowledge the help of Dr Arbind Kumar Padhee, Director, Country Relations and Business Affairs, ICRISAT and Mr Arun Pal, ICRISAT Delhi Office for their support for smooth conduct of the workshop. We acknowledge the efforts of all the authors who put in together their expertise to write the papers. We also thank the help of reviewers for giving their constructive suggestions for improving the quality of the chapters. We appreciate the help of Mr Arun Seshadri and Dr Kristofer Dodge for editorial assistance and Ms Sri Lakshmi for word processing and formatting.

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15–16 March 2017
Vivekananda International Foundation (VIF)
No: 3, San Martin Marg, Chanakyapuri, New Delhi – 110021

Editors
Suhas P Wani, Vijay Sandeep Jakkula and Dhirendra Singh

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Foreword

Agriculture is a high risk enterprise which is exacerbated by climate change and market volatility. Smallholder farmers in the dryland ecologies are resource poor with limited access to quality inputs, credit and market opportunities. To double incomes the supply side push of maximizing production has to be replaced with a demand side pull of fulfilling market needs by identifying opportunities for farmers to integrate with markets.

ICRISAT's mission to reduce hunger, poverty malnutrition and environmental degradation in the dryland tropics complements the efforts of the Vivekananda International Foundation (VIF) to meet the challenge of Prime Minister Narendra Modi for doubling farmers' income by 2022. VIF partnered with ICRISAT and J Farms to organize a "National Workshop on Doubling Farmers' Income through Scaling-up". Participants highlighted the challenges including fragmented spatial data sets, lack of convergence of programs, and information asymmetry that inhibits farmers from realizing their full economic potential. Backward integration of science-based interventions that shift from productivity focus to profitability focus will be key to unlocking sustainable and scalable economic growth.

The KISAN MITrA (Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture) initiative, which emerged from the sessions illustrate principles of convergence, partnership and inclusive value chains to benefit smallholder farmers. This will be piloted in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh. I am confident that with the right partnerships, pragmatic policies and cutting-edge technology the goal of doubling farmers' income by 2022 is within our reach. My best wishes for success for the KISAN-MITrA Initiative.

David Bergvinson
Director General

Foreword

Food security is one of India's top policy priority. India has a population of over 1.3 billion which is likely to increase to nearly 1.3 to 1.6 billion by 2050. Producing sufficient food and nutrition for such a huge population is a challenge in itself. The difficulties are compounded by the fact that India is highly venerable to the adverse impact of global warming and climate change. In the last few years India has seen major crisis in the agriculture sector. This has been reflected in the distress experienced by small and marginal farmers, who, due to financial indebtedness are taking the extreme step of committing suicide when their crops fails or when their produce do not find adequate market. The farmer is stuck at low level of income. Increasing the farmer's income is a crucial aspect of the comprehensive set of agriculture reforms.

Doubling Indian farmers' real income by 2022 (when India would celebrate 75 years of Independence) was first mentioned by Prime Minister Narendra Modi during his dedicating the Rs 1,500 -crore phase I of link-II pipeline canal of SAUNI (Saurashtra Narmada Avataran Irrigation) project and laying the foundation stone for Rs 1,694-crore phase II of link II of the project in Gujarat in April 2017. During his Independence Day address in 2017 too, he quoted "We will build an India, where the farmers will have a peaceful sleep without any worry. He will earn double than what he is earning today". The Ministry of Agriculture adopted the mission in September 2017. India holds 142 million hectares of arable land (second largest in the world after the US) in 137 million farm households and has 46 of the 60 soil types in the world with 15 agro climatic zones varying from arid to humid tropics, hot arid deserts to cold deserts with varying annual rainfall 11,873 mm at Mawsynram, Meghalaya to 166 mm at Jaisalmer, Rajasthan.

India is the largest producer of spices, pulses, milk, tea, cashew and jute; and the second largest producer of wheat, rice, fruits and vegetables, sugarcane, cotton and oilseeds. India has been the world's largest producer of milk for the last two decades and contributes 19 per cent of the world's total milk production. Agriculture remains the livelihood for more than 50 per cent of the Indian Population. As per 2010-11 agricultural census, the average size of land holdings is around 1.16 ha. Of the total 137.75 million holdings, 85 per cent of the holdings belong to small and marginal farmers. These small farms, while operating only 44 per cent of land, are the main providers of food and nutritional security to the nation. The marginal and small farmers contribute to 55 per cent of the total food grain production and 65 per cent in fruits and vegetables. However, shockingly 55 per cent of the total cultivated area today is still under rain fed agriculture. Also, agriculture contributes to only 17% of the national gross domestic product at a stagnated growth rate of 3.1 per cent.

The Vivekananda International Foundation hosted an event to brainstorm the idea of doubling farmers' income in collaboration with the International Crops Research Institute for the Semi-arid tropics (ICRISAT) as technical partner and J Farms. Over the two-day event, participants representing Ministry of Agriculture, national research institutions, state agricultural universities, corporates, international research centers and NGO groups deliberated through expert presentations to come up with ideas for new strategies to optimize use of available water & land resources. A pilot initiative was established in 18 districts of Vidarbha in Maharashtra and Bundelkhand in Uttar Pradesh for operationalizing the strategy for doubling farmers' income. On behalf of VIF, I wish the team success in the KISAN-MITra (Knowledge-based Integrated Sustainable Agriculture Network –Mission India for Transforming Agriculture) for doubling farmers' income in the pilot regions. Our farming communities will directly benefit from your collective action and knowledge.

(Dr. Arvind Gupta)
Director
Vivekananda International Foundation (VIF)

Foreword

It gives me great pleasure that the Vivekananda International Foundation (VIF) in collaboration with ICRISAT (International Crops Research Institute for Semi-Arid Tropics) and J-Farms has organized a two day national workshop on "Doubling Farmers' income through Scaling –Up" on 15-16 March 2017.

India has witnessed impressive agricultural growth since independence due to the resilience of its farmers. The country today is not only self-sufficient in respect of many agri- commodities but is also emerging as a net exporter. These impressive gains in production have not however translated into better returns for farmers. It is in this back drop, that the Hon'ble Prime Minister of India has unveiled a vision for 'Doubling farmers' income by 2022". The strategy outlined by him hinges on several steps such as Per Drop More Crop, creation of a National Farm Market, promotion of ancillary activities e.g. poultry, bee–keeping etc.

Ministry of Agriculture and Farmers' Welfare, Government of India is involved in operationalising a strategy to achieve this goal. It is in this context that the brain storming session organized by the Vivekananda International Foundation and especially the proposed launch of a pilot project in the Vidharbha region of Maharashtra for this purpose is an extremely laudable initiative. The vision of doubling farmers' income by 2022 can only be realized through a partnership between Government, NGOs, Private Companies etc. i.e. all the stakeholders in the process. I wish to extend the full support of the Ministry of Agriculture and Farmers' Welfare to all endeavors towards making farming a more remunerative enterprise for our farmers.

(Dr. S.K. Pattanayak)

About the Speakers

Sl. NO	Name of the Speaker	Designation & Organization	Brief about Speaker
1	**Gen NC Vij** 	Director, Vivekananda International Foundation (VIF), New Delhi	Gen Vij was the 21st Chief of the Army Staff from 31 Dec 2002 to 31 Jan 2005. He was the Director General of Military Operations (DGMO) during the very successful operations by Indian Army for eviction of Pakistani Intruders in Kargil in 1999. After his superannuation from the Army, he was appointed Founder Vice Chairman of National Disaster Management Authority, in the rank of Cabinet Minister, for five years from Sep 2005 – Sep 2010.
2	**Mr Dhirendra Singh, IAS (Rtd.)** 	Executive Council, Vivekananda International Foundation (VIF), New Delhi	Mr Dhirendra Singh was a member of the Indian Administrative Service of the Karnataka Cadre. He retired in 2005. He served as Secretary in the Departments of Agriculture and Horticulture, Rural Development and Forests and Ecology in the Karnataka State Government In the Central Government he worked in the Education Ministry, the Cabinet Secretariat as Joint Secretary, the External Affairs Ministry as Minister in the High Commission of India in London, the Ministry of Defence as Special Secretary, the Finance Ministry as Secretary and in the Ministry of Home Affairs as the Union Home Secretary. He is a Distinguished Fellow of the Centre of Air Power Studies.
3	**Dr Suhas P Wani** 	Research Program Director- Asia and Director, IDC, ICRISAT, Patancheru	Dr Suhas P Wani is a University Gold Medalist and has served as an expert to the Parliament Forum on Water Conservation & Management; as a member of the Working Group on Minor Irrigation and Watershed Management for the Twelfth Five-Year Plan; member of the Programme Advisory Committee for Natural Resource Management and Climate Change at MS Swaminathan Research Foundation, Chennai, India, and Honorary Trustee of SM Sehgal Foundation and the Institute of Rural Research and Development. He has served as member of the Sustainable Agriculture Advisory Board of Unilever. He is Fellow of Yunan Academy of Agricultural Sciences (YAAS), China. He has received the National Groundwater Augmentation Award from Ministry of Water Resources, Government of India.
4	**Dr David Bergvinson** 	Director General, ICRISAT, Patancheru	David Bergvinson is a Canadian who has worked in international agriculture research for development for over 25 years. Currently he is the Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). David joined ICRISAT to lead its strategy development to ensure solid science, demand-driven innovation and strategic partnerships come together to translate science into prosperity for rural families in the Drylands Tropics of Asia and sub-Saharan Africa. Prior to joining ICRISAT David worked on the Agriculture Development team at the Bill & Melinda Gates Foundation and led their Digital Agriculture initiative.

5	**Mr TR Kesavan** 	Chief Operating Officer, TAFE, Chennai	Mr TR Kesavan serves as Chief Operating Officer of Product Strategy and Corporate Relations at TAFE Motors and Tractors Limited. He serves as Chief Operating Officer of Product Strategy and Corporate Relations at Tractors and Farm Equipment Limited. Mr. Kesavan was associated with marketing and servicing of automobiles in the middle East. He has 35 years' experience and worked at Suhall & Saud Bhawan, Oman. He has been an Additional Director of Tafe Reach Ltd since 14th March, 2007.
6	**Dr Hameed Nuru** 	Representative and Country Director World Food Programme (WFP), New Delhi	Dr Hameed Nuru completed his Doctor of Veterinary Medicine (DVM) at Ahmadu Bello University in Zaria, Nigeria and his Master of Science in Tropical Animal Health and Production (MSc) from University of Edinburgh, U.K. Dr Hameed Nuru assumed duties as WFP Representative in July 2015.
7	**Shri Shobhana K Pattanayak, IAS** 	Secretary-Department of Agriculture Cooperation & Farmers Welfare Ministry of Agriculture and Farmers Welfare New Delhi	Mr Shobhana K Pattanayak IAS (Karnataka 1982) presently posted as Secretary, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India has been given an additional charge of Food and Public Distribution from 17th June to 27 June, 2016. He is also serving as Governing Board Member of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Telangana State.
8	**Mr Vijay Kapoor, IAS (Retd.)** 	Former Lt. Governor, New Delhi	Mr Vijay Kapoor is an MA in Mathematics with Economics as a subsidiary subject, from St Stephen's College, Delhi and Visiting Fellow at Queen Elizabeth House, Oxford (UK) in 1975-76 for studies in development economics. After teaching Mathematics for two years, he joined the Indian Administrative Service in 1961. After holding various posts in districts he served in the Political Division of the Ministry of Home Affairs from 1968 to 1972. From October 1972 to 1974, he functioned as Deputy Commissioner of Delhi. From 1975 to 1977, he was again on deputation to the Central Government in the Ministry of Industry. From April 1977 to October 1983, he was seconded to the United Nations and worked in the Economic and Social Commission for Asia and the Pacific at Bangkok. From February 1987 to August 1988 he functioned as Chief Secretary of Arunachal Pradesh. From August 1988 to December 1990 he was Chief Secretary, Delhi. From January 1991 to September 1992 he functioned as chief Secretary, J&K in that extremely difficult period, when Pakistan had unleashed full scale proxy war. From October 1992 to his retirement in September 1996 he was Secretary, Department of Defence Production and Supplies.

9	**Dr Arabinda Kumar Padhee, IAS** 	Director, Country Relations and Business Affairs, ICRISAT, New Delhi	Dr Arabinda Kumar Padhee has a Masters degree in Agricultural Entomology from Banaras Hindu University and a PhD from the Indian Agricultural Research Institute (IARI), New Delhi. He joined the Indian Administrative Services in 1996 and belongs to the Odisha cadre. Among the various positions he has held are District Magistrate and Collector; Director, Agriculture and Food Production; Revenue Divisional Commissioner; Chief Administrator, Shree Jagannath Temple, Puri, Odisha; and Joint Secretary, Department of Fertilizers, Government of India, New Delhi. Among the notable awards and citations he has received during his career in the Civil Services are the Best Collector award (2002-03) and the National Award for contribution to humanitarian services given by the Indian Red Cross Society (2006-07).
10	**Dr SD Attri** 	Scientist 'F" India Meteorological Department (IMD), Pune	Dr SD Attri is presently the Deputy Director General of India Meteorological Department, New Delhi. His areas of interest include Climate change, environment, Agromet and international activities.
11	**Dr SK Singh** 	Director-National Bureau of Soil Survey & Land Use Planning (NBSS & LUP) Nagpur	Dr SK Singh is an Indian national. He has Ph.D. and a Master's degree in Agriculture. Among the various positions he has held are Director at NBSS&LUP; Pr. Scientist & Head at NBSS&LUP; Pr. Scientist at CAZRI, Jodhpur & CSSRI, Karnal; Sr. Scientist and Scientist (Sr. Scale) at NBSS&LUP. He was also recognized as Member of Editorial Board for Indian Journal of Ecology Research, Ludhiana; Member of IMC, Project Directorate, Zone-II, Kolkata; Member of Project Sanctioning and Monitoring Committee for the State of West Bengal, Jharkhand and Odisha. He has published 84 research papers and books etc.
12	**Dr K Srinivasan** 	Chief Scientist, Agricultural Research J farm research centre, Tractors and Farm Equipment Limited (TAFE), Chennai	Dr K Srinivasan is currently the Chief Scientist Agricultural Research and Head at the J farm Research Centre, Tractors and Farm Equipment Limited. Dr. Srinivasan did his graduation and post-graduation in the agriculture sciences at the Tamil Nadu Agricultural University and Ph. D from the University of Agricultural Sciences, Bangalore. Before joining TAFE, Dr. Srinivasan had worked at the Nagarjuna Agricultural Research and Development Institute (R&D of Nagarjuna Fertilizers and Chemicals Limited), Hyderabad as the Head, Division of Crop Protection.

13	**Dr PK Joshi** 	Director for South Asia-International Food Policy Research Institute (IFPRI), New Delhi	Dr PK Joshi is the director for IFPRI South Asia. Earlier he held the positions of the director of the National Academy of Agricultural Research Management, Hyderabad, India, and the director of the National Centre for Agricultural Economics and Policy Research, New Delhi. Earlier, Dr. Joshi was South Asia Coordinator at the IFPRI and senior economist at the ICRISAT. Dr. Joshi has also served as the chairman of the SAARC Agricultural Centre's governing board in Dhaka, Bangladesh (2006–08); chairman of the UN-CAPSA governing board in Bogor; and member of the intergovernmental panel on the World Bank's International Assessment of Agricultural Science and Technology for Development (2007-08). He served as a member of the International Steering Committee for the Climate Change, Agriculture, and Food Security Challenge Program, led by the ESSP Science Community and the CGIAR (2009-11).
14	**Dr B Rajender** 	Joint Secretary (Crops) Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, New Delhi	Dr B Rajender Joint Secretary (Crops), Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Krishi Bhawan, New Delhi. He is 1995 batch IAS officer of Bihar Cadre. He is a Doctorate (Plant Pathology) M.Sc (Plant Pathology), B.Sc (Agri).
15	**Dr KP Viswanatha** 	Vice Chancellor, Mahatma Phule Klishi Vidyapeeth, Rahuri	Dr KP Viswanatha has Ph.D. in Genetics and Plant Breeding and a Master's degree in Agriculture. Among the various positions he has held are Director of Research; Director of Extension Education; Associate Director of Research; University Head, Genetics and Plant Breeding; Scheme Head and Principal Scientist, AICRP on Arid Legumes. He was also recognized as Vice President - Indian Society of Genetics and Plant Breeding; Indian Society of Arid legumes, CAZRI; Joint Secretary – Indian Society of Arid Legumes, CAZRI; Councellor for Southern Zone - Indian Society of Genetics and Plant Breeding, New Delhi, India
16	**Dr Abhay Gandhe** 	Head livelihoods, Tata Trusts, Mumbai	Dr Abhay Gandhe is currently heading the livelihoods portfolio of the Tata Trusts in India. Dr Gandhe has obtained his MSc degree in agriculture from Panjabrao Agriculture University, Akola, India. Post his masters, he joined Bharatiya Agro Industries Foundation, Pune, as a Joint Programme Coordinator, Forestry. Dr Gandhe is a senior agricultural development professional with experience of more than 25 years in projects on rural transformation in India.

17	**Dr KV Raju** 	Theme Leader, Policy & Impact, ICRISAT, Patancheru	Dr KV Raju is Theme Leader, Policy and Impact, Research Program-Asia in the International Crop Research Institute for the Semi-Arid Tropics, based in Hyderabad, India. He was the Economic Advisor to Chief Minister, Government of Karnataka for five years (2008-13). Earlier, he was Professor and Head of the Centre for Ecological Economics and Natural Resources in the Institute for Social and Economic Change, Bangalore. He worked as Consultant to the World Bank, Asian Development Bank, Food and Agricultural Organisation, Swedish International Development Agency, Oxfam India and other leading agencies. He was Visiting Research Fellow in the International Food Policy Research Institute, Washington DC, USA. Before that, Social Scientist in the International Water Management Institute, Colombo, Sri Lanka. Also Visiting Professor in the Institute of Economic Growth, Delhi.
18	**Dr Rajendra R Chapke** 	Principal Scientist, Indian Institute of Millets Research (ICAR), Hyderabad	Dr Rajendra R Chapke has Ph.D. in Agricultural Extension including Agril. Statistics & Horticulture and a Master's degree in Extension Education including Agril. Statistics, Entomology & Agronomy.
19	**Mr Anirban Ghosh** 	Vice President, Strategic Planning and New Business Development- Farm Sector, Mahindra and Mahindra, Mumbai	Mr Anirban Ghosh has been working at Mahindra and Mahindra since 1999. He currently leads the Sustainability work in the Mahindra Group as Vice President - Sustainability. During his tenure with Mahindra he has been a part of the team that helped the tractor business become the largest tractor company in the world.
20	**Dr Ashok Dalwai** 	Additional Secretary, Department of Agriculture Cooperation and Farmers Welfare, New Delhi	Dr Ashok Dalawai, IAS is Additional Secretary, Department of Agriculture, Cooperation and Farmers' Welfare Ministry of Agriculture and Farmers' Welfare. He is an Odisha cadre officer of 1984 batch. Dr Ashok Dalwai is PhD in Agricultural Economics and has graduated from University of Agricultural Sciences, Dharwad.
21	**Dr CS Kedar** 	Chief CSR, JSW Foundation, Bengaluru	Dr CS Kedar is an Indian Administrative Service (*Rtd.)* & Management Professional,, Additional Secretary Level IAS Officer (1979, Karnataka Cadre) PhD from University of Mysore, Mysore and MSc with 34 years' work experience in public administration, project management and business process re-engineering. Currently he is serving as Chief CSR, JSW Foundation, Bellary, Karnataka

22	**Dr T Pradeep** 	Zed Habitats, Bengaluru	Dr T Pradeep He started life as a journalist right after school in 1972. Since the mid 80's when he founded Samuha, he has built the fabric of economic development with watersheds that he painstakingly created over 300 villages, a half-million people and a million acres of cultivable lands. His present focus on climate adaptation brings a staggering world view of natural resource management and equity onto a common platform. His sharp strategic and numeric ability combines with a ground-up stirring people to action. As a trustee at Factor4, he brings a certain zest to networking ideas and resources.
23	**Dr DP Waskar** 	Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani	Dr DP Waskar is Director of Research, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. He has completed his M. Sc.(Hort.) and Ph. D from IARI, New Delhi.
24	**Mr N Subramanian** 	EICHER TRACTORS (A Unit of TAFE Motors and Tractors Ltd), Chennai	Mr N Subramanian serves as Senior Vice President of S&M (Sales/Customer service/Spare parts & exports) at Eicher Tractors. He has been with the company for more than 32 years & has worked in most functions from production to quality & project management in various capacities. His keen customer understanding & micro level filed experience across the country helps build customer centric culture in the organization. His close people connect & personal touch brings out best in an individual.
25	**Dr Nagendra Singh** 	National Professor, ICAR, Mumbai	Dr. Nagendra Singh graduated from Banaras Hindu University, Varanasi in 1978 and obtained his Ph.D. from University of Adelaide, Australia in 1985. He is recipient of several awards, including, DBT National Bioscience Award 2001-02; ICAR Rafi Ahmad Kidwai Award 2007-08; ICAR Norman Borlaug Award 2014, Fellow of NAAS, INSA and NASI Science Academies; Secretary NAAS since 2012.
26	**Mr Somnath Jadhav** 	Sr Vice President, Jain Irrigation Systems Ltd, Jalagon	Mr Somnath Jadhav presently working with Jain Irrigation Systems ltd as Sr. Vice President and Sr Engineer for Irrigation and water management Projects. Involved in survey, planning, designing, execution of large size integrated micro irrigation projects.

National Workshop on Doubling Farmers' Income through Scaling-up

Executive Summary

India holds 142 million hectares of arable land in 137 million farm households and has 46 of the 60 soil types in the world with 15 agro climatic zones varying from arid to humid tropics, hot arid deserts to cold deserts with varying annual rainfall 11,873 mm at Mawsynram, Meghalaya to 166 mm at Jaisalmer, Rajasthan. It is the largest producer of spices, pulses, milk, tea, cashew and jute; and the second largest producer of wheat, rice, fruits and vegetables, sugarcane, cotton and oilseeds.

Inspite of these remarkable figures, agriculture contributes to only 17% to the national gross domestic product value by 56 per cent of population engaged in farming. The stagnated growth rate of 3.1 % and food security for the ever-growing population in India along with poverty amongst rural population has always been a challenging task. In order to tackle this situation, a total of 60 selected participants representing Department of Agriculture, Government of India, national research institutions, state agricultural universities, corporates, international research centres and NGO groups brainstormed on the topic of doubling farmers' income by the year 2022 as envisioned by Hon. Prime Minister of India Shri Narendra Modi.

A holistic strategy for doubling farmers' income in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh and identifying the potential consortium partners and funding agencies for implementing the strategy for doubling farmers' income were discussed. To begin with, an experimental trial on pilot-basis for *Vidarbha* region of Maharashtra and Bundelkhand region of Uttar Pradesh as "sites of learning" are proposed and further will be extended to other regions of the country in a phased manner up to the year 2022.

With vagaries of climate, there is a need to develop moisture conservation practices and also link with watershed development programme that involves the use of check dams, storage structures, field bunds, gully plugs and gabions and other soil and water conservation structures to help make a difference in the regions. The introduction of millets-based and other climate smart crop systems and allied practices such as horticulture, fisheries, livestock etc. to help the farmers to realize better net incomes are required. Also, introduction of mechanization and hassle free financial support, marketing facilities and inputs support in convergence mode (single window system) and collective action through Farmer Producer Organizations (FPOs), creating awareness about health and nutritional benefits of millets through effective mass and local media to bring change in the consumer preferences and promotion of value-addition through entrepreneurship development through group approach (SHGs, NGOs) are the key strategies for both these regions.

Also, the use of technology and tools which help with agro-ecoregion based land use planning and weather-based Agro Met advisory services help the farmer chose the right crop for the right area and also help reduce the weather related losses. The use of improved drought tolerant cultivars, integrated pest management (IPM), crop diversification with vegetables, post-harvest systems, mechanization and use of Information Communication Technology (ICT) in agriculture along with value chain approach and market linkages can also help achieve double farmers' income in the regions. The use of genetically modified (GM) crops may play an important role for farmers in the future. The use of plant tissue culture, genomics and marker-assisted breeding and GM technology can also play a role in increasing productivity, food security and income for the farmers in these regions. Most importantly bridging the yield gaps through scaling-up of integrated and science-led innovations to increase productivity and reducing cost of production along with value chain approach with market linkages would help in increasing profitability for doubling the farmers' income. This new way of doing farming will help with a business model to be developed.

1 Doubling Farmers' Income: Challenges and Opportunities

Suhas P Wani and Dhirendra Singh

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Vivekananda International Foundation (VIF)

Abstract

Food security for the ever-growing population in India and reducing poverty are challenging tasks. In order to tackle this situation, a total of 60 selected participants representing Department of Agriculture, Government of India, national research institutions, state agricultural universities, corporates, international research centres and NGO groups brainstormed on the topic of doubling farmers' income by the year 2022 as envisioned by Hon. Prime Minister of India Shri Narendra Modi. The various constraints with respect to climate change and water availibilty were highlighted by the speakers and strategies to prepare a blue print of holistic strategy for doubling farmers' income in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh as an exemplar; and identifying the potential consortium partners and funding agencies for implementing the holistic strategy for doubling farmers' income in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh were discussed.

Background

Doubling farmers real income by 2022 is a goal established by the Hon'ble Prime Minister of India who is challenging the status quo of all involved stakeholders. Productivity and production increases in agriculture alone will not ensure doubling farmers' income. Meeting market demands requires a shift in mindset from "Farm to fork/plate" to "Fork to Farm". Secondly, market- intelligence must be made available to producers using innovative partnerships and communication technologies. Lastly, the changing climate has increased vulnerability of 137 million small farm holders. New innovations to collectively benefit small farmholders through a holistic value chain by adopting science-led, climate resilient and market responsive development has to be our "New Mantra" to benefit farmers.

To establish direction and overcome obstacles to rural poverty in India, the Vivekananda International Foundation (VIF) hosted an event to brainstorm the idea of doubling farmers' income. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) joined as a technical partner to conduct a brainstorming workshop in New Delhi for doubling farmers' income. Subsequently, The National Workshop on *Doubling Farmers' Income through Scaling-up* was organized by the ICRISAT - Patancheru in collaboration with the VIF- New Delhi and the J Farms at the VIF headquarters on 15th-16th March, 2017. Delegates from the Department of Agriculture-Government of India, national research institutions, state agricultural universities, private sector, international research centres and NGOs convened to develop a strategy for meeting the Prime Minister's challenge. Over the two-day event participants considered priorities through expert presentations and panel recommendation for strategies, enabling institutions and implementation mechanisms.

Challenges

Two key focuses of a strategy to double farmers' income by 2022 are reducing rural poverty by tapping food demands from the growing Indian population. Also, finite natural resources limit the potential for smallholders to meet the demand and are exacerbated by land fragmenting, and reduced water quantity per farmer. For example, per capita water availability in India has decreased from 5177 m^3 in 1951 to 1820 m^3 in 2011 due to increased population from 361 million in 1951 to 1.02 billion in 2011. Population is expected to rise to 1.39 billion by 2025 and 1.64 billion by 2050 with associated decrease in per capita water availability (1341 m^3 in 2025 and 1140 m^3 by 2050).

Changing climate, increasing weather variability, changing food habits, water scarcity and land degradation all pose severe challenges for food and nutritional security for India's growing population. Increasing cost of cultivation, low productivity and lack of remunerative market prices for farmers result in low incomes and poverty for small and marginal farm holders. However, pilot studies have demonstrated increased productivity, value chain development, market-linkages, processing and collective and cooperative arrangements can increase productivity, reduce input costs and increase profitability for the farmers. The large scale adoption is a key challenge requiring enabling institutions and policies aiding integrated science-led approaches imbeded with Public-Private-Producer partnerships. Together, this multidisciplinary team can implement and monitor the progress towards each State's doubling farmers' income.

Goal

The overall goal of the National Workshop is to improve the livelihoods of farmers by doubling their income in order to overcome the challenges faced by the farming community in India. The specific objectives and expected outputs were as follows:-

Objectives

- To brainstorm the challenges, opportunities, innovations, enabling policies, institutions and strategy for doubling farmers' income in different agro-eco regions of India.
- To develop a framework including implementation strategy and monitoring and evaluation for unlocking the potential of agriculture in India to double farmers' income.
- To prepare a blue print stategy for the Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh as an exemplar; and
- To identify the potential consortium partners and funding agencies for implementing the holistic strategy for doubling farmers' income in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh.

Expected outputs

- Distilled document on challenges, opportunities, innovations, enabling institutions and policies needed to unlock the potential of Indian agriculture for doubling farmers' income to improve farmers welfare.
- Detailed strategy for implementing the innovations, along with monitoring and evaluation mechanisms and institutional mechanisms for scaling-up the Vidarbha and Bundelkhand pilots.
- Identify potential partners to fund as well as implement the Vidarbha and Bundelkhand pilots as a model for scaling-up the strategy for doubling farmers' income.
- Summary of recommendations for the policy makers and proceedings of the workshop as a reference for doubling farmers' income to guide the strategy.

2 Inaugural Session

Gen NC Vij, Director, VIF, welcomed participants to the National Workshop on doubling of farmers' income. He mentioned the common knowledge that our agricultural sector is in distress. He highlighted that 67% people in the country are employed in agriculture, but this sector contributes to only 17% of national GDP. He also highlighted the low and stagnated growth rate of 3.1% in this sector. He expressed a strong need for innovation making living conditions better and thus stoping farmers suicide, which has been a grim reality of India. He mentioned how VIF acquired knowledge about drip irrigation from Israel and sees an opportunity to contribute in this national mission on doubling of farmers' income. He expressed the desire of VIF to increase its contribution in agriculture related topics. He mentioned the challenge of population explosion in developing nations, and highlighted the risk of rainfed agriculture from increasing water scarcity. He mentioned the increase in physical water scarcity in India is well known and documented. He also mentioned how green revolution methods could achieve higher yield gains, but also said that the challenges are huge in order to ensure food security.

Mr Dhirendra Singh, Executive Council, VIF, mentioned how the upcoming monsoon is keenly awaited by the farmers across India for the *Kharif* 2017 season. He highlighted how Indian farmers keenly follow the advisories from the Indian Meteorological Department. New app-based advisories and El Nino updates over the years have demonstrated their benefits through informing producers to climatic varience. He stressed the fact that policies and the role of agricultural support agencies are helping farmers to adapt their agricultural practices. He highlighted how in the late 1970s a canal network in Karnataka State was shifted from the agricultural department to the irrigation department with the introduction of maintenance charge for the canal. This resulted in a shift for canal-based irrigation to cash crops. He also mentioned how coffee plantations came to the Hassan area of Karnataka along with private companies supported by policies. He mentioned a great number of agencies today are working hard to help the farmers. The focus however must be given to the small-scale farmers living in the drylands as maximum impact can be achieved at this level. He expressed his expectation from the two-day deliberation to help in formulating strategies in this direction.

Dr Suhas P Wani, Research Program Director- Asia, ICRISAT, said workshop deliberations will be a drop in the ocean like vast a objective. He mentioned that the main challenges towards achieving this goal are the reduction in per capita land and water availability. He recognized how economic development has resulted in a change in food habits. He stated that food with low water productivity, such as paddy, wheat and animal-based food products are becoming more and more popular and increasing our per capita water foot-print. He stressed on the need to break the 'business as usual mode' and to formulate new strategies to face these emerging challenges. He highlighted the importance of equitable growth and regulation on the cultivation of water guzzling crops in regions suffering from water stress. The average rainfall of 1100 mm and abundance of natural resources in the country has not been properly harnessed towards agricultural growth he said. He cited drinking water crisis in Meghalaya as an example of improper resource utilization, he highlighted how the same farmer is doing multiple activities such as agriculture, horticulture, poultry, and bee-keeping whereas each come under different Govt. departments. He also said that synergy among the different Govt. departments is very important and along with proper market linkages it can help a farmer reap better benefits. He mentioned Vidarbha region has unique problems and opportunities and a model site has to be developed in this region. There is a need to identify potential partners, funding agency etc. to bring about a sustainable change and achieving maximum impact in this region. He stressed the importance of targeted participation for this workshop towards this objective. He mentioned that the workshop should come out with a strategy document to guide the decision makers.

Dr David Bergvinson, Director General, ICRISAT, highlighted the Vidarbha region as the targeted geographical region. He expressed the need for synergy among different income sources of a farmer as being important. He highlighted the risk factors involved with the Indian monsoon and its erratic fluctuations. He said that the reduction of dependance on monsoon and market linkages through diversity

in cropping system, livestock, aquaculture and empowering farmers through transparent markets and digital agriculture and market integration can enable us to achieve PM Modi's vision of doubling farmers' income by the year 2022. He highlighted that the small-scale farmers living in the drylands need spotlight today and mobile App-based, Aadhaar-based and IT enabled advisories are important to strengthen the farmers knowledge. He mentioned how removing intermediaries through IT-based tools can translate into higher income for the farmers. He also stressed on the important role which can be played by remote sensing-based technologies to help farmers. He highlighted the concept of demand driven research to shorten the path between innovation and on-field application. He explained how virtual institutes, off-grid water pumping, ICT tools, remote sensing technologies, and synergy among different Govt. departments can help us meet objectives. He also mentioned that professionals need to show a sense of urgency to see what can be done for the farmers before the onset of the monsoon in order to provide them with maximum benefits.

Mr TR Kesavan, Chief Operating Officer, TAFE, highlighted how scaling-down of mechanization is important for small and marginal farmers. He raised three pertinent questions viz. 1) How to ensure a regular monthly income for the smallholder farmer? 2) How to attach a sense of 'prestige through mechanization to agricultural activities in order to attract rural youth in agriculture? and 3) How to get assurance of 250 days of work for farmers? He highlighted reduced input cost and conservative agricultural practices as a key to increase net profits. He cited the example of Rajasthan, a much drier region compared to Vidarbha, yet experiences virtually no instances of farmers suicide. He mentioned how livestock has given a stable alternate source of income to the farmers of Rajasthan. He highlighted exploitation of green revolution has resulted in soil degradation. He shared from his vast field experience that teaching farmers with theory is difficult and demonstration should be the mode of communication for mechanization. He highlighted the role of medicinal crops, vegetable crops, low-cost hydroponics, and livestock in reducing the uncertainty of on-farm incomes.

Mr Hameed Nuru, Country Director, World Food Programme (WFP), recognized the great progress made by India since independence towards food security particularly over the last two decades. He highlighted that India is very well placed in the world in terms of a positive policy making environment, legislations such as CSR fund for corporates, AADHAAR system, world's biggest public distribution system (PDS) systems, infrastructure, funding, agricultural and R&D institutions, abundance of human resource and talent pool in Information Technology (IT), Information and Communication Technology (ICT) and Remote Sensing (RS) technologies. He highlighted the shift he sees in India's traditional conservative approach towards growth to out-of-box approach in recent years and cited 'more crop per drop' as an example for that. He recognized water scarcity as a big challenge and stressed the importance of simple mobile-based information exchange. He mentioned how the balance between minimum support price and subsidy is critical to bridge the demand-supply gap. He mentioned market linkage to be as important as the challenges faced due to yield-gap. Mr. Nuru suggested crop insurance, livestock insurance and livestock vaccination as critical measures towards increasing climate resilience of farmers. He raised the PDS and farmers relation needs a relook in order to provide a better food security to the farmers. He stressed on the need to realize that in our endeavour to double farmers' income we must not double his burden too. He highlighted the importance of listening to the farmers to understand their challenges and to form grass-root level partnerships. He also mentioned the large gap between the knowledge pool available in agricultural universities and farmers.

Mr Shobhan K Pattanayak, Secretary, Department of Agriculture, Cooperation & Farmer Welfare, Government of India highlighted the common notion that agriculture is simple and everyone is an expert without realizing how complex the system is in reality as itdepends on several variables. He compared it with steel making where given the same input same quality of steel can be made with certainty whereas same yield ouput cannot be guaranteed with agriculture. He pointed this as the key reason why agricultural sector is not seeing growth as seen in the industrial sector. He recognized how the growth of Information and Technology has greatly enhanced the accessibility to various thechnologies for the common man. He highlighted how this can help farmers to understand the input and market better than ever before. He expressed his optimism towards P.M. Narendra Modi's vision of doubling farmers'

income by the year 2022. He mentioned the key focus areas of water use efficiency, soil health, post-production storage infrastructure creation and increased market linkages. He highlighted the low access to irrigation among the farmers with about 55% of dryland farmers depending on rainfed agriculture. He mentioned that 85% of dryland farmers are having farm size of 1-1.5 ha. He stressed the enormous resilience shown by Indian farmers to sustain stable grain production over the past few years despite innumerable challenges. He highlighted the govt. initiative of creating National Agricultural Market (NAM) and expressed plans for further expansion of it. He mentioned how state and central governments co-ordination is vital to help farmers welfare. He highlighted the disbursement of 10 lakh crores of agricultural credit provided by the government through Kisan Credit Cards and urged the input companies to encourage cashless transactions to usher greater transparency. He shared the statistics that in today's India about 1 billion citizens have a mobile phone, 250 million of them are using a smartphone and about 2 million farmers have a smartphone. He stressed on the importance of local language while developing mobile-based applications for agricultural advisories. He expressed that in his opinion better varieties and correct knowledge about inputs can help to face climate change related challenges that farmers are facing today. He highlighted the need to focus on agricultural R&D, promotion of healthier crops such as millets, pulses and oilseeds in drylands which are climate smart crops. The stable income for the farmers calls for diversification of sources he mentioned. He emphasized to link farmers with institutional markets. He also highlighted the importance of custom hiring centres for farm machineries to promote mechanization and to reduce drudgery. He expressed the importance of linking army, CRPF, hospitals, schools and old age homes with PDS system to reduce purchase from the retail market by these sectors. This can help the Govt. to provide minimum support price for various other food grains beyond traditional grains such as wheat and rice.

Mr Vijay Kapoor, Former Lt. Governor, Delhi, recognized the importance of the workshop as he mentioned agricultural sector needs our focus. He emphasized the need to focus on the "bottom-line" and not the gross-income. He identified the "great inequality" in the terms of trade where unlike all other sectors farmers don't have much say over the pricing of farm produce. He stressed on the need to tilt the terms of trade towards agricultural produce substantially to improve the income for the farmers and the overall health of the economy. He asked the gathering to deliberate upon why non-agricultural development should not be promoted in rural sector. He argued that why non-agricultural development in rural sector envisioned by ex-president Dr. A.P.J. Abdul Kalam through PUARA (Providing Urban Amenities to Rural Areas) route would reduce the present practice of excessive labor engagement in agriculture. He highlighted how the Delhi Master Plan could never be executed with ambiguity over the feasibility of urbanizing 89 villages of Delhi. He highlighted the example of South Korea which utilized the great road network built by USA during the Second World War to realize non-agricultural development in the rural sector.

Technical Session I
Climate Change and Impacts on Agriculture

Chair ***:*** *Dr KP Viswanatha*
Rapporteur : *Dr Girish Chander*

3 Role of Agrometeorological Advisory Services in Managing Risk under Changing Climate

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Abstract

Changing climate and variability has always troubled farmers across India. There is a need to help farmers who suffer from weather related losses. The dissemination of information under extreme weather conditions plays a vital role in minimizing crop loss. Weather-based Agro Met advisory services to the farmer have the potential to reduce the weather related losses to a large extent by adopting suitable measures of dissemination to the farmer and planners community and the benefits of using these services has been highlighted in the text. The chapter also highlights how the use of more than one channel gives a greater chance of reaching the client or user. Also, the use of Agromet Advisory Services provided by IMD/ MoES through various channels have resulted in significant increases in farm productivity, resulting in increased availability of food and higher income generation.

Introduction

Climate plays a critical role in the lives and livelihoods of people as well as contributing to socio-economic development as a whole. Climate change (and variability) and food security are currently key challenges in India and climate variability is becoming more severe. There is a need for quantification of global and regional climate change scenarios with a special focus on the behavior (frequency and intensity) of extreme events like heat waves, cold spells, severe thunder storms, tropical cyclones, storm surges, severe storms, drought etc. and also to cope with climate change impacts by an evolving effective adaptation strategy.

As per a recent report of the IPCC (2013), there has been an increase in temperature of 0.89°C over the period 1901–2012, that has been mainly caused by anthropogenic activities. The newer findings indicate that warming is more pronounced than expected. As per consolidated analysis by the World Meteorological Organization (WMO), globally averaged temperature in 2016 was about 1.1°C higher than the pre-industrial period. It was approximately 0.83° C above the long-term average (14°C) of the WMO 1961-1990 reference period, and about 0.07°C warmer than the previous record set in 2015. All the 16 hottest years on record have been in this century, apart from 1998 when there was a strong El Niño. Also, carbon dioxide has crossed the symbolic and significant level of 400 parts per million concentrations in the atmosphere. The IPCC (2013) has projected that the global mean surface temperature and sea level may increase by 0.3°C to 1.7°C and 0.26 to 0.54 m for RCP 2.6, 1.1°C to 2.6°C and 0.32 to 0.62m for RCP 4.5, 1.4°C to 3.1°C and 0.33 to 0.62 m for RCP (Representative Concentration Pathway) 6.0 and 2.6°C to 4.8°C and 0.45 to 0.81 m for RCP 8.5, respectively by the period between 2081-2100.

