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Science, Technology and Innovation

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National Dialogue on Indian Agriculture Towards 2030
19–22 January 2021

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In spite of attaining food grain security, unethically high number of hungry and malnourished in India remains a challenge. At the same time, vagaries of CC, eroding natural resources and low profitability, make agriculture an occupation of lowest preference, specially for youth and women.

Science, Technology & Innovation with a human face will be the key drivers in transforming agriculture into an environment-friendly, sustainable and profitable engagement.

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A paradigm shift is needed to:

i) increase productivity, profitability, inclusiveness, efficiency, and competitiveness of human engagement in agriculture; realize MLM
ii) achieve complete nutrition security; save 6-10% of NGDP annually
iii) address the challenges of climate change and risk management
iv) adopt environment-friendly sustainable practices
v) establish efficient farmer-market linkages.

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Expenditure Intensity in R&D in India (NIAP, 2017-18)

Expenditure Intensity in India (percent)

Year	Research	Extension
1983	0.25	0.10
1993	0.31	0.15
2003	0.39	0.14
2014	0.40	0.18
2018	0.39	

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This paper highlights the need for a paradigm shift in agriculture and suggests effective pathways for achieving the desired goals through

i) Interdisciplinary linkages with other scientific streams, combining ITKs and conventional methods, with NextGen cutting edge technologies evolved nationally/ internationally
ii) Adoption and Scaling of situation-specific innovations
iii) Enduring STI through a Gold Class education system and human resources
iv) Leveraging strong public-private partnerships and integrating Science Social Responsibility with Corporate Social Responsibility

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This will need well defined and clear policy support

First

1. *To Increase investments in R&D (1%of AgGDP)*
2. *To mainstream Agri. Sci. (STEAM)*
3. *To reshape Agri. Education in line with the NEP, 2020.*

Second

- *Policy to encourage stronger PPP and national and international collaborations in Research, Education and Extension.*

Last

- *Enabling policy environment for adoption of cutting edge technologies, scaling innovation and establishing small / medium agro-industries.*

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Putting Smallholder Farmers at the Centre Stage, the Proposed Pathway Highlights the need for:

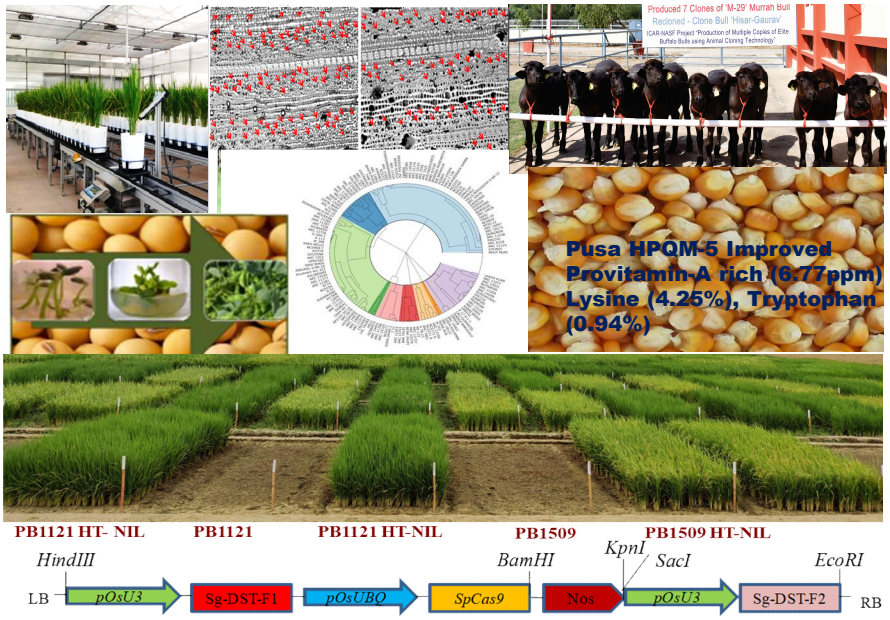
- *Technology & Innovation to Strengthen Location Specific Diversified Integrated Farming Systems for Achieving Comprehensive Nutrition Security and High Profitability .*
- *Decentralized Research to develop Sustainable Solutions using Genetic Improvement, Bio-fortification, and Value Addition through Post-Harvest Innovative Technologies, Promoting Functional foods and Food Processing Industries, especially in rural areas.*
- *To Adopt Genomics and Gene Editing as Preferred Technologies for Precision Breeding, combined with dynamic production, distribution, and utilization duly supported by Science-based Policy and well defined guidelines.*

Developing Climate Smart and Low Input and Profitable Agriculture Technologies will be Priority

This will be brought through:

