75 LECTURE SERIES

Indian Council of Agricultural Research (ICAR), New Delhi

Azadi Ka Amrit Mahotsav

Indian Council of Agricultural Research

The Indian Council of Agricultural Research (ICAR) is an autonomous body responsible for co-ordinating agricultural education research extension under the Department of Agricultural Research and Education, Ministry of Agriculture and Farmers Welfare, Government of India.

Vision

Ensure food and income security for all, through technological innovations and sustainable agriculture

Mission

Harness power of science and education with a human touch and sustainable agricultural production

Mandate

- Plan, Undertake, Coordinate and Promote Research and Technology Development for Sustainable Agriculture
- Aid, Impart and Coordinate Agricultural Education to Enable Quality Human REsource Development
- Frontline Extension for Technology Application, Adoption, Knowledge Management and Capacity Development for Agri-based Rural Development
- Policy, Cooperation and Consultancy in Agricultural Research, Education & Extension

During 1950-51 to 2021-22, ICAR's research and technology development has enabled the country to attain national food and nutritional security by increasing in:

- Production of food grains: **6.2 Times**
- Horticultural crops: **10.5 Times**
- Fish: **17.8 Times**
- Milk: **12.4 Times**
- Eggs: **67.8 Times**

Key milestones / Achievements

- **5,508** High yielding varieties of all major crops developed
- **85** Biofortified varieties developed of different crops
- **48** Varieties of crop through Molecular marker-assisted developed technologies
- **1,300** Climate-resilient varieties of different crops developed
- **74** Better nutritional value food crops attained food security by breeding
- Multi-fold increase in the production of all the commodities, in the same sown area

भाकृअनुप
ICAR

75 LECTURE SERIES

Indian Council of Agricultural Research (ICAR), New Delhi

Azadi Ka Amrit Mahotsav

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सत्यमेव जयते
डॉ. हिमांशु पाठक
सचिव, एवं महानिदेशक
Dr HIMANSHU PATHAK
SECRETARY (DARE) & DIRECTOR GENERAL (ICAR)

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली
GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
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Foreword

Azadi Ka Amrit Mahotsav was celebrated during 12th March 2021 to 15th August 2022 to mark the glorious past of 75 years of independence. Agriculture is one amongst the few sectors that helped shaping India's success post-independence. The sector's growth sailed quickly India out of the turbulence of food insecurity and placed it on the global map as one of the leading producers of foodgrains and other agricultural commodities. The science led knowledge intensive agriculture played a crucial role in this journey of success.

ICAR celebrated Azadi Ka Amrit Mahotsav through people participatory mass awareness campaigns, 75 lectures series, documentation of success stories of farmers on DFI and book on Indian Agriculture after Independence. The 75 Lecture Series under the theme India's Independence and Agriculture on diverse topics were delivered by experts in various domains related to agriculture, education and science, spiritual leaders, motivational speakers and successful entrepreneurs. These lectures have been put in public domain at ICAR website and its YouTube link to make this rich repository available to scientists, researchers and students for future reference.

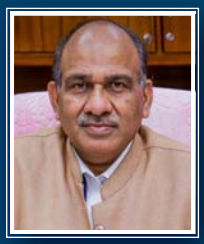
I compliment the Team Agricultural Education at ICAR Hq for organizing the 75 lectures series under Azadi Ka Amrit Mahotsav and its compilation into a document. This publication depicts the remarkable achievements of our country in agriculture and related fields during past 75 years.

I appreciate the efforts of Dr R.C. Agrawal, Deputy Director General (Agricultural Education), ICAR, who coordinated this Lecture Series and his team for bringing out this very useful publication.

New Delhi

(Himanshu Pathak)

From the Desk of Coordinator of 75 Lecture Series



The Government of India initiated 'Azadi ka Amrit Mahotsav' to memorialize and honour 75 years of India's Independence. This commenced from March 12, 2021 as a 75 weeks countdown to the 75th anniversary of independence (August 15, 2022) ending on August 15, 2023. The India@75 celebrations reflect on the hard work, innovations and enterprises of Indians and serve as a platform to collectively plan for creating a better tomorrow.

The post-independence journey of the Indian agriculture has been a great success. It has led India to be self-sufficient in food and has enhanced its life expectancy. In spirit of the 'Azadi ka Amrit Mahotsav, a massive outreach campaign titled 'ICAR 75 Lecture Series' was taken up by the Indian Council of Agricultural Research (ICAR), supported by its National Agricultural Higher Education Project (NAHEP) and it was mainly co-ordinated by the Agricultural Education Division. The lectures were delivered by the experts from various domains related to agriculture, science, spirituality, sports and several others. The lecture series were held during Covid pandemic period, and were delivered through virtual or hybrid mode 40 min. each, followed by ~20 min. discussion. The lectures were also live streamed through an online app and ICAR YouTube Channel, and were given wide publicity on the ICAR's social media platforms.

Despite Covid pandemic, the lecture series were attended by more than 1,16,090 participants, including Vice-Chancellors of Agricultural Universities, ICAR Officials, Senior Faculty, Senior Scientists, Professors, Teachers, Students (more than 96,000), and many others.

The present book is a compilation of the salient points based on the lectures delivered, discussions held and highlight key takeaways that emerged. The publication covers useful recommendations and strong points from the best minds which would help the country to progress towards 'Atma Nirbhar Bharat' (self-reliant India) and provide ideas for way forward, leading to 'Amrit Kal' (100 years from India's independence, i.e. 2047).

I immensely thank Shri Narendra Singh Tomar Ji, Hon'ble Agriculture Minister, Shri Kailash Choudhary ji, Hon'ble Minister of State (MoS) for Agriculture and Farmers Welfare, Km. Shobha Karandlaje ji, Hon'ble MoS for Agriculture and Farmers Welfare, and Dr Himanshu Pathak, Secretary, DARE and Director General, ICAR for their support and guidance in this extensive endeavour. I express my special thanks and gratitude to Dr Trilochan Mohapatra, Former Secretary, Department of Agricultural Research and

Education (DARE) and Director General, ICAR, for his suggestion for this lecture series, in leadership and identifying eminent speakers.

It has been overwhelming to have such an enthusiastic and a positive response from all the experts and eminent people from all walks of life. I am grateful to all the speakers who not only agreed to deliver lectures and interacted with audience, but also helped us to present their ideas in this document. Their greatness is amplified by the humbleness with which they approved to be part of this unique and wonderful journey!

I would like to thank the entire Project Implementation Unit (PIU) of the NAHEP, including administrative, financial, technical staff for their support in organizing lecture series. I owe special thanks to Dr Hema Tripathi, National Co-ordinator, NAHEP for all kind of assistance required during lecture series, to Ms Mitali Ghosh Roy, Technical Officer, Directorate of Knowledge Management (DKMA), ICAR and her team for providing the requisite support for live streaming lectures and publicity through ICAR's social media platforms. Sincere efforts and time devoted by Dr Anuradha Agrawal, National Co-ordinator, NAHEP, Mrs Shashi Verma, Chief Technical Officer (Retd), DKMA, and Dr Shailja Thakur, Research Associate, NAHEP-PIU in bringing out this document are acknowledged and are highly appreciated.

I hope that this compilation would be valued by all the stakeholders.

(**R.C. Agrawal**)
Deputy Director General (Agricultural Education) and
National Director, National Agricultural Higher Education Project
Indian Council of Agricultural Research, New Delhi

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Health and Good Living

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Social Issues and Sports

Special Lecture

Atmanirbhar Bharat

ATMANIRBHAR BHARAT
SELF-RELIANT AGRICULTURE

Narendra Singh Tomar

Shri Narendra Singh Tomar is the Minister of Agriculture and Farmers' Welfare, Government of India. He has also been the Minister of Rural Development, Minister of Panchayati Raj, Minister of Mines and Minister of Parliamentary Affairs in the Government of India.

A series of lectures were organized by the Indian Council of Agricultural Research (ICAR) starting on March 17, 2021 on various topics by experts, eminent scientists, policy-makers, spiritual leaders, motivational speakers and many successful entrepreneurs.

Shri Tomar spoke on "self-reliant agriculture". Referring to the developmental journey of the Indian agriculture and the contributions of the ICAR, he said that at present, we are among the world's leading countries in agricultural production, fulfilling our food demands as well as helping in foodgrains needs of other countries'.

Agriculture and farmers have to self-reliant. The ICAR and its scientists have contributed enormously in the development of agriculture. Their endeavor has been in breeding new seeds (release of climate resilient seed varieties and fortified varieties) and delivering them to fields; increasing productivity and developing new technologies for farmers.

India's large number of population depends on agriculture. What we need now is to decrease the total dependency on agriculture of the population through technologies. Technologies in a way can also attract youth to agriculture. The ICAR initiative, such as Kisan Sarthi, is a

digital platform. It will empower farmers in the remote areas with technological interventions. The ICAR has also developed many mobile apps.

On the occasion of Amrit Mahotsav of Independence, the ICAR family and all affiliated institutions, scientific and agricultural universities should take a pledge together that within a stipulated period, they would be established at the international level and the country's agriculture would be significantly highlighted in the world map.

The ICAR is also working on agriculture education; sufficient work has been done on the inclusion of the new education policy in agriculture sector also. Initiatives have been taken to include agriculture in school curricula from the very beginning, so that children have a comprehensive idea and awareness about agriculture.

There are 86 per cent small farmers in the country, who are not in a position to invest, it is important to improve their financial position. For this, ten thousand new Farmer Producer Organizations (FPOs) have been started with an expenditure of Rs 6,865 crore. Of these, about 3,000 FPOs have already been formed. Through these, small farmers would be united, which would increase the area of cultivation and then the farmers would be able to use latest technologies in togetherness. They would be a move towards modern farming and farming would be self-reliant.