India has also shown warming trends, as analysis of data from the India Meteorological Department of Climate Research and Services (CRS), Pune indicates that the annual mean surface temperature of the country has increased by 0.65° C during 1901 to 2016. The year 2016 has been the warmest on record since 1901. However, much of this increase has taken place since the year 1975. It further suggests that this warming is primarily due to rise in maximum temperature across the country. However, since 1990, minimum temperature is steadily rising and rate of its rise is slightly more than that of maximum temperature. Spatial pattern of trends in the mean annual temperature shows significant positive (increasing) trend over most parts of the country except over parts of Rajasthan, Gujarat and Bihar, where significant negative (decreasing) trends were observed. During the last 60 years (1951-2010), mean temperatures show significant decreasing trends over Punjab, Uttarakhand and Jammu and Kashmir, no trends over Chhattisgarh, Haryana, Meghalaya, Odisha, Uttar Pradesh and West Bengal, while significantly increasing trends were observed in remaining States of India. The country as a whole, in terms of

total rainfall and monthly rainfall for the monsoon months for the period 1901-2016 did not show any significant trend. However, decadal epoch has been observed. Similarly, rainfall for the country as whole for the same period for individual monsoon months also does not show any significant trend. During the season, three subdivisions viz. Jharkhand, Chhattisgarh, Kerala show significant decreasing trend and eight subdivisions viz. Gangetic West Bengal, West Uttar Pradesh, Jammu & Kashmir, Konkan & Goa, Madhya Maharashtra, Rayalaseema, Coastal Andhra Pradesh and North Interior Karnataka show significant increasing trends. Annual rainfall showed decreasing trends over 16 States and increasing trends over 15 States including the islands during the period between 1951-2010. An increasing trend in the observed frequency of heavy precipitation events and a decreasing trend in the light rainfall events and moderate to heavy rainfall events especially over the Western Ghats has also been observed. The dynamically downscaled summer monsoon temperature projections for the RCP 4.5 scenario from Regional Climate Models indicate mean warming of more than 1.5° C for the period between 2031-2060 over the central and northern parts of India, while the annual warming range over South Asia land mass is 1.8 - 3.0° C.

The crop production dynamics are influenced by multiple factors such as the type of the soil, crop variety, location, weather and management practices. To improve crop productivity and doubling income in next five years, as per Prime Minister's mission, farmers will need integrated farm advice for crop protection and production problems, and appropriate risk mitigation measures-based on weather patterns experienced and expected extreme weather events such as cold waves, dense fog for a continous period, heat waves, hailstorms, thunderstorms and dust storms, drought and failure of rains etc.

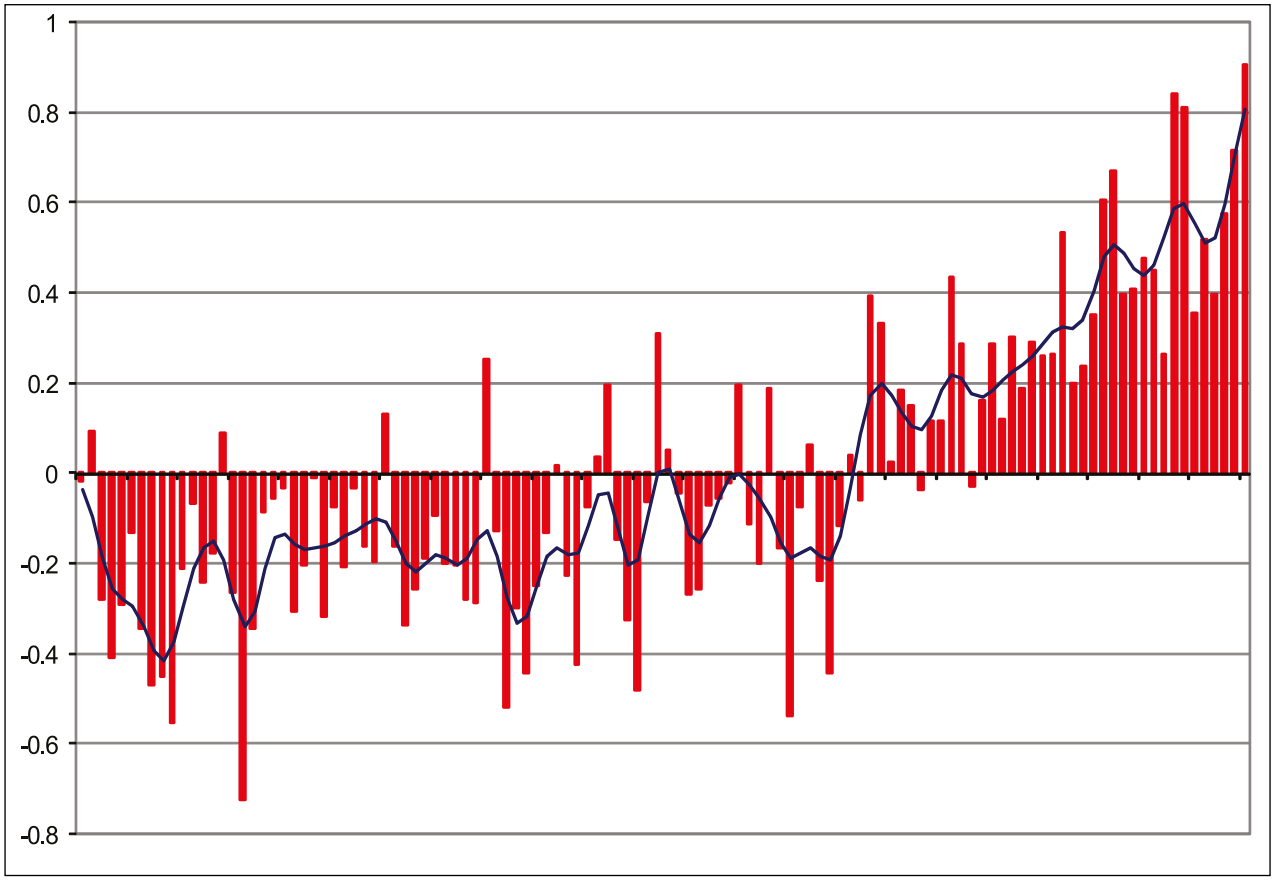

Figure 1. Tempera ture trends in India (1901-2016).

Climate variables and impacts

Climate variables like variations in a heat/cold wave, rainfall, increased extremes weather events, erratic onset, advance and retrieval of monsoon, shift in active/break cycles, intensity and frequency of monsoon lows/depressions have direct bearing on agriculture production sustainability. Higher temperatures, changes in rainfall patterns and more frequent climate extremes will:

- Change the onset of monsoon, shift production seasons, onset of sowing rains, quantum of rainfall and total, spatial and temporal distribution of number of rainy days.
- Deviate climatic events, frequency of heavy rainfall events, occurrence of floods in areas like the Indo-Gangetic plains.
- The withdrawal of monsoon and its erratic distribution results in break-in-period, dry spell, etc. The water stress of various intensities.
- Dry spell events and occurrence of droughts in the season.
- Vary temperature during *Rabi* season.
- Impact in agro-climatic zones in addition to district level.
- Shift pest and disease patterns

Agro-met advisory services in India

Weather-based Agro Met advisory services to the farmer have the potential to reduce the weather related losses to a large extent by adopting suitable measures of dissemination to the farmer and planner's community (Rathore et al*.,* 2009). Finer resolution weather forecast, satellite derived products, expert knowledge and amalgamation of new technologies in the advisory generation and real time dissemination have enhanced the decision taking ability of the farmers and contributes in weather smart farming.

IMD is issuing a quantitative district level (640 districts) weather forecast for up to five days and the products comprise of quantitative forecasts for eight weather parameters *viz.*, rainfall, maximum temperature, minimum temperatures, wind speed, wind direction, relative humidity I, II and cloudiness. This weather forecast is valid for a period of five days with state-of-the-art GFS-1534 model at 12.5 km spatial resolution at IMD New Delhi and value addition at State Meteorological Centres is disseminated to 130 Ago-Meteorological Field Units (AMFUs) of IMD for Agro advisory generation. A group of experts with agricultural expertise issue the Agro met. Advisory Bulletins (AAS) for the next five days based on the forecast. The farmers are using these advisories for sowing and transplantation of crops, fertilizer application, predictions regarding pests and diseases and measures to control them, weeding/thinning, irrigation (quantities and timing), and harvest of crops.

Presently AAS have been disseminated to 20.1 million farmers regularly and also in case of extreme weather through Short Message Service (SMS) messaging and Interactive Voice Response Technology (IVR) in regional/English language and are put on respective web sites of Universities or National Institutes. Also, IMD has planned to enhance the outreach of the bulletin to 95.4 million farming households in the country.

The National Council of Applied Economic Research (NCAER), an independent agency, during the year 2015 estimated economic benefit from the use of weather information by only 24 per cent of the farmers from the SMS services estimated $ 6502.68 million (NCAER, 2015). The use of AAS advisories have resulted in the decline in the cost of cultivation up to 25% for the study crops. In some cases, the cost of cultivation increased up to 10% as a result of follow up action on AAS advisories, but this was more than offset by the consequent increase in net returns up to 83%, with a modal value of 20%. The major crops which benefited most from the use of AAS are paddy, wheat, pearl millet and fruits and vegetables. This proves the advantage of using AAS advisories. The economic benefit of these services is extrapolated to rise to US$ 32.5 billion if the entire farming community in the country were to apply agromet information to their agricultural activity.

IMD has planned to strengthen the service in terms of observation, seamless weather forecast, human resource, real time information flow, research and development (R&D), dissemination etc. This present system of delivering the services at district level is underway to extend up to sub-district/ block level with dissemination up to village level to meet the end users' requirements in both the irrigated and rainfed systems. Also, the establishment of 660 District Agrometeorological Units (DAMU) in each district of India is in the pipeline of being developed. DAMU will be established at Krishi Vigyan Kendra (KVK), which includes 130 existing AMFU until the year 2019 and with the objective of preparing customized advice at sub district/block level with medium range block level weather forecast.

Challenges faced due to extreme weather events

India has been repeatedly battered by extreme events like heavy rainfall causing extensive flooding, droughts, unseasonal rainfall, hailstorm etc. The period between 2001–2015 witnessed the intensification of climate and weather extremes such as destructive flooding, severe droughts, heat waves, heavy rainfall and severe storms in different regions. The number of extreme events of very heavy rainfall has almost doubled in the country in the last 50 years. Among other extreme events, unseasonal rains and hailstorms are mostly observed during pre-monsoon season from March to April in the country. In some years, it has occurred early during end of February and late during mid-May also. The unseasonal rains and hailstorms have destroyed crops in millions of hectares of farmland in many states including Himachal Pradesh, Uttar Pradesh, Uttarakhand, Punjab, Haryana, Madhya Pradesh, Gujarat, Rajasthan, Maharashtra and Andhra Pradesh causing huge losses to farmers. Also, hailstorm causes substantial damage to the standing crops as well as the horticultural crops within a very short time span. The heavy rains accompanied by hailstorms damaged wheat, sugarcane and oilseed crops in thousands of hectares in Punjab and Haryana in March, 2015. Though occurrences of hail storms are unavoidable, there is a need for its prediction followed by recovery, rescue and remedial measures. There are modern methods available to detect hail-producing thunderstorms using weather satellites and weather radar imagery. Also, severe weather warnings are issued by IMD for hail storms when the hail reach a damaging size, as it can cause serious damage to structures, crops and livestock. The accurate and timely information on extreme meteorological parameters has not only great potential for increasing output to the farmers, but also is useful for modification of crop environment, protection from frost, strong wind and also irrigation scheduling leading to efficient water management and drought preparedness (Das, 2012).

With recent advances in computational power and prediction modelling and technology, it is now possible to forecast the occurrence of extreme events and the nature of devastation that they may cause with greater degree of accuracy and with longer lead time (Sivakumar et al., 2005). In a large country like India which is experiencing occurrence of different kinds of extreme events every year, the weather aberrations may be nullified to a large extent by suitable adaptive measures disseminated through Agro met Advisory Services (AAS) to the farming community (Chattopadhyay and Lal, 2007; Rathore et al.,2009; Chattopadhyay and Rathore, 2013; Rathore et al., 2013).

The World Meteorological Organization has launched Global Framework for Climate Services to use climate information services to meet the challenges of the future particularly with reference to extreme events in five focus sectors including agriculture. IMD has also established Climate Research and Services as part of national mechanism in this regard. The provision of need-based climate information to farmers can support the management of agricultural resources (land, water and genetic resources). In India, a combination of traditional and more innovative technological approaches are being used to manage drought risk. Also, technological drought management (*e.g.*, development and use of drought-tolerant cultivars, shifting cropping seasons in agriculture, and flood and drought control techniques in water management) is combined with model-based seasonal and annual to decadal forecasts. The model results are then translated into an early warning in order to take appropriate drought protection measures.

Data & tools for extreme events prediction

IMD is maintaining various observational networks in the country to monitor and assess the extreme events, which include 550 conventional observational networks, 675 automatic weather stations (AWS), 1350 automatic rainguage stations, 24 doppler weather radars in addition to satellite observations. Also, specialized forecasts are issued for track, intensity, structure changes and landfall process (wind and gust, rainfall and storm surge); heavy rain and strong winds triggered by tropical cyclones over the North Indian Ocean, South West and North East monsoon, troughs and Inter Tropical Convergence Zone (ITCZ) migration and orography; thunderstorms and hail associated with severe convection; extreme hot and cold conditions, frost etc. The automatic dissemination of warnings for disastrous weather events like severe thunderstorms, hail, squalls etc. to all mobile users of that particular area is in place.

Nature of impacts of extreme events and corresponding agromet advisories

All the extreme events are having a negative impact on farming in India. The following are some major extreme events and the agro met advisories issued to the farmers to take appropriate measures:

Drought / dry spell /deficient rainfall

Global concern has grown about the increasing in frequency and severity of drought under the changing climatic conditions. Though drought cannot be stopped, the knowledge and the experience should be put in place to adopt the measures that mitigate their impacts. Due to uncertainty of rains during the drought conditions, farmers sometimes make several attempts at sowing of seeds leading to a drastic reduction in seed reserves, ultimately which is neither sufficient for planting nor for consumption. Roots of the plants get less water while the rate of transpiration has increased. As a consequence, the water budget within the body of a plant loses balance and leads to water deficit. During drought conditions, the water deficit during the growing period of the crops distorts the development and results in the reduction of crop yield and productivity.

Presently, drought indices are being used to monitor drought and aridity anomaly index has been used to monitor the incidence, spread, intensification and recession of drought. Aridity anomalies are used to assess crop stress conditions, crop planning and issuing early warning in various parts of the country during the monsoon season. The Standardized Precipitation Index (SPI) (Guttman, 1999; Guhathakurta et al., 2011) and Normalised Difference Vegetation Index (NDVI) (Bhattacharya et al., 2008) are also used along with rainfall departure from normal for monitoring status of rainfall situation. Depending on SPI values, categories of rainfall, situation and ultimately drought condition for a particular period is determined. Under the dry spell/ drought like situation, AAS of IMD provides advice regarding contingency crop planning like cultivation of medium/ short duration crop varieties, mulching etc.

Severe cold condition

Long-time exposure to extreme cold weather combined with other meteorological phenomena results in loss of fruit crops and vineyards due to frost injury. The major agrometeorological factor influencing frost damage in crops including plant injury at the depth of plant roots is due to low soil temperature. Long and intensive cooling may also result in complete devastation of crops. IMD regularly issues cold waves and frost warnings to enable the farmers to adopt timely protective measures for the crops like potato in northern region, grapes in Maharashtra etc. Also, irrigation is important for standing crops as adequate soil moisture keeps the soil comparatively warm and saves it from cold and also smoke arrangement should be made around the fields to protect from cold injury. The farmers also cover the crop necessarily by green net *e.g.*, nursery vegetables, paddy, papaya etc. to save the crops from the ground frost. Also, it has been observed that grapes could suffer cracks due to the extreme cold conditions in the traditional belt of the crop in Nasik region of Maharashtra. If the mercury drops to 4.4 °C, farmers are advised to arrange for introducing smoke around the field, apply light irrigation to the crop and spray fresh water to the bunches. Also, advisories are being issued at district level keeping in mind the crop growing area and also for livestock and poultry.

Heat waves/ High temperatures

Water requirement of plants increases tremendously during high temperature to avoid desiccation and disturbance of balance between photosynthesis and respiration. The extremely high temperatures coupled with higher vapour pressure deficit can generate intense evapotranspiration during heat waves. The harmful effects of intense temperatures are usually aggravated with unavailability of sufficient soil moisture. When normal maximum temperature of a weather station is more than 40° C, farmers are getting advice to apply frequent irrigations to the crops, spraying of antitranspirants on the crops and mulches to maintain high moisture status in the soil.

Hailstorms

The studies have shown that the State of Maharashtra is more prone to hailstorms than other States in the country with maximum probability of occurrence in the range of 91-95% followed by Himachal Pradesh, Punjab, Assam and Madhya Pradesh with probability of occurrence in the range of 66-70%. Andhra Pradesh, Telangana, Uttar Pradesh and Haryana followed closely with probability of occurrence in the range of 61-65%. The probability of occurrence in Rajasthan, West Bengal, Odisha, Bihar, and Karnataka lies in the range of 51-55%, 46-50%, 36-40% and 31-35%, respectively. The probability of occurrence in Jammu & Kashmir is 26-30% which is followed by Kerala and Jharkhand with the value of 21-25% and by Delhi, Uttarakhand, Manipur and Mizoram by 11-15%. The probability of occurrence of hailstorm in Gujarat, Chhattisgarh, Tamil Nadu, Tripura, Meghalaya, Sikkim and Nagaland is slowest (6-10%).

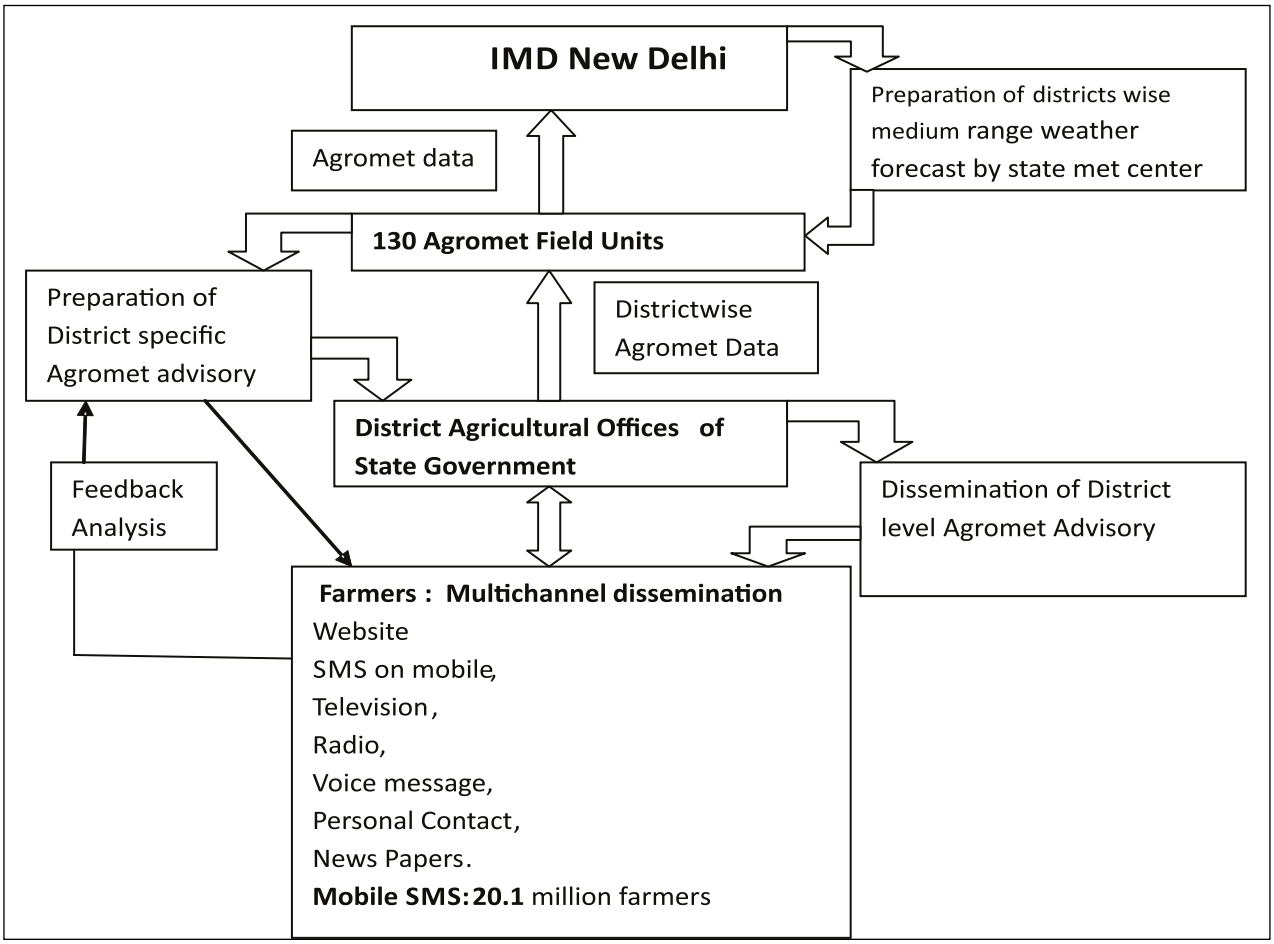

Figure 2. District Level Agromet Advisory Services

Heavy rainfall and floods

Severe natural weather events, such as rainstorms and flooding, are damaging crops in different parts of the country. Flooding can create anaerobic soil conditions that can have significant impact on vegetation. Also, chemical reactions in anaerobic soils lead to reducednitrates and the formation of nitrogen gas. This de-nitrification can be a significant cause for loss of plant vigour and growth following flooding. Additionally, heavy rainfall causes soil erosion, disruption to critical agricultural activities, water logging, increased moisture stress and attack of pests and diseases on the crops. Excess rainfall always causes water logging and runoff. Advisory services give farmers guidance to postpone fertilizer application and interculturing due to excess rainfall through Agromet Advisory bulletins.

Information dissemination process

Dissemination of information under extreme weather conditions plays a vital role in minimizing crop loss. The Information Dissemination Process are broadly divided into three channels viz mass and electronic media, group methods and individual contacts.

In general, the use of more than one channel gives a greater chance of reaching the client or user. The Agromet Advisory Services provided by IMD/MoES through various channels have resulted in significant increases in farm productivity, resulting in increased availability of food and higher income generation. There is a need for dissemination of AAS information to farmers on a wider scale and convincing them about its positive impacts on a sustainable basis. The most challenging task would be to enhance the accuracy of weather forecasts and to make the AAS more useful taking into account user friendliness advised by the farm households.

Outreach programmes

Weather and climate services, particularly under extreme weather conditions, can be strengthened through awareness programmes for the farming communities. Awareness programmes are helping the farmers to become more self-reliant in dealing with weather and climate issues that affect agricultural production and also assist the farmers tofurther develop their adaptive capacity with improved planning and better management decisions. A participatory, cross-disciplinary approach to delivering climate and weather information and enhancing the awareness of information user groups is being deployed. Key methods to addressing increased income generation of farmers are increasing production and reducing obstrainious use of farm inputs.It is a challenging task for government, IMD as well as the other stake holders to achieve this. Along with the AAS, IMD will generate high resolution medium range weather forecast and advisories and also issue advisories for livestock, poultry and fisheries

Coping strategy for climate extremes

- Weather forecasting at different spatial and temporal scales would be a significant tool for adaptation in agriculture under observed and future climate change scenarios.
- Climatic information and weather forecasts can help the farmers plan for the upcoming seasons to maximize productivity based on expected weather patterns.
- Warnings or alerts can also be given in case of floods, storms and lightning.
- Climate Smart Extension viz. technologies, methods and methodologies need to be used for the sustainable increase in productivity, support farmers adaptation to climate change, and reduce levels of greenhouse gasses. Modern ICT tools should be incorporated to facilitate decisions; systems, monitoring, modelling and prediction to support the farmers for enhancing their adaptive capacity to combat climate risks. Automation of advisory services to improve efficiency

References

Bhattacharya BK, Nigam R, Dorjee N, Patel NK and **Panigrahy S.** 2008, Normalized difference vegetation index-towards development of operational product from INSAT 3A CCD, National Symposium ISRS, 18-20 Dec. 2008.

Chattopadhyay N and **Lal B.** 2007, "Agrometeorological Risk and Coping Strategies-Perspective from Indian Subcontinent: Managing Weather and Climate Risks in Agriculture", Springer Publication, New York, 83-97.

Chattopadhyay N and **Rathore LS.** 2013, "Extreme Events: Weather service for Indian Agriculture" "Geography and You", 13, Issue 79, 12-16.

Das HP. 2012, "Agrometeorology in Extreme Events and Natural Disasters", B. S. Publications, Hyderabad.

Guttman NB. 1999, "Accepting the Standardized Precipitation Index: a calculation algorithm", *J. Am. Water Res. Assoc.*, **35**, 311-322.

Guhathakurta P, Koppar AL, Krishnan, U and **Menon P.** 2011, "New rainfall series for the district, meteorological sub-divisions and country as whole of India", National Climate Centre Research Report No. 2/2011 (www.imdpune.gov.in).

IPCC. 2013, The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp "Climate Change 2013 - The Physical Science Basis". Cambridge University Press, U.K.

Rathore LS, Roy Bhowmik SK and **Chattopadhyay N.** 2009, "Integrated Agromet Advisory Services in India", Challenges and Opportunities in Agrometeorology, Springer Publication, New York, 195-205

Rathore LS, Chattopadhyay N and **Singh KK.** 2013, "Delivering advisory services by mobile phones' in the book of Climate Exchange", World Meteorological Organisation (WMO), Tudor Rose publication, United Kingdom, (UK), 35-38.

Rathore LS, Chattopadhyay N and **Singh KK.** 2013, "Reaching farming communities in India through Farmer Awareness Programmes", in the book of "Climate Exchange, World Meteorological Organisation (WMO), Tudor Rose publication, United Kingdom, (UK), 20-23.

National Council of Applied Economic Research (NCAER). 2015. Impact assessment and economic benefits of weather and marine services, Supported by Ministry of Earth Sciences, New Delhi.

Sivakumar MVK, Motha RP and **Das HP.** 2005, "Natural disasters and extreme events in Agriculture", Springer Publication.

4 Land Use Planning for Sustainable Management of Resources in Vidarbha Region, Maharashtra

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Abstract

With irrigation potential low in Maharastra, investments are needed for water-harvesting practices. Also, it is very important that right crops in right areas are chosen for sustainable agriculture. Soil-based land use planning developed by NBSS-LUP is a vital tool in crop selection. The site specific information on soils and situation specific land use plan has been initiated. Also, Land Resource Inventory (LRI) has been adopted and makes use of high science, high resolution remote sensing data, Digital Terrain Modeling (DTM) and Global Information System (GIS) has also been developed for Maharashtra. Also the use of Geospatial Information Management (GIM) technology support has been highlighted.

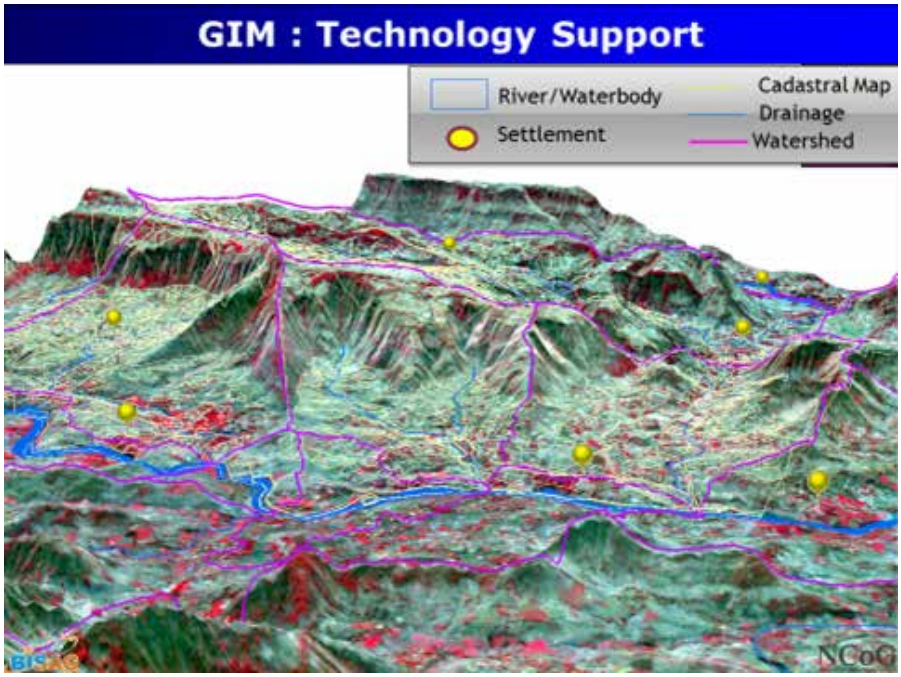
Introduction

Land use planning for sustainable management of resources in Vidarbha region, Maharashtra is critical for evaluating impact on improving crop yield. In Vidarbha region, sorghum and pigeonpea-based cropping systems are prominent. Potential for cotton was less, but is growing fast, and it has almost replaced sorghum to its maximum potential. Now competition is also arising between soybean and cotton. This can be viewed in western Maharastra cotton growing areas where the presence of clay soils do not adequatly support a sustainable growing region. Soil-based land use planning developed by NBSS-LUP is a vital tool in crop selection. In Gujarat, groundnut cadestral mapping, soil map in Telangana (Gajwel mandal), salinity map in UP (Pratapgarh) and WB (Hasnabad), Jhum land mapping in NE region have been developed. However, there is a continued need for systematic survey of soils.

Some of the sustainable tools which can maximize agricultural yields in Maharashtra are: input efficient and nutrient fortified seed, enhancing water and nutrient productivity.In Maharashtra, irrigation potential is limited and investments are needed for water harvesting practices. The figure below shows the cropping pattern introduced in Vidarbha.

In Maharashtra, site specific land use models have been practiced. Under the ICAR-NBSS&LUP initiatives, Land Resource Inventory (LRI) on 1:10000 scale has been adopted. Site specific information on soils and situation specific land use plan has been initiated. Also, LRI makes use of high science, high resolution remote sensing data, Digital Terrain Modeling (DTM) and Global Information System (GIS) has been

developed for Maharashtra. The LRI involves systematic surveys of soils (Agricultural land) on 1:10000 scale and collection of other collateral data needed for scientific land use planning in GIS environment. Landscape ecological unit has also been developed which involves degree, length and curvature of slope together with contour and drainage, which is useful in planning for Soil and Water Conservation (SWC) measures, irrigation, water harvesting potentials and precision agriculture. The use of Geospatial Information Management (GIM) technology support has also been initiated and involves the village map geo-referencing through Indian Satellite Images. This involves collection of village map, scanning of map, geo-referencing of scanned map to satellite data and digitization of geo-referenced village map. The figure above illustrates GIM technology.



There are different categories for soil-based land use planning developed by NBSS-LUP for addressing food security and adaptation to climate change for the state of Maharashtra.

Site specific land use planning has been implemented in the state of Maharashtra, the figure below illustrates success story of site specific land use planning.

Short term planning	**Medium and long term planning**
LMU 1 Jowar, small millets, horse gram, green gram, black gram, cotton and maize LMU 2 Maize, cotton, sunflower, red gram, jowar, Maize/ sunflower (short duration)-gram, millets, paddy as aerobic rice cultivation, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin LMU 3 Cotton, maize, paddy, sunflower, red gram, jowar, maize/sunflower (short duration)-gram, Cotton+red gram, millets, cowpea, green gram, black gram and vegetables like coriander, cluster bean, Pumpkin, tomato, chilli	Agri-horti system comprised of custard apple, amla, jamun and ber Boundary plantation with *Gliricidia* Water harvesting farm ponds Agri-horti-pasture system (C.ciliaris, Stylo, *Bracharia* on bunds Mango, guava, custard apple, amla, jamun, ber and suitable multi-purpose trees (MPTs) SWC measures and water harvesting farm ponds needs to be created. Agri-Horti System (Banana, mango, guava with drip). Agri-horti-pasture system (*C.ciliaris, Stylo, Bracharia)* Water harvesting farm ponds


Success story of site specific land use plan –
Cropping sequence options using Community Nursery in Maharashtra
Agricultural Land
Kharif
Rabi
Paddy
Onion
Paddy
Gram
Paddy
Linseed
Community Land
Fish farming
Vegetables and watermelon etc.
Success story : Smt. Kalpana Rupchand Dongre in Goregoan cluster by adopting Paddy-Gram and Paddy linseed cropping sequence.

5 Sustainable Development of Farm Holders through Integrated Farming and Mechanization

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Abstract

Promoting integrated farming systems involving strategic blending of crops, horticulture, dairy, agro forestry etc. along with establishment of custom hiring centers and imparting customized training is a viable option to keep the farmers engaged year round. This full-time work would yield a regular income stream. Also, several low-cost technologies are at the farmers disposal for soil and water conservation. Massey Ferguson and Eicher branded tractors are available to suit different soil types, cropping systems and the nature for which it is put to use.. Multiple uses of local resources would pave the way for doubling and in some cases tripling farmers' income.

Background

TAFE is a tractor manufacturing company based in Chennai, with a reputation of serving farmers and offering total farm solutions since 1961. It is the worlds third largest tractor manufacturer with a range of tractors and related farm equipment coupled with their own adaptive research farm viz., "J" farm. J farm and its exclusive agri portal www.jfarmindia.com are an invaluable input for improving farm production and productivity. With close to 53 years of experience in Indian farms and agricultural practices and extensive associations with leading agri universities and agri research institutions.TAFE has been facilitating lab to farm transfer of agricultural practices and is credited with success in working independently and with government agencies in releasing new and improved varieties of seed to meet the burgeoning food needs of India. One of the important objectives of J farm is to improve the livelihood of marginal and small farmers in India and other developing countries worldwide.

Agriculture remains the livelihood for nearly 52% of the Indian population. As per 2010-11 agricultural census, the average size of land holdings is around 1.16 ha. Of the total 137.75 million holdings, 85% of the holding belongs to small and marginal farmers. These small farms, while operating only 44 per cent of land, are the main providers of food and nutritional security to the nation. The marginal and small farmers contribute to 55% of the total food grain production and 65% in fruits and vegetables. Nearly 55% of the total cultivated area is under rainfed agriculture. The projections indicate that the small and marginal farmers may account for more than 91 per cent of farm holdings by the year 2030.

Modern farmers are facing several hardships like limited access to technology, agri inputs including quality seed, credit, poor market linkages, failure of monsoon, non-availability of labour, and dominance by middlemen. Under these conditions the modern viable technologies viz. integrated farming system, availability of farm machinery through custom hiring centre and training on skill development should be focused largely towards the small and marginal farmers if we have to double the farmers' income, maintain sustainability and improve their livelihoods.

Major problems faced by marginal and small farmers

The major problems faced by the marginal and small farmers in India are:

- Small and fragmented land-holdings
- Non availability of good quality of seeds
- Lack of proper integration of cropping and farming systems suited to different regions
- Lack of mechanization

- Non-availability of customized skill development program to the farmers and rural youth
- Poor purchasing power
- Inadequate storage facility
- Inadequate transport
- Limited access to inputs, technology, credit, market, and
- Intermediaries

Solution to the problem

- Introduction of integrated farming system (IFS) – Alternate sources of income
- Better soil and water management
- Training on skill development. *viz*. production of enriched vermicompost from cattle dung, low-cost soil water conservation technology, integrated farming techniques and repair & maintenance of farm machinery
- Mechanizing farm –Establishing custom hiring centres in different clusters
- Small scale processing of farm produce and by-products at the farm level
- Realization of good price for the produce
- Precision farming – for enabling techno-green revolution. This would lead to need based application of agri inputs so as to reduce the cost of production and increase profitability

An integrated farming system for sustainability of marginal and small farmers developed by J farm research centre

The major components of farm diversification viz. crop husbandry, livestock production, vermicomposting, horticulture and agro forestry have been tested and found successful. This is applicable to Southern Indian conditions with limited availability of water. The economics of experiments conducted on integrated sustainable model for small and medium farmers consisting of crop husbandry (rice + vegetable + banana) + dairy + vermicompost + boundary plantation is detailed below. The data provided in the table are an underestimate since we have considered a bare minimum selling price.

Particulars	**Net return/ha/year ($)**
Dairy – 2 milch cows (milk & vermicompost)	1026
Crop husbandry	
Vegetables (1 ha)	4645
Cooking banana (1 ha)	6038
Rice (0.20 ha) – Rice-Rice-Green manure	281
Planting of *Melia dubia* on the boundary of farm (1 ha or 400 m running length)	173
Total income by integrated farming system/ha	5753
Conventional system (growing of rice two season @ 5 t/ha)	1169
Increase over conventional system/ha	4583
Increase over conventional system (%)/ha	392.14

The Integrated farming system seeks to

- Maximize return per unit area, profitability and sustainability
- Provide year-round income to the farmers
- Utilize by-products of one component of the farming system as an input in to another
- Maintain soil fertility status
- Solve energy, fodder and timber crisis
- Generate employment year round, and
- Improve livelihood of farmers

Maintenance of soil fertility and recharging of groundwater

Over the years, degradation of soil fertility has occurred as a result of indiscriminate application of fertilizers, salinity caused by various factors and acidity etc. The groundwater is also continuously depleted where irrigation is not available through canals connecting rivers, dams and farm ponds.

In addition to the application of organic matter, soil fertility is easily restored by growing green manure crops which fix atmospheric nitrogen and simultaneously correct micronutrient deficiencies when ploughed *in-situ* at flowering stages and as a cover crop to prevent erosion of top soil. The following are best suited according to J farm research.

Amount of rainfall	**Green manure/cover crop**
Scanty rainfall	Horse gram (*Macrotyloma uniflorum*)
Low to medium rainfall	Wild indigo (*Tephrosia purpurea*)
Medium rainfall	Sunnhemp (*Crotalaria juncea*)
Medium to high rainfall	Daincha (*Sesbania aculeatea*)
High rainfall	Calapo (*Calapagonium mucunoides*)
	Black kinvach (*Mucuna bracteata*),
	Tropical kudzu (*Pueraria phaseoloides*)

A review of literature would reveal that innumerable papers are published on the methods to conserve water in the scanty, low and medium rainfall regions without assured irrigation. This is best done at J farm by using a tractor drawn chisel plough. After the advent of first monsoon showers and when the soil becomes relatively loose, a chisel plough is run across the gradient at 20 foot intervals. This makes a deep cut of about 45-60 cm in the soil. The width of cut will range from 15-10 cm. The runoff water that occurs during the subsequent precipitation is trapped in the deep cut made in the soil to recharge groundwater and stem runnoff. Excess water is collected in a small pond made at the far end of the gradient. The farm pond is lined with vetiver (*Chrysopogon zizanioides).* Additionally, chisel ploughing done once in a year breaks the hard pan.

Mechanization

Farm mechanization is an important component of agriculture to reduce drudgery and helps:

- Ensure timely operations leading to increased productivity
- Increase productivity of labour and other inputs
- Improves the quality of farm produce, besides reducing the losses and adding value to farm produce, and
- Improves the profitability by generating money through custom hiring of tractors, implements, equipment and machinery

a. Range of tractors offered by TAFE and TMTL

- Many variants of Massey Ferguson branded tractors produced by TAFE are available in the HP (horse power) range of 30-36, 37-40, 41-50 and >50 HP. Similarly, variants of Eicher branded tractors produced by TMTL is available in the following hp range 24-38 and 42-50. The best suited variant is selected depending on the size of farm holding, soil type, crops grown and the purpose for which it will be put to use (agri or non agri operations or a combination of both).
- Common implements used for primary and secondary tillage such as two and three furrow mould board plough, two and three furrow bottom disc plough, reversible mould board plough and rotary tiller with 30, 48 and 54 blades and power harrow are manufactured by TAFE. Production of pneumatic seed cum ferti drill and self-propelled elevator platform for use in orchard crops is also in the offing. One of TAFE's premium product Cruzer (harvest combine) is widely used in wheat, rice and maize. Also, expert solutions are offered by J farm in the selection of right type of tractors and implements for use in different regions.

b. Economics of mechanization

The economics is provided in the table

Particulars	Increase/saving (%)
Increase in productivity up to	12-34
Seed-cum-fertilizer drill facilitates	
Saving in seeds	20
Saving in fertilizer	15-20
Enhancement in cropping intensity	5-22
Increase in gross income to the farmers	29-49

c. Economics of custom hiring centers

TAFE and its agri division J farm offer help in identifying an entrepreneur to run custom hiring centers for tractors and associated implements. The group believes that not all farmers can afford to purchase a tractor but can hire when necessary. The table mentioned below would give an idea of small, mid and large investment and return

Annual hours of operation (hrs) for tractor viz., 1450, 2150 and 3300 for low, medium and high investment, respectively, are taken into consideration.

Note: Net return can be increased by increasing the working hours. The mechanization will also increase the productivity of crops between 5 and 10 per cent due to timely field preparation, precise and timely sowing, minimizing seed losses during sowing and grain during harvesting.

More details on the economics can be had by contacting the author.

Agri Portal www.jfarmindia.com

An agri portal www.jfarmindia.com developed by TAFE contains a wide range of production, protection and processing technologies for 170 crops grown in 18 states of India. Many chapters on mechanization,

Details	Low	Medium	High
Types of investment ($)	10756	22006	59852
Net return in first year ($ per year)	1702	19956	19956
Net return between second and seventh year ($ per year)	2044	21885	21885
Net return between eighth and ninth year ($ per year)	3027	27437	27437

cropping and farming systems, medicinal and aromatic crops, water and soil conservation methods, agro forestry and pure forestry are provided. The site is supported with 2,00,000 pictures. The default language is English. For northern Indian states, information can also be accessed in Hindi. For Tamil Nadu, information is available in Tamil.

How can TAFE group contribute to pilot project in Vidharba?

With wide expertise in the manufacturing of tractors supported by R and D and Agri Research, the TAFE group can extend help to increase productivity of crops and farmers' income at pilot project site, which is to be identified by ICRISAT in Vidharba and Bundelkhand regionof Uttar Pradesh.