- ✓ *Genetic Improvement*
- ✓ *Resource Conserving agro technologies engaging women and youth*
- ✓ *Diversified Integrated farming systems*
- ✓ *Value Addition and popularization of nutri-rich ethnic foods (Local is Vocal)*

Genomics-assisted breeding and Gene editing will be routine tools for genetic improvement in this decade



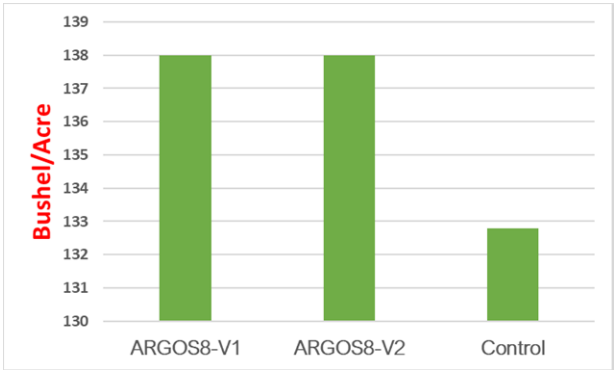
CRISPR-Cas9 for Heat Stress Tolerance in Maize

Plant Biotechnology Journal

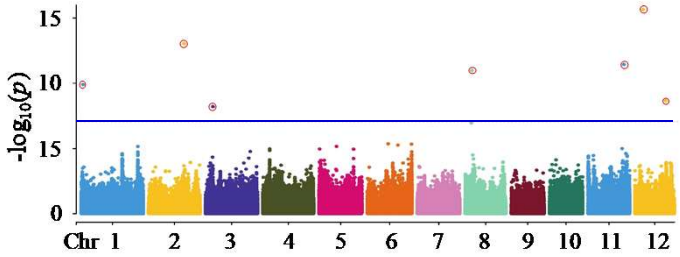
Plant Biotechnology Journal (2017) **15**, pp. 207–216 doi: 10.1111/pbi.12603

ARGOS8 variants generated by CRISPR-Cas9 improve maize grain yield under field drought stress conditions

Jinrui Shi*, Huirong Gao, Hongyu Wang, H. Renee Lafitte, Rayeann L. Archibald, Meizhu Yang, Salim M. Hakimi, Hua Mo and Jeffrey E. Habben



292 rice germplasm lines were phenotyped and QTLs were mapped for NUtE



Integration of Soil, Water and Nutrient Management

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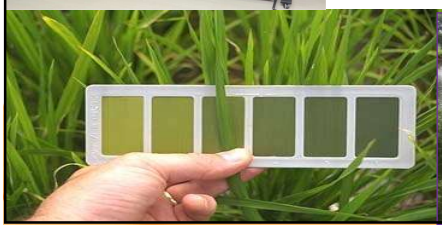
1. Soil health card and Neem-coated urea
2. LCC, ICT-based N management
3. Efficient water management: Drip, sprinkler
4. Integrated nutrient management (organic, bio-formulations, chemical)
5. Real time Crop Monitoring Using Remote Sensing



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Climate-Smart Agriculture

1. Weather	• Forecasting • Agro-advisory • Geo-ICT delivery planning
2. Crop	• Multi-stress tolerant & Input-efficient crop varieties • Crop Diversification
3. Water	• Micro-irrigation • Direct-seeded rice • Rainwater harvesting • Drainage
4. Nutrient	• SSNM • INM • N-coated urea
5. Livestock	• Stress tolerant breeds • Feed and shelter management • Health care & Diagnostics
6. Fisheries	• Composite culture • Diversification • Cage culture • Wastewater aquaculture
7. Energy	• Solar-based machines • Conservation agriculture • Energy plantation • Protected cultivation
8. Policy	• Leveraging MGNREGA • Contingency plan • Seed bank, CHC • Insurance and credit

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Increasing opportunities for agro-biodiversity through specialty crops and functional foods

- We are witnessing a rapid growth in the local, regional and global health foods and beverage markets
- This market includes condiments, herbs, spices, aromatic & medicinal plants, nuts, fruits, vegetables and nutritionally dense crops
- Many are unique to Indian cuisine, gaining popularity in domestic and international health foods markets
- Enormous opportunity to reap the socio-economic & environmental benefits provided by these specialty crops
- Bolstered by a broad consensus in the private sector, key government ministries/departments, and research institutions to support and accelerate the development of this sub sector

Srivastava & Hanumappa 2021

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Proposed Pathways - 2

- *Extenuating the emergence of new infectious diseases and aggressive pests following 'One Health' Approach.*
- *Improvement of dairy and (region-specific) small farm animals by strengthening the availability of superior germplasm and enhancing fertility through biotechnological augmentation of reproduction, and improved profitability through a demand-driven, 'Farm to Fork' approach using IoT, Big Data Analytics, AI and DSS.*
- *Develop innovative Post-harvest technologies using multidisciplinary sciences, following the principles of "zero waste, "a grain saved is a grain produced" and "wealth from waste".*