He also reiterated that the government has made a provision of the infrastructure fund of one lakh crore for private investment in agriculture sector. Along with this, a fund of more than 1.5 lakh crore rupees has been fixed for including other allied sectors; 14 thousand crore rupees under Agri Infra Fund projects have been sanctioned, out of which 10 thousand crore rupees have been approved. Pradhan Mantri Krishi Sinchai Yojana is for the common farmers and Micro Irrigation Fund has been increased from 5 thousand crore rupees to10 thousand crore rupees. Pradhan Mantri Kisan Samman Nidhi has been a boon for small farmers. So far, 2 lakh crore rupees have been deposited in the bank accounts of about 11 and a half crore farmers under this scheme.

Key takeaway

- The technologies developed by the ICAR and Government Policies together have played an important role in making the Indian agriculture self-reliant.

Sustainable Agriculture

ICAR LECTURE SERIES #74

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Friday, 12 August 2022 | 12:00 Noon

Science for the Society:
Agricultural Imperatives

Dr. Trilochan Mohapatra
Former Secretary, DARE and Director General, ICAR

To attend the lecture visit
icar75lectureseries.webconevents.com

WATCH LIVE www.icar.org.in www.icar.gov.in /IcarIndia

NAHEP

ICAR LECTURE SERIES #22

आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV

Indigenous Cow Based
Organic Farming for Aatmnirbhar Bharat

Monday, 16th August 2021 | 03:30 PM

P.P. Adrushya Kadsiddheshwar Swamiji

Mathadhipati, Shri Siddhagiri Math, Kaneri, Kolhapur, Maharashtra &
Chairman, Krishi Vigyan Kendra, Kolhapur-II

WATCH LIVE www.icar.org.in www.icar.gov.in /IcarIndia

ICAR LECTURE SERIES #29

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Friday, 24th September 2021 | 03:00 PM

Agriculture in post-independent India:
Looking back and looking ahead

Prof. Ramesh Chand
Member, NITI Aayog

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #31

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Tuesday, 12th October 2021 | 11:00 AM

Science, Technology and
Innovation for Transforming
Agriculture in India

Prof. R.B. Singh

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #41

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Monday, 17th January 2022 | 11:00 AM

FPC Movement - Challenges
and Way Forward

Mr. Vilas Shinde

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icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #28

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Tuesday, 14th September 2021 | 04:00 PM

Agricultural, Food and Nutritional Security :
The Changing Technology Landscape

Dr. Renu Swarup

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #59

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Wednesday, 1st June 2022 | 05:30 PM

India's Pride in Green
Revolution and way forward

Prof. Gurdev Singh Khush

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #37

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Wednesday, 1st December 2021 | 11:00 AM

Protection of plant varieties,
the key to improved agricultural
commerce & growth

Dr. K.V. Prabhu

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #34

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Monday, 1st November 2021 | 12:00 PM

Indian Agriculture in Perspective

Dr. Mangala Rai

Former Secretary, DARE and Director General, ICAR

AZADI KA AMRUT MAHOTSAV

ऋषि कृषि (Rishi Krishi)

Sh. Pratap Chandra Sarangi

Hon'ble Minister of State
Animal Husbandry,
Dairying and Fisheries & Micro,
Small & Medium Enterprises

Thursday, 24th June, 2021
04:00 PM

ICAR Lecture Series #7

BHARAT KA AMRUT MAHOTSAV

प्रकृति और पर्यावरण

Tuesday, 25th May 2021: 11 am

DR ANIL PRAKASH JOSHI

An Indian green activist, social worker, botanist. The Government of India awarded him the Padma Shri, in 2006, for his contributions to Indian society. He was also awarded by Padma Bhushan 2020 for social work in Uttarakhand

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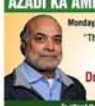
ICAR LECTURE SERIES #51

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV



Monday, 4th April 2022 | 11:00 AM

"The quest for a zero-hunger
India – lessons from the
green revolution"

Dr. Prabhu L. Pingali

To attend the lecture visit
icar75lectureseries.webconevents.com

आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV

Friday, 9th July 2021
11:30 AM

Shaping Agri-Food Systems and
Sustainable Development Goals
for Smallholders: Where are
the solutions?

MS. KAKOLI GHOSH

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #42

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Monday, 24th January 2022 | 11:00 AM

Rethinking the way
we farm in India

Prof. Bina Agarwal

To attend the lecture visit
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ICAR LECTURE SERIES #60

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Monday, 6 June 2022 | 06:00 PM

Poverty, hunger,
structural transformation and sustainability:
India and the rest of Asia

Prof. Uma Lele

President, International Association of Agricultural Economists
Independent scholar

To attend the lecture visit
icar75lectureseries.webconevents.com

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ICAR LECTURE SERIES #65

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Thursday, 30th June 2022 | 12:00 PM

Farmers' Rights – a cornerstone for
food security and the management of
seed diversity

Ms. Svanhild-Isabelle Batta Torheim

Senior Policy Advisor,
The Norwegian Ministry of Agriculture and Food, Norway

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ICAR LECTURE SERIES #62

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Wednesday, 15 June 2022 | 11:00 AM

Biodiversity Governance:
Global and National Perspectives

Dr. V B Mathur

Chairperson, National Biodiversity Authority,
Govt. of India

To attend the lecture visit
icar75lectureseries.webconevents.com

RISHI KRISHI

Pratap Chandra Sarangi

Shri Pratap Chandra Sarangi is former Minister of State for Animal Husbandry, Dairying & Fisheries and Micro Small & Medium Enterprise, Government of India. In eighties, he had started many Ekal Vidyalayas (village schools with a single teacher).

In ancient times, our *'rishis'* used to do *'yagnas'* for air purification and adopted different means of water harvesting to irrigate fields. Father of nation Mahatma Gandhi in his book 'Sarvodya' wrote that life of farmers and labourers is the true life. Farmers are the 'Annadata' **(**producer of grain), they are to be happy for the growth of the country. Swami Vivekananda once said "So long as the millions live in hunger and ignorance, I hold every man a traitor who, having been educated at their expense, pays not the least heed to them".

Before Green Revolution, we were dependent on US for food grains. To curb hunger to produce more is not the solution but more people being involved in food production is the solution.

In Punjab to produce more has led to over-exploitation and excessive use of chemical fertilisers, insecticides and pesticides and has resulted in the degradation of the soil, which decreased water-holding capacity of the soil. Rishis of the yonder days had also developed agriculture machinery for processing and storage; they also used fertilizers but all was very eco-friendly. They used cow-dung as the fertilizer. Best fertilizer can be made from the cow horn by using biodynamic method— in this method, the cow horn is placed in the cow-dung for six months after that 25 grams of the manure is mixed in 1500 litres of water and sprayed in one acre of land.

Various products such as toothpaste, soap and hawan samagri are made from cow-dung. Lately, chemical-free paint is

also prepared from cow-dung, which is non-toxic, have anti-bacterial and anti-fungal properties and can also protect from atomic radiations. Prali, which farmers burn and cause air pollution, can be converted into direct compost or can be used to generate power and then to compost. The Indian Agricultural Research Institute has developed a microbial bio-enzyme solution to decompose crop residue. This has resolved the issue of crop burning in North India.

Water is another critical input for agriculture production. Use of drip irrigation is the most efficient water and nutrient delivery system for growing crops. Water-use efficiency through drip irrigation has increased 90 per cent and water saving by 70 per cent as compared to flood irrigation. Government has also made some policies such as "National Water Policy" to govern the planning and development of water resources and their optimum utilization. Further focus needs to be on secondary agriculture and farmers should be provided knowledge and training on value addition and processing so they can earn more by basic processing also. Swami Vivekananda once said "A nation is great or good not because of its parliament but the nation is great or good because of its people".

Key takeaways

- Emphasis should be more on organic farming.
- Farmers need to be encouraged for processing their own produce to own higher returns.

AGRICULTURE IN POST-INDEPENDENT INDIA
LOOKING BACK AND FORWARD

Ramesh Chand

Prof. Ramesh Chand is at present a member of the NITI Aayog, a policy think tank of Government of India. He has been in the policy formulation of the agriculture sector since the past two-and-a half decades.

The agri-growth from 1971 to 2021 has been divided into four stages; 1. Beginning of active policy formulation, irrigation, land reforms, area expansion; 2. Revival of the growth rate after 1967; primarily driven by technology; 3. Technology growth slowed down but growth rate accelerated in liberalized economy; 4. Demand-and-price driven growth in horticulture and livestock with livestock heading to took over crops. Growth rate in output of different groups of crops and agri products showed that first 15 years beginning plan period show highest growth in crop output. Beginning Green Revolution, superiority of rice and wheat was established over pulses and other cereals. Rice and wheat experienced faster growth rate, whereas millets and pulses suffered decleration and even negative growth in some period. In recent years pulses growth revived after 2004-05 and oilseeds growth lost momentum beginning in 1991 leading to heavy import dependence. State wise growth in gross value added crop sector and total agriculture showed that in most states growth rate of total agriculture is robust but growth rate of crop sector varies from 3.6–1 per cent. Within the crop sector the major source of growth is due to

horticulture. Share of crop sector started squeezing it was 65.4 during 2011-12 and reduced to 55.3 per cent during 2018-19. This is a wake-up call for crop scientists and policy makers to prioritise research and make policies keeping in the view present trends in food system.

A major change in workforce in agriculture was observed with the growth of non-agriculture during 2001-2011 which involved shift of workers from agriculture.

Food intake and nutrition: There is mismatch in growth of food output in the country and decline in undernutrition. This is also termed as "An Indian Enigma". India being food surplus country and net exporter, but nutrition and health of people is falling behind. Nutrition levels are low and Undernourished population in India is 15.3 per cent, anemia in women 15-49 years of age is 53 per cent.

There are some myths about Indian agriculture such as feminization of agriculture. Actual data shows that while 73 per cent of total rural female workers are employed in agriculture they constitute 30 per cent of total agriculture workforce. Fertilizer use is much imbalanced at state level. The field crops where government interventions are high the growth rate is low 1.15 per cent and in fishery sector where public intervention and support was very low growth rate was highest *i.e.* 7.45 per cent. This shows that more liberalized sector, higher the growth. Lesser govt. intervention higher the growth. Putting more resources in subsidies and support do not lead to growth if demand side factors do not support.