1. Introducing integrated farming system using the locally available materials.
2. Identifying suitable hp Massey Ferguson/ Eicher tractor and implements for the primary and secondary tillage based on the soil type, land holding and the crops grown at the demo block at Vidarbha.
3. Assisting in the establishment of custom hiring centre for farm machinery with either a lead farmer or entrepreneur as and when necessary.
4. Providing a suitable sub-soiler or chisel plough to plough across slope to harness rainwater and to facilitate infiltration.
5. Introducing green manure and cover cropping with horse gram (*Macrotyloma uniflorum*) for ploughing i*nsitu*.
6. Identifying a location for farm pond in the demo block and line it with vetiver.
7. Making slight changes in the existing cropping system so as to introduce growing of either one of the minor millets viz., Fox millet *Setaria italica,* Barnyard millet *Echinocloa frumantacea,* Finger millet *Eleusine coracona*, Kudo millet *Paspalum scrobiculatum* and common millet *Panicum miliaceum* based on market demand
8. Introducing moringa for planting annually.
9. Introducing *Melia dubia* for planting in the boundary.
10. Designing cattle shed to house six animals.
11. Organizing training program for conversion of dung into vermicompost and its enrichment at J farm, Chennai.
12. Organizing training program for converting sugarcane press mud into vermicompost with the help of Tirutani Co-operative Sugar Factory located at Thruvalangadu about 60 km from Chennai. As per recent statistics about 173 co-operative sugar mills are present in Maharashtra alone. It is not known; how many sugar mills make use of press mud and convert it into value-added manure.
13. Imparting training to farmers on the proper usage of tractors and implements, and
14. Introducing low-cost modified hydroponics to grow vegetables for home consumption.

Technical Session II
Challenges and Opportunities for Doubling Farmers' Income

Chair *: Dr KP Viswanatha*

Rapporteur : *Dr Aviraj Datta*

6 Enhancing Farmers' Income: Challenges and Opportunities

PK Joshi

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Abstract

Disparity between yield increase and increase of input cost, labor cost and fuel cost is a huge facor affecting Indian agriculture. The input cost for cultivation has increased significantly over the past decades and as a result the net income for the farmer has not increased substantially. There is a need to promote profitable allied practices such as horticulture, fisheries, livestock etc. to help the farmers to realize better net incomes. Also, the realization of better pricing is important to increase the net income of the farmers as most of them sell their agricultural produce locally to intermediaries and end up not realizing appropriate value for their produce. The FPOs (Farmers Producer Organizations) can significantly help alleviate this vulnerability at the grassroot level. The author also highlights the need for a consistent land use policy to prevent the loss of any part of about 56 million ha of prime agricultural land towards non-agricultural activities.

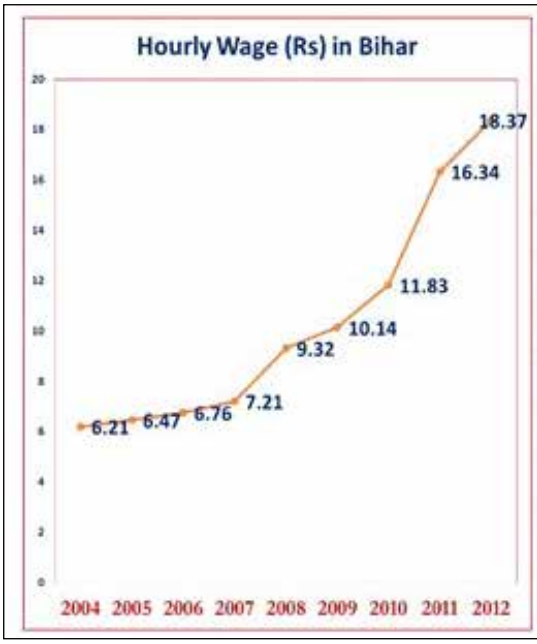
Introduction

There is a need to diversify sources of income of a farmer to realize the goal of doubling his/her income. Depending on yield increases alone is not necessarily going to achieve this objective. The gross income for a farmer depends on the yield and price realized for his produce, but the importance of increase is input cost, wages cost and cost from agriculture allied activities actually dictates a farmer's net income. The input cost for cultivation has increased significantly over the past decades without a commiserate increase in gross income. The wages for farm labour in Bihar has increased from $ 0.10 per hour in the year 2004 to $ 0.28 in the year 2012, as a result the labour costs contribution to gross value of the produce (GVP) has increased from 47% to 63%. As the net sown area has been stagnant at 140 million ha in India it is natural that the focus has been on yield increase.

Learnings from yield increase: It is important to recognize the phenomenal yield increase achieved by our farmers and scientists for crops such as rice and wheat in the past decades resulting from the green revolution. This has been the backbone of our food security today. However, over the last fifteen years rice yields witnessed an increase of only 680 kg/ha i.e. increase of 45 kg/year. Similarly, for wheat the value is 55 kg/year with a yield increase of 835 kg/ha realized over the last fifteen years. The yield increase achieved for pulses such as chickpea, pigeon pea over the same period have been very low at 250 kg/ha and 177 kg/ha respectively. Thus it is important to recognize the disparity between yield increase and increase of input cost, labor cost and fuel cost. Particularly with the introduction of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), the wages for farm labor has gone up significantly in the rural sector. Also, yield increase and sustainable utilization of resources has emerged as critical to growth in rural sector in the last decade.

Importance of crop diversification: The overall agricultural yield in states like Bihar and Odisha has stagnated over the last few decades. The majority of small farmers are achieving agricultural yield of less than 1 ton per ha owing to their lesser exposure to improved agricultural practices. About 35 % of the farmers in these regions are still growing rice which is not delivering the net income generation with its stagnant yield level. The yield stagnation and decrease of net income can be directly correlated with the prevalence of widespread poverty and malnutrition among the small and marginal farmers in this region.

Promotion of crop as well as income diversification is critical to help build prosperity in these regions. Understanding the requirement of diversitying income sourses will as a modern way of life will alleviate the poverty cycle in rural areas. Recognition of the changing food habits of the population with a decreased consumption of cereal crops and increased consumption of vegetables, poultry, and dairy products has to be translated into demand driven agricultural practices. The contribution of horticulture



Year	Hourly Wage (Rs)	Paddy price (Rs/q)	Labor used (hour)	Total wage bill (Rs)	Yield (Q/ha)	Gross value of produce Rs/ha	Wage share (%) of GVP
2004	6.21	504	875	5433	23	11494	47
2005	6.47	478	831	5379	26	12331	44
2006	6.76	531	840	5676	25	13329	43
2007	7.21	632	771	5556	29	18318	30
2008	9.32	726	797	7423	27	19344	38
2009	10.14	856	768	7784	19	16244	48
2010	11.83	968	757	8954	19	18680	48
2011	16.34	830	797	13023	28	22881	57
2012	18.37	977	808	14842	24	23695	63

Figure 1. Rising wage rates and wage-share in value of produce.

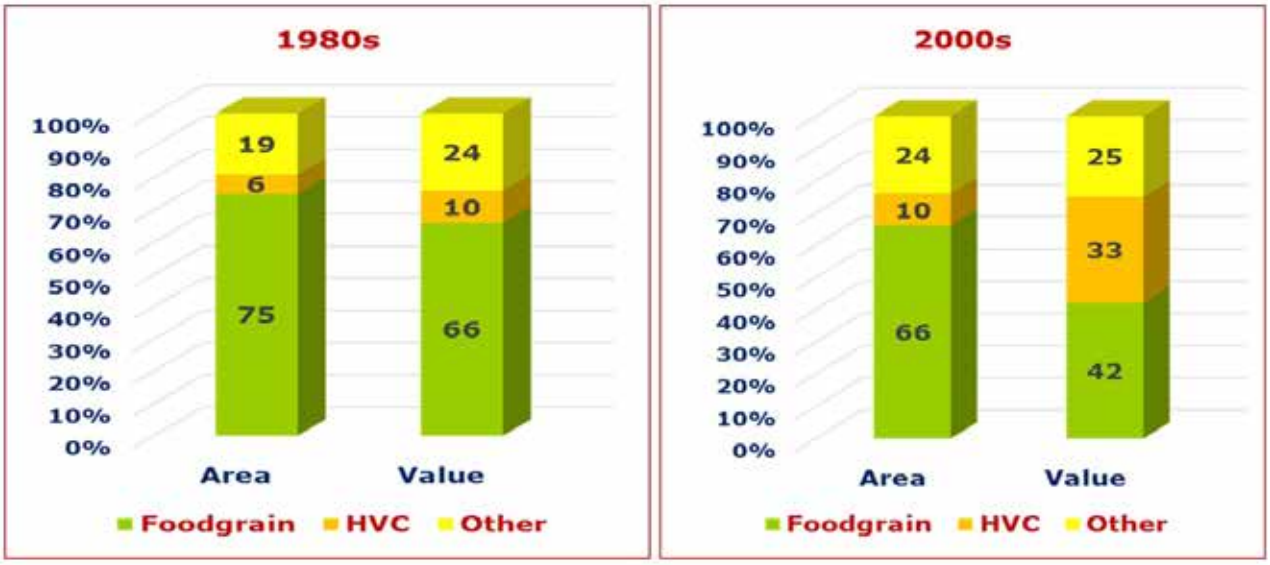


Figure 2. Share of different crops in value and area of all crops.

has become 60% towards the overall growth achieved in the agricultural sector today whereas the contributions from cereal crops has been only 6.9% and pulses 4.8%. Promotion of profitable allied practices such as horticulture, fisheries, livestock etc. will help the farmers to realize better net incomes.

Importance of custom hiring centers and market linkages: In India, small farmers with land holding sizes between 0.39 ha to 1.15 ha. are cultivating 60% of available agricultural land. The poor penetration of farm mechanization can only be improved through custom hiring centers at a community level. Also, the realization of better pricing is important to increase the net income of the farmers. The reality today is that 70% farmers sell their agricultural produce locally. This makes the farmers vulnerable to intermediaries and end up not realizing appropriate value for their produce. The FPOs (Farmer Producer Organizations) can significantly help to alleviate this vulnerability at the grassroots level by providing better market linkages to the farmers. Presently there are about 620 FPOs functioning within India and they help to provide a feasible route towards improved market linkages and better price realization.

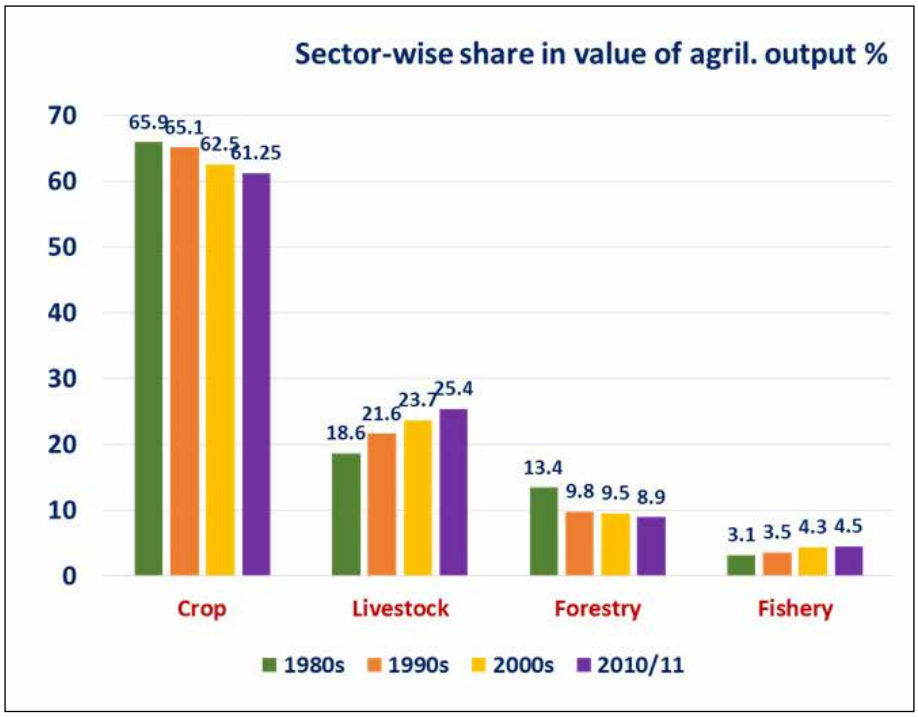


Figure 3. Importance of agricultural diversification to achieve increased incomes.

Consistent land-use policy: Poor planning of a farmers' land resources is persistent due to unclear demarcation of plots. There is an urgent need of developing transparent and consistent policy to prevent the loss of any part of the aprox. 56 million ha. of prime agricultural land towards non-agricultural activities.

7 Challenges and Opportunities for Unlocking the Potential of Dryland Agriculture

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Abstract

Land degradation, climate change and decreased water availibility has caused a challenge to food security and improved livelihoods and there is a need to translate improved scientific understanding gained from research into ground level impact. Following a holistic appraoch by implementing key aspects such as market driven innovation, building agribusinesses and sustainable intensification and also adopting the mantra of 4Cs i.e. converge, consortium, collective action and capacity building is the goal towards acheiving double digit growth in the primary sector. Also, the author highlights the importance of watershed development, which has proved as a sustainable approach towards improving the farmers livelihood. The examples of projects in Karnataka which include Bhoochetana and Bhoo Samruddhi and Rythu Kosam in Andhra Pradesh through the use of integrated watershed management, improved cultivars, integrated pest management (IPM), crop diversification with vegetables, mechanization, use of ICT in agriculture, and formation micro-enterprises for improving livelihood are mentioned in the text.

There are two aspects of the effect of climate challenge on agriculture viz. soil degradation and decreased per capita water availability. Despite the Govt. data on total agricultural land area of 141 million ha., in reality there is only about 135 million ha. of cultivable land in the country. Out of this, 120 million ha. is experiencing land degradation because of over exploitation and poor nutrient management. Additionally For example, per capita water availability in India has decreased from 5177 m3 in 1951 to 1820 m3 in 2011 due to increased population from 361 million in 1951 to 1.02 billion in 2011. Population is expected to rise to 1.39 billion by 2025 and 1.64 billion by 2050 with associated decrease in per capita water availability (1341 m3 in 2025 and 1140 m3 by 2050). These factors, together with tremendous population growth seen post-independence, have decreased the cultivable land per person from 4.8 persons/ha to 27.2 persons/ha. It is required to recognize the vast yield gaps which exists even within the drylands. Current farmers yields are lower by 2 to 5 folds than the achievable yields in drylands of India. The situation represents a formidable challenge to food security as well as the aspiration of achieving food grain self-sufficiency for the nation and 'business as usual' approach can no longer be adopted.

Science of delivery

There seems to be disconnect between the vast knowledge repositories in different agricultural universities and research organizations and the farmers. While "science of discovery" is important to develop new and improved cultivars, fertilizers, pest-control methods and improved farm practices, there is an urgent need to evaluate the on ground impact of such scientific endeavours. Research output if not piloted and tested on the ground provides no benefit or too little to the farmers. Such innovations lie in apparent "death valley for research ideas" (Figure 1) which lies between demonstrations and field scale evaluation. There is a need to focus our resources to science-led and demand driven innovations. Also, translating improved scientific understanding gained from research into ground level impact is referred as the "science of delivery" today where what to do is known, but how to do it remains a challenge. Therefore listening, learning, leveraging, adapting and inculcating a sense of ownership are the key ingredients of "science of delivery".

Need for a holistic approach

There is a need to understand the plight of the farmers from a holistic point of view. At present the recovery of variable cost itself seems a daunting task for the farmers. If one sees deeper and estimate the return on land cost and hard work put in by the farming community it will be easy to comprehend

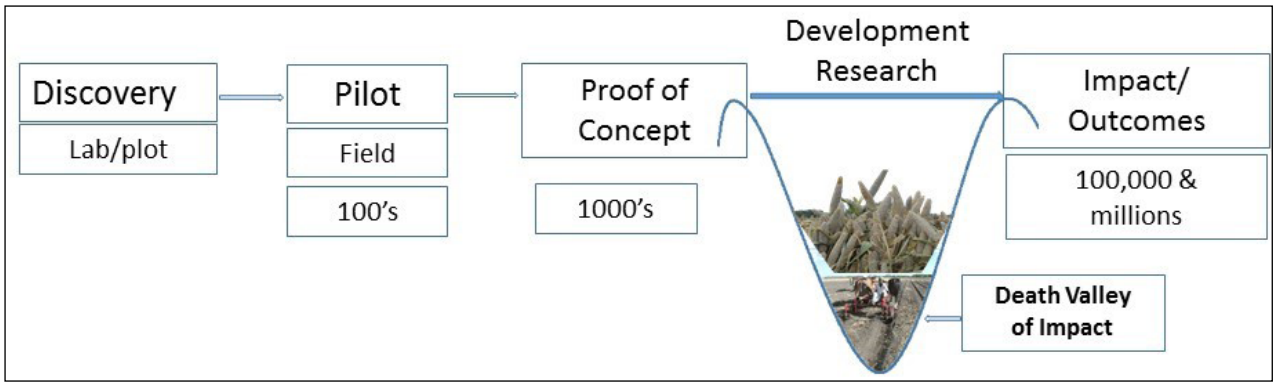

Figure 1. Improving livelihoods through crossing the "death valley" of impact.

why dryland agriculture no longer attracts the rural youth. There is a steady migration towards the urban centres from rural India. To make the country robust, food secure and economically forward, agriculture has to be the engine of growth for rural India. There is a need to shift our focus from intensification to produce food to sustainable intensification ensuring eco-system function while producing food. Increasing productivity and increasing profitability has to be addressed simultaneously to achieve our objective of doubling farmers' income (Figure 2). Market driven innovation, building agribusinesses and sustainable intensification are the three key aspects of this holistic approach. Sustainable intensification should begin with improved soil and water management, crop improvement and access to better seeds, diversification of farms and livelihoods and development of on-farm practices and technologies. Promotion of localized processing of the agricultural produce, improved market linkages through Farmer Producer Organizations (FPOs) formation and analysing key demand and opportunities in the prevailing market will lead to sustainable agribusiness development. Our approach has to be two pronged including scaling-up of low hanging fruits technologies as well as innovation at pilot sites to sustain growth. Adopting the mantra of 4Cs i.e. converge, consortium, collective action and capacity building the goal of double digit growth in the primary sector can be achieved. Convergence provides the synergy to increase efficiency in production, consortium developed through partnerships leads to value addition whereas collective action and capacity building result in better profit margin and opportunities for acquiring new skills and improving employment opportunities.

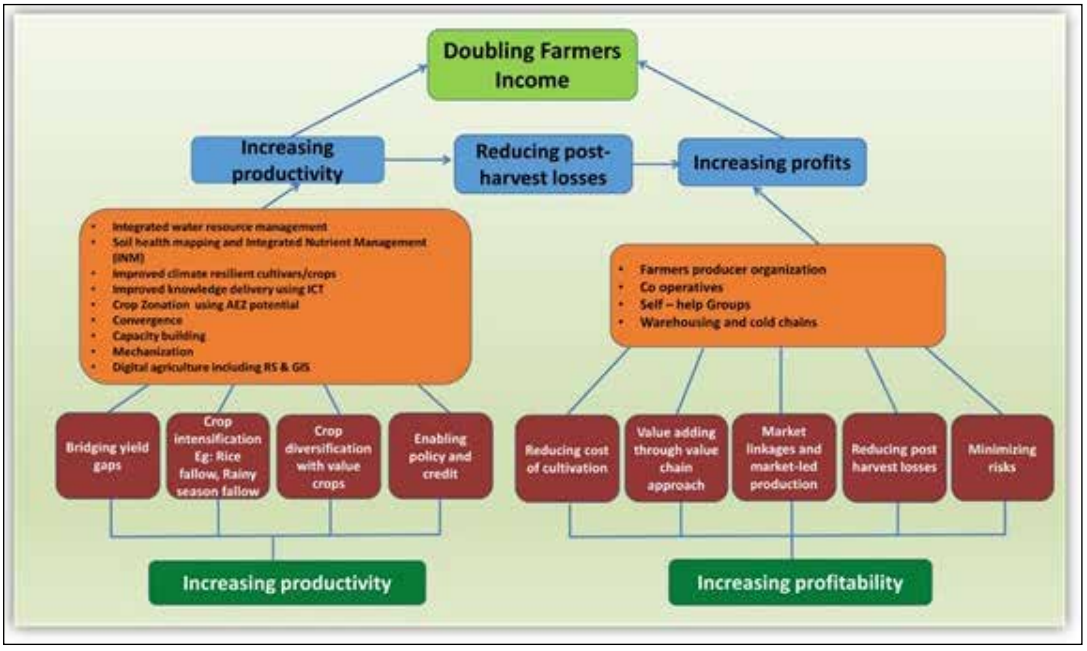

Figure 2. Framework for Inclusive Market Oriented Development (IMOD).

Current farmers yields are lower by 2 to 5 folds than the achievable yields. The vast potential of rainfed agriculture needs to be harnessed and to tap the untapped potential the following points need to be considered. A new paradigm for achieving sustainable intensification is needed by shifting focus from intensification to produce food to sustainable intensification ensuring eco-system function and profitability while producing food. Agriculture as the engine of rural growth needs attention which can be addressed by need based holistic and integrated approach and science-led and demand driven innovations. Along with these the other points to be considered are:

- Participatory approach and partnering – working side by side
- Building capacity – at a national and local level
- Integrating communications - to build awareness and share knowledge
- Monitoring and evaluation – for feedback and adjustment
- Policy support – work closely with government to encourage the needed policies

Watershed as an entry point for doubling farmers' income

The past experiences of watershed development has proved the potential of watershed development as a sustainable approach towards improving the farmers livelihood. The main aspects of this approach include soil and water conservation measures, soil testing and tailor made input, legume inter-cropping and crop rotation practices, diversification with high-value crops, seed preparation, composting and pest management to reduce the input cost further, value addition through localized processing, market linkages, water harvesting and its efficeinct use, capacity building through knowledge sharing, listening to and supporting women in leadership roles through formation of microenterprises.

Knowing and learning from the farmer is important in formulating effective strategies to increase productivity and profitability. If one farmer has 0.5 ha land, about 0.1 ha must be dedicated for horticulture. Adopting holistic approach in Andhra Pradesh, 4 fold increase in sown area and a 9-fold increase of chickpea yield has been realized by Government of Andhra Pradesh with ICRISAT and its partners in the last few years (Figure 3). Also, the State of Andhra Pradesh recorded the highest chickpea productivity in the country is a testimony in itself. Hybrid pigeon pea cultivars ICPH 2740 and ICPH 2671 are being grown as a business model by farmers in Karnataka.

Soil analysis in the country has been driven towards using NPK and the perspective has to change towards balanced nutrition inclusive of boron and zinc along with other deficient seconday and micronureints. At present farmers apply excess nitrogen, which only increases the input cost without any impact on yield. Farmers apply potash as even when it is unnecessary and end up in water bodies causing eutrophication of nearby waterbodies.

Soil test-based nutrient management has shown % increase in yield varing from 20 to 138 per cent of different crops (Figure 4), which not only increased crop yields but also increasd profitability for the farmers.

Also, ICRISAT's experience with the Govt. of Karnataka through *Bhoochetana* and *Bhoosamruddhi* and with the Government of Andhra Pradesh through *Rythu Kosam* enabled both the states to break the status-quo stagnant agricultural growth and march towards sustainable growth in agricultural GDP. In *Bhoochetana* 4.75 million farmers benefitted covering 5 million hectares of agricultural land. There was a 22-60% increase in crop yield and 1963 crores (US$ 353 million) net benefits accured in 5 years (Figure 5). *Bhoosamrudhi* established consortium for scaling-up science-led development. Established pilots of 80,000 ha as "Sites of Learning". Climate resilient and high-yielding crop cultivars identified for scaling up. Developed a strategy for sustainable intensification and capacity of the stakeholders was strengthened. In *Rythu Kosam* 6 million ha was targeted to benefit 7 million farm households by adopting new convergence model by integrating agriculture related sectors in the Primary Sector Mission. Public private partnerships were established and 23 growth engines were identified. As part of ongoing projects *Bhoochetana* and *Bhoosamruddhi* with the Government of Karnataka, ICRISAT has developed the soil-nutrient based map for

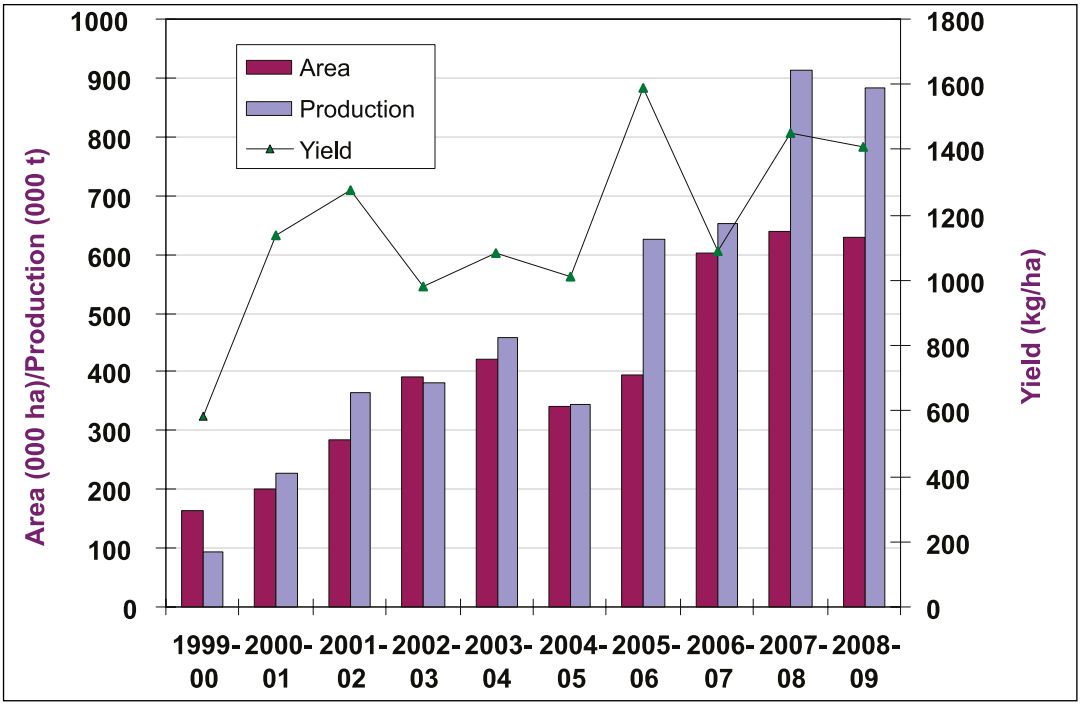

Figure 3. Chickpea increase in area, yield and production using improved varieties.

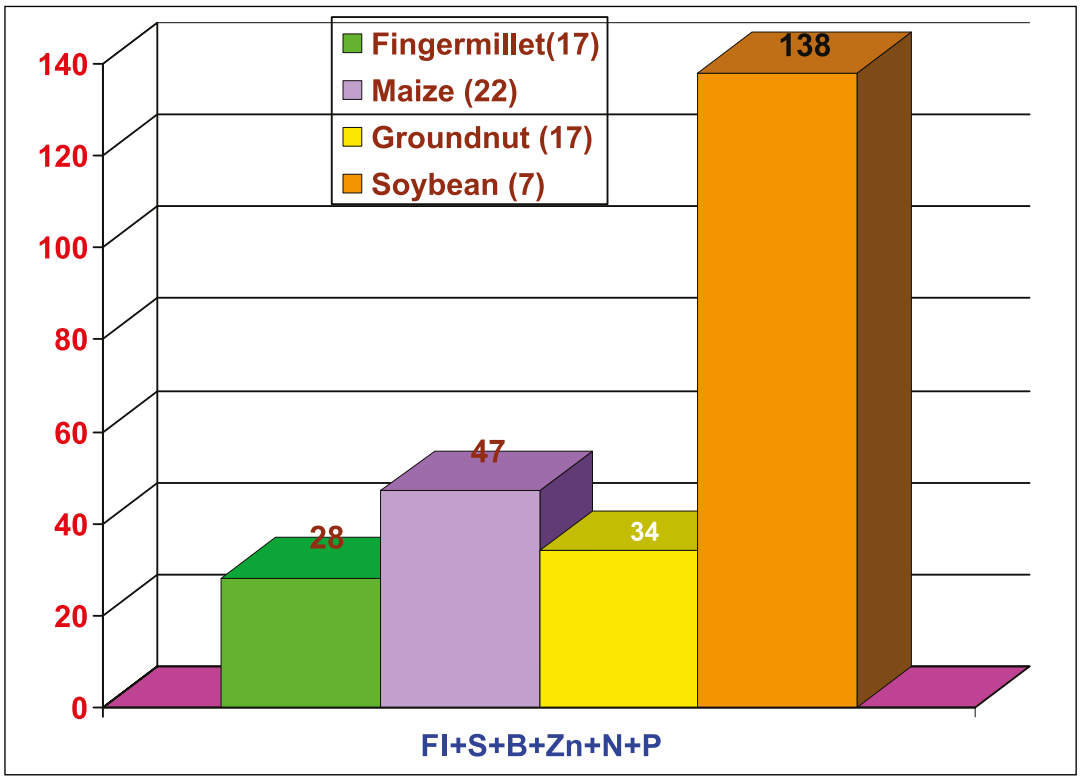

Figure 4. Per cent increase in yields of different crops due to balanced fertilization over farmers practice in Karnataka watersheds.

the state of Karnataka. The soil analysis based fertilizer recommendation along with improved practices has resulted in Increased crop yields up to 138%, reduced cost of cultivation, reduced environment pollution and increased farmers' income by $ 97.35 to $ 247.26 per ha per season. Adopting holistic science-led development approaches in Andhra Pradesh as part of ongoing *Rythu Kosam* project an 10.49 % growth in the primary sector has been achieved by the Government with ICRISAT-led consortium in the year 2015-16 and 14.03% in 2016-17.

Sustainable intensification and market linkages are critical to enhance farmers' income. There is need for optimistic doers rather than sceptic talkers to realize the mission of doubling farmers' income by 2022. The introduction and release of first pigeon pea hybrid (ICPH 2740 and ICPH 2671) has potential to transform the lives of farmers in Maharashtra, Andhra Pradesh, Karnataka, Jharkhand and Madhya Pradesh (Table 1).

Year	2009	2010	2011	2012	2013	Total
Net income (Rs in Crores)	11.49	204.81	599.45	451.80	695.30	1962.85
Net income (Million US$)	2.52	45.72	112.48	82.44	110.35	353.51

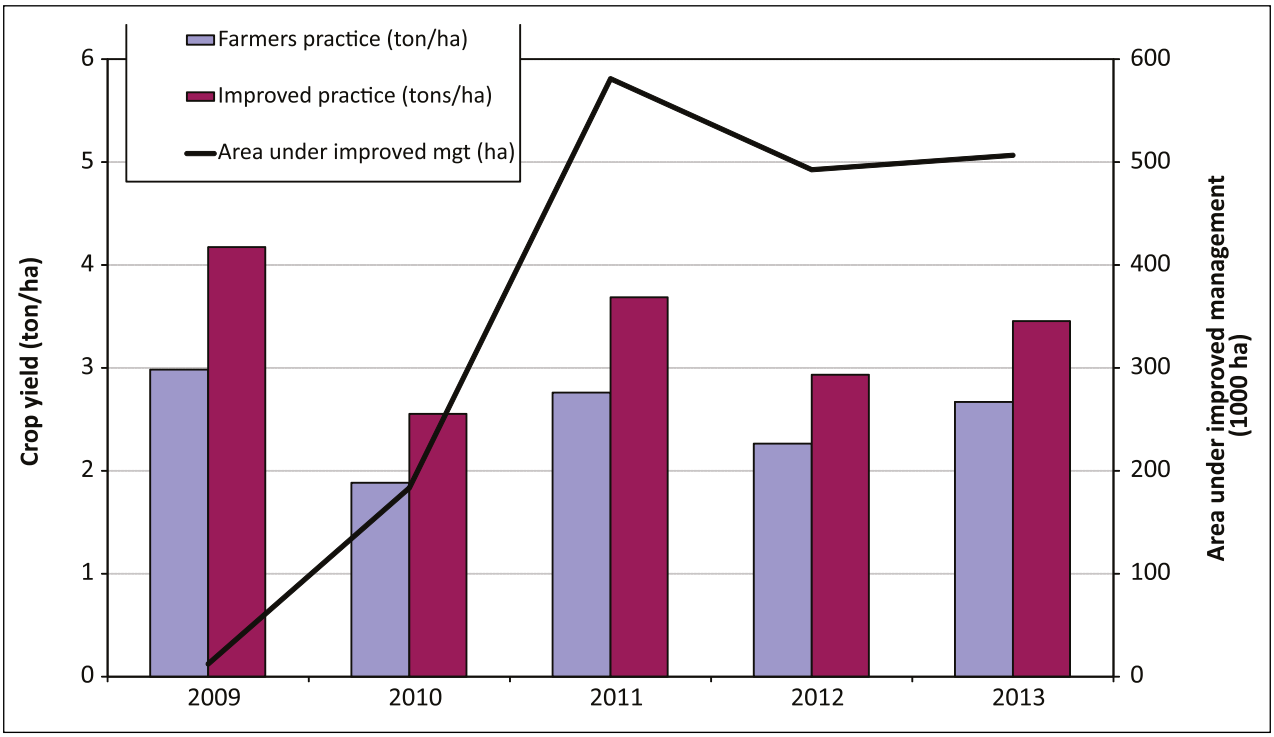

Figure 5. Improved Agricultural Practices Increased Crop Yields and Incomes in Karnataka: Bhoochetana.

Table 1. Improve variety on-farm trials in different states showing increase in crop yield.

ICPH 2740, 2671 on-farm trials (2007-10)

States	Hybrid	Control	% Gain
Maharashtra	969	717	35
Andhra Pradesh	1411	907	56
Karnataka	1201	951	26
Jharkhand	1460	864	69
Madhya Pradesh	1940	1326	46
Mean	1396	953	47

Some of the other interventions carried out are integrated watershed management to build resilience of natural resources and communities, improved cultivars, integrated pest management (IPM), crop diversification with vegetables and mechanization, use of ICT in agriculture, and micro-enterprises for improving livelihood.

Conclusion

The Prime Minister's vision of doubling farmers' income by 2022 is achievable through science-led business approaches. Also, demand driven technologies using science-led innovations to transform agriculture in a business model is a must in achieving this goal. A positive approach is of paramount importance and hence bringing together "optimistic doers" and leaving alone "sceptic talkers" is the route to be adopted.

8 National Food Security Mission (NFSM) - An Overview

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Abstract

Focussing on agricultural growth through sustainable use of natural resources such as soil and water and at the same time taking steps for improving the socio-economic conditions of agriculturists is the fresh thinking that is presently being adopted. Thinking on the above lines, the 'National Food Security Mission' (NFSM), was launched in October 2007. The Mission met with an overwhelming success and achieved the targeted additional production of rice, wheat and pulses. The Mission is being continued during 12th Five Year Plan with new targets of additional production of food grains of 25 million tons of food grains comprising of 10 million tons rice, 8 million tons of wheat, 4 million tons of pulses and 3 million tons of nutri (minor) cereals by the end of 12th Five Year Plan. Under the Mission, with collective efforts of center and state governments, focused and sincere attempts by all the stakeholders involved in implementation of NFSM enhancing production and productivity of food grain crops, restoring soil fertility and productivity at the individual farm level with enhanced farm level economy. There has been increased focus on minimizing post-production losses. Also, better market linkages is the key to enable farmer to achieve better price for their produce. In order to increase market linkages, 81 FPOs are formed in recent years though this is just one step towards increasing the market linkages.

The existing gap between oilseed production and demand remains a key challenge for the country. At present the national oilseed production is estimated to be about 8.64 million tons whereas 23.49 million tons is the present demand for domestic consumption. This area needs greater attention from all the stakeholders involved in Indian agriculture. Also, special initiatives under NFSM to enhance pulses production includes 150 seed hubs have been sanctioned with an allocation of $34.87 million for the years 2016-17 and 2017-18. For strengthening of breeder seed programme at ICAR institutes and SAUs an amount of Rs. 30.39 crores (US$ 4.70 million) is earmarked for two years. An amount of Rs. 90.06 crores (US$ 13.94 million) has been allocated for central agencies like HIL, KRIBHCO and NSC under seed production programme for increasing availability of seed of pulses. An amount of Rs. 67.56 crores (US$ 10.45 million) has been allocated for pulses seed mini-kit distribution during *Kharif/ Rabi* & summer to popularize newer varieties. Also, pulses are being promoted by launching special programme from the year *Rabi* 2016-17.

Introduction

A decade ago, the agriculture and allied sector had been facing numerous challenges. Even as the country has made large strides in increasing food production and achieving food security through the green revolution, the sector remains constrained by low productivity, excessive dependence on monsoon and weather conditions, continuing fragmentation of land and preponderance of fragmented markets. A combination of these factors has led to episodes of agrarian distress which have been widely reported. As a result, the Government has engaged in fresh thinking on the development of the agriculture sector. The multi-pronged strategy for agricultural development now comprises focussing on agricultural growth through sustainable use of natural resources such as soil and water and at the same time taking steps for improving the socio-economic conditions of agriculturists. Innovative approaches are being adopted for better management of the farming sector. Also, emphasis is being placed on improved institutions and better organization so that farmers welfare is built into the system. There are numerous steps that are being taken to strengthen diverse aspects of the agriculture system.

The National Development Council (NDC) in its 53rd meeting held on 29th May, 2007 adopted a resolution to launch a Food Security Mission comprising rice, wheat and pulses to increase the annual production of rice by 10 million tons, wheat by 8 million tons and pulses by 2 million tons by the end of the Eleventh Plan (2011-12). Accordingly, a Centrally Sponsored Scheme, 'National Food Security Mission' (NFSM), was

launched in October 2007. The Mission met with an overwhelming success and achieved the targeted additional production of rice, wheat and pulses. The Mission is being continued during 12th Five Year Plan with new targets of additional production of 25 million tons of food grains comprising of 10 million tons rice, 8 million tons of wheat, 4 million tons of pulses and 3 million tons of coarse cereals by the end of 12th Five Year Plan. Based on past experience and feedback received from the States major changes have been made in approach, norms of financial assistance and programme implementation strategy in 12th Five Year Plan.

The National Food Security Mission (NFSM) during the 12th Five Year Plan had five components (i) NFSM-Rice; (ii) NFSM-Wheat; (iii) NFSM-Pulses, (iv) NFSM-Coarse (nutri/minor) cereals and (v) NFSM-Commercial Crops.

The Broad Objectives of NFSM:

1. Increasing production of rice, wheat, pulses and nutri/minor cereals through area expansion and productivity enhancement in a sustainable manner in the identified districts of the country;
2. Restoring soil fertility and productivity at the individual farm level; and
3. Enhancing farm level economy (i.e. farm profits) to restore confidence amongst the farmers.

The strategies adopted under National Food Security Mission (NFSM) to achieve desired objective were;

- Focus on low productivity and high potential districts including cultivation of food grain crops in rainfed areas.
- Implementation of cropping system centric interventions in a Mission mode approach through active engagement of all the stakeholders at various levels.
- Agro-climatic zone wise planning and cluster approach for crop productivity enhancement.
- Focus on pulse production through utilization of rice fallows, rice bunds and intercropping of pulses with nutri/minor cereals, oilseeds and commercial crops (sugarcane, cotton, jute).
- Promotion and extension of improved technologies i.e., seed, integrated nutrient management (INM) including micronutrients, soil amendments, integrated pest management (IPM), input use efficiency and resource conservation technologies along with capacity building of the farmers/extension functionaries, close monitoring of flow of funds to ensure timely reach of interventions to the target beneficiaries.
- Integration of various proposed interventions and targets with the district plan of each identified district, constant monitoring and concurrent evaluation by the implementing agencies for assessing the impact of the interventions for a result oriented approach.

The National Food Security Mission (NFSM) has three level monitoring system i.e., at National Level; National Food Security Mission-General Council (NFSM-GC), under the chairmanship of Union Agriculture and Farmers Welfare Minister, State Level; State Food Security Mission-Executive Committee (SFSM-EC) and at District Level; the scheme will be implemented through Agricultural Technology Management Agency (ATMA). Apart from these, Project Management Team (PMT) were also constituted at National Level and State Level to Guide the States/districts in organizational and technical matters, help in the implementation and monitoring of the various interventions of the Mission, assist the States/districts in capacity building programmes and record the data on crop yield through crop cutting experiments, assist the district and State agencies in concurrent evaluation based on case studies in identified districts and document and disseminate the success stories, undertake publicity/ information campaign to create awareness about the Mission activities, ICAR institutes, SAUs and KVKs functioning in the district will provide technical support in formulation of district action plans, its implementation and monitoring, the technical staff will be sourced from these organizations for imparting training to the farmers and extension personnel.

During the 11th Five Year Plan, NFSM-Rice was implemented in 144 districts of 16 states, NFSM-Wheat in 142 districts of nine states and NFSM-Pulses in 468 districts of 16 states. From the year 2012-13, six (6) NE states, viz. Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Sikkim have been included

under NFSM-Rice and two Hill states, viz., Himachal Pradesh and Uttarakhand under NFSM-Rice and Wheat and J&K under NFSM-Wheat. Thus, the NFSM was implemented during 2012-13 and 2013-14 in 27 states of the country. From the year 2016-17, NFSM is implemented in 638 districts of 29 states. Also, NFSM-Rice is being implemented in 194 districts of 25 states. NFSM-Wheat is being implemented in 126 districts of 11 states. NFSM-Pulses is being implemented in 638 districts of 29 states and NFSM-Coarse (nutria/minor) cereals are being implemented in 265 districts of 28 states. The number of districts covered under each of the components of NFSM during 2016-17 is given in Annexure-I.

Interventions promoted under NFSM

Under National Food Security Mission (NFSM) various interventions are being promoted to achieve the objective of enhancing production and productivity; these includes:

- Cluster demonstrations with latest crop production technologies such as timely sowing, seed rate, recommended package of practices, etc.; Promotion of newer varieties/hybrids, stress-tolerant varieties.
- Assistance of integrated nutrient management for maintaining soil health and to improve yield and integrated pest management to protect the crops from insects, pests and diseases, promotion of improved farm machineries for timely completion of agricultural operations and reduction in cost of cultivation, water saving devices like sprinklers, raingun and water carrying pipes to save precious water and avoid to flood irrigation.
- Cropping system-based trainings to farmers for updation of their knowledge and capacity building.

Apart from this, additional area coverage for increasing pulses production during *Rabi* season is also being implemented under NFSM to enhance pulses production whererecluster demonstration and seed distribution of newly released varieties are being promoted amongst the farmers. Under additional area coverage for increasing pulses programme there were 17 states given financial allocations for enhancing the pulses production during 2016-17. The funding pattern under NFSM from the year 2015-16, the mission is being implemented on 60:40 sharing pattern between Centre and State Governments and on 90:10 sharing pattern between Centre and Northeastern & three Hill states.