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Proposed Pathways - 3

- *Interdisciplinary and international collaborative approach to develop Climate Smart and Green technologies with better profitability, while conserving natural resources, ensuring economic, social and ecological sustainability.*
- *Create high accuracy decision support systems at various levels using Big Data Analytics and AI tools and develop affordable precision farming technologies.*
- *Disruptive technologies and situation-specific innovations to build diversified, intensified secondary and specialty agriculture as well as urban and peri-urban agriculture.*

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Crop Diversification

Devise Science backed, Need based, Differentiated Diversification of Crops and Farming Systems.

- ✓ *This will Build upon ITK, Farmers' Experiences, Scientific Validation and Upscaling.*
- ✓ Incentivize Water Use Efficiency, Water Saving, C-Sequestration, Soil Health Enrichment and Conservation of Biodiversity.
- ✓ *For this we need an STI Continuum to Adopt Short, Medium and Long Term Strategies*

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Proposed Pathways - 4

- *Promotion of certified organic farming clusters in the de-facto organic eco-regions developing suitable varieties and profitable production technology.*
- *Integrated pest and disease management practices through ITK, conventional practices, chemical and biological controls, genetic manipulations, molecular diagnostics and vaccination of livestock.*
- *Appropriate regulatory system and policy support are needed for adoption of cutting edge technologies, such as genetically modified and gene edited plant varieties; liberate science to serve society.*

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Diffusion of Innovative Technologies

- *Scaling up and effective diffusion of innovations hold the key to success in agriculture. With the growing presence of pluralistic extension system with varied approaches, a robust research framework, including social & behavioral sciences, and methodology and PPP are needed; internalize disruptive technologies viz. Apomictic Hybrid Seed and "Surrogate Dads"*
- *Strong Innovation Centres and Business Incubation and Creation of a National Agri-Innovation Board is proposed.*
- *Capacity building and skill development to employ local*

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Non-Agricultural Disruptive Technologies

- ✓ *Mechanization, automation, Uberisation, use of resource conserving technologies, data management, DSS and ICTs will be vital in agriculture in 2030. Massive cross-sectoral, interdisciplinary technological partnerships are envisaged.*
- ✓ *Blockchain Technology will have wide application, from Crop Management, Marketing and Procurement to Certification and Traceability.*
- ✓ *Use of Non-Fossil fuel, Renewable energy sources, Waste water management and technologies to mitigate the challenges of climate change and to create wealth from waste.*

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Alleviating the Asymmetries and Rejuvenating the Agriculture Education System by,

- *Integrating basic and applied sciences, focus will be on demand-driven innovations and their pluralistic delivery.*
- *Reshaping of the Agriculture Education System (AES) through structural changes, focus on science but also promoting vocational education, investment, and partnerships to prepare "Youth for Leadership in Agriculture".*
- *Capacity building of the rural youth to be 'Technology Agents' and successful entrepreneurs.*
- *Encouraging long term South-South, South-North and trilateral collaborations and PPP for quality education*

Process Flow of Six Key Steps in Development of STI for SDG Roadmap (IATT, 2020)

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Integrate, Incentivize and Implement

- *Synergistically Integrate the STI and SDG Plans with the National Plan as suggested in the IATT, 2020 of the UN. Develop a detailed national 'ASTI for SDGs' roadmap.*
- *Incentivize Technology and Innovation for development in agriculture, with adequate protection of IPR.*
- *Support effective implementation of National Plan with clear policies and guidelines developed through consultation with scientific think tanks viz., NAAS, TAAS and other Academies and representatives of all stakeholders; adopt Measure to Manage*

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Summing up…….

- ✓ *Science-Technology-Innovation Continuum to be founded on Quality Education in Agriculture from Primary schooling as outlined in the NEP, 2020, and be Farmer-centric, Sustainable and Demand-driven, and Recognise the role of Women.*
- ✓ *An Agri-Food system-based approach should secure that research and innovations in sub-systems are clustered, monitored, and evaluated.*
- ✓ *An inclusive growth system should attract youth in agriculture promote SMEs, entrepreneurship, and participation of smallholders along the value chain.*

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Summing up…….

- ✓ *Policies and regulations should be in place to ensure land tenure security, access to credit, training, technical assistance, and resilience-enhancing social protection.*
- ✓ *Agri-Food system-based multi-institutional, inter-disciplinary research, is expected to lead to rapid problem solving and Building Back Better in post Covid-19 era.*

Thanks!

Any questions?

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