Recent initiatives for agriculture and farmers are 'Pradhan Mantri Krishi Sinchai Yojna' for irrigation water, e-NAM (a pan India electronic trading portal), 'Soil Health Card' to assess status of soil health, 'Kisan Sampada Yojna' for Agro-Marine Processing and Development of Agro-Processing Clusters, Kisan Credit Card for animal husbandry and fisheries. Agriculture contributes to 20 per cent in GDP at current prices; its Net foreign exchange earnings are quite significant as value of agricultural export is more than double the value of agricultural imports. It is remarkable that agriculture in India sustaining food and nutrition security of 1.38 billion people despite global food price shocks.

Main challenges in agriculture in future are climate change, sustainable use of water and soils, increasing farmers' income and improving nutritional security. For nutritional sustainability, we need diversification towards nutri cereals by price support and by making value chains for achieving profitability and sustain growth in livestock sector. Horticultural crops would be main focus for processing and reducing post harvest losses by increasing their shelf life. Along with, a shift is required from costly growth to efficient growth; food security to nutrition security and health; linking production to processing for job creation and balancing need with capacity.

Some suggestions for the National Agricultural Research Systems (NARS) are National Agricultural Research Systems should reprioritize and reallocate resources and manpower over commodities, themes and states based on future scenario; Redefine research goals like wider adaptation to agro climatic based productivity; Yield maximization to minimization of average cost/ unit of output; High priority to agro forestry with cropping system and more active involvement with private sector.

Key takeaways

- Reprioritize and reallocate resources and manpower over commodities, themes and space based on future projections. Drive Private sector vehicle to carry technology from lab to land.
- Active participation of the private sector in agricultural activities is desired utmost for agricultural growth and raising farmers' income.

AGRICULTURAL, FOOD AND NUTRITIONAL SECURITY

THE CHANGING TECHNOLOGY LANDSCAPE

Renu Swarup

Dr Renu Swarup is former Secretary, Department of Biotechnology (DBT), Government of India. In the recent COVID Pandemic time, she has led COVID Vaccine, Diagnostic and Genome Sequencing Mission.

"The future of the food security will depend on a combination of the ecological prudence of the past and the technological advances of today" M.S. Swaminathan. The Sustainable Development Goals (SDGs) aim to end all forms of hunger and malnutrition by 2030, making sure all people, especially children, have sufficient and nutritional food all-year round. This involves promoting sustainable agricultural practices such as supporting small scale farmers and allowing equal access to land, technology and markets. It also requires international cooperation to ensure investment in infrastructure and technology to improve agriculture productivity. To achieve zero hunger by 2030 would require innovations addressing all dimensions of food and nutrition security related challenges such as improving productivity and minimizing post-harvest losses. Varieties developed through molecular breeding in maize (HQPM1 vitamin A rich), in Rice bacterial blight resistant varieties (Pusa Basmati

1728, Pusa Basmati 1718, CARI Dhan 6, DRR Dhan-50), wheat resistance against leaf and stripe rust (Unnat PBW343), Soybean Kunitz trypsin inhibitor free variety (NRC127).

The main program of the Indian Council of Agricultural Research is on the characterization of crop genetic resources for trait discovery and this program is going on a Mission-mode pattern. Department of Biotechnology has established a National Genomics and Genotyping Facility (DBT-NGGF). All the mission-mode programs on characterization of genetic resources have been linked to the National Genomics and Genomics facility for genotyping of indigenous germplasm Resources. Gene editing is an important tool in functional genomics and crop breeding. Speed breeding is an important approach that significantly shortens generation time of crops and accelerates breeding and research programs.

We require data science, remote sensing and image processing of crops maps, yield data and weather data, then we require advisory services for increasing crops yield and for pest incidence prediction. There are many technologies which we need to employ from lab to market— use of robotics, automation in sorting and storage facilities for reducing post-harvest losses, estimation of crop yield using multi-satellite remote sensing. Farmer Biotech Kisan hubs have been started by the Department of Biotechnology, which has now spread over 105 districts. There have been 50 interventions carried out, 7000 front line demonstration in the farmers' fields and 50,000+ farmer beneficiaries covered under training programs and workshops. In agrimulsion programmes scientists will spend 3-4 months with farmers and based on the personnel need of that farmer technology would be developed. This way the success of one farmer would encourage other farmers. We need to popularize the small technologies such as domestic solar dryer, harvesters, conjunction of agriculture, nutrition and health for inclusive development of women such as "veggielite" these technological innovations are helping the farmers. Nutri gardens for food-based nutritional security need to be established. "If you define the problem correctly, you almost have the solution" Steve Jobs. Our Hon'ble Prime Minister Shri Narender Modi said" I see technology as a means to empower and as a tool that bridges the distance between hope and opportunity".

Key takeaway

- To contain hunger, we need lab-field and market interlinkages.

SCIENCE, TECHNOLOGY AND INNOVATION FOR TRANSFORMING AGRICULTURE IN INDIA

R.B. Singh

Prof. R.B. Singh, Former Chancellor, Central Agricultural University, Imphal, is a versatile leader. He has played a vital role in national, continental and global capacities in improving agrarian livelihood, food, nutrition and ecological security, in cutting-edge research and technology development, in higher education and human resource development and in policy and programme formulation, execution and appraisal.

Globally, science, technology and innovation (STI) continuum has been the main driver of agricultural growth, development and transformation of national socio-economic, agro-ecological and environmental security and is evolving dynamically to meet fast-changing development goals. In the midst of the unprecedented COVID-19 pandemic, the world is challenged to meet new and emerging health and nutrition demands along with the United Nations' Sustainable Development Goals Agenda 2030. In this scenario, an effective STI system would be needed to disruptively transform Agriculture-Food Systems to achieve veritable goals, "leaving no one behind", especially youth and women.

The foremost challenge for the STI is the increased number of hungry and

malnourished people in India and other agriculturally important developing countries. One-third of the humanity is malnourished and nearly one-fourth of the world's children are stunted, annually costing about 6-10 per cent of GDP.

India represent, nearly one fourth of hungry, one third stunted and half of wasted children of the world.

The situation in India is highly asymmetrical, paradoxical and enigmatic. Along with the above glaring deprivation, in India, STI-led Rainbow Revolution has transformed the country from 'ship-to-mouth status to the 'Right-to-Food Bill' situation with formidable food-grain export and buffer stocking, making it the second largest agrarian economy in the world. Accounting for 18 per cent of world's population, with only 2.3 per cent of world's land and less than 4 per cent of global freshwater, the country's STI effort are geared to be accelerated to produce More from Less for More without further damaging agro-ecological system and accentuating the water and carbon footprints. The foremost thrust of STI for development in India must be geared to break the co-existence of food surplus, wastage and high incidences of hunger and malnutrition; check high inequities, trade and market distortions; halt unabated depletion of natural resources; stop accelerated emergence of infectious diseases and aggressive pests; and of course mitigate ever-aggravating climate change volatilities, posing major challenges to the Indian agriculture.

Another challenge for STI in India is to break asymmetry of low and poorly planned investment in agricultural research, education and in technology generation and transfer. Whereas, investment in agriculture in India is almost three times more effective than in other sectors in alleviating hunger, under-nutrition and poverty. Hence, moving beyond research and production as usual, an unusual science-technology-innovation continuum must be adopted to meet these challenges and create zero hunger India. Further, the importance of advancement in science-led technology, enhanced role of private sector, liberalized output and active land lease market and increased input-use efficiency along the value chain for transforming Indian Agriculture can hardly be overemphasized.

Some paradigm shifts and pathways to achieve our goals are as follows

- Keep small holder farmers at the centre stage of national development; especially their linkage with markets towards doubling farmers' income.
- Make nutrition security a key goal of agriculture-food system and save children from epigenetic fixation of stunting.
- Widely adopt value-chain management and prevention of food losses; a grain saved is a grain produced.
- Transform from Green Revolution to Gene Revolution, gene editing, genomics, IPR protection; liberating science to serve society.

- Adopt digital solutions and artificial intelligence for Ever Green Revolution by judiciously scaling innovations and disruptive technologies evolved nationally or internationally.
- Attracting youth and empowering women in Agriculture and strengthening their entrepreneurial abilities.
- Rejuvenating agricultural education from primary school to university level by fully aligning with NEP 2020, with due emphasis on skill development.
- Ensuring effective implementation pathways with differentiated accountability of all stakeholders.

Hon'ble Prime Minister, Narendra Modi has recently said "I see startups, technology and innovation as an exciting and effective instrument for India's transformation".

Towards Zero Hunger, Nutrition-Secured, Prosperous New India, we must be guided by the following profound words of the Father of Nation Mahatma Gandhi: "judiciously blend knowledge with character, commerce with morality, science with humanity and politics with principles".

Key takeaways

- Climate Smart Agriculture with the triple support from productivity increases, resilience and mitigation of environment is the need of the hour.
- Integrate Server-Side Rendering (SSR) with Client-Side Rendering (CSR) to create liberalized output market, active land lease market, enhanced input-use efficiency and effective collaboration between the Centre and the States.
- Synergise science of discovery, science of delivery and science of communication, all together; none left behind.
- A mere shift from price policy to income policy would enhance inclusiveness, eradicate poverty and double farmers' income.

SCIENCE FOR THE SOCIETY
AGRICULTURAL IMPERATIVES

Trilochan Mohapatra

Dr Trilochan Mohapatra is the former Director General of the Indian Council of Agricultural Research and the Secretary, Department of Agricultural Research and Education (DARE). His areas of specialization are molecular genetics and genomics and his research accomplishments include development of first high-yielding Basmati rice variety resistant to bacterial leaf blight through molecular-marker assisted selection; physical mapping and genome sequencing of rice and tomato. He initiated mega research programmes in the frontier areas of genomics, phenomics, bioprospecting of genes, allele mining and induced mutagenesis for functional genomics.