The food grains have been categorized into rice, wheat, pulses and nutria/minor cereals categories. The green revolution has helped in the past decades to increase the yield of rice and wheat, which provides the staple food to the majority of Indians. This enhancement is a result of improved cultivars, improved inputs, and better farm practices. The route adopted by the government towards increased food grain production includes both yield increase as well as sown area increase. The national objective towards food security is broadly divided into three categories including a) increasing production of rice, wheat, pulses and nutria/minor cereals through area expansion and productivity enhancement in a sustainable manner in the identified districts of the country; b) restoring soil fertility and productivity at the individual farm level; and c) enhancing farm level economy (i.e. farm profits) to restore confidence amongst the farmers. Additional food grains production of 25 million tons consisting of rice-10 million tons, wheat-eight million tons, pulses- four million tons and nutria/minor cereals – three million tons by 2016-17 is one of the key priorities. Also, ensuring higher crop productivity in low-yielding districts in comparison to state average is another key area of concern.

States & Districts covered under NFSM

	2012-13		2016-17	
Name of crop	**No. of States**	**No. of Districts**	**No. of States**	**No. of Districts**
Rice	24	210	25	194
Wheat	12	166	11	126
Pulses	16	468	29	638
Nutri/minor (Coarse) Cereals*	-	-	28	265

The comparison of major food grains production before implementation of NFSM scheme and during its implementation in XI Plan along with targets set for XII plan is summarized below;

		XI Plan			XII Plan
NFSM Component	**Target of Additional production up to during terminal year of XI Plan**	**2006-07 (Pre-NFSM year)**	**2011-12 (Terminal year of XI Plan)**	**Percent Increase (%)**	**Target of additional production up to during terminal year of XII Plan**
Rice	10	93.36	105.30	11.94	10
Wheat	8	75.81	94.88	19.07	8
Total Pulses	2	14.20	17.09	2.89	4
Nutri/minor (coarse) Cereals*	-	-	-	-	3
Total Food grain	20	217.29	259.29	42.00	25

Note : * Nutri/minor (course) Cereals included under NFSM from 2014-15

The production of major food grain crops during XII Plan and targets set for 2016-17 in comparison with production of food grains as per 2nd Advance Estimates is summarized below:

Crops	**2012-13**	**2013-14**	**2014-15**	**2015-16 ***	**2016-17 Targets**	**2016-17 (2nd advance estimates)#**
Rice	105.24	106.65	105.48	104.41	108.50	108.86
Wheat	93.51	95.85	86.53	92.29	96.50	96.64
Total Pulses	18.34	19.25	17.15	16.35	20.75	22.14
Nutri/minor (coarse) Cereals	40.04	43.29	42.86	38.52	44.35	44.34
Total Food grains	257.13	265.04	252.02	251.57	270.10	271.98

*Final estimate

Source: Directorate of Economics and Statistics, DAC&FW

The key achievements of the NFSM in the year 2015-16 and its target in the year 2016-17 are presented in the tables below.

Achievement of NFSM during 2015-16.

Sl No	**Interventions**	**Achievement**
1	Cluster Demonstrations (ha.)	17.54 lakh ha.
2	Seed distribution (Rice, Wheat, Pulses & Coarse Cereals)	11.73 lakh q
3	Integrated Nutrient Management (ha.)	20.21 lakh ha
4	Integrated Pest Management (ha.)	19.07 lakh ha
5	Improved Farm Machineries (No's)	2.36 lakh
6	Distribution of Pump sets (No's)	48,892
7	Distribution of mobile raingun (No's)	88
8	Distribution of sprinkler set (ha)	0.19 lakh ha
9	Water carrying pipe (meter)	84.59 lakh meter
10	Cropping system based training (No's)	9688

(* 1 lakh = 100,000)

Target of NFSM for 2016-17.		
Sl No	**Intervention**	**Target**
1	Cluster Demonstrations (ha.)	19.31 lakh ha
2	Seed distribution (Rice, Wheat, Pulses & nutri/minor Cereals)	26.73 lakh q
3	Integrated Nutrient Management (ha.)	98.04 lakh ha
4	Integrated Pest Management (ha.)	36.48 lakh ha
5	Improved Farm Machineries (No's)	3.51 lakh
6	Distribution of Pump sets (No's)	63.245
7	Distribution of mobile raingun (No's)	1263
8	Distribution of sprinkler set (ha)	0.24 lakh ha
9	Water carrying pipe (meter)	201.38 lakh meter
10	Cropping system based training (No's)	16568

(* 1 lakh = 100,000)

The challenge of demand and supply gap for oilseeds

The existing gap between oilseed production and demand remains a key challenge for the country. At present the national oilseed production is estimated to be about 8.64 million tons whereas 23.49 million tons is the present demand for domestic consumption. This area needs greater attention from all the stakeholders involved in Indian agriculture. The major constraints in yield improvement of oilseeds include continued dependence on rainfed production systems leading to larger fluctuation in area and yield with larger variation in groundnut crop, agroclimatic limitations like adaptability of mustard under saline soil / low water areas of >4 million ha; groundnut under low rainfall / drought prone areas of >2 million ha and soybean under upland black cotton soils of >10 million ha, farmers giving priority to cereals under irrigated condition due to assured buy back, availability of cheaper imported vegetable oils with admissible blending, which is depressing domestic markets of oilseeds leading to stagnation of area under oilseeds, lack of assured procurement of oilseeds. The strategies formulated by NFSM for increasing the oil seed production include increasing seed replacement rate (SRR) with varietal replacement, promotion of new varieties through mini kits and front level demonstrations (FLDs), area expansion under protective irrigation, area expansion through diversification of low-yielding cereals, use of rice fallows and intercropping, enhancing procurement of oilseeds. A number of frontier technologies have been identified by NFSM to increase the oil seed production in the country. These include ridge-furrow/broad-bed-furrow technologies in soybean and groundnut, line sowing in mustard, sprinkler irrigation in groundnut and rapeseed-mustard, use of drip irrigation and hybrid in castor, application of gypsum in groundnut and intercropping groundnut and soybean with arhar (pigeonpea). The key Interventions in this area have been production of foundation/certified seed (> 8 lakh quintal), distribution of more than 14.0 lakh seed mini-kits of less than 10 years old varieties of oil seeds including 6.4 lakh mini-kits of less than five year old varieties of mustard, distribution of more than 2.6 lakh quintal certified seed, demonstration of improved technologies over 2.75 lakh ha area, supply of farm machineries to more than 24,000 farmers, drip/ sprinkler system to about 30,000 farmers, five national kisan mela and three exhibitions and numerous farmers training. The table below gives area, production and yield scenario of oilseeds.

Research support under NFSM

Under National Food Security (NFSM) scheme, assistance is also given to conduct strategic adaptive research, address various research issues and gaps of potential yield and yield realized at farmers field of food crops. The research projects were being supported during the 12th Plan to State Agriculture Universities (SAUs), National and International research organizations. The broad category under which support is extended are; conservation of natural resources (land, water) and their efficient use, integrated nutrient management, integrated disease and pest management, modification/ refinements in farm

Year	Area (Lakh ha)	Production (Lakh tonnes)	Yield (Kg /ha)
1950-51	107.30	51.60	481
1960-61	137.70	69.80	507
1970-71	166.40	96.30	579
1980-81	176.00	93.70	532
1990-91	241.50	186.10	771
2000-01	227.70	184.40	810
2010-11	272.20	324.82	1193
2011-12	263.10	297.99	1133
2012-13	264.84	309.43	1168
2013-14	285.25	327.49	1153
2014-15	257.26	275.11	1037
2015-16	261.86	252.51	989
2016-17 (2nd adv)	266.33	335.96	1261

machines/ tools for various soils types/cropping systems, upscaling of improved crop varieties/ hybrids in NFSM adopted states/ agro-climatic zones under water/ thermal stress conditions, nutrient management in acidic/alkaline/sodic, crop-husbandry, input use efficiency, rain-water management in *kharif* pulses, refinement of relay cropping systems, agronomic practices for intercropping systems involving pulses, quality seed storages in the humid and hot climatic conditions-coastal areas, value addition in case of nutri/minor cereals and pulses, precision farming -nutrient manager and crop manager, any other innovative approach for enhancement of crop productivity.

Training

Under National Food Security Mission (NFSM), assistance is also given to training of trainers/farmers, which plays crucial role in speedy dissemination of improved crop production practices. Since the Mission has adopted cropping system-based approach, it is proposed to organize four sessions of each training. One at the beginning of *Kharif* and *Rabi* season, one each during *Kharif* and *Rabi* season. The training will be imparted by crop/subject matter specialists of ICAR institutes/SAUs/KVKs and will involve crop management (agronomic and plant protection practices) including primary processing of produce, storage etc. There will be a group of 30 participants/farmers in each session and participants in all four sessions will be same. In order to propagate latest crop specific technologies amongst Central and State functionaries who are involved in implementation of NFSM programme, the SAUs, National and International research organizations would be assisted to organise crop specific trainings within the country.

Other initiatives under NFSM

(a) *Specialized projects for high productivity areas:* For sustainability of the high productivity areas, special projects such as reclamation of problematic soils, development of water-logged areas and mitigation of adverse effect of climate change would be funded under the Mission.

(b) *Support to institutes/organizations including NGOs in remote areas*: to reach out farmers in remote areas is difficult due to poor accessibility, hence, these regions are mostly rainfed and inhabited by tribal and poor farmers. Under the mission, States may identify such areas requiring special efforts for raising productivity of food grain crops and suitable institutes/organizations including NGOs may be assigned to undertake clusters demonstrations in these areas.

(c) *Value Chain integration of small producers:* The majority of the farmers are small producers who face difficulties in managing high risk involved in farming mainly due to weather aberrations, uneven access to technologies, unreliable input supplies, erratic power supply, inadequate marketing arrangements etc. Their situation is likely to worsen in the near future if these challenges are not addressed. Also, forming and strengthening of Farmer Producer Organizations (FPOs) is likely to mitigate atleast some of the risks and constraints faced by the farmers. The formation of FPOs may offer a collective strength for seed production and seed procurement, access to credit and improved technologies, reduce transaction costs, facilitate value addition, tap high-value markets and enter into partnerships with private entities on more equitable terms.

(d) *Assistance to Custom Hiring Centres:* For small land holders, the farm mechanization by individual farm families is economically not viable. Therefore, such farm holders utilize the services of Custom Hiring Centres for the various farm operations. Also, under special cases, community operations of selected farm activities are required to be undertaken within a time frame. In view of this, provision has been made to subsidize cost of hiring machines for farming operations at individual farmer/community level.

(v) *Marketing support for pulses and millets:* For promoting the production of pulses and millets, under the mission, marketing support would be provided to growers in form of insurance cover, dal mill and millet processing unit to individual/communities, incentives to processing agencies etc. The support for value addition and marketing in pulses and millets will cover the following areas: Establishment of mini dal mills by farmers, farmer groups or registered FPOs, support for branding and marketing of milled pulses or millets, marketing support to un-registered farmer groups, SHGs, SHG federation etc. for local marketing of pulses and millets, support to registered FPOs to set up and equip procurement centres to grade and process pulses and millets. Also, special initiatives under NFSM to enhance pulses production are: As many as 150 seed hubs have been sanctioned with an allocation of $34.87 million for the years 2016-17 and 2017-18. For strengthening of breeder seed programme at ICAR institutes and SAUs an amount of $ 4.70 million is earmarked for two years. An amount of $ 13.94 million has been allocated for central agencies like HIL, KRIBHCO and NSC under seed production programme for increasing availability of seed of pulses. An amount of $ 10.45 million has been allocated for pulses seed mini-kit distribution during *Kharif/ Rabi* & summer to popularize newer varieties. Also, pulses are being promoted by launching a special programme from the year *Rabi* 2016-17 under 'Targeting Rice Fallow Areas in Eastern India' in the states of Assam, Bihar, Chhattisgarh, Jharkhand, Odisha and West Bengal.

Conclusion

Under the mission, with collective efforts of center and state governments, focused and sincere attempts by all the stakeholders involved in implementation of National Food Security Mission (NFSM) enhancing production and productivity of food grain crops, restoring soil fertility and productivity at the individual farm level with enhanced farm level economy will be a reality in the near future. There has been increased focus on minimizing post-production losses. Also, better market linkages are the key to enable farmer to achieve better price for their produce. In order to increase market linkages, 81 FPOs have been formed in recent years though this is just one step towards increasing the market linkages. The national e-market for farm produce and better minimum support price (MSP) for food grains has been the other initiative steps towards this common objective. Also, larger support for protective irrigation and mechanization, strengthening seed chain for promotion of newly released variety / hybrids, assured procurement support with competitive prices over food grain to encourage diversification of areas, processing support for oilseeds and oil palm in new non-traditional areas are the key areas where more work needs to be done to help achieve the noble objective of food grain security of the nation.

Annexure-I

Districts Covered (Identified) Under National Food Security Mission (2016-17)

Sl. No.	State	Number of Districts covered under			
		NFSM-Rice	NFSM-Wheat	NFSM-Pulses	NFSM-Nutri/minor (Coarse) Cereal
1	Andhra Pradesh	5	-	13	6
2	Arunachal Pradesh	10	-	17	17
3	Assam	13	-	27	4
4	Bihar	15	10	38	11
5	Chhattisgarh	13	-	27	9
6	Goa	-	-	2	-
7	Gujarat	2	5	26	8
8	Haryana	-	7	21	5
9	Himachal Pradesh	2	11	12	12
10	Jammu & Kashmir	8	8	22	22
11	Jharkhand	4	-	24	11
12	Karnataka	7	-	30	11
13	Kerala	1	-	14	1
14	Madhya Pradesh	8	16	51	16
15	Maharashtra	8	3	33	8
16	Manipur	9	-	9	9
17	Meghalaya	7	-	11	11
18	Mizoram	6	-	8	8
19	Nagaland	11	-	11	11
20	Odisha	8	-	30	6
21	Punjab	-	12	22	3
22	Rajasthan	-	14	33	12
23	Sikkim	2	-	4	4
24	Tamil Nadu	8	-	30	10
25	Telangana	4	-	9	6
26	Tripura	8	-	8	8
27	Uttar Pradesh	23	31	75	20
28	Uttarakhand	5	9	13	13
29	West Bengal	7	-	18	3
	Total	**194**	**126**	**638**	**265**

9 Doubling Farmers' Income in Maharashtra

KP Viswanatha

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Abstract

Rainfed agriculture poses great challenges to farmers in Maharashtra State and the contribution of the primary sector has reduced from 34 % of the state GDP to about 13-14 % over the last few decades. Despite these challenges, the farmers of Maharashtra have shown great resilience over the past few years with highest production of grapes and onion in the country. Moreover, the steady increase of pulses production over the past few decades with cultivation area for pulses in the state increased from 2.7 million ha in the year 1981 to 4.1 million ha by the year 2008. The yield improved with the introduction of better cultivars and farm practices from 300 kg per ha to 770 kg per ha over the same period. The net result reflected is the gross pulses production in the state crossing 3.2 million tons from 0.8 million tons in 1980s. The text further highlights the need for an integrated farming system and highlights the importance of post production and market linkages in order to help distressed farmers in the State of Maharashtra.

Introduction

About 85 million ha of farming area in India is considered rainfed at present of which 68.5 million ha is completely rainfed whereas the balance is partially rainfed. The erratic rainfall pattern and frequent drought years in recent decades have made rainfed agriculture more vulnerable. The situation becomes critical when combined with degraded land (due to over exploitation and poor nutrient management of the soil), resource poor farmer and depletion of groundwater levels in large parts of Maharashtra. About 80.24% of the 17.5 million ha. net cropped area of Maharashtra is rainfed. The overall crop intensity in the state is about 127%. Also, about 52% of the net cropped area is drought prone due to which rainfed agriculture poses great challenges to the farmers. The share of agriculture and allied sectors in state GDP is exhibiting a declining trend in last 40 years (Fig 1). The contribution of primary sector has reduced from about 34% of the state GDP to about 13-14% over the last few decades.

Less than 1 % of farmers of Maharashtra are large farmers and hence it is relevant to focus our activity towards improving the livelihood of small and marginal farmers who form the bulk part of the 53 % of the state's population dependent on agriculture.

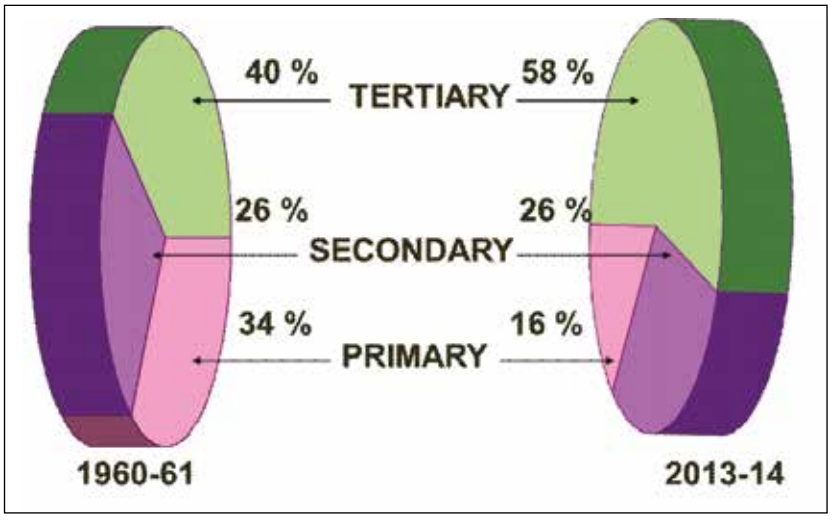


Figure 1. Sectorial composition of state income for the year 1960-61 and 2013-14, at current prices (Economic Survey of Maharashtra 2014-15).

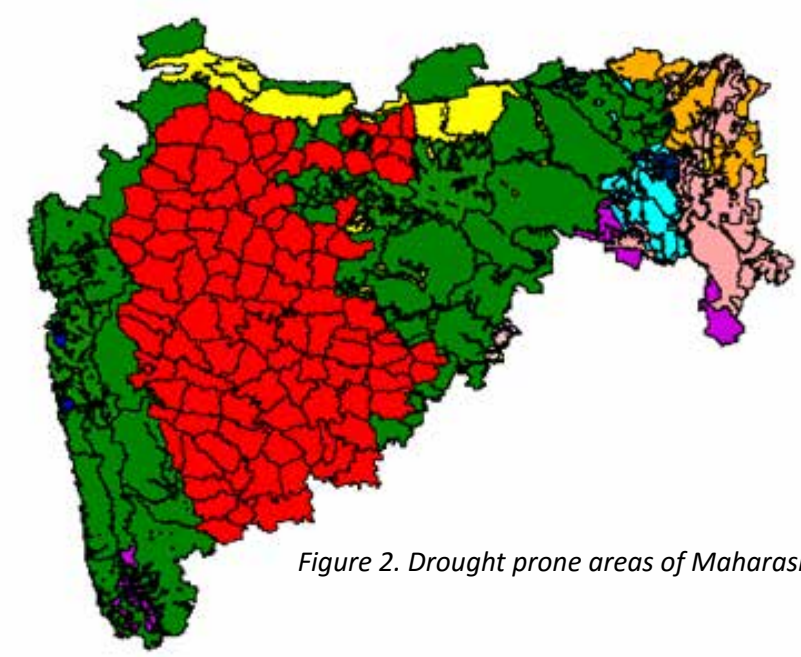


Figure 2. Drought prone areas of Maharashtra (marked in red).

Table 1. Land holding pattern of farmers in Maharashtra.

	No. of Operational Holdings (Lakh)		Area (Lakh ha)	
Farmers		%		%
Marginal	53.06	43.71	26.49	13.18
Small	36.06	29.71	51.27	25.5
Semi-medium	22.74	18.73	61.09	30.39
Medium	8.65	7.13	48.80	24.27
Large	0.87	0.72	13.38	6.66
Total	121.38		201.03	
SC	9.44	7.8	12.41	6.23
ST	7.78	6.46	15.34	7.7

(* 1 lakh = 100,000)

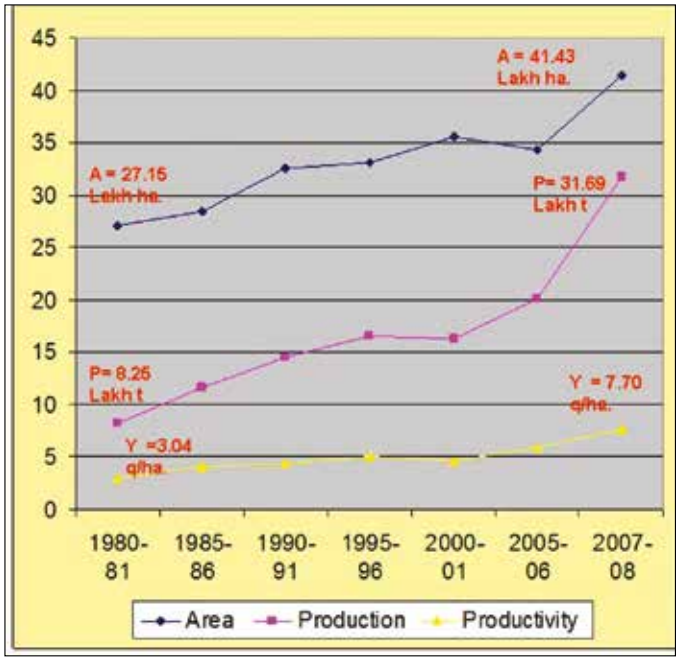
Key strength

Despite the challenges Maharashtra has several key strengths which can help in achieving the objective of doubling farmers' income by the year 2022. These are presented below:

1. Diverse agro-climatic conditions
2. Strong research support (four state agricultural universities)
3. Twelve national research institutes (NRCs), exists in the state
4. About 15,500 field level staff
5. Strong co-operative network
6. Proximity to international airport & sea port along with logistic advantages
7. Crop-based farmers organizations
8. Innovative farmers
9. Availability of large coastal area
10. Scope for primary industries
11. Huge market potential
12. Higher share of working adults

The success stories of pulses in Maharashtra

Despite the consecutive drought years, the farmers of Maharashtra have shown great resilience over the past few years with highest production of grapes and onion in the country. Moreover, the steady increase of pulses production over the past few decades is a success story worth recognition. The cultivation area for pulses in the state increased from 2.7 million ha in the year 1981 to 4.1 million ha by the year 2008. The yield improved with the introduction of better cultivars and farm practices from 300 kg per ha to 770 kg per ha over the same period. The net result is reflected is the gross pulses production in the state crossing 3.2 million tons from 0.8 million tons in 1980s.



Challenges

Knowing the challenges is considered the first step to formulate suitable mitigation strategies. The key challenges are listed below:

1. Limited irrigation resources
2. Erratic Monsoon
3. High extent of drought prone areas
4. Inadequate crop insurance support
5. Inadequate crop credit
6. Lack of varietal breakthrough
7. Inadequate storage infrastructure
8. Inadequate processing facilities for value addition and poor marketing facilities
9. Inadequate infrastructure facilities
10. Slow pace of watershed development
11. Inadequate micro level planning of agricultural production
12. Weak training and extension setup after discontinuation of Training and Visit system

Challenges specific to rainfed agriculture

Number of factors which make rainfed agriculture difficult with very little net return to the farmers are given below:

1. Drought and water scarcity is a constant threat
2. Stubborn poverty & food insecurity
3. Low rainwater use efficiency, low crop productivity & high instability
4. Land degradation & declining soil health
5. Acute fodder shortage and poor livestock productivity

Strategies to circumvent the challenges

Recommendation of the high level committee on agricultural development under the chairmanship of Dr MS Swaminathan has come out with 347 recommendations to achieve higher productivity (P), quality (Q), returnability (R), sustainability (S). The key strategies recommended to achieve the same are listed below:

1. Promoting Integrated Farming System (IFS)
2. Strengthening Crop Diversification
3. Promoting *in-situ* water conservation in rainfed areas
4. Promoting Organic Farming
5. Popularizing Concept of IPM (integrated pest management)
6. Expanding coverage under micro-irrigation
7. Broad basing agricultural extension
8. Empowering through grass root level organizations
9. Creating post-harvest handling facilities bringing in marketing reforms
10. Adding value through agro-processing
11. Sensitizing towards quality agro-produce
12. Encouraging Public Private Partnerships
13. Making agri research more relevant
14. Making agri education more useful
15. Revitalizing agri - extension education
16. Increasing use of IT through cyber extension
17. Bringing in institutional reforms
18. Preparing for WTO (World Trade Organization) challenge

Integrated Farming System

To increase the net income of resource poor farmers and to help in reducing the vulnerability of their livelihood, integrated farming systems have been emerging as a feasible strategy. The diversification of farm income through horticulture, livestock, apiculture, sericulture, vermiculture alongside long-term crop diversification are the key components of integrated farming system which reduces the input cost and creates more revenue generation.

Importance of post-production and market linkages

The success stories such as Ralegan siddhi highlights the importance of better post-production practices and the better price realization in presence of crops based Farmer Producer Orgnaizations (FPOs). Inadequate post-harvest processing facility is a key bottle neck towards value addition of farm produce today.

Figure 3. Integrated farming system.

Technical Session III
Enabling Institutions and Policies for Desired Impact

Chair *: Dr Girish Sohani*

Rapporteur : *Dr Mukumd Patil*

10 TATA TRUSTS
Initiatives on Agriculture – Strategic Directions into the Future

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Abstract

Tata Trusts has been playing a large role in community development initiatives .The Trusts work towards increasing profitability of small farmers and projects of the Trusts are strengthening value chains of select crops across a diversity of landscapes. The Trusts are moving ahead from their current focus on investments in projects in to programmable ideas leading to widespread and strong impacts. Evolving with time, the Trusts are also investing in post-harvest systems, market development, financing of agri projects, technology applications etc.

Tata Trusts are one of India's largest philanthropic organisations investing financial and other resources into community development initiatives. The Trusts focus on verticals like rural livelihoods, health and nutrition, education, water and sanitation, media, arts and culture, urban poverty, innovations etc. The portfolio of rural livelihoods encompasses crop production, animal husbandry, water use efficiency, technology applications, value chain development and enterprises through community-based organisations.

The Trusts work through partner organisations and also have their own regional implementation teams that are identified as Regional Initiatives. A regional Initiative is a strong system of project management having its own team, sanctioned budget and a defined action plan. The regional Initiatives are as below.

Historically, livelihood projects of the Trusts have focused strongly on production systems and the core function was the transfer of technology from existing research institutions to farmers. Evolving with time, the Trusts now are also investing in post-harvest systems, market development, financing of agri projects, technology applications etc.

SN	Regional Initiative	Priority geography of operation
1	Central India Initiative (CInI)	Tribal areas of Gujarat and Jharkhand
2	Centre For Microfinance (CMF) (Called Sakh Se Vikas)	Rajasthan
3	Centre for Microfinance & Livelihood (CML)	Assam and Meghalaya
4	Coastal Salinity Prevention Cell (CSPC) Kharash Vistar Utthan (KVY)	Gujarat
5	Eastern UP project Management Unit	Uttar Pradesh
6	Himmotthan Pariyojana	Uttarakhand
7	KALIKE Called KSU	Yadgir district of Karnataka
8	Leh Initiative	Leh district of Jammu & Kashmir
9	The North East Initiative Development Agency (NEIDA) Called North East Initiative.	States of Arunachal Pradesh, Mizoram and Nagaland
10	Reviving Green Revolution (RGR)	States of Punjab and Tamilnadu
11	Sukhi Baliraja Initiative	Vidarbha region of Maharashtra
12	South Odisha Initiative	State of Odisha
13	Tripura Initiative	State of Tripura
14	Vijayawada Initiative	State of Andhra Pradesh

Towards increasing profitability of small farmers, projects of the Trusts are strengthening value chains of select crops across a diversity of landscapes in regional initiatives. Also, investments in the future will be made in the following segments of value chains.

More and better irrigation

- Solar power for irrigation- Initiatives of the Trusts are assisting farmers and their groups to access technologies and government subsidies towards installation of solar water lifting devices in Uttar Pradesh, Jharkhand and Odisha
- Promoting gravity-based irrigation- In the undulating hilly areas, the Trusts are developing diversion-based irrigation systems in Leh, Jharkhand, North East and Odisha
- Micro irrigation applications- The Trusts are promoting such systems for demonstration and pilots within their regional initiatives.
- **Mechanization-** Teams of the Trusts are promoting enterprises of common service/ facility centers from where small farmers can take benefit of rental services for equipment.
- **Strengthened CBOs** – projects of the Trusts are bringing in sustainability of the enterprises by strengthening the community based organizations like federations, cooperatives and Farmer Producer Companies.
- **Value chain strengthening** – Trusts are developing value chains of crops like pulses, apricots, groundnut, milk, pigs etc.
- **Support systems-** Trusts are trying to improve profitability of farming through financial & digital services, warehousing/ market access
- **Technology-** Investments of the Trusts are applying cutting edge biotechnologies for crop improvement

The Trusts are moving away from their current focus on investments in projects in to programmable ideas leading to widespread and strong impacts. The platform of the regional Initiatives of Tata Trusts is an ideal point for convergence of resources from different systems.

11 Linking Farmers with Market through FPOs: Challenges and Opportunities[1]

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Abstract

Linking farmers with markets to prevent intermediaries from reducing their profits is vital to help farmers fetch better prices for their produce. The present paper focuses more specifically on 'Remunerative prices for farmers by linking them with better markets through Farmer Producer Organizations (FPOs). The current public procurement system is biased towards certain crops and regions. The infrastructure facilities from road, safe storage, cleaning & grading facilities etc. are very seriously constrained at many regulated markets. The total volume of agricultural produce traded through regulated markets in the country is very minimal. Both Central and State Governments are stressing on promoting 'Farmer Producer Organizations (FPOs)' as an important strategy for creating an ecosystem for enhancing farmers profits. This structure not only provides technical know-how to farmers but also connects to both input and output markets by completely negating the role of intermediaries. The Government of Andhra Pradesh has envisioned double digit growth in primary sector in collaboration with the ICRISAT-led consortium and has developed a primary sector strategy. It also brought out the 'policy and operational guidelines to promote FPOs' in the state. The state government also envisioned to set-up 1000 FPOs to benefit at least one million farmers during the initial stages. The chapter clearly mentions how this can be done on a larger scale and provides recommendations and critical drivers for success.

Introduction

The most appropriate measure of farmers well-being is the level of farm income. However, appropriate estimates of farm income are not available in most countries, including India. In the absence of this information, conclusions on the state of farmers and their income are drawn by alluding to policies or indicators that directly or indirectly affect agriculture and farmers' income, or, by using indicators that are proxies for farmers' income (Chand et al 2015). But, while presenting Union Budget 2016-17, the Union Finance Minister, Mr. Arun Jaitely mentioned that one of the objectives of the Government of India is to double the income of farmers by the year 2022. This announcement was probably driven in light of evidence of agrarian distress in the country (Chandrasekhar and Nirupam 2016). On 4th November 2016, an eight-member panel has been set up by Prime Minister Mr. Narendra Modi, to formulate a strategy to achieve the goal is working on calculating the base income of farming households in India that would be used as a benchmark to measure increased income. The committee is headed by Agriculture Additional Secretary, Dr Ashok Dalwai, examining all the data available on farmers income and the analysis carried out by various experts to come up with a base income and quantifiable parameters. The committee is expected to submit the final report by end of March 2017. Meanwhile, several critics had pointed out that it would be meaningless without a base income for comparing growth. Also, questions were raised on what would be constructed as farm income and whether growth would be calculated in real or nominal terms. Also, doubts were expressed by few economists that the doubling of income of farmers would be in net or gross terms. With this background, the committee has also been asked to identify potential areas for greater investment in agriculture and suggest ways to reduce risk of farming by diversifying to horticulture and allied activities to boost income. The committee is also exploring a slew of measures to reduce the costs of farming so that farm net income gets doubled during stipulated time.

Issues/challenges

The agriculture situation in India, in general is confronted with several issues. After careful deliberations, the Task Force on Agricultural Development chose to concentrate on the following five major issues (Occasional Paper, NITI Aayog, 2015).

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1. This paper is prepared based on a comprehensive scoping study carried out by ICRISAT in Andhra Pradesh under Rythu Kosam project. Access complete research report at Raju et al. 2017.

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1. A series of essential steps are required to raise agricultural productivity. This includes addressing the low average productivity at the national level and high variation within the region. To increase productivity, progress is required along three dimensions: (i) Quality and judicious use of inputs such as water, seeds, fertilizer and pesticides; (ii) Judicious and safe harnessing of modern technology including genetically modified (GM) seeds; and (iii) shift into high-value commodities such as fruits, vegetables, flowers, fisheries, animal husbandry and poultry.
2. Farmers need to be ensured to receive remunerative prices. This issue has two aspects, one relating to the Minimum Support Price (MSP) and the other relating to the farmer's share in the price paid by the final consumer. Taking the MSP first, it effectively applies to a specified set of commodities and is available only in a subset of producer states. For commodities such as fruits and vegetables, which are not subject to any procurement by official agencies, sometimes the market price can be excessively low due to perishability and localized nature of markets for them. The supply chain remains fragmented, scale of operations is low and there is excessive presence of intermediaries. The poor state of competitiveness is more pronounced during above normal or below normal production.
3. The second aspect of the price received by the farmer concerns the small fraction of the price paid by the final consumer that the farmer receives in the market place. The continued presence of regulations flowing from the Agricultural Produce Marketing Committees (APMC) Acts in most commodities in most states has meant that the farmer is compelled to sell her/his produce in the government-controlled marketing yards. These controls restrict transactions to the handful of local players and results in easy manipulations.
4. For historical reasons, land leasing laws in India have taken forms that discourage formal leasing contracts between the owner and the tenant. Several studies have shown that most of tenancy in the country is concealed and, thus, unofficial. The lack of identification of tenants as actual farmers has very serious implications for the conduct of public policy. Benefits intended for the tenant farmer such as disaster relief or direct benefit transfers risk being disbursed to the owner of the land who appears as the cultivator in the official records. Another closely related aspect, ownership rights in India are also poorly defined.
5. Farmers are frequently affected by natural disasters such as droughts, floods, cyclones, storms, landslides, hails and earthquakes. Because most farmers lead subsistence existence, such disasters can lead to extreme distress and hardship. One critical problem in the existing crop insurance scheme was credit linked to the scheme. There is acute need to rectify this situation by providing minimum quick relief to marginal and small farmers.
6. There is urgent need for special attention to the problems of farmers in eastern states. Given fertile land and abundant water resources, these states have a high potential in agriculture. Therefore, concerted effort is required to bring the Green Revolution to these states.

The above five major issues are currently posing greater challenges to Indian agriculture. However, 'Remunerative prices for farmers by linking them with better markets through Farmer Producer Organizations (FPOs)' remains the strategic focus of this effort. Some of the more specific challenges in linking farmers with markets are elaborated based recent studies below:

- The conventional Agricultural Produce Market Committee (APMC) Acts/marketing arrangements have undermined the interests of the farmers and benefited the intermediaries (Chand 2012; Gulati 2013). The model APMC Act, 2003 introduced by the Central Government is yet to be fully implemented by many states. Also, half of the states, which made provisions in law to implement reforms, did not notify the change and thus the provisions of model Act remained ineffective.
- While the government currently announces Minimum Support Price (MSP) for 22 crops, procurement is effective mainly for wheat, rice, cotton and sugarcane. The past four and a half decades policy bias has significantly distorted the cropping pattern in the country towards rice and wheat at the expense of other crops such as pulses and oilseeds. Despite significant volume of imports, prices of pulses have seen frequent spikes and its per capita availability also declined significantly from 25.2 kg in 1961 to 15.3 kg more recently. In case of oilseeds, India's dependency on import has risen to 60% of domestic consumption. The intensive cultivation of these two cereals (rice and wheat) has resulted in depletion of water resources, soil degradation and deterioration of water quality in some states, especially in the northwestern region.

- The price policy has also discriminated against eastern states where procurement at the MSP is minimal or non-existent. The prices of wheat and rice in these states end up below what they would be in the absence of price interventions of the government due to part of the Public Distribution System (PDS) demand in these states already met at grain procured in other states. Thus, the price policy also created a regional bias in crop pattern as well as incomes of farmers.
- Current agricultural marketing suffers from fragmentation resulting from large number of intermediaries and poor infrastructure, lack of vertical integration and policy distortions. A consequence of this fragmentation is that the farmer often receives a small fraction of the final price paid by the consumer. Therefore, urgent reforms are needed in agricultural marketing so as to enable farmers to receive a larger proportion of the final price paid by the consumers.
- The agricultural produce marketing systems suffer from major distortions and multiplicities of levies and mandi taxes (Patnaik 2011 and Subramanian 2014). There are neither transparent nor uniform processes across the states and have been a major barrier to farmers realizing remunerative prices. There remain serious restrictions on the movement of agricultural commodities even within states.
- Market infrastructure, institutions and public policy are not very favorable towards marketing of livestock products such as meat and meat products, inland and brackish water fisheries. Policies that facilitate the development of food processing industry will automatically create lucrative prices for these high value commodities. This industry can also create vast employment opportunities for agricultural work force in the country.
- In the post-reform era, India has relied more heavily on prices to expand agricultural production with technology and other non-price factors taking a backseat. This has had the unhappy side effect of relatively high food inflation and cyclical growth pattern. There is a need for a paradigm shift from price centric instruments to non-price i.e., create enabling market environment for produce for high price realization for farmers.
- Chand and Singh (2016) constructed an 'Agricultural Marketing and Farmer Friendly Reforms Index' (AMFFRI) to compare the status of reforms undertaken in agricultural sector across states and Union Teritories (UTs). This index is based on actions taken by each state or UT on: (i) reform the system of agricultural marketing (ii) facilitate and liberalize lease-in and lease-out of agricultural land, and (iii) liberalization of regulation on felling and transit of trees grown on private land. The study concluded that none of the states in the country implemented an entire set of market reforms. The state of Maharashtra achieved first rank (81.7) in the implementation of various reforms. Gujarat secured the second rank (71.5) followed by Rajasthan (70.0) and Madhya Pradesh (69.5).
- Development Monitoring and Evaluation Office (DMEO) has undertaken a primary study with an objective to analyze the 'efficacy of MSP on Farmers for the period from 2007-08 to 2010-11 (Niti Aayog 2016). A multi-stage, stratified random sampling method was employed to cover 1440 households from 144 villages, 72 blocks, 36 districts and 14 states. The study has concluded that only 21% of the sample farmers expressed their satisfaction about MSP declared by the Government whereas 79% expressed their dissatisfaction due to various reasons. Only 81% of cultivators were aware of MSP fixed by the Government for different crops and out of them only 10% knew about MSP before the sowing season. In few selected states of Eastern India, the poor impact of the scheme may be judged by the fact that none of the selected farmers were even aware of the existence of such a scheme.
- Indian agriculture has become increasingly market-oriented and monetized. The proportion of agricultural production that is marketed by the farmers has increased significantly over a period of time (Sharma and Harsha 2016). The study observed that medium (76.2%) and large (100%) farmers have very high access to paddy-regulated markets while small and marginal had poor access. They also noticed huge inter-state variations in paddy market access (very high in Punjab and Haryana while lower in West Bengal). The unit prices of paddy received by farmers in Punjab were much higher than West Bengal under all channels. Also, farmers cultivating nutri/minor (coarse) cereals, pulses and oilseeds have poor access to regulated markets and are forced to sell their produce in unregulated markets at lower prices. Strengthening physical infrastructure at markets and access to quality of information are critical to get remunerative prices of agricultural produce.

Above are some of the direct challenges with the current agricultural marketing system in the country. Also, linking small and marginal farmers to better markets and providing them a choice to where and when they want to sell their produce is critical. The current public procurement system is biased towards certain crops and regions. The infrastructure facilities from road, safe storage, cleaning & grading facilities etc. are very seriously constrained at many regulated markets. The total volume of agricultural produce traded through regulated markets in the country is very minimal. So engagement of private sector is inevitable to meet demand as well as creation of necessary infrastructure facilities. To overcome all these limitations, we need institutional innovative systems which are farmer voluntary membership based and self-sustainable in the long-run.

Interventions to double the income

The high vulnerability of small and marginal households is largely attributed to lower scale of operation, lack of information, poor access to cheaper credit, weak participation in the consumers' markets and consequently, exploitation by intermediaries in procuring inputs and marking of their produce. A variety of approaches have emerged over the years to address these problems. The success of cooperatives in India point to many limitations, except few successful exceptions in the field of dairy farming. In recent years, collectivization of producers, especially small and marginal farmers, into producer organizations has emerged as one of the most effective pathways to address the many challenges of agriculture. Hence, on the recommendations of a high-power committee, the Government of India introduced the Companies (Amendment) Act 2002, which paved the way to Producer Companies (PCs). It is one of the important elements in innovative institutions to support farmers in this transformation.

Experiences in India and other parts of the world clearly indicate that farmers institutions that are membership based, financially robust, adopt business model, well integrated (to technology, research, markets, banks and other infrastructure facilities) and could provide enormous economic benefits to its members. Such collective action goes beyond coming together for merely aggregation of outputs, but goes to realms of business and markets through scale of operations. In this backdrop, both Central and State Governments are stressing on promoting 'Farmer Producer Organization (FPOs)' as an important strategy for creating an ecosystem for enhancing farmers profits. This structure not only provides technical know-how to farmers, but also connects to both input and output markets by completely negating the role of intermediaries. The formal networking of farmers also improves their capacity and helps empower them significantly.

Small Farmers Agribusiness Consortium (SFAC)[2] is an autonomous society promoted by Ministry of Agriculture Cooperation and Farmers Welfare. The Government of India launched a pilot programme for promoting FPOs during the year 2011-12 in partnership with 25 state governments and mobilized approximately 0.695 million farmers in over 694 FPOs (428 registered and 266 under the process of registration), the majority of which have been incorporated as producer companies under the Companies Act, 1956. Support to Producer Organizations (POs) has been one of the priority areas also identified by NABARD considering the significant role the POs can play, if nurtured in right manner, in empowering the farming community especially in production and marketing. To give a fillip to NABARD's initiatives, Govt. of India, in the Union Budget 2014-15, announced setting up of "Producer Organization Development and Upliftment Corpus (PRODUCE) Fund" in NABARD[3] with a corpus of $ 30.96 million to be utilized for the building and promotion of 2000 FPOs across the country in two years.