Science has always facilitated addressing the problems of the society. Harappan Civilization also known as Indus Valley Civilization had extensively applied science and innovations. Innovative ideas were there and were combined with science for betterment of varied developments. There are large number of examples such as LED display systems, lithium batteries etc. where science has contributed to societal needs. Norman Bourlog said that science driven agriculture is important for overcoming hunger and malnutrition and is the essence of a country not only in agriculture but also in other fields. It is not the induction of high-yielding varieties only but the science involved in their development is important.

There are a lot of challenges — Climate change, Conflicts at global level, Emerging new diseases, Land degradation and decline in quality and quantity of water. We have to think how they can be overcome by centralizing science to help

make a prosperous society. Technology is the driver of the change, but there is lot of disparity in its adaptability in different regions, Punjab is more inclined to changes and adopt new technologies as soon as they are released, whether in the form of new seed or any other; In Andhra Pradesh, however, replacement of the old varieties with new ones is very low; Bihar lately adopted to new hybrid of maize (which is high yielding) and the value chain is active now and farmers are getting higher returns. We need to have disruptive (out-of-box) technologies to drive innovation and to replace the old ones. Farmers need better remuneration and this has been well indicated in pulses revolution, where old varieties were replaced with the new ones. The seeds for varietal replacements are provided by seed hubs. Co 238 sugarcane variety which now occupies 90 per cent area produces 34-35 Mt sugarcane and it has been a use of disruptive technology for bioethanol production, which can be used as a fossil fuel and would be revolutionary with regard to environment.

We are losing our biodiversity, sea levels are rising, ice is melting and water scarcity and pollution, food insecurity, toxic air quality and intensified flooding and wildfires all are leading to climate change. And to protect nature we have to act for nature positive agriculture and for this we need to revisit our traditional systems, *Vedas* and civilization to know how we were managing and what science was behind traditional systems. Regenerative agriculture is the need of the hour farming in a way to build and improve soil fertility; sequestering and storing atmospheric CO_2 increasing on farm diversity and improving water and energy management. It is a holistic solution that represents the first step towards a wider set of economic, environmental and social benefits.

Institutional framework needs to be strengthened. For institutes to be mainstream, we need to learn from the Bhrosa Kendras (established in Andhra Pradesh). The Bharosa Kendra which will be launched by the concerned authorities of Andhra Pradesh government would play an important role in the life of the farmers of the state. Through Bharosa Kendra, the farmers would be able to solve the problem with the assistance of professionals. These professionals will be sitting in the Rythu Bharosa Kendras to help all farmers in their farming activities which will result in bigger output and also bigger profit for all of the ranchers.

Poverty is an important parameter for the development of the country the global Multidimensional Poverty Index (MPI) is an international measure of acute multidimensional poverty covering over 100 developing countries. It complements traditional monetary poverty measures by capturing acute deprivations in health, education and living standards that a person faces simultaneously. The Multidimensional Poverty Index (MPI) tracks deprivation across three following

dimensions and 12 indicators health (child mortality, nutrition and antenatal care), education (years of schooling, enrolment) and living standards (water, sanitation, electricity, cooking fuel, floor, assets and bank account). It first identifies which of the 12 deprivations each household experiences, then identifies households as poor if they suffer deprivations across one-third or more of the weighted indicators. According to India's MPI, Bihar has the highest population of multidimensionally poor people and Kerala the lowest. Bihar also has the highest number of malnourished people, followed by Jharkhand, Madhya Pradesh, Uttar Pradesh and Chhattisgarh. Uttar Pradesh ranked the worst in the child and adolescent mortality, followed by Bihar and Madhya Pradesh, while Jharkhand performed the worst in the percentage of the population deprived of sanitation, followed by Bihar and Odisha.

Youth are the future and we need to attract youth into agriculture for this we need to motivate youth. Maslow's Hierarchy of Needs Theory is regarded as one of the most popular theories on motivation. It explains how humans can be highly motivated to fulfil their needs. It is based on the hierarchy of the needs, which starts with the most basic needs and subsequently moves on to higher levels. The main goal of this need hierarchy theory is to attain the highest position or the last of the needs; the need for the self-actualization. The levels of hierarchy in Maslow's need hierarchy theory appear in the shape of a pyramid, where the most basic need is placed at the bottom while the most advanced level of hierarchy is at the top of the pyramid. Maslow was of the view that a person can move to the subsequent levels only after fulfilling the current level. The needs at the bottom of the pyramid are very basic and the most complex needs are placed on the top of the pyramid.

An innovative initiative by the ICAR "Mera Gaon Mera Gaurav" has been planned to promote the direct interface of scientists with the farmers to hasten the lab to land process. The objective of this scheme is to provide farmers with required information, knowledge and advisories on the regular basis by adopting villages. This programme would also help in capacity building and empowerment of farmers, youth, women and entrepreneurs to sustain society.

Key takeaway

- Society cannot prosper if we do not have innovative science and technology and evidence-based policy making and reforms .

INDIA'S PRIDE IN GREEN REVOLUTION
WAY FORWARD

Gurdev Singh Khush

Prof. Gurdev Singh Khush had led the rice-breeding programme of the Interbational Rice Research Istitute (IRRI) for 35 years, which has played an important role in the green revolution in rice.

Green revolution has been written in golden words in the history of Indian Agriculture, as it has brought in food sustainability and also general development. There has been a continuum of improvements in the living standards and general welfare of the Indian population due to green revolution from 1950 to 2019-20 abundance of food (70 mt buffer stock), rice export (20 mt) for rice lovers worldwide; life expectancy from 32 years of age to 68 years; reduced poverty from 70 per cent to 20 per cent; child mortality reduced from 210 deaths per 1000 to 32 deaths per 1000; literacy rate increased from 11 per cent to 73 per cent. There were some major breakthroughs during 20th century. Ralph Cicerone, President of the US National Academy of Sciences had divided the breakthroughs of the 20th Century into the following four groups.

1. Breaking of the DNA Code: led to achievements in molecular biology, biotechnology, all kind of pharmaceutical and human health.
2. Man to Moon project: led to breakthroughs in communication technology such as emails and internet etc.
3. Elimination of the small pox and polio from the planet: These two viruses have been a curse on humanity.

4. Green revolution: earlier to green revolution there used to be lot of famines. There were four major famines in 19th century: famine of Bengal, China, Bangladesh and Ethiopia. Green revolution provided food security. Before green revolution, crop varieties were tall, long duration, disease susceptible, their harvest index and production were low and the varieties produced during the green revolution were dwarf, short duration, disease resistant and with higher harvest index and production.

Even after a huge success of green revolution, Indian agriculture still faces following challenges: Crop varieties with low yields and poor nutrition; Degraded soils; Stressed water resources and Poor crop diversity.

These problems can be solved by developing resistant crop varieties through breakthroughs in genetics and molecular biology; developing biofortified crop varieties for better nutrition; improving soil health and improving water management and enhanced crop diversity.

Gene editing for development of new crop varieties is one of the major breakthroughs in the last 10-12 years to develop new varieties. And the Discovery of new genes has also helped a lot in crop improvement. Mention can be made of some of the following:

1. KRN2 gene increases number of grains in maize corn.
2. OSTRR gene increases number of grains in rice.
3. Highlander gene derived from Arabidopsis produces sterile progenies and is sought after gene by plant breeders to produce male-sterile lines.
4. Gene in wild wheat for inhibiting biological nitrification. This gene inhibits nitrification thus allowing absorption of all fertilizers efficiently.

Some gene-edited crops already existing are: powdery mildew resistant wheat crop, gene edited barley and potato. Central government has also passed an order that SDN1 and SDN2 type gene editing will not require regulatory process stipulated for genetically modified (GM) crops. Gene modifications has been used for development of new crops. Indian agriculture has been deprived of benefits from the use of genetic engineering technology due to moratorium on genetically modified (GM) crops. Only GM crop grown in India is cotton. In other countries this technology of genetic modification has been utilized in other crops like Bt corn, Bt brinjal, GM Canola and GM wheat.

In India, malnutrition is prevalent due to deficiency of iron, zinc and vitamin-A and its consequences are higher mortality, lower cognitive ability, lower work productivity, stunted growth of children. Improving the nutritional status

of children and adults is an effective way to increase economic productivity in agriculture and other sectors. To contain malnutrition, a programme Harvest Plus was launched. This scheme is improving nutrition and public health by developing and promoting biofortified food crops rich in vitamins and minerals and providing global leadership on biofortification evidence and technology. HarvestPlus is part of the Consultative Group International Agricultural Research Program on Agriculture for Nutrition and Health. Presently there are 393 biofortified varieties of 12 crops in 49 countries released from 2004 to 2020. Such as iron reach beans, cowpea, lentil and pearl millet; vitamin-A rich banana, cassava, maize and zinc rich maize, rice (golden rice), sorghum and wheat.

Presently, Indian soils show organic matter only 0.5 per cent as compared to 2.25 per cent required. Restorative agriculture is the best solution to re-carbonize soils. Most of organic matter in soils is due to plant roots. Increase in organic soil content can be by returning maximum amount of biomass to soil using minimum tillage, spray of microbial spray called Pusa decomposer and biomass to expedite decomposition and by practicing good crop rotation practices.

Biggest threat is of depleting water aquifers in India, especially in Punjab; where water tables have gone down by 10 metres since, 1973. At present, water table is going down at the rate of 0.2 to 0.5 m per year. Water is not unlimited in the coming years people will not be able to draw water from aquifer in Punjab, Haryana and Rajasthan so, we have to use water judiciously to conserve water for future.

Following policy interventions are desired for improving water management — withdraw subsidy for tube well irrigation, start direct sowing of rice instead of transplanting, thus saving 30 per cent water, use short duration crops and reduce area under rice in North India.

Key takeaways

- Gene editing would prove a promising tool to produce new varieties.
- Focus should also be on the efficient use of water.
- Utilize biofortified crops for containing malnutrition.

THE QUEST FOR A ZERO HUNGER INDIA
LESSONS FROM THE GREEN REVOLUTION

Prabhu L. Pingali

Dr Prabhu L. Pingali is the Director of the Tata-Cornell Institute for Agriculture and Nutrition (TCI) and Professor of Applied Economics at the Cornell University. His research areas are agriculture transformation, food systems and nutrition transition, market and value chain.

Factors responsible for the success of the green revolution

1. Long-term sustained investments in agricultural research and development led to sustained grain productivity.
2. Technology for irrigation was there but would not have worked if investments in irrigation across districts were not made.
3. Land savings happened by increasing cropping intensity.

Intensification in the cropping is the major gain of green revolution that allowed us to feed the growing population. And there would not have been any land for the forest and biodiversity conserves. But with increased crop intensity some land is available for biodiversity conserves also.

The following four I's have come together to make green revolution a success:

1. Innovations in agricultural technology,

2. Infrastructure investments in irrigation, power, road etc., 3. Institutional reforms, especially land rights, access to credit etc. and 4. Incentives for enhancing productivity, price policy input subsidies, procurement policies for foodgrains exports.

Some issues were not the focus

Regional differences in productivity gains were owing to lack of investment in irrigation and infrastructure in different parts of India. The main focus was only on a few staple grains such as rice and wheat. There were some areas where rice and wheat intensification worked but there were also some areas where it did not work. In central parts oilseeds were grown, but they were neglected because of wheat and rice. Pulses and coarse cereals disappeared or completely removed from the major producing areas and were replaced by wheat and rice. There was inefficient use of chemical inputs like fertilizers. We have to think how can these be rejuvenated.

Hunger remains the challenge

Despite the enormous growth and high productivity, 50 per cent of the population is undernourished; 72 per cent of infants and 52 per cent of married women are anaemic. Even if we resolve the problem of hunger, we are facing triple burden of nutrition of the population hunger, hidden hunger (deficiency of micronutrients) and increasing obesity. Children malnutrition trends in India during 1992 to 2021 has showed that reduction in stunting and underweight. But still much needs to be done.

When we think about nutritional security, we think of it in the multidimensional and multisectoral way. Food security requires multisectoral approach—investments in agriculture and agriculture development; accessing diversity of food groups; affordability of diverse food groups; making food accessible to poor through set programmes which is nutritionally richer; maintaining equality in food access to women and child.

Investments in agricultural research and development led to sustained staple grain productivity growth. Increased the rice, wheat and rice yield from 15,000kg/ha, 9,000 kg/ha, 10,000 kg/ha (1961) to 40,000 kg/ha, 35,000 kg/ha and 30,000 kg/ha respectively.

Rising GDP per capita leads to greater food consumption, demand for quantity and quality of food have risen. Diversification for quality is increasing and share of cereals is declining but share of fruits, vegetables, milk, meat and eggs in total caloric intake is increasing. At present, challenge is how to enhance productivity and how we to enhance investments in fruits and vegetables growing.

Greenhouse gas emission and energy use per capita are on rise in agriculture. How we can double productivity by minimizing the greenhouse gas emission is a big challenge and also energy use in agriculture.

To understand the relationship between the agriculture and the nutrition is important at the micro level.

To fight hunger, government implemented hunger-fighting initiatives are National Nutrition Mission (NNM), National Food Security Mission, Zero Hunger Programme, Eat Right India Movement and efforts toward food fortification.

Key takeaways

- Focus should shift from addressing calorie hunger to micronutrient malnutrition.
- Food policy should look beyond staple grains; focussing on enhanced availability and affordability of diverse, nutrition-rich foods.

POVERTY, HUNGER, STRUCTURAL TRANSFORMATION AND SUSTAINABILITY
INDIA AND THE REST OF ASIA

Uma Lele

Prof. Uma Lele is the President of the International Association of Agricultural Economists (IAAE). She has immense experience in research, operations, policy analysis and evaluation in the World Bank, universities and international organizations.

Globally the number of the poor living in extreme poverty, i.e., living on less than $1.9 a day were estimated by the World Bank to be 696.45 million (2017). Of these 25 per cent lived in South Asia, 62 per cent in Sub-Saharan Africa; 4 per cent each in East Asia and pacific and Middle East and North Africa; 3 per cent in Latin America and the Caribbean; 1per cent in Europe and Central Asia and 1per cent in the High-income group. From the 1981 base year, the number of poor had decreased significantly in Bangladesh, China, India, Indonesia, Philippines, Thailand and Vietnam (1981-2019), reaching near zero in China and several South-East Asian countries. India still had 130 million poor in 2016, the latest year for which poverty data were available. Most poverty is concentrated in the rural areas. Global poverty had increased by 75 million to 95 million from 2017 to 2022 due to COVID and Ukraine war, according to the World Bank.

Globally, an estimated 768 million were undernourished, i.e., people having insufficient food or other substances for good health and condition, according to FAO (2020). But there is disconnect between estimates of incidence of poverty and hunger. A much higher estimated 40 per cent of the undernourished were in South Asia compared with 24 per cent of the poor; 34 per cent of the estimated hunger is in Sub-Saharan Africa compared to 62 per cent of the poor as reported above; 8 per cent in Latin America and Caribbean; 8 per cent in West Asia and North Africa; 6 per cent in South East Asia; 3 per cent in East Asia and pacific; and 1per cent in high income countries. Among the 130 countries we analysed, the countries lagging in total factor productivity growth in food and agriculture lagged in structural transformation.

Climate change is a continuing long-term shock to the food system leading to increase in temperature, more frequent droughts and floods. And yields are projected to decrease by 10 per cent for every 1°C increase in temperature. We should not only focus on addressing individual stress in response to climate change, as this approach is very inefficient, but on addressing multiple stresses, so as to protect the plants.

India faces other challenges too. For example, groundwater exploitation has become unsustainable; soil degradation is widespread, biodiversity loss is rapid and a third of the production is lost to food losses and waste impacting environment significantly (FAO).

Extraordinary growth was observed in per capita GDP from 1960 to 2019. in South Korea, followed by China, Thailand, Indonesia, with lesser growth in India, Bangladesh, Vietnam and Nepal in that order.

In this study we have reported progress of countries using the structural transformation framework.

Structural Transformation is defined as:

- Decline in the share of agriculture in GDP and employment.
- Total factor productivity growth in agriculture.
- Demographic Transition.
- Overall income growth.
- A recent concern expressed by Rodrik about Premature de-industrialization.

A principal conclusion of this study, based on systematic evidence across Asian countries is that India has lagged much of the rest of Asia, although most Asian countries started with similar initial conditions in the 1960. The paper suggests number of policies, institutions and investments by which Indian structural transformation could be accelerated.

Each of the elements of structural transformation is examined below.

Total Factor Productivity (TFP) Growth in agriculture shows huge differences across countries (1960-2018). Despite the

strengths of the TFP measurement, one major weakness is that TFP growth does not measure changes in natural resource quantity or quality (e.g., soil or ground water depletion, pollution of water due to chemical runoffs) as the sources of agricultural growth change over time, a particularly significant weakness for India. Lowest TFP growth rate was observed in Africa. Agricultural production there increased mostly due to the expansion in cultivated area. In Southeast Asia, by contrast, the increase in TFP was comparatively most rapid and occurred due mainly to intensification of agriculture. India's TFP growth remained somewhere in the middle, not as high as would have been expected given that India was the cradle of the Green Revolution in the 1960s. This could be because India's public spending in agricultural research, development and education (R&D), particularly central government expenditures. have grown very slowly, especially after 2010-2011. Chinese annual growth in R&D expenditures was 16.19 per cent, compared to 5.31 per cent annual expenditure growth of India China and Brazil have also overtaken India in research publications. India needs to invest more in research and development to achieve more rapid transformation.

There is also difference in growth among Asian countries in **demographic transition**. Again, India is behind several other Asian countries. This slower demographic transition in India is due to many factors and one among them is the slower rate of decline in female fertility rates. Female fertility rates declined much more rapidly in countries like South Korea with dramatic increase in women's labour force participation, whereas in India women's labour force participation as share of female labour force has not only lagged but declined over time. With slower demographic transition, India's population would reach its peak somewhere in 2027; and this would increase population pressure. Furthermore, India would be the country with the largest population in the world outpacing China. The so-called "demographic dividend" of a young labour force can become a curse if not enough productive employment is created in the economy for the youth.

There has also been decline in **the share of Agriculture, Forestry and Fishing value added (per cent of GDP);** but this decline is slower in India than in other countries. Asian countries are also concurrently experiencing rapid **decline in Agri employment**; here again India's decline is slower. The fact that the share of Agri in GDP has declined but the share of Agri employment has not declined rapidly in India, indicates that majority of the poverty resides in rural areas. Furthermore, India's share of manufacturing value added in GDP is lower compared to other countries, like China and Korea. Furthermore employment in manufacturing is not increasing as rapidly in South Korea, China and even Bangladesh. What is needed is the investment for improving quality of human resource. India has a

substantial number of Indian Institutes of Technology (IIT's), which are world class management institutes, but resources in State Agricultural Universities (SAUs) are spread thin. We need substantial increase in the quality of human capital from SAUs.

India's rainbow revolution has improved diet diversity (dairy, fisheries, horticulture, livestock and poultry). But India, still needs more investment in policies, institution infrastructure, food safety standards to increase poor people's access to diverse foods at affordable prices and to improve farmers' income.

How can this be achieved? One avenue besides more investment in R&D is promoting vertical integration of markets. In tonnage horticulture production in India now exceeds foodgrains production, but post-harvest losses are high due to fragmented markets, limited storage and processing facilities lack of standardization and information systems.