With similar enthusiasm, the Government of Andhra Pradesh has envisioned double digit growth in primary sector in collaboration with the ICRISAT-led consortium and has developed a primary sector strategy. It also brought out the 'policy and operational guidelines to promote FPOs'[4] in the state. The state government also envisioned to set-up 1000 FPOs to benefit at least one million farmers during the initial stages. The state government also requested ICRISAT to carry out a comprehensive scoping study[5] of

2. Refer more at www.sfacindia.com
3. Refer more at 'FPOs - Enriching Lives of Farmers, Brochure prepared and published by NABARD
4. See complete details at 'Andhra Pradesh Farmers Producers Organization Promotion Policy, 2016' Operational guidelines, GoAP, 2016.
5. Refer Raju et al 2017

the FPOs in the state with an objectives to (i) understand the status, initiatives and strategies for setting-up of FPOs in the state (ii) examine the organization, functions and constraints of existing FPOs and (iii) to identify key issues and strategic options to move forward. This proposal summarizes the critical drivers from extensive review of literature and is also based on scoping study in Andhra Pradesh.

Critical drivers for success

Drivers at global level	Drivers at Andhra Pradesh level
A compelling vision along with potentially successful business model	Identification of strategic location with coverage of sub-sectors in primary sector and creation of awareness among farmers
Early success to institute rules/norms that reinforce patronage cohesiveness and operational performance	Supporting in preparation of compelling business plans for long-term sustainability and economic viability
Strong transparent institutional structure	Engage in multiple activities/multiple crop production so that year round revenues will be generated
External agency for initial hand holding in business development	Support for creation of infrastructure facilities and their 100% capacity utilization
Harnessing local available human resources, train and empower them to reduce the costs	Initial hand holding by NGOs, Corporates, NABARD, line Departments etc.
Complementary investments in public goods and physical infrastructure to reduce costs	Providing enough credit access and insurance coverage to mitigate the anticipated risks and shocks
Agricultural production and rural marketing thinking must be supported by 'business thinking'	Facilitating in establishing strong backward and forward linkages so that it will attract more no. of farmers

Recommendations

Major issues	Options/key recommendations
Lack of convergence of various government schemes	Support establishing state and district level agency for convergence
Untapped social capital/ community resources	Utilize existing CBOs like SHGs, Rythu Mithra groups, JLGs, Cooperatives, MACS etc.
Inadequate business planning and high registration costs with time cumbersome process	Prepare business plans through professional help and facilitation. Simplify the registration process with nominal costs
Inadequate knowledge base of resource institutions	Identify Resource organizations for skill improvement and creation positive awareness among farmers
Traders have become key functionaries of FPOs	Create transparent farmer membership based organizations
Few executive members handle all responsibilities	Governance and function of FPOs should be transparent
Improper market identification and price discovery	Use digital platforms and link FPOs to transparent trading facilities
Primary level processing is inadequate	Transfer technological innovations on commodities to enhance the value addition opportunities
Absence of forward and backward integration	Facilitate strong forward and backward linkages
Access to credit is limited	Provide bank credit linkages at district and mandal level
Better growth models	Obtain institutional support and building strong linkages with the institutions to achieve better growth models

References

Anonymous. 2015. Raising Agricultural Productivity and Making Farming Remunerative for Farmers. Occasional Paper NITI Aayog, Government of India.

Chand Ramesh. 2012. Development Policies and Agricultural Markets, Economic and Political Weekly, Review of Rural Affairs, Vol. 47 (52): 53-63.

Chand Ramesh, Raka Saxena and **Simmi Rana. 2015.** Estimates and Analysis of Farm Income in India, 1983-84 to 2011-12. Economic and Political Weekly, Vol no.22, May 30, 2015.

Chand Ramesh and **Jaspal Singh. 2016. Agricultural marketing and farmer friendly reforms across Indian States and UTs.** NITI Aayog report. Access at www.niti.gov.in on 10th March 2017.

Chandrasekhar S and **Nirupam Mehrotra 2016.** Doubling Farmers' Incomes by 2022 – What would it take? Economic and Political Weekly, Vol no. 18, April 30, 2016.

Gulati Ashok. 2013. How to create economic freedom for Agriculture – Can Agriculture be unshackled from Government Controls, *in* Bibek Debroy and Laveesh Bhandari (*Ed*) State of Economic Freedom in India 2013.

GoAP. 2016. *Rythu Kosam*: Andhra Pradesh Farmers Producers Organizations' Promotion Policy-2016, Operational guidelines. Government of Andhra Pradesh, Hyderabad.

NITI Aayog Report. 2016. Evaluation Report on Efficacy of Minimum Support Price (MSP) on Farmers, PEO Report no.231, Development Monitoring and Evaluation Office, New Delhi.

Patnaik G. 2011. Status of Agricultural Marketing Reforms: Presented at the workshop on 'Policy options and investment priorities for accelerating agricultural productivity and development in India", IGIDR Proceedings/projects series. PP-069-11b, New Delhi: India International Center, Nov. 10-11, 2011.

Raju KV, Ranjit Kumar, Surjit Vikraman, Moses Shyam, Srikanth R, Kumara Charyulu D and **Wani SP. 2017.** Farmer Producer Organization in Andhra Pradesh: A Scoping Study, IDC Research Report no.16, Research Program Asia, ICRISAT, Patancheru, Hyderabad.

Subramanian Anandi. 2014. Crossing the Rubicon – Towards a Pareto Efficient Indian Agriculture Market with specific focus on rice and wheat market, Department of Economic affairs, MoF, GOI, and Working paper No.04/2014/-DEA.

Sharma Vijay Paul and **Harsh Wardhan. 2015.** Assessment of Marketed and Marketable Surplus of major Food Grains in India. Final Report, Centre for Management in Agriculture (CMA), Indian Institute of Management, Ahmedabad (IIMA), Gujarat.

12 Role of Millets in Doubling Farmers' Income and Sustainable Development of Vidarbha Region of Maharashtra

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Abstract

Vidarbha region in Maharashtra is home to 2.3 crore people and 73% of the population in Vidarbha belongs to rural regions compared to 55% for Maharashtra state. There have been more than 200,000 farmers suicides in Maharashtra in a decade, of which 70% being in the 11 districts of Vidarbha region. There is a need to promote and enhance millet production in the region by bridging yield gap and by enhancing productivity and by using promising production technologies from R&D organizations. With vagaries in climate, there is a need to develop moisture conservation practices and also link with watershed development programme.The introduction of millets-based crop systems and allied farming activities that involve women, poultry, dairy, goat farming, piggery and apiculture are highlighted in the text. Also, introduction of mechanization and hassle free financial support, marketing facilities and inputs support in convergence mode (single window system) and collective action through FPOs, creating awareness about health and nutritional benefits of millets through effective mass and local media to bring change in the consumer preferences and promotion of value-addition through entrepreneurship development through group approach (SHGs, NGOs) are the key strategies for this region.

Introduction

A large segment of the Indian population (56%) is dependent on agriculture which governs national economy, also food and nutritional security of the country and accounts for

Less than one-fifth of the total gross domestic product (GDP). With increasing population, agriculture has prolonged scope for sustainable development to feed the vast population and also provide livelihood support for the rural population. To begin with an experimental trial on pilot-basis for Vidarbha region of Maharashtra as "site of learning" to double farmersincome is contemplated and scaled to other regions of the country in a phased manner until 2022. For doubling farmers' income, challenges of agro-ecological potential and climate change impacts must be considered along with growing water scarcity, land degradation while devising the agroecoregion wise interventions.

Agro-ecological scenario of Vidarbha region

This region comprises of eleven districts in two divisions of eastern Maharashtra viz; Amravati division comprising Buldhana, Akola, Washim, Amravati, Yavatmal and Nagpur division comprising Wardha, Nagpur, Bhandara, Gondia, Chandrapur, Gadchiroli districts. The Vidarbha region is significantly underdeveloped compared to the rest of Maharashtra and India. Also, the Vidarbha region is home to about 2.3 crore people, comprising about 23% of state's total population. About 73% of population in Vidarbha belongs to rural regions compared to 55% for Maharashtra state. With a total geographical area of 9.72 million ha. (32% of state), about 4.98 million ha (28% of state) is the net sown and about 6.45 million ha. is gross cropped area. The Vidarbha region is characterized by dominance of agricultural sources of livelihood. It is also more vulnerable to climate change impacts. The soils are mostly deep black cotton soils (Vertisols and associated intergrades).

Vidarbha has three major agro-ecological zones (Fig. 1) *viz*., (1) Western Vidarbha zone (Akola, Amaravati, Buldhana, Washim and western part of Yeotmal districts), (2) Central Vidarbha zone (Wardha, Nagpur, eastern part of Yeotmal and western part of Chandrapur districts), and (3) Eastern Vidarbha zone (Gadchiroli, Gondia, western part of Chandrapur and Nagpur districts). The southwest monsoon sets over Vidarbha by the second week of June and the rains normally recede by the end of October. Also, rainfall

during winter is low and uncertain. The annual rainfall varies from 700 to 950 mm in the western parts to more than 1250 mm in the eastern parts. Also, there is great spatial variability in rainfall; in Amravati district, rainfall varies from 700 mm 1600 mm across taluks. The number of rainy days varies from 45 to 65. In the northwestern region, Chikhaldara and Dharni taluks of Amravati district receive high annual rainfall of 1000 to 1600 mm and parts of Bhandara, Gondia, Chandrapur and Gadchiroli receive high annual rainfall of 1200 to 1600 mm. The month of July is the rainiest and is followed by August. However, dry spells of 15-25 days duration occur in second half of July and August and first half of September. Because of these dry spells, agricultural drought occurs once in four to five years.

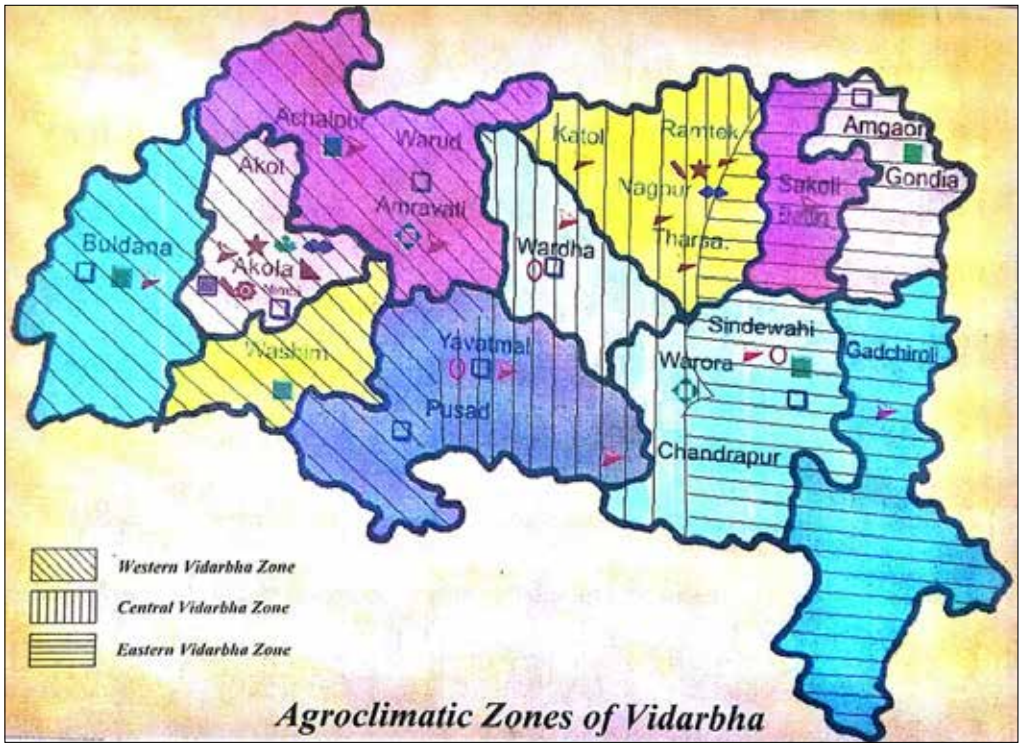

Figure 1. Agro-climatic Zones of Vidarbha.

The major crops grown are paddy, sorghum, pigeonpea, soybean and cotton during the rainy (*kharif)* season and wheat and chickpea during the post-rainy (*Rabi*) season. The major cash crops are cotton, soybean and oranges. The traditional crops are sorghum, pearl millet and paddy. The highest cultivated crop in Vidarbha is cotton but farmers do not get remunerative price, which leads to high distress among them.

Climate change impacts

Agriculture is more vulnerable due to warming and related aridity, shifts in rainfall patterns, and to the increased frequency and duration of extreme events. Also, climate projections for Vidarbha region based on the Model BCC_CSM1.1 RCP8.5 for the year 2050 are used to assess the changes in thermal and moisture regimes. The projected monthly changes for Vidarbha show that there is great month-to-month variation in both maximum and minimum temperatures and rainfall. The rainfall in first-half of *kharif* is projected to be less; June and July rainfall is crucial for rice and soybean as they will be in vegetative phase and also water management is crucial. The minimum temperature during *Rabi* is projected to increase by 2.5°C compared to the present conditions. The projected increase in *Rabi* temperatures have great impacts on wheat and chickpea crops. The overall impact of climate change on agriculture, industries as well as livelihoods is expected to be negative, threatening not only food security but sustainability. There is urgent need for promotion of climate smart crops.

Constraints

The living conditions of farmers in Vidarbha region are poor compared to India as a whole. There have been more than 200,000 farmer suicides in Maharashtra in a decade, of which 70% being in the 11 districts of Vidarbha region. It is considered as the epicenter of the farmer suicide in the country, and recorded 942 farmer suicides in 2013. Nimbarte (2016) listed out major problems of farmers distress are due to: (i) natural calamities and vagaries of climate, most of the farmers suffered and become poor, (ii) lack of irrigation facilities, crop production is low, (iii) use of science and technology by rich farmers, (iv) social, cultural, religious and economical causes, and (v) existing financial and slavery system. Along with water scarcity, land degradation, lack of good crop management are chief bio-physical constraints and need a roadmap for addressing individual parameters while focusing on enhancing system-level productivity. Also, the unique problem of this region is irrigation and it has to be used very judiciously in black cotton soils to avoid salinization of soils as well as water logging. The farmers need to be capacitated with suitable knowledge to use water judiciously and efficiently and, crops like, sugarcane and paddy to be avoided. The Maharashtra state irrigation coverage, specifically for Vidarbha region is much lower than the national average. The canal and open well irrigation system covers the maximum irrigated area and low water use efficiency in agriculture and declining per capita water availability due to increasing population and rising multi-sectorial water demand, are major issues of concern. In this scenario, there is need to concentrate on adoption of moisture conservation practices and water harvesting dynamics of development requires a wide array of human skill too.

Importance of millets

Millets are one of the cheapest sources of energy, higher content of digestive fibers, protein, vitamins and minerals (Ashok Kumar et al., 2012 and 2013). In terms of nutrient intake, sorghum accounts for about 35% of the total intake of calories, protein, iron and zinc in the dominant production/consumption areas (Parthasarathy Rao et al., 2006). Besides, being a major source of staple food for human beings, it also serves as an important source of fodder, feed and industrial raw material. It is grown in semi-arid climate where other cereal crops fail to perform (Paterson et al., 2009). Sorghum is the third cereal crop after rice and wheat in India, mostly grown under marginal and stress-prone areas of the semi arid tropics. The threat of climate change is looming large on the crop productivity of millets. The area under cultivation of millets and consumption is declining due to, low remunerative price, limited productivity, high drudgery involved in their processing, negative perceptions as a food of the poor man and policy neglect when compared to other crops (Karthikeyan, 2016). However, the millets including sorghum are emerging as a potential alternative food, feed, and fodder crop because of its resilience to high temperature and drought makes it a climate-ready crop.

In this globalization and modernization era, farmers needs are changing very fast. The traditional crops in Vidarbha region are sorghum, pearl millet and paddy (Table 1). Also, sorghum and pearl millet are mainly used for human consumption and animal fodder. Whereas, area under sorghum and other millets is reduced drastically and productivity is also low (Fig. 2). It is mainly due to low remunerative price, dependence on monsoon rains, no use of soil type-based high yielding varieties (HYVs), non-adoption of soil moisture conservation practices and improved production technologies coupled with fast changing food habits of the people. However, the national average yield of sorghum has doubled since the year 1980 due to adoption of both improved varieties and management practices by the farmers (Pray and Nagarajan, 2009). Though, we have potential with the sorghum and other millets technologies developed by the research organizations, there is a wide gap between the potential yield of the scientific technologies and that the farmers obtain in their fields due to the several reasons like, lack of knowledge, skill and input support at grass-root level, etc. Also, the marketed surplus ratio (MSR) of sorghum has increased significantly over the years from a mere 24 in 1950-51 to 64.14 in 2012-13 which implies that sorghum farmers have started selling off their products after meeting the consumption needs. Similarly, MSR of bajra has also increased over the years. The marketed surplus ratio of finger millet has become almost half as compared to the early 2000's (ASG, 2014). It means that there is lot of scope for value-addition and processing to earn more than the routine business.

Therefore, promotion of sorghum and other millets has a large scope to help mitigate the risk in agriculture unlike other food crops and can be useful especially in drought-prone regions like Vidarbha. Also, suitable intercropping of pulse crops with these millets and allied farming is also a viable option towards nutritional and economical security in a sustainable way. The four key pathways to achieve the goal are: (i) by increasing productivity, (ii) by reducing cost of cultivation, (iii) by increasing market opportunities, and (iv) by developing sustainable value chain.

Table. 1 Millets grown in Vidarbha region of Maharashtra during 2015-16 ("00" ha)

		Kharif sorghum		Pearl millet		Rabi sorghum	
S.No.	District	Area (00 ha)	Yield (Kg/ha)	Area (00 ha)	Yield (Kg/ha)	Area (00 ha)	Yield (Kg/ha)
1	Buldhana	204	623	19	98	103	564
2	Akola	114	908	0	98	1	564
3	Washim	96	449	3	98	21	564
4	Amravati	254	730	1	98	0	0
5	Yavatmal	421	407	2	98	59	564
6	Wardha	43	523	0	0	22	364
7	Nagpur	40	876	0	0	7	443
8	Bhandara	0	0	0	0	0	0
9	Gondia	0	0	0	0	0	0
10	Chandrapur	27	644	0	0	57	354
11	Gadchiroli	0	0	0	0	2	424

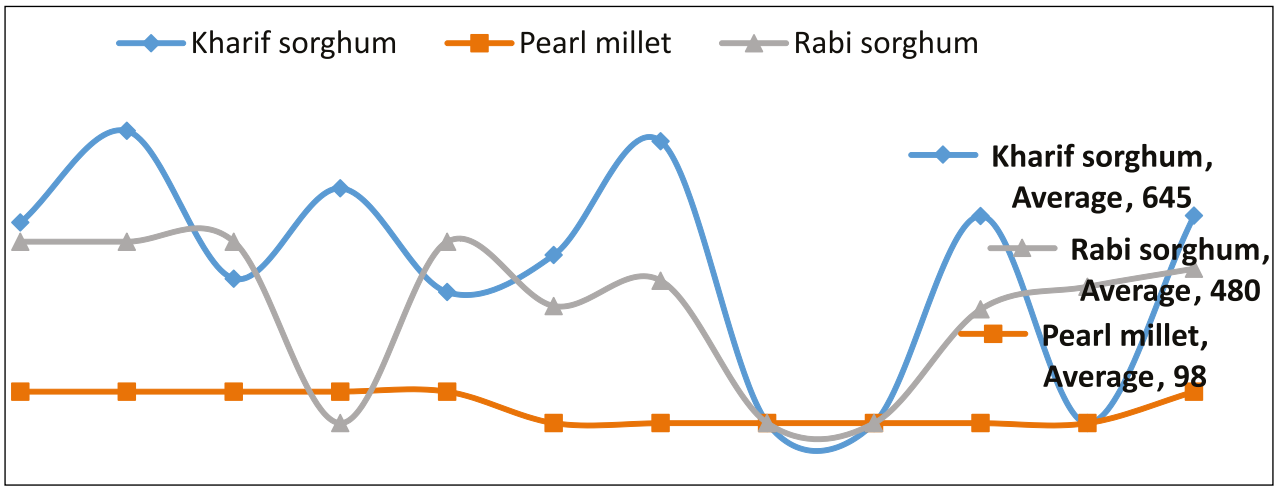

Figure 2. Productivity of millets in Vidarbha region during 2015-16 (kg/ha).

Challenges related to millets in Vidarbha region

Since, this region has wide variability in rainfall, soils, temperature, terminal droughts, and vulnerable to climate change impacts, there are following crucial challenges which need to be addressed with science-based solutions.

- **Low productivity:** Due to inadequate irrigation facilities and low rainfall, most of the area is under rainfed cultivation, no use of soil type-based high yielding cultivars, non-adoption of soil moisture conservation practices and improved production technologies led to the low productivity.

- **Biotic stress:** Difficulties in timely sowing and non-adoption of disease tolerant cultivars resulted into severe infestation of shoot fly and grain mold disease, respectively in *kharif* sorghum. Also, due to cultivation in isolated areas, sorghum has been damaged by bird and wild boar attacks.
- **Competition with cash/vegetable crops:** These millets are not treated as cash crops and therefore growers cultivate them on medium to poor soils with low or no inputs, like fertilizers, irrigation, etc.
- **Low remunerative:** Due to low productivity, lack of standardized market, buy back arrangements based-on minimum support price (MSP) and non-inclusion in mid-day meal (MDM) or public distribution system (PDS), farmers could not get remunerative price.
- **Fluctuating market prices:** Since, there are no standardized market facilities and intelligence and procurement by the governments, market prices of these millets are sometimes less than cultivation cost. The intermediaries play a huge role in fixing the prices.
- **Low awareness about health and nutritional benefits:** Though, the millets are good for human health and overcome celiac diseases, their consumption is reducing drastically due to lack of awareness, lack of commercial ventures and policy ignorance.
- **Lack of irrigation facilities:** Since, irrigation facilities are scanty and these millets are low/non remunerative, the farmers grow other cash crop or vegetable with available irrigations. Also, the lack of availability of assured water supply and protective irrigation for millets is a major reason for low yields.
- **Soil salinity:** Also, continuous rainfall and irrigation leads to accumulation of salts and drainage problems in black cotton soils. It is a unique problem of this region. Therefore, the irrigation has to be used very judiciously to avoid salinization of soils as well as water-logging.
- **Low organic carbon content:** Almost all rainfed soils are poor in organic carbon content, which plays an important factor in minimizing the productivity. The unavailability of organic fertilizers and continuous use of chemical fertilizers for cash crops has led towards poor soil status and health.

Technology interventions

There is a large scope for increasing productivity and profitability for farmers through scaling-up of climate resilient agriculture; however, it calls for concerted efforts including adoption of location-specific and cost-effective technologies. The new technologies should also be less input intensive, cost-effective, less labor intensive and economically viable. Based on the experience of millets cultivation, some promising interventions are

Use of high-yielding cultivars specific to soil types

Recently, twelve *kharif* sorghum cultivars were introduced in seven sorghum growing states including Vidarbha region of Maharashtra under front line demonstrations (FLDs). They yielded 78% more grain and 60% stover when compared to the local cultivars, which resulted in 51 per cent more net returns than the local cultivars. Similar results were obtained in *Rabi* sorghum in Maharashtra. The soils of sorghum growing areas have been classified into three major categories based on soil depths, viz., shallow (<45 cm depth), medium (45-60 cm depth) and deep (>60 cm depth) with low-medium water holding capacity. The moisture retention capacity varies and therefore soil-types based varietal selection is more suitable.

Improved practices and timely management

Impact of the demonstrated technologies under FLDs shows that adoption after FLD period significantly increased by more than forty eight percent especially in practicing seed treatment (85%), use of high yielding varieties (70%), use of nitrogen fertilizer (57%), following time of sowing (49%) and maintaining plant spacing (48%). It has resulted into increase in higher net returns (170%), followed by grain yield (58%) with better quality (78%) and fodder yield (26%), found to be significantly positive over the pre-FLD. It proves that even small changes in use of low-cost recommended practices and timely management can have large effects on yields and monetary benefits (Chapke et al., 2011).

Water conservation practices

Dependence on rainfall for *kharif* and residual moisture for *Rabi* crops is a major concern. The cultivation of *Rabi* sorghum on residual soil moisture and occurrence of terminal drought are the major reasons of low productivity of *Rabi* sorghum. The *in-situ* moisture conservation practices like compartmental bunding and ridges and furrows, adoption of soil-based improved cultivars, nutrient management and irrigation scheduling based-on water availability whereas, organic mulching in *kharif* are the important management options for improving sorghum productivity (Patil et al., 2013). Also, results revealed that compartmental bunding during *kharif* season conserved 12.6% more soil moisture and produced 20.6% higher grain yield over farmers practice.

Millets-based intercropping

To achieve appropriate land use, efficient inter- and sequence-crop systems were recommended based on soil type, rainfall and length of growing seasons. Also, intercropping sorghum with legumes not only produces higher yields per unit area and time, but also provides nutritional security, economic benefits and improves soil health. Also, sorghum+pigeonpea (2:1/3:1/6:2) and sorghum+ soybean (3:6/2:4) are the two most common intercropping systems. The medium duration sorghum genotypes are most suitable for intercropping. The soybean - *Rabi* sorghum has been found more productive and economically viable system in areas receiving annual rainfall above 700 mm and medium to deep soils having high water retention capacity, and sorghum (*kharif*)-chickpea, safflower and mustard (*Rabi*) under limited irrigation conditions. Many other millets-based intercrop and sequence cropping are found to be more profitable.

New niches of millets cultivation (in rice fallows)

Although millets are known to be climate resilient crops, their cultivation in traditional areas is reducing. New niches like rice fallows sorghum or millets cultivation plays significant role in economic security of the farmers. Sorghum hybrid; CSH 16 (7.50 t ha^{-1}) yielded significantly better than the locally popular hybrid Mahalaxmi 296 (5.86 t ha^{-1}) in rice fallows in Guntur district of Andhra Pradesh, during the four years from 2012 to 2016. The significant increase of 27% was observed in grain and ultimately it was resulted into 73% higher monetary benefit to the farmers (Chapke et al., 2011a). The district yield average of sorghum is 6.80 t ha^{-1} during 2014-15, which is around seven times more than the national yield average (0.90 t ha^{-1}), such a success story can be replicated in Vidarbha as there is scope in Gadchiroli and Chandrapur district to introduce sorghum and other millets in rice fallows, which assures additional income to the farmers.

Value-addition and post-harvest processing

The increasing MSR indicated that there is interest for value-addition and processing to earn more.. The creation of demand for millets and millets value-added products as healthy food will boost the production and consumption scenario of millets, which will have a long term impact on the sector. The increase in demand for the millets and value added products will boost the farmers morale towards millets cultivation and will also help in realising better prices for their produce.

Mechanization

Millets cultivation, especially sorghum, is more labour-intensive and more than 55% cost goes towards labour. Hence, a suitable harvesting–cum-threshing like combine machine is required. Moreover, proper tillage and precise placement of seed and fertilizers in the moist zone are most critical to for successful crop establishment in drylands. Since the sowing of crops must be completed in a short span of time, use of appropriate implements is necessary to cover large area before the seed zone dries out. The above mechanization can help to reduce cost and labour requirements which will encourage millets farmers.

Promotion of biofortified cultivars

Inspite of a number of production technologies that have evolved recently, arable cropping in drylands continues to suffer from instability due to aberrant weather and market fluctuations. To provide stability

to farm income utilizing marginal lands for market driven trait-specific production of millets which have nutraceutical values is a commercial endeavour. Iron rich bio-fortified pearl millets varieties (Dhanshakti and Shakti 1201) are available which have 80 ppm iron and is almost double in comparision to other cereals. To tap increasing market demands of iron rich millets as food for anaemic women and children through bio-fortified millets production can also fetch more profits.

Sustainable millets production and value chain through FPOs

The most important factor that accelerates the competitiveness of the sorghum and other millets in the international as well as domestic markets is the grain quality and organic produce. Use of pest and disease resistant varieties and organic millets production could create more opportunities. Also, the enhancement of export competitiveness of Indian millets in the international as well as targeted domestic markets will help the farmers to fetch good returns for their produces in the long term. For this and in view of small and marginal farmers background, their collectivization into farmer producer organizations (FPOs), may be an effective pathway to harness collective synergy.

Promotion of allied enterprises as integrated farming system

Since monocropping and traditional farming are not viable options and address only one component of the farming system, e.g. crop variety, and fertilizer use or even crop husbandry is not expected to bring about a significant increase in the productivity as witnessed in irrigated areas. The soil, plant, animal cycle is the basis for all feed used by the animals. The livestock in the rainfed regions are weak and farmers in this area often sell their cattle due to the scarcity of fodder. The land holdings are being reduced with increased population pressure. There is large unexploited scope to harness system level productivity and value chains, where in women have income-generating opportunities through women-focused activities. Therefore, the millets-based integrated farming system approach with introduction of poultry, dairy, goat farming, piggery and apiculture at each household will help to supplement the farmers' income and women empowerment.

Drivers to strengthen value chain

The farmers have limited resources and diversified needs under several socio-economic and farming constraints, which had become their primary concern in motivational perspectives before they decided for any changes and adoption of the new practices. Also, sorghum and minor millets are less remunerative, which requires the following necessary supports as drivers in value chain mode to make them more profitable in order to enhance farmers' income.

- **Institutional support:** There is a large scope for increasing productivity and profitability for farmers through promising production technologies developed by research and development (R&D) organizations and scaling-up of climate resilient crops *viz*., millets. Also, weather forecasting- and resource-based crop selection coupled with soil test-based recommendation have crucial role in bridging out the wide yield gap. The adoption of new technologies and farm practices requires a wide array of human skill which is also an equally important component.
- **Input support:** Availability of quality inputs like, seeds of HVYs, fertilizers, agro-chemicals, are the key requirements for increasing productivity and profitability. Varietal replacement with high-yielding and climate smart crop backed with developing de-centralized seed systems group approach (farmers cooperatives, SHGs, FPO, etc.) needs to be operationalized.
- **Financial support:** Hassle free and timely financial support for mechanization in labour intensive operations is a stepping stone for encouraging farmers to overcome labour problems and to avoid losses for failing in timely operations. Promoting on-farm mechanization through PPP mode, incentives to entrepreneurs to set-up village level one-stop-center for agricultural mechanization and other ways are viable options.

- **Market support:** Standardized market facilities, intelligence development, reduction in the role of intermediaries and buy back arrangements at grass root levels would enhance confidence of the millets farmers. These are the important issues to be addressed on priority.
- **Infrastructure support:** Millets are known to be good for health and even primary processing can double the income of farmers and help sell the grain. To overcome short shelf-life problems of millets; storage, improved roads, transport facilities and adequate electricity supplys are essential.
- **Policy support**: There is lot of scope for value-addition and processing to support additional on-farm income. This can be promoted through entrepreneurship development through SHGs and FPOs. In addition, policy support for farm-gate processing, control of wild animals, buy back assurance, implementation MSP for all millets, their inclusion in MDM and PDS system will boost-up the economy of millet farmers in this region. Farmers should be covered under insurance schemes to avoid any revenue loss due to crop failure and other natural calamities.

Strategy

From the discussions above it can be asserted that there lies a huge potential to enhance the income of the resource poor farmers in dryland conditions which needs strategies that can match the challenges faced by the farmers. The following key steps constitute the strategy emphasizing plough to plate transition in order to help doubling farmers' income in Vidarbha region by the year 2022.

- Bridging yield gap by enhancing productivity and by using promising production technologies from R&D organizations.
- Emphasis on moisture conservation practices and also link with watershed development programme.
- Introduction of millets-based crop systems and allied farming activities that involve women. The allied farming activities include poultry, dairy, goat farming, piggery and apiculture
- Introduction of mechanization and hassle free financial support.
- Marketing facilities and inputs support in convergence mode (single window system) and collective action through FPOs.
- Creating awareness about health and nutritional benefits of millets through effective mass and local media to bring change in the consumer preferences.
- Promotion of value-addition through entrepreneurship development through group approach (SHGs, NGOs).
- Policy support for buy back arrangements with MSP, crop insurance, inclusion in MDM and PDS system, infrastructure for farm gate processing and warehouses.

Conclusion

The farmers' socio-economic condition is complex where several aspects of value addition are out of the hands of the community. The role of the farmers in the whole system is more on the receiving end as 'passive subjects' rather than 'active stake holders' despite the fact that sorghum and other millets constitute one of their main sources of livelihood. In order to achieve the goal of doubling farmers' income through millets cultivation, there is need for a viable strategy comprising of three major elements: (i) scientific crop cultivation in participatory mode and capacity building with support of R&D organizations coupled with inputs supply in single window mode, (ii) promotion of value-addition and creating market demands through collective action like, formation of FPOs and SHGs, and (iii) policy support for buy back arrangements with MSP, crop insurance, inclusion in MDM and PDS system, infrastructure for farm-gate processing and warehouses.

References

ASG. 2014. Agricultural Statistics at a Glance 2014. Ministry of Agriculture and Farmers Welfare, Government of India

Ashok Kumar A, Reddy BVS, Ramaiah, B, Sahrawat KL and **Pfeiffer WH.** 2013. Gene effects and heterosis for grain iron and zinc concentration in sorghum [Sorghum bicolor (L.) Moench]. Field Crops Research 146: 86–95.

Ashok Kumar A, Reddy BVS, Ramaiah B, Sahrawat KL and **Pfeiffer WH.** 2012. Genetic variability and character association for grain iron and zinc contents in sorghum germplasm accessions and commercial cultivars. The European Journal of Plant Science and Biotechnology 6 (Special Issue 1): 66-70 (Print ISSN 1752-3842).

Chapke RR, Mishra JS and **Patil JV.** 2011. Improved Production Technologies for *Kharif* Sorghum. *DSR Bulletin No. 26/2011-12/Ext.*, Directorate of Sorghum Research, Hyderabad 500 030: 10p.

Chapke RR, Mishra JS, Subbarayudu B, Hariprasanna K and **Patil JV.** 2011a. Sorghum cultivation in rice-fallows: A paradigm shift. Book, Directorate of Sorghum Research, Hyderabad 500 030, India, ISBN: 81-89335-34-0: 31p

IPCC. 2007. 'Summary for Policymakers.' Cambridge, United Kingdom and New York, USA.

Karthikeyan M. 2016. Small Millets in mainstream diets: Promoting Decentralised Processing Infrastructure. Policy Paper. November, 2016. DHAN Foundation. Madurai, Tamil Nadu.

Nimbarte GN. 2016. A holistic overview of farmers problems in Vidarbha region of Maharashtra. *International Journ. Current Research*, 8, (02): 26327-26329.

Patil JV, Mishra JS, Chapke RR, Gadakh SR and **Chavan UD.** 2013. Soils moisture conservation agro-techniques for rainfed *rabi* sorghum. *Indian Farming* 62(12): 04-07.

Parthasarathy Rao P, Birthal PS, **Reddy BVS, Rai KN** and **Ramesh S.** 2006. Diagnostics of Sorghum and Pearl Millet Grains-based Nutrition in India. International Sorghum and Millets Newsletter 47: 93-96

Paterson AH, Bowers JE and **Bruggmann R.** 2009. The Sorghum bicolor genome and the diversification of grasses. Nature 457. 551-6

Pray CE and **Nagarajan L.** 2009. Pearl millet and sorghum improvement in India. IFPRI 2020 Vision Discussion Paper 00919. Washington DC: International Food Policy Research Institute. 27 pp. http://www.ifpri.org/publication/pearl-millet-and-sorghum-improvement-india.

13 Use of Technologies for Harnessing the Potential of Agriculture

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Abstract

As many as 32 villages from Damoh in Madhya Pradesh were developed by integrated watershed management project taken up by the Government of Madhya Pradesh and Mahindra & Mahindra under Public Private Partnership (PPP). Under the program check dams, storage structures, field bunds, gully plugs and gabions and other soil and water conservation structures have made a huge difference in the area. It has led to increased water availability and farmers are able to irrigate their entire land. More than 100 households were helped through cultivating this vegetables program via the use of technology and the text suggests how various low-cost and science-led interventions can help convert Vidarbha region into a profitable region for farmers.

Introduction

A case study of 32 villages from Damoh, in Madhya Pradesh highlights the priority need for water for agricultural purposes. This area was affected by water scarcity and other socio-economic constraints due to increased competition from the municipal sector as well as drier climatic conditions. The farmers raised concerns about availability of water and associated impacts on their lands. The government of Madhya Pradesh and Mahindra & Mahindra entered into a public private partnership (PPP) to take concrete action on making water available for agricultural purposes. Another effort focused on integrated watershed development in these villages to efficiently plan for all water users needs in collaboration with Mahindra & Mahindra and Govt. of Madhya Pradesh in the year 2010. The availability of water, crop yield, employment, SHGs, were the prime focus of this partnership.

Water was harnessed using a “ridge to valley” approach, which included contour trenches, boulder check dams, gabions, percolation dams, stop dams etc. Under the program more than 50 check dams, 75 storage structures, 350 km of bunds, around 3000 gully plugs and gabions and other soil and water conservation structures have made a huge difference in the area. Before these interventions available water would be sufficient unitil March or April every year, but now water is available until June. Though villagers and cattle from three villages use this water, the water is still available for agriculture. The water harvesting capacity is increasing in this village as more and more water harvesting structures are being built. Despite the fact that an increased population is using water for agriculture, the water table has stillincreased by 2 feet. The interventions have increased the available soil-water content to the extent that wheat is grown on marginal lands where it was never seen in the past. In total 2-3 additional irrigations are possible and productivity has doubled as a result.

In the past, farmers would only be able to irrigate 0.4 to 0.8 ha. even if they had four ha. Now they are able to irrigate the entire land due to increased water availibility. The project, called the “agri-doctor”, introduced micro irrigation to help the villagers conserve water. Some local participants were trained as “agri-doctors” bringing an extension knowledge that increased production from five sacks of grain on their 0.4 ha. To now growing 20-25 sacks.The success of the agri doctor used high yielding seeds and water conservation techniques to take advantage of watershed planning methods. These agri-doctors are directly connected with the farmers, since they are from the communities, and if they need help they go to the krishi vikas Kendra (KVKs).Some young farmers are selected from the village and trained at the krishi vikas kendra by equipping them with a tablet and ICT software so that they can help farmers enhance productivity.

More than 100 households increased their income by growing vegetables and storing them in a simple low-tech grameen refridgerator. The green vegetables kept in the grameen fridge remain fresh for five days, giving farmers a longer shelf life to consolidate fresh produce before it is brought to market. Also,

Mahindra has done a lot of livelihood work for the landless farmers. These efforts to improve livelihoods include production of poultry, small ruminants, atta chakki etc. which are are common components of a local smallholder farm. Earlier buyers used to complain about the quality of milk in the village, but Mahindra started a project to give fair value for the milk increasing production to 300 liters per day. This market outlet and associated training has dramatically improved quality and hygenic standards. Mahindra also built a cattle manger to keep fodder from spreading or getting dirty. The cattle have also been provided with drinking water throughout the day. The tank needs to be refilled only once in 3-4 days. The easily accessible cow dung from cattle the manger was used to make bio gas, for household use reducing cardiovascular health problems by reducing smoke from burning biomass for cooking.

To reduce the drudgery of collecting water for the household a new technology called the “wello water wheel” was introcduced. The wello water wheel is filled at at the source and rolled to the destination changing gender rolls and family dynamics. As before water collection was the responsibility of the woman/mother, who would carry heavy canisters on her head, now 40 liters can be filled in a wheel and even a child can fetch water.Defecation in the open was a very common practice, however by building toilets in the village this problem was also solved. As many as 2000 women in 400 SHGs have now become entrepreneurs. The village now has solar lights. More than 150 tractors and almost 50 micro-irrigations have been adopted by 32 villages covered under the program. Mahindra has worked on more than 17 programs in watershed development in the area as a result sowing has increased and also the frequency of irrigating the crop. This has resulted in increase in crop productivity and increase in groundwater level.

To summarize, rainwater harvesting structures have improved the water availability in this area. The extra water availability coupled with mechaninization and micro-irrigation have directly increased irrigated areas and seen a five-fold increase in grain yields. For landless villagers, livelihood improvement interventions, such as the tent house, pottery, poultry, dairy, bamboo basket, etc., were also introduced for improving the income from non-farm activities. Mahindra & Mahindra also worked on drinking water and sanitation requirements of the village.

Recommendations

- Focus should be on tapping the potential of dryland agriculture in Vidarbha instead of creating irrigation infrastructure.
- Developing and strengthening the FPOs in Vidarbha region for collective production, processing, and marketing of the produce.
    - Seed hubs for pulses
    - Local processing of the produce
    - Mechanization for processing
- Site specific technology for improving the productivity and reducing cost of cultivation
    - Promoting short duration pulses in rainy season fallows
    - Rejuvenating degraded soils (soil salinization) and improving their productivity
    - Rainwater harvesting and improving water use efficiency
    - Promoting millet production as nutritious and climate resilient crop
    - Mechanization through custom hiring centers may be cost effective options for farmers and an income source for youth / landless in the villages
    - Bringing awareness about available new cultivars and increasing seed availability of new cultivars.
- In addition to improving income through agriculture, non-farm activities are also contributing to increasing the income of farmers.

Technical Session IV
Building Climate Resilient Agriculture through Integrated Watershed Management

Chair *: Dr NP Singh*

Rapporteur : *Dr Vijay Sandeep*

14 Sustainable Rainfed Agriculture Initiatives of Government of India

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Abstract

The need to shift from supply driven approach to market-led approach, to help farmers double their income has been highlighted in the text. Also, integrated farming system is the only way forward, and there is a need to bring value chain right from sowing to harvesting to marketing as the author suggests.