India's trading regime has also been restrictive, compared to South-East Asian countries. Studies of effective rates of protection (e.g., Ashok Gulati) show that India's price policy has been more pro-consumer rather than pro-producer as compared to the other Asian countries. Indeed, India has been an outlier in this regard. India's food procurement and distribution policies show on the supply side that, current procurement policies have a dual role of stabilizing prices and acquiring enough grain to distribute to meet the food Act (2013). In principle, one act should focus on only one objective, this dual-purpose in India has led to increased buffer stock, ballooning cost of stocks and discouraging diversification out of cereal production. On the Demand side, this idea of feeding eight hundred million people leads to errors of exclusion and inclusion, i.e., the most deserving (poor) do not always have access to low-cost food and those less needy are able to access it at subsidized/favourable rates. Importantly, such a policy takes resources away from other urgently needed investments such as infrastructure, R&D, quality education and does not promote balanced production/ concentrating it in rice and wheat and leading to an unbalanced diet.

Possible ways of achieving more investment in R&D

- Separate procurement price to achieve price stability and prices to achieve food distribution needs.
- Set minimum price to procure only amount needed for buffer stocks.
- Purchase larger amounts needed for distribution at market prices or above the MSP.
- Move to cash transfer rather than physical food distribution in kind and correct bias against agriculture.

Technologies for sustainable development

Strengthen and expand technologies which are already in place.

- **Soil health card scheme**: It targets every farmer to have balanced use of nutrients on soil-test basis.

- **Investing in precision irrigation technologies:** Through satellite crop monitoring system assess soil moisture, expected rainfall and overall crop condition to suggest exact quantity of irrigation required.

More policy interventions to improve market efficiency

- Free-up of agricultural markets for greater competition and lowering transaction cost and food losses;
- Allow farmers to sell their produce where they can get better price without restrictions on sale, stocking etc.;
- Increase investment in building efficient and sustainable supply chains while ensuring better share of farmers' earnings in consumer's rupee;
- For nutritional security, increase consumer education, link farmers to market. Digital marketing platforms such as electronic unified agricultural markets (e-NAM), negotiating warehousing, government initiatives like Agriculture Infrastructure funds, Atmanirbhar Bharat and Farmers Producer Organizations are the steps in the right direction to increase farmers' income.

Key takeaways

- Shift in policies should be from pro-consumer to neutral/pro-producer income-oriented ones.
- To double farmers' income, need is to increase farmers access to finance, storage and market.

BIODIVERSITY GOVERNANCE
GLOBAL AND NATIONAL PERSPECTIVES

Vinod B. Mathur

Dr Vinod B. Mathur is the former Chairperson of the National Biodiversity Authority. He has extensive experience as an environment professional and his special interests include natural resource conservation, protected area management, natural heritage conservation, environmental and strategic impact assessment.

Biodiversity is the variety and variablity of different life forms viz. animals, plants, fungi and microorganisms etc. Human interference is leading to deterioration of biodiversity at both local and global levels. 75 per cent of the land area is significantly altered; 66 per cent of the ocean is experiencing increased cumulative impacts and more than 85 per cent of the wetlands have been lost. Global extinction rate is at least tens to hundreds of times higher than it had been on average over the last 10 million years. Highest extinction per centage has been in amphibians, followed by mammals, birds, reptiles and fishes. Scientists and policy-makers need to act fast— even though extinction cannot be stopped completely but at least anthropogenic rate of extinction caused by humans can be minimized. Dramatically saying our planet is collapsing because extinction rate is high (up to 1000 times faster), population of major species are declining (68 per cent decline in the last 45 years).

Poverty is linked closely to nature and climate. Climate change makes poor people poorer; 10 per cent of the world's

population is in extreme poverty; half of it in sub-Saharan Africa. There are 17 sustainable development goals and as many as 10 sustainable development goals in particular are linked with human development and nature. If nature is not protected, it is impossible to take care of these goals. Current agricultural methods cause 70 per cent biodiversity loss and 80 per cent deforestation. Nature's loss or damage causes loss of production base through soil depletion and decline in population of pollinators.

In today's world, all are busy developing surroundings and spoiling beautiful natural environment. There is an urgent need is to conserve the natural heritage.

Half of the global gross domestic product is dependent on nature; forest sector is worth $ 583 billion/year (2014), however, each year an area of forest equivalent to the size of the UK is cut down. Fisheries worth $148 billion/year (2016) are produced but 93 per cent of the global fish stocks are harvested to the limit or beyond every year; different pollinators increase value of crops by $577 billion/year (2008) but 40 per cent pollinators species are threatened.

Innovations are needed in agricultural practices to prevent loss of biodiversity. New soil and water conservation techniques such as organic farming and drip irrigation are useful in conserving soil and water. Doubling yields can only happen if the soils are healthier and healthier soils can be only be produced by protecting top soil and by stopping soil erosion.

Protecting nature supports economic growth and also leads to job-creation. Global forestry employs 10 million persons per year and ecosystem services provides estimated value of $125 trillion (2020). Every $1 invested in the restoration of nature would yield $9 return, which is a much higher return than from any other investment.

Resource conservation is very important for conservation of biodiversity. It can happen if we take the right steps such as green infrastructure restoration, investment in natural capital, agricultural innovation, ensuring sustainable consump-tion (e.g., reduce meat consumption as its consumption rate is very high and nature cannot sustain such consumption levels), along with subsidy reforms (in India we do need subsidy in agriculture but we need to remove perverse subsidies, which harm nature).We need to invest more in nature socially, politically and economically to conserve biodiversity.

One of the best methods to conserve biodiversity is through awareness. This can be achieved by word of mouth and through social media.

Key takeaway

- All together must make every effort to conserve biodiversity, as our future livelihood depends on biodiversity. *If Nature is protected, we are protected*.

SHAPING AGRI-FOOD SYSTEMS AND SUSTAINABLE DEVELOPMENT GOALS FOR SMALLHOLDERS

WHERE ARE THE SOLUTIONS?

Kakoli Ghosh

Dr Kakoli Ghosh is the Chief Technical Advisor, Sustainable Rural Agriculture Development Programme, Food and Agriculture Organization, Riyadh, Saudi Arabia. She is specialist in the sustainable agriculture, agrobiodiversity and partnership development.

In India, agriculture sector, the major provider of the livelihood to the poor, especially in the rural areas is facing many challenges declining size of landholdings; deteriorating natural resources, especially soil and water; adverse impact of climate change; declining productivity; rising input costs; fluctuating markets and declining farm income. All these factors make agriculture a riskier venture for the millions of smallholders farmers and producers across the country.

How can agriculture contribute towards achieving sustainable development goals (SDGs) while strengthening the smallholders? There are 17 SDGs with 169 targets designed with main focus on food security societal and nature sustainability

to take a holistic approach to address social, economic and environmental aspects of the sustainable development. About 2 billion of the world's population directly depends on the agriculture sector for their livelihood (working as cultivators or wage-earning labourers). Women farmers and labourers play a special role. The centrality of the small farm development to address targets and growth to achieve the SDGs is undeniable. Nine of the 17 SDGs, pertaining to poverty eradication (SDG 1 and SDG 8), hunger and nutrition (SDG 1 and SDG 3), social emancipation and inequality (SDG 5 and SDG 10) and the environment (SDG 12, SDG 13 and SDG 15), are directly linked to the sector.

Smallholders and sustainable agriculture can be the winners. And yet the inter-linkages, the trade-offs and their consequences are largely under-explored due to lack of policy coordination, low prioritization and poor investments in research and development. The current food systems of the world constitute production, processing, distribution, consumption and disposal of food. Consumers, distributors, manufactures and service sector are increasingly shaping food systems. Strengthening the interconnectivity between the various elements of agri-food systems, the sectors and their ecosystems in a sustainable manner can transform agri-food systems. Sustainability challenges of the current food system webs include complex inter-linked drivers with many trade-offs; scarcity and degradation of natural resources land, water, soil and biodiversity; market concentration of food and agricultural input and output challenge resilience and equitability. Rural and urban poverty is due to the distribution not due to the production. Linking small farms to urban food value chains can be promising in reducing rural poverty.

Measuring productivity and income of the small-scale food producers is critical in tracking SDG 2, zero hunger. With the inclusive policies such as input subsidies, marginal support price and public storage, extended research on the climate smart agriculture, investments from public and private sectors, re-shaping education, short chain supply and good practices have increased positive impact in smallholders' income. Investment in rural market infrastructure allows smallholders to commercialise and enhance supply of perishable products.

One needs to focus on a food systems' perspective and encourage diversification with nutrition-rich legumes, pulses, horticulture crops and livestock. Investment in the rural market infrastructure would allow small holders to commercialize and enhance the supply of perishable products. Linking small farms to urban food value chains would also be a promising new venture for rural poverty reduction.

Major improvements in agricultural productivity of the recent decades have come with social and environmental costs.

Policies on education, innovations and investments should cater to the needs of smallholders who are the backbone of agriculture for diversification, income generation and prosperity. So, there is an urgent need to ensure reorientation of on-going efforts toward higher efficiency and effectiveness of various initiatives by developing a road map to achieve the goals well before 2030.

Key takeaways

- The agri-food systems approach offers a novel opportunity to advance particularly in the areas linked to SDGs for sustainable agriculture, management of natural resources, gender and equity.
- Mapping of smallholders, while recognising their scope, range and linkages in the agrifood, would help achieving targets of the Sustainable Development Goals.

INDIAN AGRICULTURE IN PERSPECTIVE

Mangala Rai

Dr Mangala Rai was former Secretary, DARE and Director General, ICAR and is a fellow of the National Academy of Agricultural Sciences, India. He has been an able manager and a great policy planner. His areas of expertise are in genetics, plant breeding, seeds management, policy and perspective planning.

Recalling spectacular agricultural achievements in independent India, he indicated the need for introspection at the time of celebration, to move forward further. He recalled the year 1947, when the first Prime Minister of independent India, laid emphasis that "Everything else can wait but not Agriculture" and in 1948, Father of the Nation, Mahatma Gandhi, stated that bread is the GOD for the hungry. Agriculture presently has led to self-sufficiency in food and increased life expectancy. After independence, there has been 6 times increase in foodgrains production, 10 times increase in milk, meat, fruits and vegetables production, 15 times increase in fish production and 50 times increase in egg production. From 1950 to 2019, tremendous increase of 1900 per cent was observed in milk production despite only 34 per cent increase in livestock population; this was through technological innovations, cattle management, health-care and nutrition management.

Globally, recalling the problems of agriculture which is primarily natural resource based, he mentioned that 80 per cent of the natural resources are accessed only by 20 per cent of people and the richest 1 per cent have 40 per cent of the natural resources and 50 per cent poor survive only on 1 per cent of the natural resources of the world.

India has only 2.3 per cent land and 4.2 per cent water of the whole world. We have 5-6 times more population density per unit of land as compared to the world average. Our 80 per cent people have less than 2-hectares of land and 36 per cent of the geographic area is eroded and degraded (47.7 million hectares facing chemical degradation, 7 million hectares are saline soils and 26 million hectares are acidic soils). Micronutrient-use efficiency of the soils is also low — soils are deficient in zinc, boron and iron by 49, 33 and 12 per cent, respectively. To address varied issues, varietal improvement and integrated systems of farming are desired. Improving soil health and soil biota are to be given importance, as 80-90 per cent biological processes are through soil biota.

In 1970-71, when the green revolution had started, 1 kg of NPK produced 50 kg extra wheat but lately it produces only 5 kg extra wheat. Climate is changing at a very fast pace and every 1°C increase in temperature would increase 2 per cent more water demand. Water is a serious issue as 65 per cent underground water goes to agriculture. Madya Pradesh may be producing good quality wheat but for its per kg wheat production, water use is the highest. We need to consider this and need to have some strong measures such as shift in crops (from high water requiring crops to low water requiring crops) and some policies to stop excessive use of water. If water use continues at this speed, there will be 755 billion cubic meter water deficit by 2030.

The efforts of the researchers/ scientists, who in the last two years have produced 651 improved varieties in 50 crops, 70 fortified varieties and 451 varieties with inbuilt resistance to biotic and abiotic factors, need to be appreciated. Kadaknath is an example of fortification in meat—kadaknath meat is rich in protein and low in cholesterol and contains medicinal properties.

There is a pressing need for agriculture to shift its focus to secondary agriculture to enhance employment and income. Accelerated processing and diversified value-added products development and converting so-called 'agricultural wastes' into wealth can improve our rural economy. There are also certain alternative agriculture activities like beekeeping, mushroom production, backyard poultry, etc., which can bring much needed improvement. Increasing total factor productivity of Indian agriculture is essentially called for. There is a burning need to have a mass movement for activities like vermicompost and vermi wash production, residue recycling, production of biologicals, etc. to ensure profitable and sustainable eco-friendly agriculture. A system wide system approach in systems perspective to be resorted too.

There is an urgent need to enhance investment in agriculture and increase capital formation. There must be a policy environment to ensure remunerative and resilient agriculture

Key takeaways

- Develop district-wise land use plan.
- Researches need to be intensified to enhance input-use efficiency.
- Soil carbon needs to be enhanced and soil biota improved.
- Secondary agriculture is to be ventured in the right earnest.
- Research intensity ratio has to be improved from 0.3 per cent to at least 1.0 per cent.
- Processing of produce, value-added products development, marketing and trade are to be improved.
- Investment need to enhanced in land development, water harvesting and multiple water use.

INDIGENOUS COW-BASED NATURAL FARMING FOR ATMANIRBHAR BHARAT

P.P. Adrushya Kadsiddheshwar Swamiji

Shri P.P. Adrushya Kadsiddheshwar Swamiji is a sole trustee of the Shri Siddhagiri Math and Siddhagiri Gurukul Foundation. He has a keen interest in gaining knowledge in scientific and developmental aspects and implementing it in the fields of education, agriculture, health and culture.

India is basically an agriculture-based country. To improve soil health, we have to increase carbon content of the soil. At present, the carbon content of the soil has decreased from 3 per cent to 0.2 per cent. And owing to reduction in vegetation cover, soils are becoming more compact leading to reduced water drainage or seepage. Earlier there used to be 25 trees per acre, now the number is reduced to 5 trees per acre, which contributed in increasing soil organic matter and facilitated better drainage and seepage of water. Carbon content of the soil can be increased by natural farming using cow dung & urine. It is rich in nutrients and its beneficial bacteria boost soil fertility. A mixture of cow urine and water extract of neem leaves has proven to keep away pests.

Swami ji said that for our country to become Atmanirbhar; natural farming is the need of the hour. Examples that people are earning Rs 12 lakh per acre by integrated (natural) farming. Earlier cows were called 'Gau Dhan' and very rightly it is true in the present also they

are the source of milk and various dairy products, wet dung can be used for producing biogas for making food and remaining slurry can be used as a manure. Punchgavya a natural growth promoter is also prepared from cow milk, ghee, curd, cow urine and cow dung. In a way, using desi cow-based natural farming our villages and country can become self-dependent (Atmanirbhar).

Key takeaways

- Orientation of agriculture needs to be towards traditional methods for maintaining sustainability of the ecosystem.
- Integrated (natural) farming is important and cow-based farming system needs to be popularized to make country Atmanirbhar.

RETHINKING
THE WAY WE FARM IN INDIA

Bina Agrawal

Prof. Bina Agrawal is a Professor of Development Economics and Environment at the Global Development Institute, The University of Manchester, UK. She writes on diverse but interconnected subjects property, land rights and livelihoods; environmental governance, sustainable development and collective action; agriculture, technology and food security; poverty and institutional transformation; legal change; and intersecting inequalities.

Indian agriculture today represents a paradox. On the one hand it was the only sector in India's economy which had a positive growth rate through the pandemic. In the first quarter of 2020 while overall GDP contracted by 23.9 per cent, agriculture grew by 3.4 per cent. At the same time, over the decades, agricultural growth has come at a high environmental cost, making it unsustainable.

Problems and challenges

Agriculture today contributes only 15-16 per cent of India's GDP. The yields of the major food crops, rice and wheat, are much below their potential. Climate change is speeding up. Some 86 per cent of our farmers are small and fragmented and most of them want to leave farming. It is therefore time to rethink the way we farm. Ecologically, we see depleting water sources, degraded soils and declining biodiversity, in addition to climate change. Water is the key to higher production and yields, but even after 70 years of planning only 47 per cent of India's cropped area is irrigated. India uses 90 per cent of its groundwater for irrigation and has been grossly over-extracting, leading to falling water tables. By recent World Bank

estimates, 65 per cent of India's blocks will be over-extracting groundwater by 2030. Free electricity has contributed particularly to this over-extraction. No state has metered groundwater use, except West Bengal. Groundwater is a common. But rich farmers treat it like a private resource, overdrawing heavily. Moreover, 37 per cent of India's geo-area is degraded, with large parts facing water logging and soil salinity or contaminated by excessive use of chemicals. With climate change, India's crop yields are also predicted to fall sharply. Technologically, we are far behind in terms of investing in water conserving technology and climate resilient crops. Institutionally, India is still dependent on very small family farms: 86 per cent of farmers cultivate 2 ha or less, often in fragments. And they occupy almost 50 per cent of operated area. They have limited access to land, inputs, extension, credit and markets. Most are too small to effectively use even machinery. Small farm size reduces economic viability. Overall farm incomes are low and erratic. While prices and markets are important, these smallholders can only gain if they first produce enough net surplus to sell. At present, 70 per cent of farmers produce barely 4-5 per cent of marketed surplus in wheat and rice, even in surplus producing states; and only a small per centage gain from MSPs. Hence, many farmers say they would prefer another job. An NSSO survey asked over 50,000 farmers: do you like farming? Forty per cent said they did not, including poor farmers, women, as also better-off farmers, especially young educated ones (see Agarwal, B. & Agrawal, A. 2017. 'Do farmers really like farming?' Oxford Development Studies, 45/4). Also agriculture's allied sectors "livestock, fisheries and forests" have vast unused potential, as does the wider rural economy which, at present, lacks synergy with agriculture. These problems cannot be solved by focusing only on prices. Higher prices and market reforms can benefit smallholders only if we first address their production constraints. There are three types of constraints-ecological, technological and institutional-which need solutions.

Ecological and technological solutions

To begin with, we need to regenerate our water and soils. Irrigation expansion can greatly increase yields, cropping intensity and the production of high value crops. We need to rethink irrigation and crop technology, going beyond tubewells and large dams. India has over 5200 dams. We have always treated large dams with great reverence, even though they come with high environmental and human cost. And we have neglected other surface irrigation methods, especially rainwater harvesting. We need a complex combination of groundwater regulation, rain water harvesting and micro-irrigation. Rainwater catchments provide both surface irrigation and recharge groundwater. India has an ancient history of rainwater harvesting via tanks and stepwells. Some of these are now being revived. But new systems are also being created in some regions. If expanded across the country,

these can greatly increase agricultural output. For example, between 1999-2009 Gujarat's agriculture grew at almost 9.6 per cent, attributed to rainwater harvesting (linked micro-structures) and BT cotton. In addition, for surface irrigation, we need cooperation among farmers to ensure equity in water sharing between upstream and downstream, as well as big and small farmers. Alongside, to use water efficiently, several measures can help ranging from drip irrigation to growing less water guzzling crops. Today only 6-7 per cent of India's crop area is under micro-irrigation. MGNREGA can be used to build check dams and tanks, designed using hydrological expertise.

Another necessary technological shift would be to move away from cereal monocultures to crop diversity and agro-ecological farming. Broadly this means cultivating to revive the local ecology, involving diverse natural practices and mixed cropping. This would have both ecological and economic benefits. It would revive soils, save costs, employ more labour and increase net profits. Ensuring a diversity of produce including, poultry, fruits and vegetables will also be in line with India's changing dietary patterns. Furthermore, we need research into heat resistant crops to deal with climate change. Here there is enormous scope for regional cooperation in Asia. A related need is efficient extension services. There is great potential in using cell phones to transfer information about new farming techniques, the adoption of which is found to improve significantly as a result.