- In India, food grain production has quadrupled over the last five decades from 52 million in 1951 to 272 million at present. This increase is driven by technology deployment, management practices along with policy framework.
- However, these are restricted to limited crops. Some of the technologies adopted from CIMMYT have been beneficial in increasing yield of maize. In states such as Punjab there has been resurgence in crop production, which can be replicated in other states.
- India needs appropriate technologies for growing crops in 0.65 to 1.15 ha. of land to accomidate the reality of the smallholder farmer.
- An integrated farming system is the only way forward, and there is a need to valorize the process from sowing to harvesting to marketing.
- Also, farmers have to be trained on post-harvest technology and its benefits and both the state government and central government agriculture departments should provide appropriate storage facilities to enable farmers to store their produce post-harvest for longer periods.
- For improving living standards of farmers India must concentrate on production technology from seed sowing to post harvest technology.
- Post-harvest produce from farmers fields to market needs a value added chain which takes into account the quality of produce and fixed price based upon the commodity value in open market.
- The market driven approach has to be the main emphasis for farmers to sell their produce at a competitive price.
- Frmers should be trained to sell their produce in open markets and the agriculture departments should conduct training programmes in this regard.
- The farmers should be given opportunities to seize the market for selling their produce at the right time in order to obtain maximum benefits.

15 Watersheds for Unlocking the Potential of Dry Land Agriculture: Need for Promoting Appropriate and Sustainable Institutional Mechanisms for Doubling Farmer's Income

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JSW Foundation, Karnataka

Abstract

Watershed development technologies and interventions have proved their value for unlocking the potential of dry land agriculture nation-wide. However, if the aim is to double the watershed farmers' income level within a defined period of time and sustain it, there needs an appropriate cutting edge process innovation. In this regard, the authors suggest a three-pronged approach; 1) promote climate resilient agriculture practices through participative research and technology transfer, 2) aggregate goods and services of the farming community at watershed level, and 3) enable the local community to leverage the market collectively (demand-supply chain) and the Government services through systematic institution building. The paper discusses a model based on Women SHGs centred Farmer Producer Organisations (FPOs), which set-up and manage a Farmers Service Centres (FSCs) at a watershed level. The model aims to build capacity of local communities to redefine farming "norms" and "practices" at one end and leveraging and linking with market forces and the Government services on the other. As this kind of an intervention calls for a continued and consistent "engagement" of all the key-stake holders involved, the authors suggest a 'consortia' approach for implementation.

Primarily, a proof of the concept has to be established in the agro eco-region on a pilot watershed and a blueprint of doubling farmers' income has to be developed and demonstrated to the local community before outscalling. The approach requires a high level of participation and engagement of the local community. It includes up to 50% cost contribution, and making 70% of project expenditure directly by the Women FPO making the proof of concept a key benchmark at initiation phase.

The model has importance of empowering the local communities, especially the rural women, through a sustainable institutional development, farm-families, women-SHGs and women-FPO, Farmers Service Centre (FSC) and Village Resource Centres (VRCs).

Introduction

During the last three decades, watershed development technologies and interventions have proved valuable for unlocking the potential of dryland agriculture. Well planned and executed integrated watershed interventions start with institutional capacity building and collective actions that focus on soil and water resource conservation, improving productivity enhancement and providing various livelihood opportunities. At the same time they strengthen various regulating and supporting ecosystem services such as carbon sequestration, base flow, groundwater recharge, soil formation, self-pollination, etc. It is now a proven fact that watershed approach is the only option to address the issue of food and water scarcity in dryland agriculture areas. Such watershed interventions do strengthen various ecosystem services by i) improving water resources availability in agricultural lands and ii) providing better linkage with management of downstream aquatic ecosystems. However, this is true only if the watershed approach is adopted for managing natural resources and values of ecosystem services.

If the aim is to double the watershed farmers' income level within a defined period of time, and sustain it further on, there needs some cutting edge process innovation. This could bring a larger scope for increasing productivity and profitability for farmers and scaling-up of climate resilient agriculture.

However, such innovative interventions need concerted efforts and adaptation of a holistic approach in a streamlined manner. Therefore, it requires formulating appropriate strategies for promoting and adopting climate resilient agriculture and scaling it up in the target eco-regions in a mission mode. Thus it

is important to identify the challenges and opportunities for increasing the productivity, cutting the cost of cultivation and thus aim to double incomes of farmers in the target eco-regions. And more importantly identifying the right consortium partners and appropriate institutional mechanisms for promoting climate resilient agriculture at the beginning will foster a sustainable effort. Building community capacity to aggregate and negotiate with market forces will benefit the producers perhaps it is important to prepare a biilueprint for doubling farmers' income and demonstrating it on the ground in the target eco-region.

Issues/challenges

There are a number of issues/challenges from globalisation, privatisation to people's changed priorities in food and feeding habits, job priorities, living style, etc., that are contributing to the ever decreasing land productivity and profitability and the ability of dry land agriculture towards supporting the livelihood options of the dependent farmers, there are three issues to address:

- **Land degradation:** Increased pressure on land for producing more food for meeting the bloating population needs and the corresponding market forces that are driving towards monocropping are resulting in reduced land productivity and profitability, which in turn are contributing to land degradation in a large scale. And the land degradation is also exacerbated by climate variability and climate change that further increased the vulnerability of agricultural production systems. This is clubbed with a grave lack of knowledge, skills and attitude towards sustainable agriculture and watershed management practices. These are limiting farmers ability to become more resilient.

Learnings from Command Area:

Parameters	CADA*	WADA**
Distinct Geography	Command Area	Watershed Area (area within the ridge-line)
Binding Factor	Copious Canal water	Scanty Rain water
Usage Pattern	Flood irrigation	**SOAKING** rain , enhancing soil & moisture conservation, rain water harvesting, using ground water judicially through pot irrigation, drip, sprinkler, etc., even if from tube-well / open-well sources
Tendency	Heavy duty Mono-cropping, cash crop preference, and high external inputs yield driven approach	Crop diversification, focus on food crops and low external inputs approach
Aggregation of the goods & services	**Better established. Thanks to scale of operations**	**Lack completely; Compulsion to aggregate**

** Command (Canal) Area Development Approach* *** Watershed Area Development Approach*

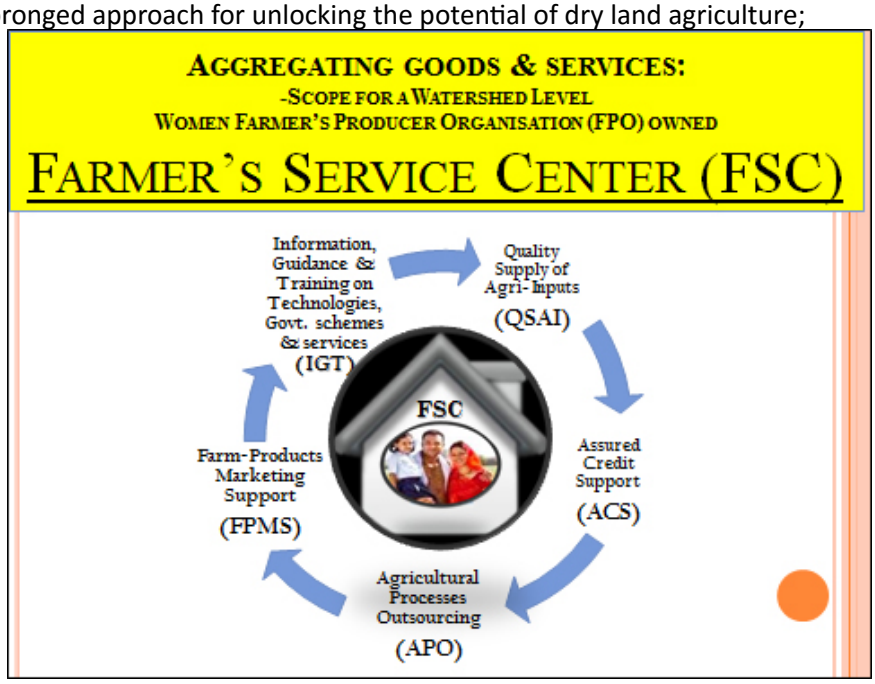
- **Lack of a mechanism that aggregate goods and services needs of the dryland farmers and allow them to connect with the market forces:** A quick glance at a comparative table between the irrigated (command) area scenario and the dryland (watershed) area scenario highlight one striking factor; there is a complete lack of an economically viable mechanism enabling them to aggregate the goods and services demands of the local farmers tocollectively negotiate with the market. Small producers are "price takers" and enherently vulnerable. Also, scant rainfall, uncertainty in crop and crop yield, relatively smaller scale and size of goods and services demand etc. result in immediate collapse or gradual defunct in the mechanisms to sustain economic viability.
- **Lack of appropriate institutional mechanisms that enable the local farming community to redefine farming "norms" and "practices", and adopt climate resilient agriculture on one side and negotiate with the market forces collectively on the other side :** This kind of an institutional mechanism plays a vital role in transferring the technologies related to watershed treatment, productivity improvement, processing of agro-products or to reach the unreachable with the services of banking industry, agriculture inputs supply industry, agriculture processes out sourcing or to agri-products marketing.

Therefore the challenge is to address the above listed issues holistically. Then, while sustainable agriculture and watershed management practices can break the downward cycle by reducing vulnerability

to climate change and increasing people's ability to become more resilient—and in many cases contribute—to the mitigation of climate change through improved carbon sequestration and reduced GHG (Green House Gas) emissions, the institutional mechanisms reduces vulnerability from the market forces converting what is perceived as threat in to opportunity for business promotion. Therefore, maintenance of different interventions is very critical to ensure continued ecosystem services thru sustainable use and management of land, water and human resources which can only be achieved with community participation and by adopting a systematic institutional building & information technology (IBIT) approach.

Intervention to double the farmers' income

If the mission is to double the farmers income by 2022 as proposed by Hon. Prime Minister of India, then there is a need to go for a three-pronged approach for unlocking the potential of dry land agriculture; a) promote climate resilient agriculture practices, b) aggregate goods and service needs of the farming community at watershed level, and c) enable the local community to leverage collectively with market forces (demand-supply chain) and as well with the Government services through a systematic institution mechanisms.



The proposed intervention, ***"Watershed level women – FPO owned Farmers service Centre"*** is based on an approach inspired by the JSW – ICRISAT pilot (2013-18) taken up in Sanduru block of Ballari district.

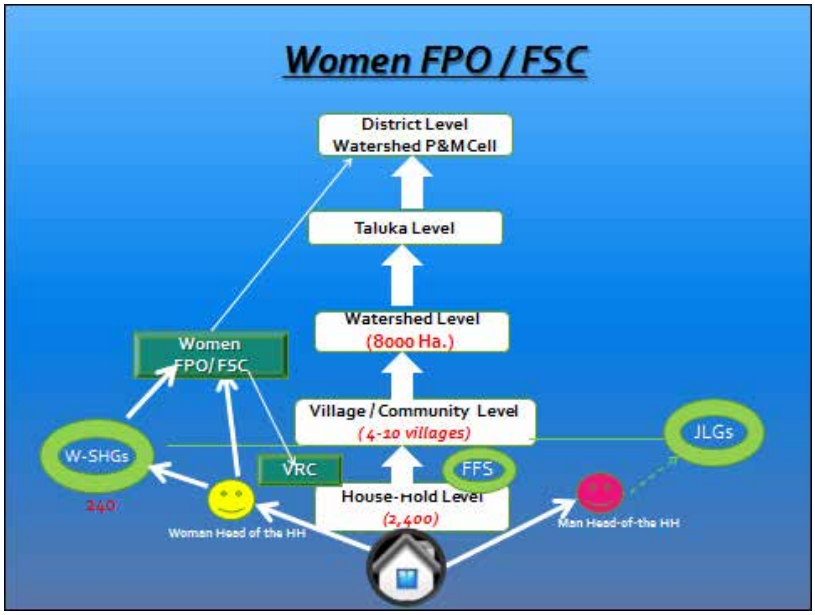
ICRISAT has already developed and demonstrated many technologies on the ground related to soil and water conservation and crop management. The same set of technologies would be used towards treating the watershed development.

However, an innovative process is proposed to be put in place to promote an appropriate institutional mechanism at watershed that is centric to a women-FPO towards aggregating goods and services needs of the local farming community and to negotiate with the market forces. Farming communities need to understand market forces as opportunities and not threats. Women in agriculture have to start playing a more central role if climate resilient sustainable agriculture and watershed management practices has to make a big impact on farmers profitability. The information technology plays a critical role in this transformation. Thus institution building and information technology (IBIT) forms crux of the proposed intervention.

The proposed model assumes about 8,000 ha. land fit for cultivation as a unit of replicability and each of the village communities (4-10) and families (around 2000 to 3000) under the target area forms the primary stake-holders of the development intervention. A total budget calculated @ $ 371. 46 per ha for implementing a 5 year action plan. As much as 50% of the budget is expected to come from the local community in the form of cash, kind, services and loans by individual farm families. This is an essential step towards increased ownership of the local community.

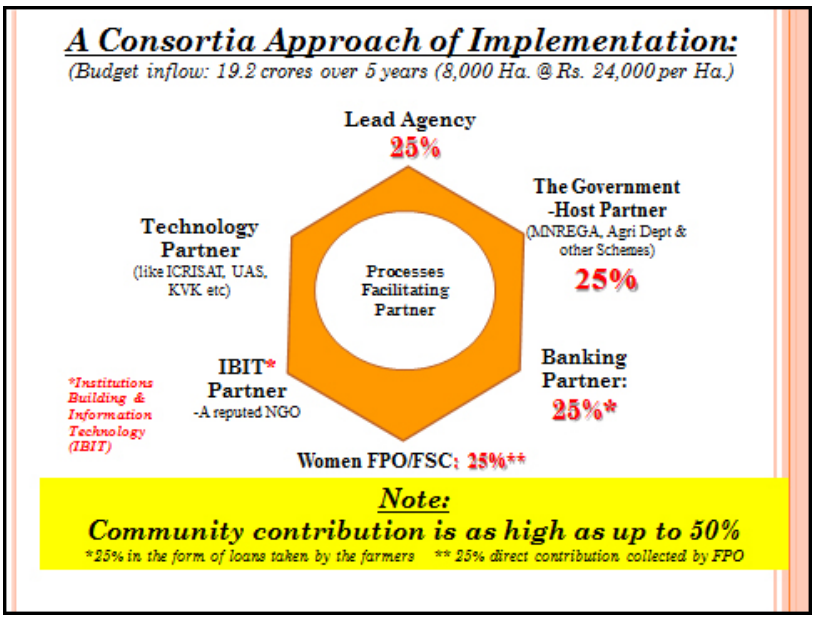
Women head-of-the house hold of each family in the watershed join/farm women-SHG, and also takes up primary membership of the watershed level Women-Farmer's Producers Organisation (W-FPO). The

FPO then sets up and manage a Farmer's Service Centre (FSC) at watershed level as its economic activity for aggregating goods and services requirements of the farming community and negotiate with market players related with land improvement services, technical expert's advises, credit needs, agri-inputs like quality seeds, weedicides, soil nutrients, formulated fertilizers and renting agricultural implements to crop and animal insurance, agro products marketing support, etc.



The FPO also set up and manages one Village Resource Centre (VRC) in every village within the watershed area towards linking with the Government services including *Raitha Samparka Kendra, Raita Sahayawani* (Farmers Helplines), Krishi Vignan Kendra (KVK)/University of Agricultural Sciences (UAS), MGNREGA, PRIs, schemes of the Agriculture Department, Animal Husbandry Departments, etc.

Meanwhile the male head-of the house-hold are encouraged to join/ form Joint Liability Group (JLG) and link up with P-CARD and PLDB services. The FSC plays an active facilitator role in accessing such services.



As the model is aimed at capacitating local communities to redefine farming "norms" and "practices" at one end, and leveraging and linking with market forces and the Government services on the other, this call for a continued and a consistent "engagement" of all the key-stake holders involved. Therefore, a 'consortia' approach for implementing such intervention is advocated.

Salient features of the proposed intervention

The proposed intervention is watershed centric, and therefore focuses on unleashing potential of dryland agriculture. It is women SHG and FPO centric, expands scope to business opportunities in aggregating and negotiating goods and services, uses institutional mechanisms and information technology for leveraging markets and involves a high level of participation and engagement by the local community both in terms of cost sharing and benefit sharing. However, it is technology neutral as far soil and water conservation and crop management, and applies a consortia approach for implementing the plans.

Critical drivers for success

- **Women participation:** In the proposed model, mobilising almost up to 50% local contribution, and making up to 70% expenditure is by the Women FPO. Therefore quality of women participation is a critical driver in making the approach a success. Given the track records such as women SHGs succeeding in all sectors, women banks record highest recoveries, over 75% of agro activities performed by women, 80% of allied and non-farm activities such as diary, fisheries, and handicrafts in rural areas are carried out by women, etc., makes the assumption a realistic one. And thus the proposed intervention would lead to the empowerment of women as well.
- **Role of Institutional and Community Facilitators:** The model adopts a multi-partners and a multi-level intervention. There are always more than one agency/actor needed to deliver any given task at any given time. Thus the potential inter-agency complications and conflicts are also high. Therefore, process facilitator for carrying it on institutional processes and 'norm' change processes plays a critical element for attaining intended success. Frontline '***Samudaya Preraks***' community motivators play a very important role in ensuring community participation and engagement and women empowerment.
- **Role of Institutions Building & Information Technology (IBIT):** Aggregating and leveraging from the market following goods and services related to land improvement, expert's advice, credit needs, supply agro-inputs like quality seeds, weedicides, soil nutrients, formulated fertilizers, renting agricultural implements, accessing crop and animal insurance, agro products marketing support services, accessing and leveraging the Government schemes and services through linking with Raitha Samparka Kendras, Raita Sahayawani (Farmers Helplines), KVK / UAS, MNREGA, PRIs forms crux of the intervention. Therefore, the success of the model is based on the successful performance of the IBIT agency.
- **Smooth functioning of the consortia approach:** The model adopts a multi-partners and multi-level intervention. Thus, the possibility of inter-agency complications and conflicts are also high. Therefore, the process facilitator has to perform its role successfully for smooth functioning of the proposed consortia approach.
- **Participative research, technology development and information dissemination:** As the community becomes an active participant in the process with respect to research, technology development and information sharing, a critical drive of the success comes only with a technology partner which is a learning organisation in spirit.
- **A blueprint of doubling farmers' income:** As the model demands a high level of engagement of the local community, the farmers have to see and believe in the benefits they can gain through the process. Therefore, in any given agro eco-region, such a blue print has to be developed and demonstrated to the local community by undertaking the intervention on a pilot watershed.
- **Funding and fund flow:** As the models five year promotion and hand-holding period aims to double farmers' income in a stipulated time-bond period,. Therefore, to roll out the implementation process in a mission mode, the funding and fund flow has to be made smooth.

Conclusion

The paper draws the following conclusions:

- While existing watershed development approaches, technologies and interventions proved to unlock the potential of dryland agriculture to some extent, there is a greater need to promote appropriate and sustainable institutional mechanisms if farmers' income has to double and sustain.
- In this regard, aggregating the goods and service needs of the farmers at the watershed level and aligning them in line with market forces through a systematic institution building holds key to success.
- A better approach for aggregating such goods & services is by helping the communities to have Women SHGs centred FPOs and enabling them to set-up and manage Farmers Service Centres (FSCs) towards leveraging collectively with market forces.

- As the challenge includes redefining farming “norms” and “practices”, managing institutions and dealing with market forces, it requires a continued and consistent “engagement” of all the related key-stake holders. Therefore, a consortia approach has to be adopted in execution of such a model.
- Once the proof of the concept is established in a pilot watershed (around 8000 ha) in a given agro eco-region, a blueprint has to develop and demonstrate on doubling farmers’ income and use this as a take-off point in rolling out the mission mode of scaling-up operations as the model demands a very high level of engagement by the local community.
- The model should be based on business principles, where the local community has to have a major stake in terms of cost sharing and the benefit sharing.

Recommendations

The paper makes two specific recommendations:

- As the proposed model is aimed at capacitating communities to redefine farming “norms” and “practices” at one end and leveraging and linking with market forces and the Government on the other, it calls for a continued and consistent “engagement” of all the key-stake holders involved, therefore it is recommended to have a **‘consortia’** approach for implementing such an intervention.
- In any given agro eco-region, first proof of the concept has to be established on a pilot watershed and a blueprint of doubling farmers’ income has to be developed and demonstrated to the local community as the approach proposes a relatively high level of engagement of the local community; almost up to 50% cost contribution, and 70% direct expenditure by the Women FPO.

16 Doubling Farm Income: A Possible Answer to Rainfed Agriculture is the Combined Innovation of Rain-based Assured Irrigation and the '4Water Concept'

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Abstract

Water harvesting structures when not designed properly can also turn out to be a bane for the farmers. India's agriculture is still systemically driven by the Green Revolution and 45 % of Indian agriculture is irrigated and climate change is slowly undermining this capability. Unfortunately, in the absence of policy and support mechanisms, the need and greed drive farmers to irrigated agriculture and it is happening mainly because there is no Brown Revolution system to support agriculture under an improved watershed. Factor4 and Water Pressure believe that there is a need to integrate knowledge and understanding of watersheds, and to adapt this to the changing requirements of climate adaptation. They believe that a combination of 4Waters+RbAI+Water Budgeting can allow the government to move away from centrally-administered watershed funds, and create JalDhan as an entitlement and help increase local water and food resources.

Factor 4 is a centre for sustainable enquiries promoted by ZED/BCIL

- Factor4 is inspired by the principle of 'halving the use of financial and natural resources, and doubling productivity'.
- Factor4's brief is to explore sustainability in all its different facets

Water pressure is a centre for water enquiries promoted by SAMUHA

- Our brief is to influence 10 trillion liters in water savings and improved water quality
- And to understand water in its different and ever-evolving facets
    - Copper coil-based drinking water filtration and storage
    - Cloud monitoring of wastewater and effluents
    - Indigenous membranes for reverse osmosis plants

Doubling farm income is possible, but asks policy framers to revisit basic assumptions about water before committing themselves to a second Green Revolution. Also, rainfed agriculture provides much of India's food requirements.

However, the focus since the Green revolution has been on promoting irrigation. Presently, 45% of Indian agriculture is irrigated and climate change is now undermining this capability. We forget that nearly all canal, lift and bore well irrigation systems are also rain-dependent -- except for that which taps into deep, closed aquifers. Groundwater and surfacewater must be replenished, which is increasingly inconsistent. As farmers in the Tungabhadra Left Bank Canal in Raichur district have discovered, the assumption that canal-irrigation was a guarantee has backfired upon them and the canal has been found dry and the last two consecutive *Rabi* crops (2015-16, 2016-17) failed because of inadequate water in the Munirabad Dam.

Can you build climate resilient agriculture through integrated watershed management?

There is an assumption that watershed development as it is presently practiced is good for the Land-Water-Trees paradigm that it protects and enhances. This assumption has been questioned by

T Hanumantha Rao, whose technical counsel continues to provide the basis for the practice of watershed development in India. As he said in his Dr M Channa Reddy Memorial Lecture on 15 Oct 2016: "Indian and International studies revealed that even in the 40 watersheds, out of a sample study of I000 watersheds, where stakeholder's participation was very good and funds were spent properly, there was no improvement in groundwater levels, soil erosion still continued and 85% of stakeholders did not derive any benefit at all on land and water[6]."

At the other end of this resource-intensive government-supported intervention is that of Rajendra Singh with his Jal Biradari of the Tarun Bharat Sangh, Rajasthan. This has enthused farmers and villagers to invest their own labor, resources and energy in water harvesting structures.

Why do farmers exercise ownership under Jal Biradari and similar movements of SEDS or Timbuktoo in South India or Gramin Vikas in Madhya Pradesh, but do not do so when the State provides them all the needed support?

There might be a more fundamental reason that was first stated by Dr KL Seth, former Watershed Commissioner to Government of India: watersheds are built on the wrong technology approach for India.

Foreshore treatments of the Damodar River Valley Dams, starting in 1953 were the first such manifestations of watershed development in India. This saw treatments with a heavy dependence on cement, developed for temperate climates, and was force-fitted into a tropical environment.

Drop the silt and let clear water flow. These treatments were built around the need to protect dam reservoirs from silting up and reducing the life of the dams. The treatments were designed to ensure that these helped the water to drop its load of soil, allowing clear water to flow through. When this failed to do so, watersheds were upscaled to their full hydrological scale as basin watersheds. But with siltation of dams continuing unabated, the scale of watershed development was reduced to larger and then micro watersheds of just 500 ha.

Making running water walk. The verbiage around watersheds as these changed became more participatory. However, the technologies did not. These continue to meet their design parameters to drop the soil and let clear water flow.

On the other hand, the goal of Jal Biradari and other water movements is to **stop the water, impound it, and use it**.

Can a watershed be integrated when anthropogenic factors are not part of the design?

India's agriculture is still systemically driven by the Green Revolution when policy, research, extension, credit, inputs supply, storage and marketing were designed as an interlocking system.

Because watersheds were designed to protect dams and not improve agriculture, policy-makers forgot to initiate a Brown Revolution to support and optimize rainfed agriculture.

Watersheds create better groundwater recharge and allow farmers to dream of increased income and climatic security of irrigated crops. Unfortunately, in the absence of policy and support mechanisms, anthropogenic factors, market demand, better returns, need and greed, drive farmers to irrigated agriculture since there is no Brown Revolution system to support agriculture under an improved watershed. Also, watersheds are gateways for farmers to transition from rainfed agriculture to irrigated agriculture. But when this change becomes extreme, the net result is a deteriorating environment that drives rainfed farmers to migration, while ensuring that rainwater as a public resource is utilized by a

6. "WATER FOR ALL: — NO WATER WARS": Dr. M. Channa Reddy Memorial Lecture, October I5, 20|6
- T. HanumanthaRao, Engineer-in-Chief (Rtd), Irrigation, GOAP and former Consultant to United Nations (OPS)

smaller number of farmers with the resources to withstand multiple bore well failures, and to dig, as deep as 1500 feet in the Dakshini Pinakini river basin around Chikkaballapur district in Karnataka.

The Dakshini Pinakini: the river that was, and the river that is

The 314-km Dakshini Pinakini River is born in the Nandi Hills ecosystem, 50 km northeast of Bengaluru, flows south and southeast of the Silicon City into Tamil Nadu where it becomes thenpennai and then the Ponnaiyar before flowing into the Bay of Bengal near Cuddalore.

From its source in the Nandi Hills to a distance of 78 km [until it reaches Seegehalli and Mallasandra] the Dakshini Pinakini does not even have a base flow: it is dead. This is *The River That Was*.

Beyond this, the Dakshini Pinakini flows again, driven by over 700 MLD (million liters day) of, largely, Bengaluru's sewage, and some industrial effluents. This is *The River That Is*.

While Eucalyptus trees (with an intake of 1800-2200 mm water against an annual rainfall of 750 mm), the demand for food, fruit and vegetables from the Bengaluru Urban Agglomeration, and the extreme exploitation of groundwater are causes for the 'slow death' of the Dakshini Pinakini river, it is clear that unless agriculture is willing to operate within the discipline of water budgeting, the existing desertification will only intensify.

A major cause of this is a technical failure: while water budgeting by definition is built by taking into account rainfall, surfacewater, soil moisture and groundwater, present-day watershed practice is confined to undertaking supply and demand *only* against rain, surface and water resources. The practice of understanding and quantifying water in the soil and in the ground, has almost become a lost art, leading to unscientific exploitation of these resources.

The challenge of climate change: greater variability in rainfall and rising temperatures

- It's already affecting local agriculture
- The micro region's rains don't seem to match the current crop calendars
- Contradictorily, the quantum of rainfall has not reduced. A mathematical model based on 100 years' rainfall data undertaken by Dr Vasubandhu Misra of the Florida State University shows that our rains have been deficit in only 30% of our monsoons.

A possible answer to our rainfed agriculture might be *rain-based assured Irrigation*.

This is based on the understanding that farmers are not going to be weaned away from their bore-wells; not till these run dry.

The Shashwatha Niravari Horata Samithi (Committee to Fight for Permanent Irrigation) comprising farmers from Chikkaballapur, Kolar and Bengaluru Rural, for example, believes that the portion of the rivers in Karnataka that flow westward [at a formidable distance of 200 km from Chikkaballapur] into the sea could be diverted eastward to the districts of Tumkur and further east to Chikkaballapur and Kolar.

The reality is that while water resources are scarce, people from water-surplus areas aren't going to allow their natural advantage to be frittered away by populist interventions.

What then is the answer?

The answer might lie in our rainfall. While trench-cum-bunds, farm ponds and drainage line treatments have harvested rainfall, the agriculture ambition has always been for this supplementary rainfall to provide life irrigation. There has never been the ambition to meet the whole agronomic requirements of agriculture and horticulture from rain.

Factor4 and Water Pressure believe that there is a need to integrate our knowledge and understanding of watersheds, and to adapt this to the changing requirements of climate adaptation.

T Hanumantha Rao, before he died, outlined the “4Waters” concept and practice as one way to go into the future. This focus on rain water, surfacewater, sub-surfacewater and groundwater is presently being proven in Rajasthan where the Chief Minister has aligned her complete Land Water Trees strategy and resources to ensuring that the ‘4Waters concept’ makes Rajasthan green.

If you add Rain-based Assured irrigation (RbAI) for an acre-per-farmer, and align this resource to the agronomic requirements of a package of cash and food crops and fruit trees, then we have an integrated package that can help farmers within their hydrological boundaries to ensure that they adapt to, and cope with, Climate Change and the anthropogenic pressures that will continue unabated, and which has the power to take them from food security to wealth generation.

Factor4, Water Pressure and SAMUHA believe that a combination of **4Waters+RbAI+Water Budgeting** can allow the government to move away from centrally-administered watershed funds, and create **JalDhan** as an entitlement and as Panchayat Raj institutions to allow communities to identify, manage and enhance their local water and food resources with a large share of self-governance.

17 Challenges and Opportunities for Dryland Agriculture in Maharashtra

DP Waskar
Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra

Abstract

The State of Maharashtra has erratic rainfall and 82 % is dryland region. Soil and water conservation technologies such as broad bed furrow for soybean, conservation furrow in cotton and soybean sole and intercropping, artificial well recharge model for open wells, farm ponds and protective irrigation are suggested by the author. Along with contingency planning and soil water conservation technologies, prominent intercropping systems are also proposed for Maharashtra. Integrated farming system approach is not only a reliable way of obtaining fairly high productivity with considerable scope for resource recycling, but also a concept of ecological soundness leading to sustainable agriculture. Also, the selection of short duration and drought tolerant varieties have also been developed. Also, watersheds need to start from farmer level, individual farmer needs to adopt watershed management which is a necessity and integrated water resource management is the need of the hour.

Introduction

In Maharashtra, dryland area is around 82% of the total 308 lakh ha. out of which cultivable area is 225 lakh ha. Only 18% of the total area (40.58 lakh ha.) is under irrigation. Also, major crops grown in Maharashtra are: Cotton, Soybean, *Jowar* (*Rabi*), Rice, *Gram* (chickpea) and Tur (pigeonpea). Horticulture crops are also prominent such as fruits, vegetables and flowers. The GSDP of Maharastra has declined over the years due to erratic weather conditions in in various regions. Rainfall in the last five years has fallen from 115% to 43%, and most of the rainfall around 80% is received at the end of September.

Region wise area, production and yield of major crops are presented below:

Region	Crop	Area (00 ha)	Production (00 tons)	Yield (kg/ha)
Konkan	Rice	3798	9946	2619
	Ragi	341	356	1044
Western Maharashtra	Jowar	16890	5709	630
	Cotton Sugarcane	9252	10163	122
		7539	608789	81
Marathwada	Cotton	18058	9248	88
	Soybean	13146	4167	317
	Jowar	8805	2524	284
Vidarbha	Soybean	20077	8987	441
	Cotton	14760	19731	228
	Rice	7345	8794	713

Maharashtra is a large state with progressive agriculture and industry. The size of landholdings in Maharashtra varies from 0.5 ha to 20 ha. Most of the farmers are small and marginal with average operational holdings in the range of 0.5-1 ha (6,709,000), followed by 1-2 ha. (4,052,000) and 2-5 ha. (2,473,000). Only 464,000 falls in the range of (5-20 ha.). More of the rainfed area (82%) is vulnerable to monsoon behavior therefore farmers are in distress in Vidarbha and Marathwada. There is an unreliable water supply as most irrigation projects depend on south west monsoon. There is also high diversity in crops and cropping systems. The crop wise production scenario in Maharashtra comprises of sugarcane followed by cotton, rice, soybean and jowar.

Some of the prominent horticulture crops, their area and production is given below:

Crops	Area (000 ha)	Production (000 MT)
Fruits	742.28	11089.53
Vegetables	595.21	8783.01
Flowers	7.25	38.53
Aromatic plants	0.32	0.26
Spices	123.24	130.09
Plantation crops	216.50	367.58

Climate change and its challenges

The climate of Maharashtra experiences wide inter districts and intra districts variability. The various regions of Maharashtra experiences wide variability within and in between districts in terms of rainfall. Occurrence of frequent droughts, unseasonal rains and hailstorms are the features of climate change in the region. Also, monsoon commences by June and terminates in September, and around 80% of the rainfall is concentrated in these months. Agriculture is highly influenced by weather, which is unpredictable. Unfavorable weather conditions like delayed onset of monsoon, intermittent dry spells, prolonged droughts and extreme weather events are major concern to agriculture in these regions.

Some of the factors influencing lower yield in these regions are:

- Low and erratic rainfall
- Dry spells during crop growth stages
- Low adoption of *in-situ* soil moisture conservation techniques
- Limited number of farm ponds at farm levels and its use
- Degraded soils with low water retention capacity
- Soil erosion due to high intensity rainfall &
- Micro-watershed development programme on limited area

Some of the challenges faced by farmers in these regions are non-availability of input at proper time, non-availability of farm machinery for small farmers, non-support price for some dryland crops, non-availability of equipments suitable for different agricultural operations for fragmented holdings, intercropping systems etc., mono-cropping and crop failure. Some of the socio-economic problems faced by farmers are rising inputs costs and declining profits and only 15% farmers are benefitted from crop insurance.

Climate resilient technologies

Some of the climate resilient technologies developed to combat climate change in Maharashtra are:

- Sowing of crops as per the onset of monsoon
- Selection of short duration and drought tolerant varieties
- Intercropping systems
- Sowing with broad-bed furrows especially for soybean and cotton
- Ridges and furrow sowing and sowing across the slope
- Opening of conservation furrow/dead furrow
- Recharging of open wells and bore wells
- Construction of farm ponds for rainwater harvesting and protective irrigation

Contingency crop planning is in place for delayed onset of monsoon in Maharashtra as below:

Sowing date	Crops/cropping systems to be adopted
Up to 30 June after normal onset of monsoon	Cotton + soybean, soybean + pigeonpea, sorghum + pigeonpea, castor + soybean, bajra + pigeonpea, green gram, black gram, pearl millet, cotton and soybean
1-15 July	Cotton + soybean, soybean + pigeonpea, castor + soybean, bajra + pigeonpea
16-30 July	Soybean + pigeonpea, bajra + pigeonpea, castor + soybean

Along with contingency planning selection of short duration and drought tolerant varieties have also been developed for various regions of Maharashtra as below:

Soybean:	MAUS 71, MAUS 158, MAUS 612, MAUS 711, MAUS 509, MAUS 740
Cotton:	PA 255, PA 08, PA 402, PA 528
Pigeonpea:	BDN 711
Sorghum:	PVK 801, PVK 809
Chickpea:	BDNG 797
Safflower:	PBNS 12, PBNS 40, PBNS 86

Soil water conservation is critical in these regions, various water conservation techniques have been proposed for the various regions of Maharashtra which include *broad bed furrow* for soybean, conservation furrow in cotton and soybean sole and intercropping, artificial well recharge model for open wells, farm ponds and protective irrigation.

Along with contingency planning and soil water conservation technologies, prominent intercropping systems are also proposed for Maharashtra such as soybean + pigeonpea, cotton + pigeonpea, cotton + soybean, cotton + greengram and sorghum + pigeonpea. Some of the real time contingency interventions which are currently being practiced in Maharashtra include dust mulching, gap filling, re-sowing, altering plant density and thinning for early season drought; dust mulching, straw mulching and foliar spraying of KNO_3 for mid-season drought and protective irrigation for terminal drought. Also, custom hiring centers (CHC) are also playing a key role in Maharashtra. In total there are 1080 CHC service providers in the state with active participation of local Krishi Vignan Kendra (KVKs), Non-governmental Orgnaizaotns (NGOs), Self-Help Groups (SHGs), Farmers Interest Group (FIG) and Farmer Producer Organizatons (FPOs).

Integrated farming system approach is not only a reliable way of obtaining fairly high productivity with considerable scope for resource recycling, but also a concept of ecological soundness leading to sustainable agriculture. In Maharashtra, farming system represents an appropriate combination of farm enterprises, viz. cropping systems, horticulture, livestock, fishery, forestry, poultry and the means available to the farmers to raise them for profitability. The goals of sustainable integrated farming systems in Maharashtra are soil and water conservation, soil-productivity restoration, improvement in air and water quality, reduction in the use of external inputs, overall increase in farm productivity and income.

Strategies for doubling farmers' income in Maharashtra

The strategies need to be region specific. Allied enterprises i.e. (dairy, meat, poultry, horticulture, sericulture etc.) will play a pivotal role along with agriculture in increasing farmers' income. Processing and value addition with required infrastructure will add substantial income and non-farm income will contribute significantly in future. The region wise prioritization for various activities need to be formulated, i.e. for Konkan (quality production of mango and cashew, grading, packing and export oriented units and improved technology in marine fisheries) is in dire need. In western Maharashtra (mechanization in sugarcane, high value intercrops, export oriented horticulture and floriculture) needs emphasis. In marathwada (soybean processing, mechanization and primary value addition in cotton, pulse processing) needs emphasis and finally for Vidarbha (cotton value chain, post-harvest value addition to citrus fruits, non-timber forest produce including herbals) needs attention.

Recommendations for this state

- Water budget needs emphasis; enhancing water use efficiency by farm ponds is needed
- Watersheds need to start from farmer level, individual farmer needs to adopt watershed management which is a necessity
- Integrated water resource management is need of the hour and finally
- Cropping systems are evolving therefore it is necessary to take it forward.

Technical Session V
Strategy for Transforming Agriculture in Vidarbha, Maharashtra

Chair *: Dr Ashok Dalwai, IAS*
Rapporteur : *Dr Girish Chander*

18 Farm Mechanization Strategies (Doubling Farmers' Income in 5 years through Mechanization)

N Subramanian

EICHER TRACTORS (A Unit of TAFE Motors and Tractors Ltd.), Mandideep

Abstract

India holds 157.35 million hectares of land and has 46 of the 60 soil types in the world. It is the largest producer of spices, pulses, milk, tea, cashew and jute; and the second largest producer of wheat, rice, fruits & vegetables, sugarcane, cotton and oilseeds. The Indian yields have improved per ha from 522 kg (1950-51) to 1930 kg (2010-11) but the present yields are much below the global benchmarks. One of the critical factors driving the higher yields has been from increase in availability of energy kW/ha which presently stands @ ~2 kW/ha; and which needs to double by the year 2030. But several challenges are seen by farmers in the journey towards mechanization such as lack of awareness, affordability etc. The solutions as highlighted by the author are providing affordable mechanization through low cost solutions to be supported through subsidy, improved awareness, training and skill development etc.

Agenda

- Snapshot of Indian Agriculture
- Drivers of mechanization
- Challenges in mechanization
- The strategic way forward

Snapshot of indian agriculture

- Arable Land :- 163 m ha (50% of Land Area)
- Net Cropped Area :- 140 m ha (88% of Arable Land)
- Gross Cropped Area :- 192 m ha (35% of Area Sown Twice – 50 m Ha)
- Net Irrigated Area :- 68 m ha (48 % of Net Crop Area)
- Gross Irrigated Area :- 82 m ha (43 % of Gross Crop Area)
- Av. Size of Land Holding:- 1.3 ha (80 % farms are Small & Marginal)
- Indian Agriculture: - Contributes 15 % of GDP and employs 52 % of working people.

Agriculture in India–where do we stand today

- 2nd largest agricultural land:
- At 157.35 million hectares, India holds the second largest land in the world.
- Favourable climatic conditions :
- With 20 agri climatic regions, all 15 major climates in the world exist in India. The country also possesses 46 of the 60 soil types in the world.
- Record production of food grains:
  In FY2015, total food grain production in India was recorded at 252.68 million tonnes, which increased to 253.16 million tonnes in FY2016.
- Largest producer of major agricultural and horticulture crops:
  India is the largest producer of spices, pulses, milk, tea, cashew and jute; and the second largest producer of wheat, rice, fruits & vegetables, sugarcane, cotton and oilseeds.

- Increasing farm mechanization:
  India is the one of the largest manufacturers of farm equipments such as tractors, harvesters and tillers. India accounts for nearly one- third of the overall tractor production, globally, with the tractor production in the country estimated to increase from 0.57 million units in FY16 and is set to reach 16 billion units by 2030.

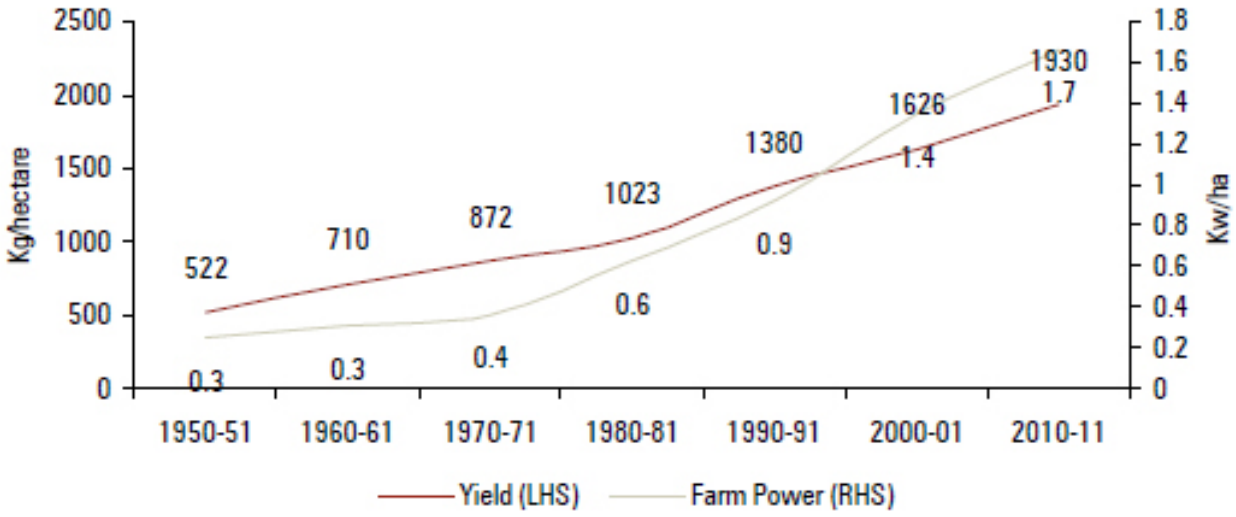
Future demand of food grains

- Increase in demand for food grains:
  As per vision document of ICAR for 2030, the Domestic Demand is expected to be 355 MT and the Fruit and vegetable demand is expected to go to 290 MT for an expected Indian population of 1.45 Billion.
- Hence there is a need is to increase the yield from the same land to meet this growing demand
  - The Indian yields have improved per ha from 522 kg (1950-51) to 1930 kg (2010-11)
  - The CAGR growth in yield for the last 10 years has been ~2%
  - However the present yields are much below the Global Benchmarks.

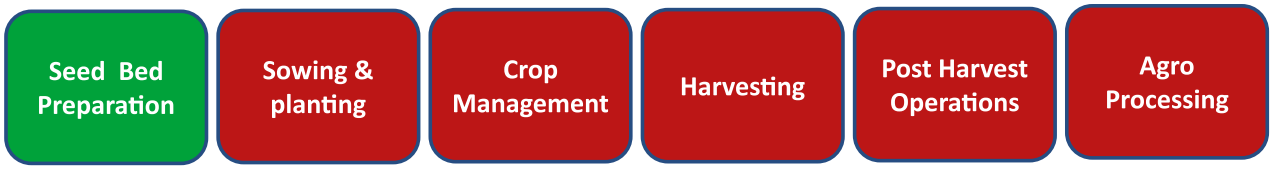
Need of mechanization

- One of the critical factors driving the higher yields has been from increase in availability of energy kW/ha which presently stands @ ~2 kW/ha; and which needs to double by the year 2030.

Exhibit 11: Farm mechanisation (farm power) vs. domestic farm yield

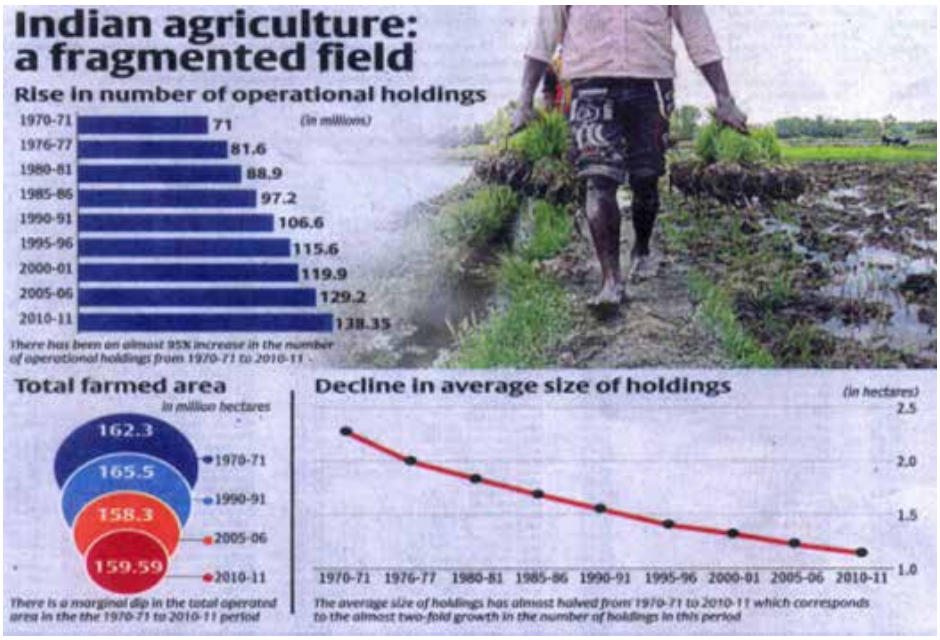


- Presently the farm mechanization is skewed toward land /seed bed preparation & irrigation and is @ 40% (>55% population engaged in Agriculture)
  - Harvesting/Threshing mechanization is largely limited to wheat & paddy.
  - The level of mechanization is much lower at small / marginal farms.
  - Brazil mechanization is @75% with ~15% population engaged in agriculture.



Land holdings getting fragmented but average HP of tractor usage is going up….a right balance is needed to choose to make an economic sense:

- In India today we have ~ 5million tractor population.
- Landholdings (owners) have doubled to 138m in last 40 years through fragmentation and thus average land holding has come down from 2.4 ha to 1.2 ha in the year 2010-11.
- However , during this period the average tractor HP used was 22 (21-30 Hp segment was almost 50%) , followed by 31-40 Hp. Even up till early 2000, the mix was 75 % for below 40 Hp tractors .
- But now, it has rapidly moved to 40 Hp & above and almost 55% of India & 21-30 has shrunk to just < 6%. While most of the land work can be done by small & medium Hp tractors, but the craving to own BIG tractors has also led to economic imbalance for many of the farmers and pushed them into huge debts.



Challenges in mechanized journey:

- Lack of awareness of mechanization benefits.
- Mechanization solutions for Small & Marginal Farmers.
- Affordability constraints (Excessive Costs / Interest Rates / Credit availability).
- Uncertainty of income due to Monsoons, MSPs, demand-supply gaps.
- Utilization opportunities for on-field and off-field work.

Drivers of mechanization…

- Shortage of labor in Agriculture sector.
- Low farm income due to rising input cost.
- Need for power intensive work- faster at lower cost.
- Increased use of tractors as power sources replacing manual & animal labor.
- Availability of credits.
- Encouraging youth to adopt the farming.
- Easy access to technology.
- Farming as Profitable business.

Strategies & way forward

- Affordable mechanization:
  - Development of affordable crop and geographic based agriculture tools for better productivity and yield.
  - Demonstrate the mechanization benefit for a complete crop cycle from village to village level.
- Cost & profitability:
  - Low cost solutions to be supported through subsidy.
  - Hi-Tech solutions can be implemented thru CHC / Govt. Ownership.
  - Higher utilization thru Aggregator Model.
  - Integrated solution for best results.
- Awareness, training & skill development:
  - Imparting knowledge and skill through a Nation-wide Program.
  - Attract youth to adopt farming with modern technology.
- IT technology support:
  Integrated Mobile based Platform for access to information, schemes, and helpdesk for knowledge transfer:
- Ecosystem:
  - Entire ecosystem to be built to align stake-holders to this objective.
  - Make farming as profitable business for sustainability
- Treating farmers as " Annadata " in true sense:
  - Campaign to e-Connect India with Farmers.
  - Respect & Pride.
  - Sensitizing urban India for Rural Bharat.

19 Leveraging Bio-technology

Nagendra Singh
National Professor, ICAR

Abstract

The use of genetically modififed (GM) crops may play an important role in increasing productivity for farmers in the future. The GM crops are also integral part for leveraging biotechnology to increase crop yield. The GM crops aids in productivity enhancement,nutritional and processing quality, safer foods-from chemical to genetic, designer foods, fiber crops etc. and growth of seed industry and job opportunities. The use of plant tissue culture, genomics and marker-assisted breeding and GM technology has provided excellent results and the author highlights the sucessful use of these technologies.

Seed is an important input in agriculture and biotechnology. Some proven plant biotechnologies include: plant tissue culture, genomics and marker-assisted breeding and GM technology. Plant tissue culture is useful in propagating good variety/seed and is an important technology in increasing incomes. Also, genomics coding enable understanding of gene sequence for useful traits and also marker assisted breeding to quicken the process of variety development. The GM crops may play an important role in enhancing productivity, nutrition, resource use efficiency. Bt cotton is one example, which has led to yield benefit and reduction in pesticide use. Also, rice genome sequencing has enabled scientists to successfully transfer genes for tolerance to submergence in rice.

Mining for agronomically important genes in wild rice germplasm and stress-tolerant landraces of rice growing in the hot spots was carried out as part of a project. The objectives of this project were collection and characterization of wild rice samples from stress hot spots, re-sequencing of known genes for stress tolerance, and validation of function of identified genes. Also, SUB 1, a Major QTL on rice chromosome 9, provides protection against 10-18 days of complete submergence as shown below:

+SUB1 **-SUB1**

Marker Assisted Selection (MAS) is a tool which has advantages to simplify the breeding method compared to phenotypic selection especially for traits with laborious screening and may save time and resources. For selection at seedling stage, it is important for traits such as grain quality and ideal for plants with long juvenile phase. There is also increased reliability with no environmental effects and can discriminate between homozygotes and heterozygotes and select single plants. Finally, it nearly halves the time for new variety development.

Pigeonpea is a crop which has huge economic significance. Some of the objectives which have been addressed for pigeonpea genome project includes : 100,000 ESTs and genic-SSR /SNP markers and Genomic SSR markers, mutant lines and mapping populations as resource for gene discovery, high density molecular linkage map as a reference map, markers and genes for important agronomic traits, pigeonpea genome informatics platform and sequencing gene-rich BAC clones of pigeonpea. Pigeonpea genome sequencing along with ICRISAT is another flagship initiative that has been initiated. Identification of major QTLs/Genes for yield, quality and stress tolerance traits by combining high resolution genetic mapping and whole genome expression profiling was major part of the project. Mapping of plant type triats in pigeon pea is illustrated below :

Mapping Population: ♀ Pusa Dwarf X ♂ HDM04-1

Trait	Pusa Dwarf	HDM04-1
Plant height (cm)	88	118
No. of primary branches/plant	20	5
No. of pods/plant	120	24
Days to Flowering	106	65
Days to Maturity	158	116
Growth habit	Determinate	Indeterminate

The GM crops are also integral part for leveraging biotechnology to increase crop yield. First GM crop released in 2002 by Mahyco, GM covered 11 million ha in 2011-12, several hundred hybrids were developed during this period, 100% yield gain, 50% reduction in pesticide use and >200% increase in profit. The GM crops aids in productivity enhancement (prevents yield losses), nutritional and processing quality, safer foods-from chemical to genetic, designer foods, fiber crops (reduced lignin content), timber (rapid bio-mass growth), bio-energy (bio-diesel, ethanol etc.), bio-fertilizers and nutrient use efficiency, improved profitability to farmers and growth of seed industry and job opportunities. Some of the issues associated with GM crops are: Inadequate food and feed safety assessments, development of super weeds, horizontal transfer threat to biodiversity, loss of soil fertility, loss of crop diversity and biodiversity, GM seeds are costly, dominance of MNCs, imprecise gene transfer long-term consequences, labeling of GM products (right of choice), GM is unnatural (moral and ethical grounds), productivity enhancement.

Recommendations

The road ahead for leveraging biotechnology in agriculture needs:

- The NARS public institutions and Indian private sector have shown the capability of developing useful transgenic events, but need enhanced capacity to be globally competitive.
- Global IPR regime makes it imperative to have our own genes and transgenic events to make transgenic seeds affordable to the farmers.
- R & D in frontier areas of gene discovery and transgenic development through state-of-the-art National Institutions required (Genome decoding of Indian Species and Functional Genomics).
- Human capital needs to be developed in the frontier scientific areas including genomics, bioinformatics and nanobiotechnology.
- Policy issues including, efficient regulation and technology competitiveness need attention to facilitate commercialization.

20 Enhancing Water Use Efficiency in Agriculture by using Micro Irrigation Systems

Somnath Jadhav

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Abstract

With an evergrowing population, India is slowly reeling under water crisis and also land resources have taken great pressure due to urbanisation. Also, water losses in the form of percolation, evaporation, seepage and conveyance are high, and the constant rotational system giving strain and stress to the crops, the water supply is unreliable and inadequate. Therefore there is a need to use the water for irrigation very judiciously. Also, micro irrigation is a modern method of water application to the crops. In this type of systems, water is applied through a network of pipes (generally PVC, LLDPE), filters, emitting devices near the root-zone of the plants through very low pressure up to 1.00 kg/cm². The method is proved to provide minimal losses and efficiency of the project is very high up to 90%. The Government of India has a mandate to increase the Water Use Efficiency at least by 20% and the use of drip/sprinkler irrigation can help realise the dream of water conservation for farmers.

Resources in India

India is a vast country with a population of 1.27 billion comprising 18.9% of the global population. India occupies about 2.2% of the worlds land mass and has 4.3% of water resources in the world. Therefore, limited water and land resources have pressure of huge population in the country. India's water demand from all sectors is estimated to be 843 BCM during the year 2025 and 1180 BCM in the year 2050, which is going to cross the availability of 1123 BCM before the year 2050. Before 2050 we are going to face a water shortages with adeficit of about 57 BCM. The following table shows distribution of resources in India.

Resource	World	India	% to world
Population, Million	6710	1270	18.9
Land, 000' Km²	149000	3288	2.2
Water, BCM	48632	2085	4.3

Water Availability and Demand:

	Water Demand in km³ or BCM		
Particulars	**year 2010**	**year 2025**	**year 2050**
Water Demand from all Sectors	710	843	1180
Irrigation	557	611	807
Drinking water	43	62	111
Industry	37	67	81
Energy	19	33	70
Others	54	70	111
Availability of Utilisable Water	1123	1123	1123
Excess / Short Fall	413	280	-57

Source: Ministry of Water Resources, GOI

Apart from the limited resources, India has the problems of loss of agricultural land due to urbanization, water shortages and pollution, irrigation problems and huge water losses, climate change, shortages of arable land and land degradation. These constitute the limits and constraints of food production in the country. In India, the gap between irrigation potential created and utilized is huge. We need to fill this gap by increasing irrigation efficiencies and water use efficiency. This is required particularly in canal irrigated areas because the water use efficiency in canal command areas are lacking, since the productivities in the canal command areas are less than well irrigated areas. The water use in canal command areas is also higher than in well irrigated areas.

Supply-based systems

In supply based systems (i.e. alternately called canal systems), normally the water is applied through flow irrigation, water losses in the form of percolation, evaporation, seepage and conveyance are high, it is rotational system giving strain and stress to the crops, the water supply is unreliable and inadequate. Farmers in the command area tend to cultivate low value short duration crops such as sorghum, pearl millet etc. This leads to poor recoveries of water and electricity charges if any and unviable projects.

Demand-based systems

On the contrary, in demand based systems, i.e. well irrigated areas, the normal method of water application to the crops is drip/sprinkler systems, water supply is reliable and demand based, very high Irrigation efficiencies and water use efficiencies because of high crop productivities and less water use. These systems are reliable and permit to cultivate high value cash crops such as banana, grapes, sugarcane, and oranges etc. Recoveries of water and power charges are high and therefore these are viable and sustainable projects.

Micro irrigation-a perfect demand-based system

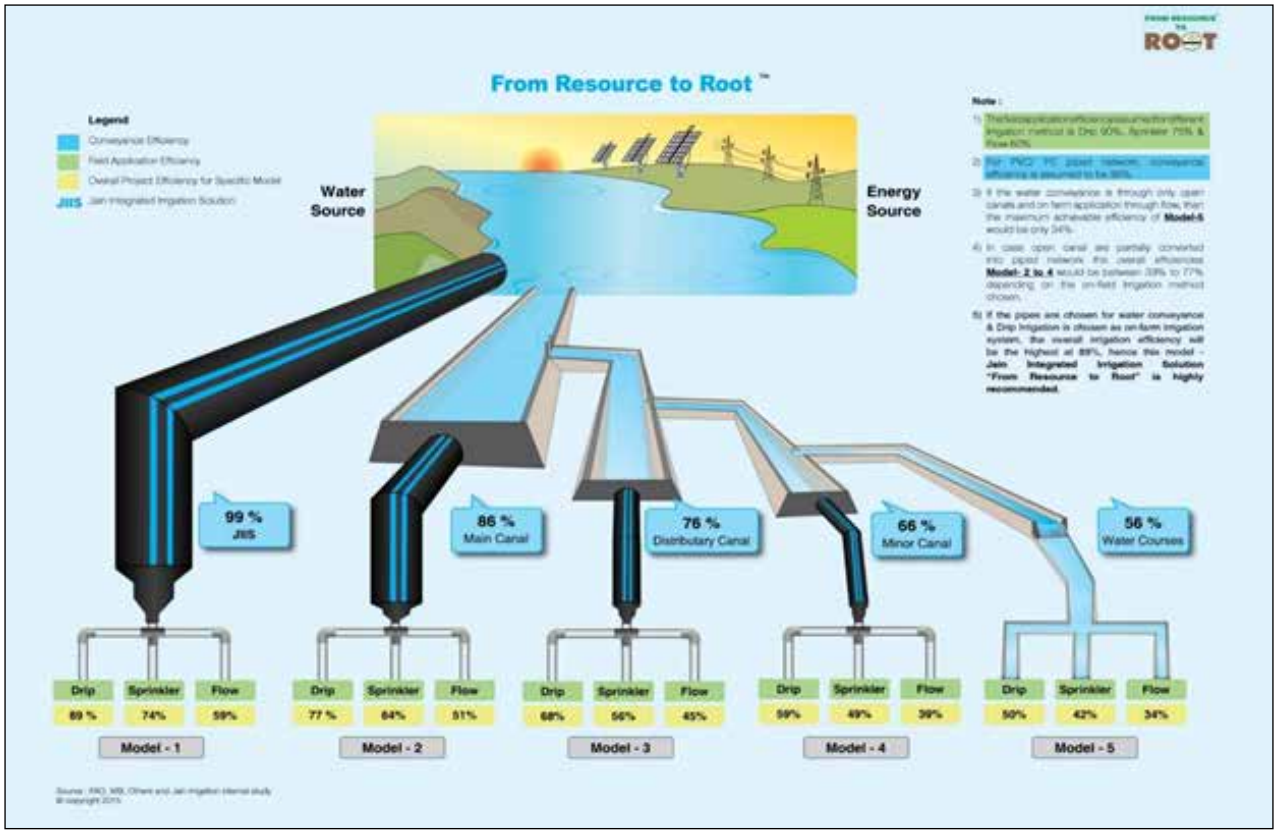
It can also be observed that more than 75% of the water is used for agricultural sector.

Use	Year 2010	Year 2050
Irrigation	78%	68%
Domestic	6%	9.5
Industries	5%	7%
Power Development	3%	6%
Other Uses (Environmental etc.)	8%	9.50%
Total	**100%**	**100%**

Therefore, we need to use the water for irrigation very judiciously. Also, micro irrigation is a modern method of water application to the crops. In this type of system water is applied through a network of pipes (generally PVC, LLDPE), filters, emitting devices near the root-zone of the plants through very low pressure up to 1.00 kg/cm^2. The losses including evaporation, conveyance, seepage and deep percolation are very low and the overall efficiency of the project is very high up to 90% (Refer Fig). Also, higher crop productivity because of fertigation is possible, huge water savings, high water use efficiency, high fertilizer application efficiency, reduced weeds and input costs, use of undulating terrain, power savings, etc. are some of the major advantages of this systems. This system is suitable for almost all types of crops including rice, subject to economic viability.

Irrigation efficiencies

Following figure explains the overall efficiency of the project. In the right-hand side of the figure, where the water conveyance is through open channels and application is through flow irrigation, overall efficiency of the project works out to be 34%. As we go on introducing the intervention of pipes for conveyance and application by sprinkler/drip, the overall efficiency of the project goes up. Thus, in the model which is on the left side of the figure, wherein the water conveyance is through pipes from resource



to the field and application is through only drip Irrigation, the overall efficiency of this model is 89%. There is a scope for improving overall efficiency of the project from existing 34 % to 89%. The overall efficiency will depend up on the stage at which we are bringing the technological intervention.

Water use efficiency

GOI has a mandate to increase the water use efficiency at least by 20%. It can be observed that the water use efficiency in terms of biomass produced in kg/m^3 of water consumed can be increased by more than 200% in case of vegetables by using drip method of irrigation. Similar is the case with fruits, oilseeds, pulses, cash crops such as sugarcane and cotton etc. If the drip irrigation systems are adopted on large scale for all the crops, this will not only provide “Har Khet Ko Pani” and “Per Drop More Crop “, but will also fulfil our beloved Prime Ministers’ dream of “Doubling Farmers’ Income” in very near future. The following table illustrates the same.

Water Saving and Productivity Gains under Drip Method of Irrigation : India

	Water consumption (mm/ha)		Yield (tonne/ha)		Water Saving over FIM	Yield Increase over FIM	Water use Efficiency (yield/ ha)/(mm/ha)		
Crop's Name	**FIM**	**DIM**	**FIM**	**DIM**	**(%)**	**(%)**	**FIM**	**DIM**	**%Diff.**
Ash gourd	840	740	11	12	12	12	0.013	0.016	23
Bottle gourd	840	740	38	56	12	47	0.045	0.075	67
Brinjal	900	420	28	32	53	14	0.031	0.076	145
Beet root	857	177	5	5	79	7	0.005	0.028	460
Sweet Potato	631	252	4	6	61	40	0.007	0.023	229
Potato	200	200	24	34	nil	46	0.118	0.172	46
Lady's finger	535	86	10	11	84	13	0.019	0.132	595
Onion	602	451	9	12	25	31	0.015	0.027	80
Radish	464	108	1	1	77	13	0.002	0.011	450
Tomato	498	107	6	9	79	43	0.012	0.083	592
Chillies	1097	417	4	6	62	44	0.004	0.015	275
Ridge gourd	420	172	17	20	59	17	0.041	0.116	183
Cabbage	660	267	20	20	60	2	0.03	0.075	150
Cauliflower	389	255	8	12	34	39	0.021	0.045	114
Vegetable (Avg)	638.1	313.7	13	17	54	26	0	0.1	243

References

FAO Manual

Guidelines for improving Water Use Efficiency in Irrigation, Domestic and Industrial sector, by CWC, New Delhi

Ministry of Water Resources, Government of India

Narayanmurthy's research papers

Das Anup, Mudra G and **Patel DP.** 2009. Technological Options for Improving Nutrient and Water Use Efficiency

Strategies to Improve Water Use Efficiency. 2016. http://extension.psu.edu/plants/crops/news/2016/07/strategies-to-improve-water-use-efficiency , accessed on 5th Oct, 2016

21 Recommendations

Chair: Mr Dhirendra Singh; Mr NC Vij

Mr Dhirendra urged all to coalesce with Government, NGOs and industries to achieve this noble target. He highlighted a need for continuous monitoring for changes in policies. He also urged everyone to point out the weaknesses of recommendations.that emerged from the event.

Dr. Wani said that to double incomes on a sustainable basis has emerged clearly. And we need to identify speedbreakers during the year-1 to advice government on policy in all 11 districts in Vidarbha region of Maharashtra and seven districts of Bundelkhand region in Uttar Pradesh. Varying agro-ecologies, available natural resources, 137 million farming families, and farmer-centric policies of government of India provide an immense potential to transform subsistence agriculture in India for doubling farmers real income by 2022 by adopting a new business and farmers-centric approach for sustainable development.

Dr. KV Raju shared a PPT on recommendations particularly in reference to Vidarbha region. The recommendations are presented below:

The following recommendations covering strategy, possible interventions,enabling institutions, and mechanisms emerged from the two-day workshop.

Inadequacies

1. Doubling farmers' income boundaries due to agro-ecological potential and climate change impacts must be considered along with growing water scarcity, land degradation while devising the agro eco-region wise interventions.

Strategies

- For achieving the goal of doubling farmers' income by 2022 business as usual must be challenged. The starategy must in clude innovation focused on: participatory achievements multi commodity, integrated mission approach to address chalanges based on agroecological zones. These science-led, demand driven interventions by adopting inclusive market oriented development (IMOD) value chain approach through building new partnerships to harness collective action and capacity building are required to meet the sustainable needs of the farming communities. It should include all micro-enterprises. KISAN–MITrA (Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture) as indicated below Figure 1 is recommended to achieve the desired goal.
- The principles of "Ease of Doing Busines" need to be applied to the Agriculture sector. This implies converging and simplifying all schemes and simplifying everything to a single form, which is available on the internet as well as a digital app, so that a farmer merely logs in using his / her thumbprint and applies online, with just a click. Entitlements, as due, could be directly remitted into the bank account of the beneficiary as part of the Direct Benefit Transfer. This, of course implies that the bank account, Aadhar number and mobile number are registered to each other and to the farmer.
- The workshop and subsequent actions must push hard for a digital economy. This would eventually result in competitively priced retail loans available by a phone app. This also implies that rural women-folk too, would have equal access to loans – a situation that sadly is not the norm today. It would also result in a situation where the collateral for loans is at affordable levels. The Finance Ministry and RBI could consider a move in the Agriculture sector, similar to the constitution of IDFs for the Infrastructure sector for Co-operative farming. The IDFs extend long tenuor loans at lower interest cost to the infrastructure sector to promote infrastructure development.

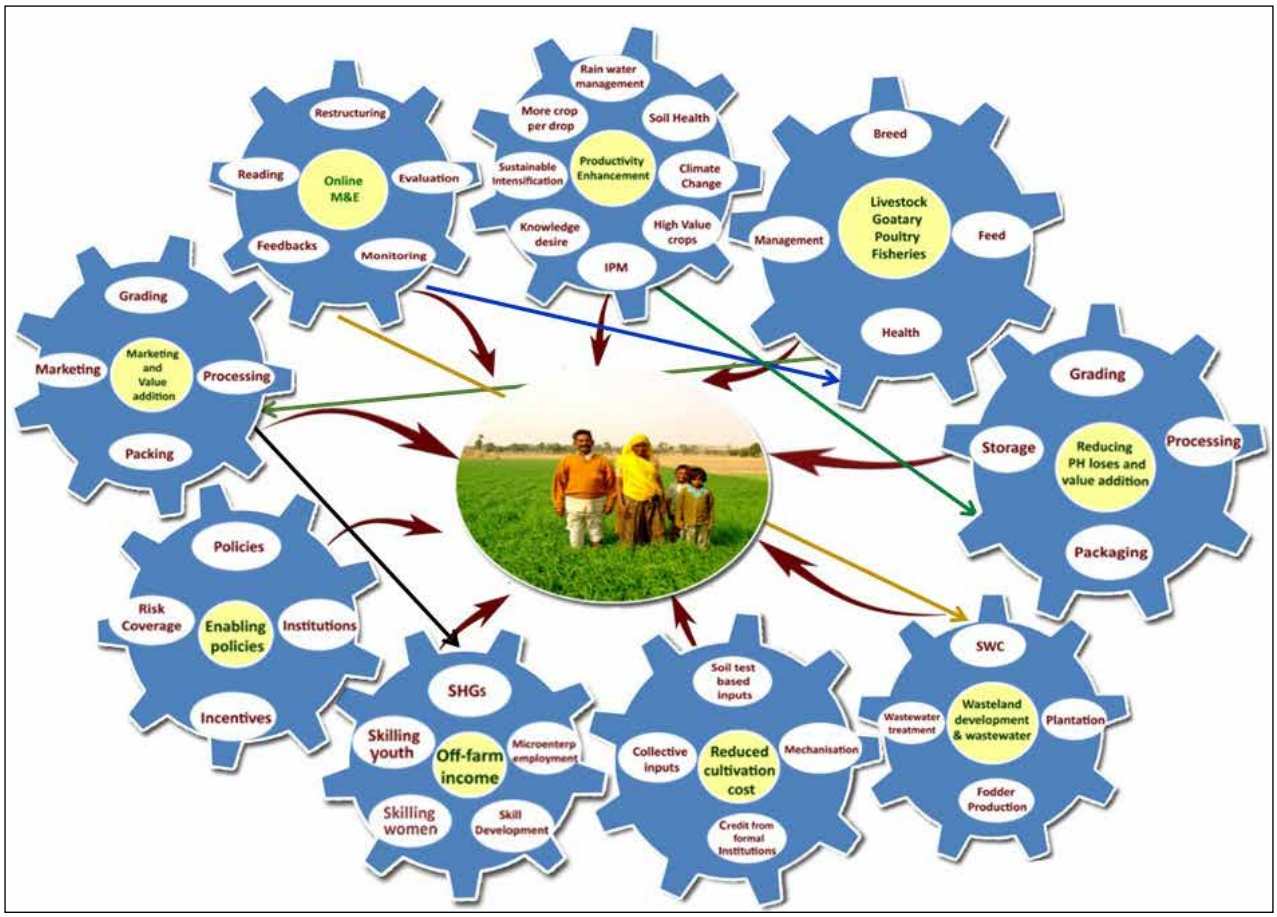


Figure 1. KISAN – MITrA (Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture) Farmers-Centric Integrated and Inclusive Market Oriented Development

- A digital database of all successful EMI payments on farm loans over the last 10 years, be used to register borrowers as "farmers". This is to prevent people from misusing farming income and "Jan Dhan" accounts from the perspective of income tax, subsequently. These "registered farmers" will then be permitted to withdraw cash from their bank accountswithout any transaction charges, against loans provided by cashless means. This principle also needs to be applied to Micro-Finance loans. This community also needs to be targeted subsequently by Banks & NBFCs in a systematic manner for improving their digital and financial literacy.
- Agro-ecoregion wise integrated plans with possible innovative growth engines including diversified livelihood options need to be prepared urgently. The strategy should be increasing productivity thru efficient use of available resources (more crop per drop and per unit of inputs), reducing cost of cultivation, minimizing post-harvest losses, value addition through processing and value-chain along with market linkages would increase agricultural incomes. Through skill development employment for women and youths in rural areas through microenterprises and industries in rural areas need to be promoted. Science-led agriculture thru mechanization and use of information technology including remote sensing, UAVs for precision agriculture and value chain approach would benefit youths. Potential partnerships needed for success including public private partnerships (PPP), financial institutions, scientific institutions, community-based institutions, etc. need to be harnessed.
- A pilot for Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh "sites of learning"are proposed to be established to serve as "Seeing is believing" for transforming 11 districts in Maharashtra and seven districts in Bundelkhand region of Uttar Pradesh in a phased manner up to 2022. Detailed blue print is to be prepared soon identifying the right partners to fund, implement and scale-up to achieve the goal using new science-led innovations for sustainable intensification including digital agriculture, value addition, market linkages, and risk mitigating strategies urgently.

The consortium partners will be some of the participating institutions in the workshop plus few others. The proposed name for this initiative is "KISAN – MITrA (Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture). (15 May 2017).

- For implementing the pilots in the state of Maharashtra and Uttar Pradesh, a semi-autonomous body Special Project vehicle (SPV) for complete design, execution, monitoring and learning, funding (from state, central and other sources), with clear terms and effective dash board for wider use is recommended. The proposed institutional arrangement (Figure 2) is recommended with a Chief Executive Officer (CEO), advisory body at national state, district and taluk/block level is recommended. The SPV could be formed in both the regions soon. (30th April 2017).
- There will be an in-built monitoring and evaluation along with specific performance monitoring indicators. We need to design specific monitoring and evaluation indicators (e.g. reduction in farmer suicides, climate information dissemination, yield improvement, shift in crop pattern, input use efficiency, water use efficiency, area under micro irrigation, market linkages, functional FPOs, increase in reuse of wastewater, increase in per capita income, reduction in out-migration both in seasonal and annual, increase in nutritional intake, increased role of women in various activities and increased income for rural women, value addition for various commodities).
- At the earliest, the Department of Agriculture, Cooperation and Farmers Welfare (DoAC&FW) of the Government of India and the Government of Maharashtra and Government of Uttar Pradesh need to appoint a nodal officer each for setting up a State Level Coordination Committee (SLCC) (Steering committee).

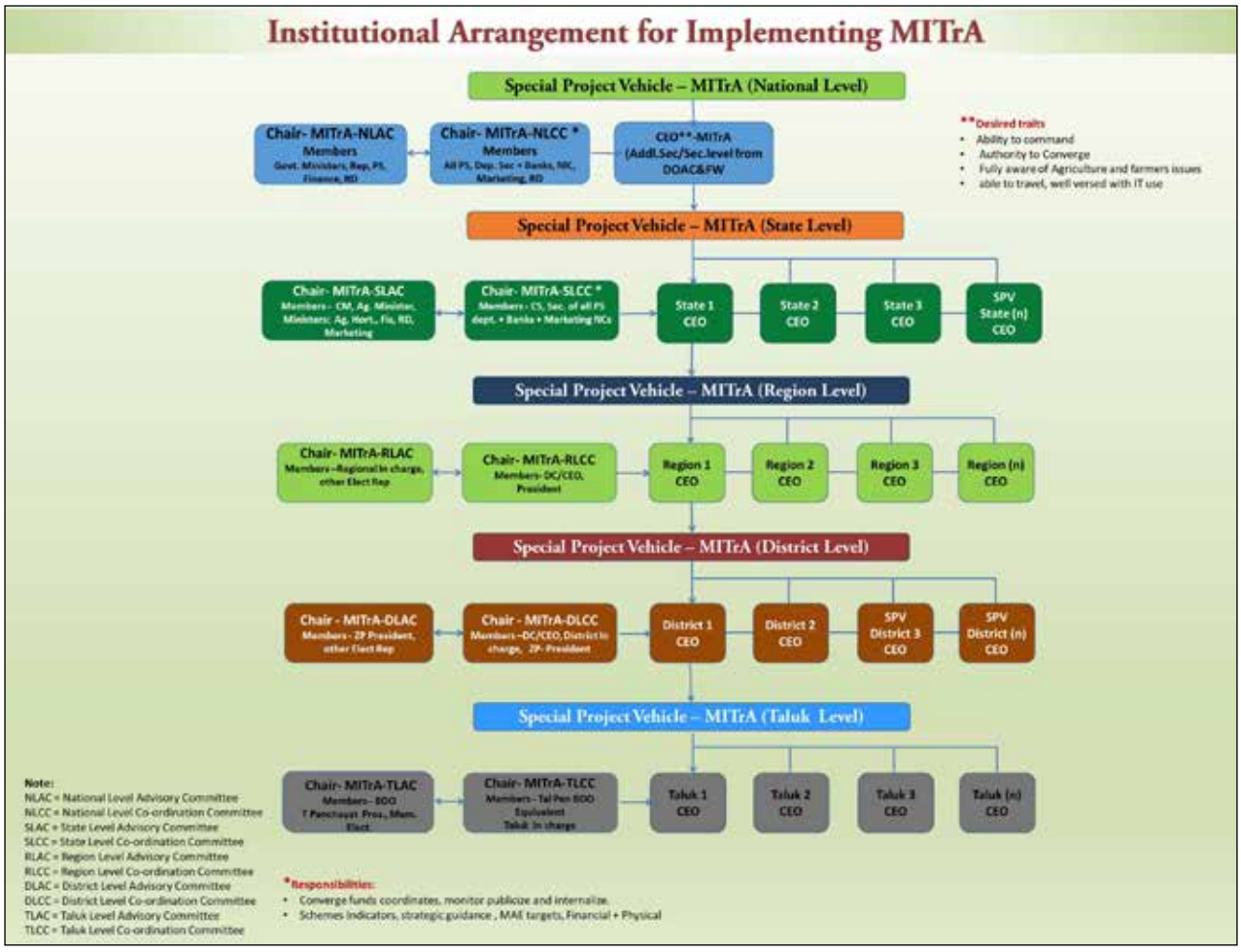


Figure 2. Institutional Arrangement for Implementing KISAN - MITrA.

Then, VIF, ICRISAT, ICAR and other leading private and public organizations (including NABARD, financial and marketing organizations) should add one representative to this steering committee (**1**5 April 2017).

- ICRISAT along with a select team should prepare a strategy for Vidarbha region in Maharashtra and Bundelkhand region in Uttar Pradesh adopting watershed/ catchment approach in river basins, segregating tribal and nontribal areas, converging all the schemes of GoI, GoM and CSR initiatives in consultation with all the stakeholders. This strategy should be presented to concerned ministers (or a group of ministers, to be held in ICRISAT, Hyderabad). It should have ministers of GOI and GOM. The strategy should have demand driven interventions linking farmers "*Aadhar* "numbers, bank details and land survey numbers on GIS platform. Accurate recording of Land titles and delineation, using remote sensing and GIS techniques, needs to be taken up and placed on the internet urgently. This would enable speedy loans at affordable interest rates against farming land for small farmers wishing to upgrade to modern methods of farming and irrigation (Action: 30th April 2017).

Way Forward

Knowledge-based Integrated Sustainable Agriculture Network – Mission India for Transforming Agriculture (KISAN–MITrA)

Suhas P Wani, KV Raju, Girish Chander, Gajanan Sawargaonkar

The National Workshop on Doubling Farmers' Income through Scaling-up was organized by Vivekananda International Foundation (VIF) in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and J Farms in March 2017. Following the workshop, it is recommended to establish a pilot in Vidarbha region of Maharashtra and Bundelkhand region of Uttar Pradesh. Based on the recommendation emerged from the brainstorming session on doubling farmers' income held at VIF, New Delhi, detailed concept note titled "Knowledge-based Integrated Sustainable Agriculture Network-Mission India for Transforming Agriculture: Doubling Farmers' Income in Vidarbha Region, Maharashtra and Bundelkhand Region, Uttar Pradesh" was prepared and submitted to the Ministry of Agriculture, Department of Agriculture, Cooperation and Farmers Welfare (DoAC), New Delhi. The DoAC & FW suggested that the concept note was to submit to the two state governments under RKVY (Rashtriya Krishi Vikas Yojana) initiative for their respective districts. Below is the Concept note submitted.

Concept note

Background

In India, nearly 60 per cent of the population is dependent on agriculture and allied sectors for their livelihoods, and a major share of the population below poverty line is dependent on agriculture for their livelihood.

The Hon'ble Prime Minister of India had stressed on doubling farmers real income by the year 2022 and provided seven strategic points (see box). Then, the Union Budget speech 2016–17, had highlighted the need to think beyond 'food security' of the country to focus on 'income security' of the farmer. The Finance Minister had also laid emphasis on the optimal utilization of the country's water resources; creation of new infrastructure for irrigation; conservation of soil fertility with balanced use of fertilizer; and provision of value addition and connectivity from farm to markets.

Prime Minister's Seven Point Strategy for Doubling Farmers Income by 2022

- Focus on irrigation with per drop-more crop;
- Quality seed and soil health;
- Investments in warehousing and cold chains;
- Value addition through food processing;
- Creation of a national farm market;
- New revolutionary crop insurance scheme to mitigate risks at affordable cost; and
- Promotion of ancillary activities like poultry, beekeeping, and fisheries.

Ajay Vir Jakhar, Chairman, Bharat Krishak Samaj says, following critical aspects of Indian agriculture should be considered in enhancing farmers income:

- Majority of farms will remain small, with a large proportion of sharecroppers and tenants.
- At least one member of a farm household will be entirely dependent on the farm for a living with no other occupation.
- Of the total cultivable land in India, about 60 per will remain rain-fed, irrespective of investments in irrigation.
- Therefore, commodity stocks will be only as predictable as the monsoons are.
- The population in India will take two more decades to stabilize, and in the meanwhile, economic growth will push the composition of the food basket away from food grains towards high-value products such as fruits, vegetables, dairy and poultry products, as also meat and fish.

Changing climate, increasing weather variability, water scarcity and land degradation poses severe challenges for food and nutritional security for India's growing population. Increasing cost of cultivation, low productivity and lack of remunerative market prices for farmers result in low incomes and poverty for small and marginal farm holders. However, pilot studies have demonstrated increased productivity, value chain development, market-linkages, processing

Based on the trends in farm income from 1983–84 till 2011–12, Chand et al (2015) concluded that:

- The income earned by farmers net of input cost and wage bill has seen low and high growth paths in different periods;
- The growth in farm income accelerated towards recent period ending 2011–12;
- Decent growth in farm income requires high growth in output, favourable farm produce prices, and some cultivators moving out of agriculture;
- A high growth in agriculture can reduce income disparities and promote inclusive growth;
- Low growth of farm income seems to have been associated with agrarian distress; and,
- More than half of farm households in the country will remain below poverty level unless they adopt high-income earning avenues and augment their incomes through non-farm activities.

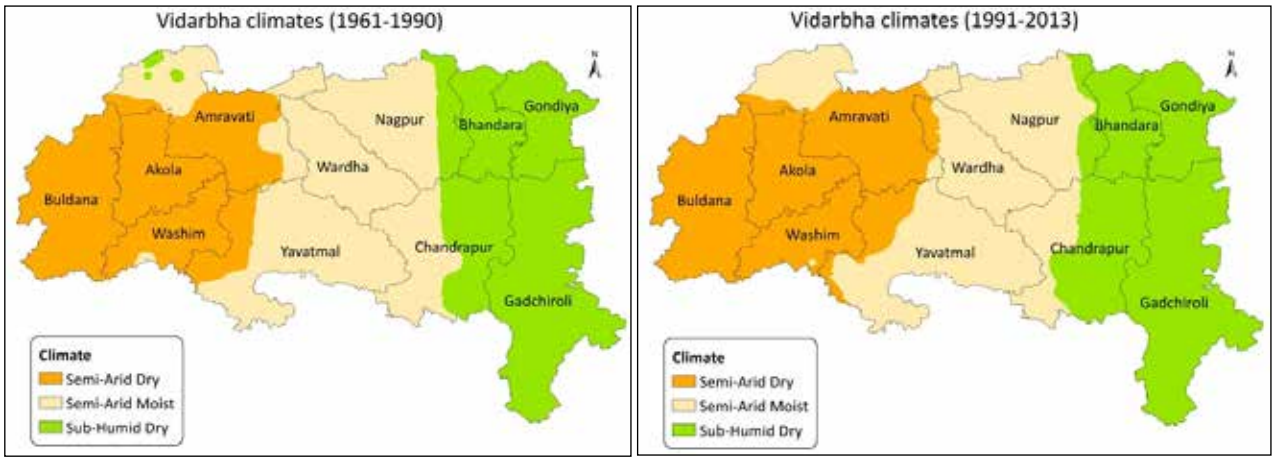
and collective and cooperative arrangements can increase productivity, reducing input costs and increasing profitability for the farmers. Large scale implementation is a key challenge that requires enabling institutions and policies working in concert with integrated science-led approaches that are coupled to Public-Private-Producer partnershps and tools to track and adjust implimention tailored to the needs of each state to realize a doubling of farmers' income by 2022.

A National Workshop on Doubling Farmers' Income through Scaling-up was organized by Vivekananda International Foundation (VIF) in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and J Farms in March 2017. The workshop covered strategy, possible interventions and enabling institutions and mechanisms to address two key areas given the diverse agro-ecologies, available natural resources, 137 million farming families, and farmer-centric policies of government of India 1) how can we transform subsistence agriculture in India through new business models to support sustainable development; 2) how can this transformation be achieved while living within the ecological boundaries, especially given the growing water scarcity, land degradation, through tailored production systems for a given agroecology.

Target region

Vidarbha region

- Vidarbha region in Maharashtra comprises eleven districts (Amravati, Akola, Bhandara, Buldhana,Chandrapur, Gadchiroli, Gondia, Nagpur, Wardha, Washim and Yavatmal). This region is home to 23 million people, with 4.98 m ha net sown area and 6.45 m ha gross cropped area.
- Indian Meteorological Department (IMD) in Vidarbha provided daily rainfall data set over the past 53 years at a high spatial resolution of0.25° × 0.25° (latitude × longitude) Pixel-wise water balances and climate indices were computed based on the revised water budgeting approach of Thornthwaite and Mather (1955).
- Results of the climate change analysis of Vidarbha show that Amravati district has witnessed great shifts in climate types. Area under Semi-Arid dry climate has increased by an estimated 138,000 ha. Wardha district also has witnessed increase in the Semi-Arid dry areas by 64,000 ha that was Semi-Arid moist. Washim, Yavatmal and Akola have also increased their Semi-Arid dry climates by about 10, 7 and 2 thousand hectares all being shifted from Semi-Arid moist ecologies. Nagpur and Bhandara districts have also showed increasing dryness, with 90,000 ha and 1,000 ha have shifted from Sub-Humid dry to Semi-Arid moist climate, respectively. Thus, out of the eleven districts in Vidarbha, seven districts Amravati, Wardha, Washim, Yavatmal, Akola, Nagpur and Bhandara districts have become drier in the past 15 years compared to the 1961-90 period. Buldhana, Gondia and Gadchiroli did not show any change in the climate type. Chandrapur is the only district that showed increased wetness with 135,000 ha shifting from Semi-Arid to a Sub-Humid dry climate
- When the whole Vidarbha region is considered, about 221,000 ha area under Semi-Arid moist climate has been shifted towards drier side (Semi-Arid dry climate) and only 24,000 ha have shifted towards wetter side (Sub humid dry climate).

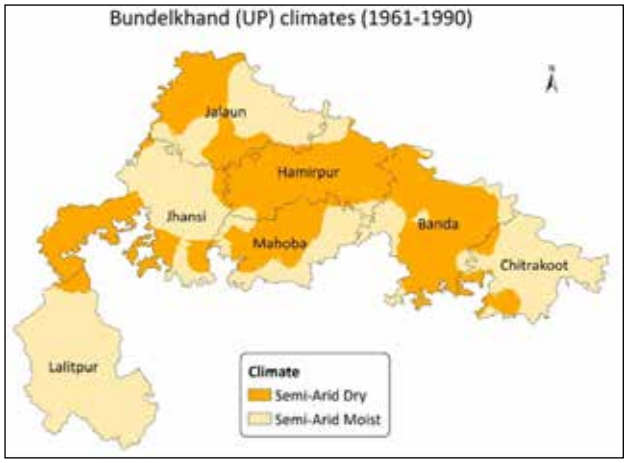


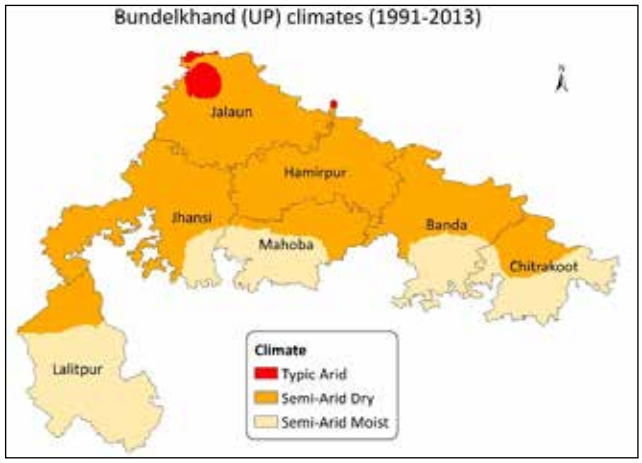
Changes in climate types in Vidarbha, Maharashtra during 1961-1990 to 1991 to 2013.

		Area in '000 ha			
District	**Period**	**Semi-Arid dry**	**Semi-Arid moist**	**Sub-Humid dry**	**Total**
Amravati	1961-1990	658	543	20	1221
	1991-2013	796	425	0	1221
	Difference	138	-118	-20	0
Nagpur	1961-1990	0	768	221	989
	1991-2013	0	858	131	989
	Difference	0	90	-90	0
Gondia	1961-1990	0	0	523	523
	1991-2013	0	0	523	523
	Difference	0	0	0	0
Chandrapur	1961-1990	0	556	588	1144
	1991-2013	0	421	723	1144
	Difference	0	-135	135	0

Bundelkhand region

- Bundelkhand region in Uttar Pradesh comprises of seven districts (Banda, Chitrakoot, Jhansi, Jalaun, Mahoba, Hamirpur, Lalitpur).
- The average numbers of rainy days during the monsoon and non-monsoon period are 42 and 13, respectively. Long-term data analysis showed that annual average rainfall has decreased from 950 mm between 1944 and 1973 as compared to an average of 847 mm between 1974 and 2004.
- Most of the areas are single cropped and completely under rainfed conditions. Bundelkhand is largely dependent on groundwater resources for domestic and agricultural use.
- Socio-economic status of the Bundelkhand is characterized by high poverty; literacy is lower and women and land less people are highly vulnerable. Drudgery for women and girls is high as they spend significant time and energy to collect water for domestic use.





Changes in climate types in Bundelkhand, Uttar Pradesh during 1961-1990 to 1991 to 2013.

		Area in '000 ha			
District	**Period**	**Typic Arid**	**Semi-Arid dry**	**Semi-Arid moist**	**Total**
Jalaun	1961-1990	0	224	233	457
	1991-2013	66	391	0	457
	Difference	66	167	-233	0
Jhansi	1961-1990	0	230	272	502
	1991-2013	0	443	59	502
	Difference	0	213	-213	0
Mahoda	1961-1990	0	152	136	288
	1991-2013	0	133	155	288
	Difference	0	-19	19	0
Banda	1961-1990	0	348	98	446
	1991-2013	0	304	142	446
	Difference	0	-44	44	0

Goal & objectives

The overall goal of this initiative is to pilot and demonstrate an integrated science-led approach for increasing productivity and profitability for the farmers compressing weak value chains for commodities that can be sustainably produced and processed by farmers and farmers producers organizations that leverage ICT and advanced analytics to manage production risks, optimize water and soil resources and maximize market opportunities. The specific objectives of the proposed initiative are:

- Establish pilot sites (5000 ha in cluster of villages per district) as "sites of learning" by integrating science-led interventions for increasing productivity, affordable food and nutrition, primary processing and profitability through structured markets for the farmers, in five years.
- To pilot value-chain approach for selected commodities in the target districts for realizing higher unit value for the farmers.
- To establish online monitoring, learning and evaluation (MLE) platform for documenting progress and sharing the results for scaling-up.
- To build capacity of the stakeholders in the target districts as well as other parts of the country for doubling the farmers real income through scaling-up of integrated science-led approach.

Strategy

- To address the issue of growing water scarcity, food and nutrition security, an integrated community watershed approach will be adopted as an entry point to promote collective action in the pilot areas.
- In order to tackle the increased climate variability, the impacts of climate change at district and taluk level will be assessed in order to develop appropriate adaptation and mitigation strategies for sustainable development.
- For each region, a Consortium of associated line departments, state agricultural universities, research institutions in the region, non-governmental organisations (NGOs) and private companies will be formed under the leadership of ICRISAT to benefit the farmers.
- At state level, in the region workshop of all the stakeholders including Consortium partners will be organized to identify the suitable growth engines for achieving the goal of doubling the farmers' income by adopting value chain approach
- Considering the impacts of climate change and marketing demands based on the suitability of the agro-eco region suitable crops/ cultivars will be evaluated and promoted through demonstrations with productivity enhancement measures.
- Through convergence, all the schemes of Government of India [*Pradhan Mantri Krishi Sinchai Yojana* (PMKSY), Soil health mapping and direct benefit, *Pradhan Mantri Gram Sadak Yojana* (PMGSY), *National Agriculture Market* (e-NAM), *Pradhan Mantri Fasal Bima Yojana* (PMFBY) and *Paramparagat Krishi Vikas Yojana* (PKVY), RKVY, NFSM etc.,] and state government farmers will be covered to benefit through integration and collective action through Farmers Producers Organizations (FPOs) to harness the benefit through scale of operations.
- In addition to the growth engine for crops, other growth engines like livestock as well as micro-enterprises for value addition will be identified and promoted as per the suitability and market demand.
- The strategy for increasing productivity and profitability in the small and marginal farm holders will be to provide demand-driven interventions to the farmers for which farmers will have to register themselves and take lead role for ensuring sustainability of the initiatives.
- Using online monitoring, learning and evaluation (MLE) platform of the farmers, interventions and progress will be monitored using digital technologies in partnership with consortium members. Third party evaluation will also be undertaken.
- Allied sector activities like livestock, small ruminants, poultry, bee keeping and high-value crops like fruits and vegetables using harvested rainwater / groundwater through protective cultivation will be harnessed.
- Micro-enterprises for youths and women will be promoted to benefit agriculture and small farm holders in the region as well as generating employment in the region.
- Through public private partnership, market linkages as well as value addition through collective action of FPOs will be promoted to benefit small and marginal farm holders.
- To disseminate results and popularize the interventions hands-on training for the farmers, documenting short videos, as well as conduct of field days for the surrounding farmers will be adopted.
- Documenting the success stories to share with other regions and states will be undertaken by the Consortium team members.

Activities

Objective 1: To establish pilot sites (5000 ha in cluster of villages per district) as "sites of learning" by integrating science-led interventions for increasing productivity, affordable food and nutrition and profitability for the farmers, in five years.

- Preparation of strategy for doubling the farmers' income in Vidarbha, Maharashtra and Bundelkhand, Uttar Pradesh regions considering the impacts of climate change and market intelligence.
- Conduct state level workshops to form a Consortium, building the team and identify the growth engines as per the strategy for doubling the farmers' income.
- Identification of pilot sites (~5000 ha of cluster of villages) representing 18 districts of Vidarbha and Bundelkhand.
- Baseline characterization (socio economic, biophysical and agricultural eco regional including climate change impacts) to be used later for monitoring and evaluation of impacts.
- Soil health mapping for all the farmers by adopting stratified approach, preparation of soil health maps, dissemination of information to villagers and awareness building.
- Development of soil test-based recommendations and integrated nutrient management strategies for selected crops in the districts.
- Farmer participatory evaluation/selection of improved stress tolerant high-yielding crop cultivars and establishing seed systems in the pilot areas.
- Soil moisture conservation through different land form interventions and efficient use of water.
- Soil carbon building strategies through composting, green manuring, aerobic composting, minimum tillage and residue management.
- Enhancing efficiency of natural resources like integrated, land and other inputs.
- Weather-based insurance to mitigate the risk of crop failure and loss. An enabling environment to implement this will be created by bringing convergence among various agencies (state departments, insurance companies, local body institutions, agencies responsible for collecting agro-meteorological information etc.).
- Recycling of wastewater and other use of treated wastewater for agriculture.

Objective 2: To pilot value chain approach for selected commodities in the target districts for realizing higher value for the farmers.

- Identify companies involved in procurement/processing and marketing of crops produced in the district.
- Formation of FPOs (Farmer Producer Organizations) for collective action to harness the benefits through scaling-up operations.
- Micro-enterprises for value addition and processing of farm produce as well as for inputs needed in agriculture (machine hiring centers, solar drying, dal making, vermicomposting, nursery raising, village seed banks, livestock etc.,)
- Establish market linkages between FPOs/individuals and private companies for high quality produce supported by appropriate grading.

Objective 3: To establish online monitoring, learning and evaluation (MLE) platform for documenting progress and sharing the results for scaling-up.

- To establish online mobile-based MLE platform.
- To identify Key Performance Indicators (KPIs) for each growth engine.
- Develop score card and online dashboard.

- Registration of farmers in the pilot site along with Aadhar card and bank account linkages and field survey numbers using satellite imagery.
- Develop smart phone-based applications for capturing individual farmer data and also for disseminating information to the farmers.
- Monitor online dash board and generating reports using KPIs at specified intervals for all the 18 districts in Maharashtra and Uttar Pradesh.

Objective 4: To build the capacity of the stakeholders in the target districts as well as other parts of the country for doubling the farmers real income through scaling-up of integrated science-led approach.

- To conduct exposure visits of the farmers from the pilot sites to model villages/research stations and model farmers.
- Conduct annual review and planning workshops and synthesize the reports.
- Train lead farmers in handling videos and knowledge dissemination using tablets to other farmers.
- Conduct field days to disseminate the results of the demonstration plots.
- Capacity building of master trainers for further scaling-up by the state departments and providing hand holding support.
- Documentation and preparation of reports for different stakeholders and policy guidelines for scaling-up of pilot initiatives for increasing farmers' income.

Expected outputs

Most important output of this initiative will be a "proof of concept" for doubling real farmers' income in five years and a scaling-up model for the same. The specific outputs of this initiative will be as follows:

- Sites of learning in each of the 18 districts established for doubling the farmers' income in harsh regions of Bundelkhand region in Uttar Pradesh and Vidarbha in Maharashtra.
- Online monitoring system and platform established which can be used for scaling-up at state and country level.
- A holistic knowledge/science-led integrated model for food, nutrition and income security for the small and marginal farm holders demonstrated.
- Documented case studies of doubling the farmers' income and increasing agricultural productivity through efficient use of inputs will be available for sharing with master trainers and policy makers.
- A blue print/ road map for doubling the farmers' income will be available to be shared with policy makers for scaling.

Duration: Five years

Vidarbha region, Maharashtra

During the meeting of district officials of Government of Maharashtra, the concept and strategy of KISAN MITrA was presented and discussed in Mumbai on 10th August 2017.

Figure 1. Chief Minister of Maharashtra chaired a meeting to review initiatives for doubling farmers' income by 2022, as envisaged by Hon. Prime Minister, Sri Narendra Modi.

For KISAN MITrA Initiative, a meeting was attended by Dr. Suhas Wani, Director Asia Regional Program, ICRISAT and Dr. KV Raju, Principal Scientist, ICRISAT with Hon. Chief Minister of Maharashtra, State Agri. Minister and Cabinet Minister, Agriculture with the Department of Agriculture (DoA) officials along with team of World Bank aided Project on Climate Resilient Agriculture (POCRA) in Maharashtra on ***10th August in Mumbai***. The concept and strategy for KISAN-MITra or doubling farmers' income initiative in Vidarbha region of Maharashtra covering 11 districts was presented by Dr Wani. Hon. Chief Minister of Maharashtra appreciated the initiative and advised the officials to take it forward quickly and integrate the POCRA activities in KISAN MITrA initiative.

After this meeting, a meeting was conducted under the chairmanship of Mr Bijay Kumar, Principal Secretary and Mr Sachindra Pratap Singh, Commissioner of Agriculture on ***16th September 2017 at Pune.*** From ICRISAT Dr Suhas Wani updated the group comprising all department officials of Maharashtra regarding DFI project and selection of Vidarbha for this initiative. ICRISAT team comprising Drs KV Raju, Kesav Rao, Gajanan Sawargaonkar, Kapil Raje, Kiran Petare, Rohan Khopde, Mukund Patil, Prasad Kamdi attended this meeting.

Principal Secretary informed the participants that this is a good initiative from Maharashtra government in collaboration with ICRISAT and we need to see that from coming *rabi* season, the Kisan Mitra program should become operational in Vidharbha. It was decided to adopt watershed approach while selecting the

Figure 2. Mr Bijay Kumar, Principal Secretary and Mr Sachindra Pratap Singh, Commissioner of Agriculture Government of Maharashtra and Dr Suhas Wani, ICRISAT during meeting on KISAN MITrA in Pune on 16th September, 2017.

5000 ha pilots across all 11 districts of Vidarbha and also to include already identified micro-watersheds in PoCRA program which will also help to use the resources from PoCRA for scaling up the good practices in the districts where ever the program exists. Similarly, all the national schemes will be integrated into Kisan MITrA.

Following this, one more meeting was held in ***Nagpur on 26th September, 2017*** wherein both Amravati and Nagpur divisional level agricultural department officials viz, Joint Director of Agriucltures (JDAs), District Superintendent Agriculture officer (DSAO), Sub Divisional Agriculture officer (SDAO) and Taluka Agriculture officer (TAOs) attended this meeting and from ICRISAT side, all district incharge scientists attended this meeting. ICRISAT has given presentation on broader level activities to be conducted in the districts starting from pilot identification, soil samplings, beneficiary identification, input sharing as well as capacity building across districts in Vidarbha region. For operationalization of the initiative, the team has been regularly in touch with DoA officials and other stakeholders and in this context, a multi-disciplinary team of scientist has visited the region along with department officials viz SDAO, TAO, Agricultural Officer (AO) and Mandal Agriculture officer (MAO) and the work towards developing pilot sites has been started. A brief detail of works undertaken so far is as under;

Figure 3. ICRISAT Scientists along with JDAs and DSAOs, SDAOs and TAOs of all districts in Vidarbha region during KISAN MITrA planning and implementation meeting at Nagpur on 20th September, 2017.

Identification of representative pilot sites

An introductory visit of ICRISAT team (Drs Sawargaonkar GS, Pawar CS, Patil MD, Raje Kapil, Khopade Rohan, Petare Kiran and Kamdi Prasad) was undertaken during 21st to 25th September 2017 for identifying pilot sites. During this visit, the team had discussion with different stakeholders including JDAs, DSAOs, SDAOs, AOs and farmers in all the districts. The team identified representative pilot villages/blocks in consultation with DSAOs and other officials (Table 1).

Stakeholders orientation and farmers meeting for *rabi*

Constraint identification: Agriculture is the main occupation of the people in rural parts of the Vidarbha region. Cotton, soybean and jawar (sorghum) are the major crops. Other important crops of the region are wheat, sunflower, canola, peanut, Bajra (pearl millet), chickpeas, pigeonpea, black gram and green gram. Most crops are dependent on the monsoon. Vidarbha›s Amravati division (including Akola District) share gross cropped area under irrigation of 9%. Considered one of Maharashtra›s least developed regions,

Table 1. Representative pilot sites across 11 districts in Vidarbha.

District	Pilot Block	selected villages	Cropping pattern
Amravati	Chandur bazar	Belora Hirapur, Dabha, Pala, Durgapur and Shendani	Cotton, Pigeonpea, and soybean (Kharif) Chickpea (Rabi)
	Nandgaon	Kharwadi, Talvel and Wadura	
Akola	Murtajapur	Lakhapuri and Durgawada	Soybean, Cotton, Red gram and Sorghum (K); Wheat and Chickpea (R)
	Akot	Khaparwadi, khurd, Khaparwadi Budruk, Jaulka, Lothkhed	
Buldhana	Nandura	Kokalwadi, Pimpri adhav	Pigeonpea, Soybean, Maize, Blackgram, Greengram, Cotton, Sorghum (K); Chickpea and Wheat (R)
	Mehkar	Dongaon	
Bhandara	Sakoli	Jambli, Bodra, Gudhari, Girola, Baradkinhi, Mundipar, Kitali, Sarati	Paddy, Soybean, Pigeon pea (K); Wheat, Chickpea (R)
	Lakhni	Pimpalgaon, Kairi, Manegaon, Samewada	
	Mohadi	Usarla, Salai Budruk, Katebramhi.	
	Tumsar	Khapa, Hasara, Hingana	
Chandrapur	Mul	Bembal and Chuck Bemba	Paddy, Soybean, Cotton (K) Chick pea, wheat and rabi sorghum (R)
	Pombhurna	Ghosari, Phutana Mokasa, Chuck Phutana	
Gadchiroli	Gadchiroli	Markabodi, Shivani, Murmadi, Aambetola and Sawargaon	Paddy, cotton (K); Paddy, Chickpea (R)
	Chamorshi	Kunghada re., Vaghdhara, Khopardi, Bhendla, Jairapur and Talodhi mo.	
Gondia	Morgaon Arjuni	Parastola, Dhamtitola, Arattondi, Ilda, Bharnoli, Rajoli, Sappgaon, Kanhalgaon, Khadki, Keshori, Kanheri, Kelvad, Tukumnarayan, Dongargaon, Amarpayali, Varnahi, Ambhora, Gardenpur, Garvara	Paddy, Pigeonpea (K); Wheat, Chickpea (R)
	Sadak Arjuni	Chikhli, Baki, Maneri, Kanheri, Kokana, Khoda, Chingi, Raka Palasgaon, Pimpri.	
Nagpur	Katol	Therla dhote, wandali, Digras B., Wadvihira, Khangaon, Kolabi, Chinchala, Naygaon, Dahirwadi	Cotton, soybean intercropped with pigeonpea (K) Chick pea and wheat (R)
	Savner	Khubala, Risala, Hingna, Kocchi, Pipla (Ritha), Sonpur	
Yavatmal	Pusad	Kondai, Dahiwad Bk., Khadakdari, Yehala, Weni Kh., Harshi, Pokhari, Balawadi	Cotton, Pigeonpea, and soybean (K); Chickpea (R)
Wardha	Seloo	Manabala Janglapur, Kolhi, Kolgaon, Ghorad, Kinhi, and Sukali station	Paddy, Soybean, Cotton (K) Chickpea, wheat and sorghum (R)
	Samudrapur	Gual, Bhosa, Umra, Nandpur, Derda, Lavangi and Mangaon	
Washim	Malegaon	Tiwali, Ghata, Mirzapur	Soybean, Cotton, Pigeonpea (K), Gram (R)
	Karanja	Gaiwal, Sohol, Wai, Murambi	

Vidarbha has seen not only farmers suicides but also deaths caused by malnutrition. In some tribal are major reasons of recent suicide deaths of farmers in the Akola region and other surrounding parts of Vidarbha, which has rung alarm bells in the Maharashtra state government and government of India. Oil and dal mills are becoming popular in this region because of the crops taken. Textile mills are also increasing to support the cotton growing industry.

The constraints identified are as follows

- Low productivity and high cost of cultivation
- Uncertain rainfall and recurrence of drought
- High cost of livestock maintenance.
- Low and less realization of price for crop produce
- Labour problem and their high cost
- Pest and disease problems and sometime drought, Heat wave, Hail storms, water scarcity
- Only/major dependence of farmers on agriculture, less of joint activity with livestock.
- Lack of other income generating activities in most farming families.
- Lack of group initiatives for common benefit of village community/ies

Table 2. Strength, Weaknesses, Opportunities and Threats (SWOT) analysis of the region.

Strengths:	**Weaknesses:**
• Soil with high water holding capacity • Suitable climate for important crops like, pegionpea and cotton • Less labour shortage • District has good number of livestock population and potential natural resources to support the livestock • Low per capital availability of milk indicate potential market for milk in the district	• Degradation of natural resources (land, water, and vegetation) • Poor irrigation facility • Poor marketing and storage facility • Less awareness regarding good agriculture practices • Low yielding livestock • Fodder shortage • Insufficient veterinary infrastructure and man power • Insufficient organized procurement and processing agencies
Opportunities:	**Threats:**
• Soil and water conservation • Improving use efficiency of land and water resources • Interventions to reduce cost of cultivation. • Strengthening agriculture extension system for taking good agriculture to all farmers. • Improving market and storage facilities • Developing region specific strategy for livestock related schemes. • Development of wasteland for fodder production • Strengthening milk cooperative societies for producing the milk product	• High dependency on monsoon rainfall. • Decline interest in agriculture as the income from agriculture is very less as compare to cost of cultivation. • Less price for livestock commodities • Fodder scarcity during drought period. • Risk of infectious diseases in poultry industry

***Growth Engines*:** In order to promote faster development in the pilots, and also based on the discussion with department officials and farmers, following growth engines are identified across all pilots in Vidarbha.

Table 3. Growth engine identified for pilot site in Amravati district.

Growth engines	INM	Soil and water management	Mechanization	FPO	Protected cultivation
Cotton*/Paddy*	Y	Y	Y	Y	
Pigeonpea	Y	Y		Y	
Chickpea	Y	Y	Y	Y	
Milk	-	Y	-	Y	-
Vegetables	Y	Y	Y	Y	Y

** Will be selected based on district specific important crop*

Participatory trials/demonstration during *rabi* 2017-18

Participatory trials and demonstrations to be conducted *Rabi* 2017-18 have been discussed with the farmers in the selected pilot villages and accordingly in all the seven districts participatory trials are planned to be conducted during the *rabi* season. The specific interventions grounded in pilot sites with a purpose to implement selected need-based interventions during *rabi* 2017-18, a team of scientists along with department officials visited the districts during 21 September-1 Oct 2017 and oriented department staffs about the protocols of participatory trials/demonstrations. As entry point interventions, ICRISAT has arranged to provide drought tolerant chickpea (JG 11) seed, machine harvestable chickpea (NBeG 47) seed, deficient secondary and micronutrients (zinc sulphate, borax), PGP cum nutrients (aquasap) and aerobic composting culture for participatory trials/demonstrations in the pilot sites (see district wise details in Table 4. Each district is also going to be given zero till multi crop planter and shredder to help in preparing the material for composting.

Table 4. Detail of inputs arranged for participatory trials/ demonstrations.

District	Chickpea (JG 11) (kg)	Chickpea (NBeG 47) (kg)	Mo	Zinc sulphate (kg)	Agribor (kg)	Aquasap (Litre)	Aerobic composting culture (each packet of 1kg)
Akola	400	300	2	300	100	50	100
Amravati	160	80	0	0	0	0	100
Bhandara	100	100	1	150	50	25	100
Buldhana	240	240	0	150	7.5	0	100
Chandrapur	400	0	2	300	100	50	100
Gadchiroli	100	0	1	200	50	0	100
Gondia	100	100	1	150	50	25	100
Nagpur	400	200	2	300	100	50	300
Wardha	400	0	2	300	100	50	100
Washim	200	200	1	300	75	50	100
Yavatmal	100	60	0	0	0	0	100
Total	2600	1280	12	2150	632.5	300	1400

Mr Ajay Kulkarni, SDAO Murtajapur and Dr Gajanan, Senior Scientist-ICRISAT during meeting with farmers from Lakhwadi village, Murtajapur tq, Akola district.

ICRISAT staff discussing with farmers in Dongaon village, Mehkar Taluk and Pimpri Adhav village, Nandura Taluk, Buldhana.

ICRISAT personnel interacting with farmers in Chuk Futana village of Pombhurna Taluk (left).

A protocol of participatory trials will soon be given to the identified NGOs and farmers

- Improved package of practices to be followed in max ½ acre by a farmer and to be compared with local practice in the same farmer's field or adjoining farmer's field.
- Crop cuttings are to be done at maturity to document yield benefit.
- Farmers to bear 50% cost of inputs i.e. $ 0.70/- per kg of chickpea seed, $ 0.31/- per kg of zinc sulphate, $ 0.93 per kg of agribor, $ 2.32 per litre of aquasap and $0.93 per kg bag of aerobic culture.
- Technical guidelines;
    - Full dose of micronutrient fertilizers - 10 kg $acre^{-1}$ of zinc sulphate and 1 kg $acre^{-1}$ of agribor.
    - Aquasap to be sprayed thrice after 30-40 days of sowing at 7-10 days interval. For spray at a time, 300 ml of aquasap to be mixed in 200 litre water and sprayed in 1 acre crop.
    - Chickpea seed rate @ 32 kg $acre^{-1}$.

Trials will be initiated in pilots across all the districts whose details are as follows.

Table 5. Detail of participatory trials initiated in pilots across 11 districts in Vidarbha.

District	Location	No of trials
Akola	Murtajapur taluk and Akot taluk	120
Amravati	Chandur bazar and Nandgoan Khandeshwar taluks	24
Bhandara	Sakoli-Lakhani taluks and Tumsar-Mohadi taluks	45
Buldhana	Mehkar and Nandura Taluks	48
Chandrapur	Mul and Pombhurna taluks	90
Gadchiroli	Gadchiroli and Chamorshi taluks	10
Gondia	Sadak Arjuni and Arjuni Morgaon taluks	45
Nagpur	Katol and Savner taluks	110
Wardha	Seloo and Samudrapur taluks	90
Washim	Malegaon and Karanja taluks	90
Yavatmal	Pusad taluk	16

More trials are being implemented and progress is being monitored on regular basis.

Bundelkhand region, Uttar Pradesh

Dr Wani has visited Department of Agriculture (DoA), Government of Uttar Pradesh at Lucknow on 4th May 2017 and presented the strategy and details of the project KISAN MITrA to the DoA officials as well as the staff from the allied sectors. During the meeting discussed with the Agricultural Production Commissioner (APC) about the framework for implementation of the KISAN MITrA was discussed and institutional arrangements for efficient convergence and implementation of the initiative was discussed. Subsequently, Govt of Uttar Pradesh through a Government Order dated 11 September 2017 Institutional arrangements for coordination of the KISAN MITrA initiative, Bundelkhand region of Uttar Pradesh has nominated nodal officer and also constituted the State Level Coordination Committee (SLCC) (Steering committee) chaired by the APC and at District level, District Level Coordination Committee chaired by District Magistrate.

Following meeting held under the Chairmanship of Agriculture Production Commissioner at Jhansi on 27th May 2017, ICRISAT has initiated interventions in the Bundelkhand region viz. 7 districts of Lalitpur, Jhansi, Jalaon, Hamirpur, Mahoba, Banda and Chitrakoot. For operationalization of the initiative, the team has

Figure 1. Dr Wani attended meeting with DoA and allied sector officials on 4th May 2017 at Lucknow.

been regularly in touch with DoA officials and other stakeholders and in this context, a multi-disciplinary team of scientist has visited the region three times so far - 28 May to 3 June 2017, 28 June to 02 July 2017 and 8-15 Oct 2017. A brief detail of works undertaken so far is as under;

Identification of representative pilot sites

An introductory visit of ICRISAT team (Drs KK Garg, Girish Chander, Vijay Jakulla and KH Anantha) was undertaken during 28 May to 3 June 2017 for identifying pilot sites. During this visit, the team had discussion with different stakeholders including JDAs, DDAs, AOs and farmers in all the districts. The team identified representative pilot villages/blocks in consultation with DDAs and other officials (Table 1).

Table 1. Representative pilot sites across 7 districts in Bundelkhand.

District	Pilot block	Tentative selected villages	Cropping pattern
Lalitpur	Talbehat	Poora-Birdah	Groundnut, Blackgram, Maize (kharif season- K); Peas, Wheat, Mustard (Rabi season-R)
Jhansi	Babina	Imiliya, Raja Kheda, Bachhauni, Rajapur, Raska, Taidol & Tiletha, Baral	Groundnut, Mungbean, Blackgram, (K); Wheat, Chickpea, Mustard (R)
Jalaun	Mahiva	Hydalpur, Noorpur, Naserpur	Peas, Mentha, vegetables (K); Wheat, chickpea (R)
Hamirpur	Sumerpur	Nazarpur, Sumerpur	Mustard, wheat, sesame (R)
Mahoba	Charkari	Chandopura, Nathupura, Patehpura Bajaria,	Peas, Blackgram, sesame (K); Wheat (R)
Banda	Thindwari	Palra, Benda, Thindwari,	Pigeonpea, sesame (K); Chickpea, lentil, peas, wheat (R)
Chitrakoot	Karwi	Gowda, Rowli Kalyanpur	Munbean, Pigeonpea, sesame (K); Wheat, peas, chickpea, Lentil (R)

Figure 2. Discussions between ICRISAT scientists and DDAs/officials for pilot sites identification and project implementation.

Stakeholder orientation and farmer meetings for *rabi* 2017-18 interventions

With a purpose to implement selected need-based interventions during *rabi* 2017-18, a team of 3 scientist (Girish Chander, KK Garg, Vijay Jakkula) visited the districts during 8-15 Oct 2017 and oriented NGO partners about the protocols of participatory trials/demonstrations. Alongwith NGO partners, farmer meetings were conducted in pilot sites (Poora Birdah village in Lalitpur district; Naseerpur in Jalaon district; Nazarpur in Hamirpur district; Chando in Mahoba district; Gonda village in Chitrakoot district; Benda Ghat in Banda district) and briefed farmers (~20-40 in each meeting) about the technologies being promoted during the *rabi* 2017-18 season and the initiative as such. An initial slow response was changed into good demand after seeing the technical inputs and briefings about the science-led technologies.

Figure 3. Farmer meetings in villages across 7 districts in Bundelkhand.

Participatory trials/demonstrations during *rabi* 2017-18

***Interventions grounded in pilot sites*:** As entry point interventions, ICRISAT has arranged to provide drought tolerant chickpea (JG 11) seed, deficient secondary and micronutrients (zinc sulphate, borax), PGP cum nutrients (aquasap) for participatory trials/demonstrations in the pilot sites (see district wise details in Table 2.

A protocol of participatory trials is shared with NGOs and farmers, the highlights are as under;

- Improved practice to be followed in max ½ acre by a farmer and to be compared with local practice in same or other adjoining farmer.
- Crop cuttings are to be done at maturity to document yield benefit.
- Farmers to bear 50% cost of inputs i.e. $ 0.70 per kg of chickpea seed, $ 0.31 per kg of zinc sulphate, $0.93 per kg of agribor and $ 2.32 per litre of aquasap.
- Technical guidelines;
    - Full dose of micronutrient fertilizers - 10 kg acre-1 of zinc sulphate and 1 kg acre-1 of agribor.
    - Aquasap to be sprayed thrice after 30-40 days of sowing at 7-10 days interval. For spray at a time, 300 ml of aquasap to be mixed in 200 litre water and sprayed in 1 acre crop.
    - Chickpea seed rate @ 32 kg $acre^{-1}$.

Trials are initiated in pilots across all the districts and current detail by 25th Oct 2017 is summarized as under (Table 3; see Appendix-2a-g for farmer wise details).

Table 2. Detail of inputs arranged for participatory trials/ demonstrations.

District	Chickpea (JG 11) (kg)	Zinc sulphate (kg)	Agribor (kg)	Sagarika Aquasap (Litre)	Aerobic composting culture (packet/kg)
Lalitpur	1000	250	12.5	25	20
Jhansi	1000	250	12.5	25	20
Jalaun	1000	250	12.5	25	20
Hamirpur	1000	250	0	25	20
Mahoba	1000	250	6.5	25	20
Banda	1000	130	6.5	25	20
Chitrakoot	1000	250	12.5	25	20
Total	**7000**	**1630**	**63**	**175**	**140**

Table 3. Detail of participatory trials initiated in pilots across 7 districts in Bundelkhand (by 25th Oct 2017).

District	No of trials initiated	Villages
Lalitpur	32	Poora-Birdah
Jhansi	60	Imiliya, Rajapur, Raska, Taidol & Tiletha, Baral
Jalaun	46	Naserpur
Hamirpur	24	Kalla, Viharevar, Kalimati, Saukar, Simnaudi, Dhanpura
Mahoba	30	Chandpur, Nathopura
Banda	60	Palra, Benda
Chitrakoot	53	Gowda, Rauli Kalyanpur,
Total in Bundelkhand (by 25th Oct 2017)	305	

More trials are being implemented and progress is being monitored on regular basis.

Workshop Events through Lens

Scene setting of doubling farmer's income workshop by dignitaries.

General NC Vij, Director, VIF introducing the workshop to dignitaries and delegates.

Special address by Sri Shobhana K Pattanayak, Secretary, DOAC & FW.

Address by Mr Dhirendra Singh, Eexcutive Council, VIF.

Chief Guest Address by Shri Vijay Kapoor, Former Lt. Governor.

Address by Dr Suhas P Wani, Research Program Director, Asia and Director, IDC, ICRISAT

Inaugural address by Dr David Bergvinson, Director General, ICRISAT

Keynote address by Dr Hameed Nuru, Country Director, WFP.

Challenges and Opportunities by TR Kesavan, COO, TAFE.

Vote of thanks by Dr AK Padhee, Director Business & country relations, ICRISAT.

Group Discussions

Post workshop felicitation to Dr David Bergvinson.

Post workshop felicitation to Dr Suhas P Wani.

National Workshop on Doubling Farmers' Income Group Photo

Annexure I

Program

15 March 2017		
0930–1000	Registration	
Session 1	**Inaugural Session**	
1000–1010	Welcome Remarks	General NC Vij, Director, VIF
1010–1015	Scene Setting	Mr Dhirendra Singh, IAS (Retd.) EC, VIF
1015–1030	Objectives of the Workshop and Expected Outputs	Dr Suhas P Wani, Director-IDC, ICRISAT
1030–1045	Inaugural Address	Dr David Bergvinson, DG, ICRISAT
1045–1100	Challenges & Opportunities for Mechanization	Mr TR Kesavan, COO, TAFE
1100–1115	Keynote Address	Dr Hameed Nuru, Country Director, WFP
1115–1130	Special Address	Sri Shobhana K Pattanayak, IAS, Secy, DOAC & FW, MoA & FW
1130–1145	Chief Guest Address	Mr Vijai Kapoor, IAS (Retd.) Former Lt Governor, Delhi
1145–1150	Vote of Thanks	Dr AK Padhee, Director-Business & Country Relations, ICRISAT
1150–1210	Group Photograph and Health Break	

Session 2	**Technical Session I**	
	Climate Change and Impacts on Agriculture	
	Chair : Dr KP Viswanatha	
	Rapporteur : Dr Girish Chander	
1210–1230	Role of Agromet Advisory Services in Managing Risk under Changing Climate	Dr SD Attri, IMD
1230–1250	Land Use Planning for Sustainable Management of Resources in Vidarbha Region, Maharashtra	Dr SK Singh, NBSS & LUP
1250–1310	Sustainable Development of Farmholders through Integrate Farming and Mechanization	Dr K Srinivasan, TAFE
1310–1330	Discussions	
1330–1430	Lunch	

Session 3	**Technical Session II**			
	Challenges and Opportunities for Doubling Farmers' Income			
	Chair : Dr KP Viswanatha			
	Rapporteur : Dr Aviraj Datta			
1430–1450	Enabling Policies for Unlocking the Potential of Dryland Agriculture in India			Dr PK Joshi, IFPRI
1450–1510	Challenges and Opportunities for Unlocking the Potential Of Dryland Agriculture			Dr SP Wani, ICRISAT
1510–1530	National Food Security Mission: An Overview			Dr B Rajender, IAS
1530–1550	Strategy for Doubling Farmers' Income in Maharashtra			Dr KP Viswanatha, MPKV
1550–1610	Discussions			
1610–1630	Health Break			

Session 4	Technical Session III	
	Enabling Institutions and Policies for Desired Impact	
	Chair : Dr Girish Sohani	
	Rapporteur : Dr Mukund Patil	
1630–1650	Tata Trusts Initiatives on Agriculture- Strategic Directions Into the Future	Mr Abhay Gandhe, SRTT
1650–1710	Linking Farmers with Market through FPOs: Challenges and Opportunities	Dr KV Raju, ICRISAT
1710–1730	Pathway for Pulses Self-sufficiency in India	Dr NP Singh, IIPR
1730–1750	Role of Nutri Cereals in Sustainable Development Of Vidarbha	Dr Rajendra Chapke, IIMR
1750–1810	Use of Technologies for Harnessing the Potential Of Agriculture	Mr Anirban Ghosh, M & M
1810–1830	Discussions	
1900	Workshop Dinner	Hotel Jaypee Siddharth, Rajendra Place

16 March 2017		
Session 5	**Technical Session IV**	
	Building Climate Resilient Agriculture through Integrated Watershed Management	
	Chair : Dr NP Singh	
	Rapporteur : Dr J Vijay Sandeep	
0900–0920	Sustainable Rainfed Agriculture Initiatives of Government of India	Dr Ashok Dalwai, IAS
0920–0940	Watersheds for Unlocking the Potential of Dryland Agriculture Need for Convergence	Dr CS Kedar, IAS (Retd.), JSW
0940–1000	Innovation in Water Budgets and Water Pressure	Dr Hariharan, ZED/ Mr T pradeep, ZED
1000–1020	Challenges and Opportunities for Dryland Agriculture in Maharashtra	Dr DP Waskar, VNMKV
1020–1050	Discussions	
1050–1120	Health Break	

Session 6	Technical Session V	
	Strategy for Transforming Agriculture in Vidarbha, Maharashtra	
	Chair : Dr Ashok Dalwai, IAS	
	Rapporteur : Dr Girish Chander	
1120–1140	Strategies for Developing Farmers' Income in Central India	Dr AK Singh, RVSKVV
1140–1200	Role of Mechanization and Post-harvesting Technologies	Dr KK Singh, CIAE
1200–1220	Farm Mechanization Strategies	Mr N Subramanian, TAFE
1220–1240	Leveraging Bio-Technology	Dr Nagendra Singh
1240–1300	Enhancing Water use Efficiency in Agriculture	Mr SP Jadhav, Jain Irrigation
1300–1330	Lunch	

Session 7	Group Discussion	

Annexure II

List of Participants

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Annexure III

Powerpoint Presentaions Click here

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ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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We believe all people have a right to nutritious food and a better livelihood.

ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation.

We work across the entire value chain from developing new varieties to agri-business and linking farmers to markets.

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480-2017

ISBN No. 978-92-9066-594-6 Order code: CPE175