Institutional transformation

The most difficult problem to tackle is small farm size. This requires institutional change. Our farms are too small for using machines efficiently or tapping scale economies or providing farmers enough bargaining power in diverse markets. A key way of increasing farm size is by encouraging smallholders to cooperate in production. Cooperation in farming can have many levels. It can range from single purpose to multipurpose to fully integrated. Globally, single purpose marketing cooperatives are most common, especially in the dairy industry. In India, Amul is a case in point. In between, we find medium-level cooperation, such as for jointly buying machines and crop planning across ecological zones. But for reaping the most benefits, we will need fully-integrated cooperation in the form of group farming. This would involve land and labour pooling and sharing costs and returns.

Conceptually, smallholder cooperation for group farming could help enlarge farm size through pooling owned or leased land. This would improve economic viability and reap economies of scale. Also groups can help save on hired labour; bring in a larger pool of funds and inputs; tap into a greater diversity of skills and help farmers experiment with risk-prone higher value crops with larger payoffs. Groups can better deliver

on contracts and have higher bargaining power in markets. They would also be better positioned to take steps to adapt to climate change. For women farmers, groups can help overcome conservative social norms to give them greater mobility and autonomy in farm management. These group farms, however, have to be constituted differently from those formed when India tried to promote cooperative farming in the 1960s. Those efforts had failed. At that time, cooperatives were promoted top-down and were structurally unequal since large and small farmers were expected to form one cooperative, without recognising conflicting interests. There were no clear mechanisms for participative decision-making, conflict resolution or equal sharing of costs and benefits. In other words, the basic principles of successful cooperation were not followed. For cooperation to work, careful institutional design is needed. To begin with, cooperation must be voluntary. The groups should be small, economically homogenous and cemented by trust. We need participative decision making, checks on free riding (so that everyone turns up for work) and fair and transparent sharing of production costs and returns. In fact, today, there are many examples of successful group farming that follow these principles, both in India and Europe. In India, for example, in the early 2000s, a very different model of group farming emerged compared to the 1960s, first in Kerala and Telangana and then in other states, many adapting the SHG model.

The best example of successful group farming is found in Kerala. In the early 2000s, as part of its Kudumbashree anti-poverty Mission, Kerala promoted all-women group enterprises, especially group farming. It modified the SHG model to constitute village-level neighbourhood groups as savings-cum-credit groups. Many members of these groups took up group farming. For this, small numbers of women come together to jointly cultivate leased in land, pooling labour and resources. They receive a start-up grant, technical training and access to subsidised credit via NABARD. Today, there are over 68,000 such farms across Kerala, involving more than 3 lakh women. To compare the relative performance of women's group farms and largely male managed individual family farms, the author surveyed two districts of Kerala, (Alappuzha and Thrissur), over 2012-14. The sample of 250 farms included all-women group farms and individual family farms (95 per cent of which were male managed). Quantitative data were collected weekly for all inputs and outputs for an entire year, as well as qualitative data via focus group discussions. The average group size was six women; all members were literate and they were economically disadvantaged but socially heterogeneous by caste and religion. The groups leased in land to cultivate. Their average farm size was 1 ha while individual farms owned their land and cultivated 0.35 ha on average.

This research showed that the groups were much more productive and profitable than the individual family farms. The annual value of output/ha of group farms was 1.8 times that of small individual farms. The average net returns per group farm (calculated by deducting all paid out costs) was five times that of individual farms. Women learnt to be managers and acquired new technical skills. They became familiar with a range of public institutions and learnt to negotiate in multiple markets. They also reported improved status in the family and community. And many stood for village council elections and won. (For details, see: Agarwal, B. 2018. Can group farms outperform Individual family farms? World Development, 108: 57-73; and Agarwal, B. 2020. Does group farming empower rural women? Journal of Peasant Studies, 47/4). Group farming is also found today in Telangana, Bihar, North Bengal and Gujarat. Telangana's group farms are as old as Kerala's, launched in 2000 with UNDP support and operationalized by a local NGO. Here groups had lower annual value of output/ha on average than individual farms due to lack of sustained support and technical inputs (the project ended after 5 years) as well as large group size, but did as well as individual farms in net returns per farm. In Bihar and N. Bengal, there are a diversity of group farms: all-women, all-male and mixed gender. All the groups showed increase in yields (some doubled their wheat yields) compared to when they were farming individually. This was due to a combination of irrigation and joint cultivation. Irrigation would not have been possible without group formation and plot consolidation. These groups have also gained from scale economies and saved on hired labour and input costs. In Bihar, they have negotiated lower rents from landlords. Most notably, some youths have begun doing vegetable farming in groups instead of migrating to cities for work. Finally, under COVID, group farms did better than individual farms. In Kerala, 87 per cent of the groups survived economically, especially vegetable farmers, whereas individual male vegetable farmers lost most of their produce due to lack of harvest labour and market access. In Gujarat and Bihar, the farmers' groups reported that they were more food secure during the COVID-19 lockdown than individual smallholders in their village. These experiences provide lessons for replication. For group farms to succeed we need State support and NGO guidance in the initial stages; members connected via neighborhoods; small group size of 6-10 members who are economically homogeneous while being socially heterogeneous; egalitarian in decision making and in the sharing of labour and costs and scaled up via autonomous federated structures. Moreover, groups of farmers' collectives could form farmer producer organisations for marketing.

Allied sectors

In addition to crop cultivation, agriculture's allied sectors – livestock, fisheries and forests have huge underused potential. Livestock is a poor-centric and women-centric venture and can gain from

cooperative marketing, as done for milk. India is also the world's second largest producer of aquaculture fish, employing large numbers, including women. In 2017-18, Indian fisheries grew at 11.9 per cent. There is thus a huge potential for growth here, especially by groups of women. Similarly forests and commons provide small farmers green manure, fodder, soil, water and other ecosystems services. But we need to protect and revive forests. Here community forestry launched in 1990 has borne fruit. India's forest cover has increased to 21.5 per cent of our geographic area. The target is 33 per cent. It is notable that forest improvements are much greater if community forest management included poor women, since they have the most stake in forests for their firewood and fodder needs. In fact, forest protection, plantation and biodiversity restoration could create thousands of jobs.

Hence to transform agriculture ecologically, technically and institutionally, we should treat crops, livestock, fish and forest as an integrated whole. In addition, the rural sector can be a major partner of farmers: 61 per cent of the income of rural households comes from the non-farm sector. But we need to enlarge farm-nonfarm linkages by promoting activities such as agro-processing, machine tools, farm tourism and eco-tourism.

Transforming agriculture and its allied sectors through a model of cooperation will help us build back the economic and social fabric of communities. Institutional and technical transformation in farming would also help more rural youth find local jobs and live closer to their families, rather than being forced to migrate to inhospitable cities. India has an opportunity to forge another path to agrarian change that is equitable and inclusive, ecologically sustainable, institutionally innovative and attractive to women & youth. This path will require cooperation, community revival and resource conservation. By rethinking the way we farm, India can bring transformative change in agriculture and the country's development.

Key takeaway

- Cooperation in farming, all along the value chain, is the way forward for economically profitable and environmentally sustainable agriculture.

PROTECTION OF PLANT VARIETIES
THE KEY TO IMPROVED AGRICULTURAL COMMERCE AND GROWTH

K.V. Prabhu

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Plant breeders' rights (PBR), also known as plant variety rights (PVR), are rights granted to the breeder of the new variety of the plant that gives the breeder exclusive control over propagating material seed, cuttings, divisions, tissue culture and harvested material, cut-flowers, fruit, foliage of the new variety for a number of years. Marrakesh Agreement on agriculture is related to the World Trade Organization (WTO) The Trade-Related Aspects of Intellectual Property Rights (TRIPS) are for plant varieties. The TRIPs became integral treaty for any country becoming member of the WTO. The WTO agreement on the Trade-Related Aspects of Intellectual Property Rights (TRIPS) is the most comprehensive multilateral agreement on Intellectual Property (IP). Since the plant varieties play the role of 'Player in a game' in agriculture, creativity of varieties becomes most critical for successful agriculture and hence PBR has become the most important IPR as the IPR on operating system and Internet of Things. Hence, TRIPS made it compulsory

that plant breeders be granted PBR on the plant varieties.

Varieties that can be protected are: New variety under section 15(1), extent variety under section 2(j), 15 (2) and essentially derived variety under section 2(i), 23. Breeders have exclusive rights to produce, sell, market, distribute, import or export the protected variety. Farmers rights under a farmer can save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under the Protection of Plant Varieties and Farmers Rights Authority (PPV&FR) Act, 2001 in the same manner as he was entitled before the coming into force of this Act. But the farmer shall not be entitled to sell branded seed of a variety protected under the PPV&FR Act, 2001.

Objectives of the PPV & FR Act, 2001

- To establish an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants.
- To recognize and protect the rights of farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties.
- To accelerate agricultural development in the country, protect plant breeders' rights; stimulate investment for research and development both in public and private sector for the development of new plant varieties.
- Facilitate the growth of seed industry in the country which will ensure the availability of high-quality seeds and planting material to the farmers.

Benefit Sharing

The benefit sharing is one of the most important ingredients of the farmers' rights. Section 26 provides benefits sharing and the claims can be submitted by the citizens of India or firms or non-governmental organization formed or established in India. Depending upon the extent and nature of the use of genetic material of the claimant in the development of the variety along with commercial utility and demand in the market of the variety breeder will deposit the amount in the Gene Fund. The amount deposited will be paid to the claimant from the National Gene Fund. The Authority also publishes the contents of the certificate for the purpose of inviting claims for benefits sharing.

Extent of farmers rights: A farmer will be violating farmers rights or infringing the breeder's rights on a variety if he sells seed in branded form (packs, labels), adopts any practice that can be described as processing, if the product is beyond farm produce, multiplies seedlings, propagules under protected cultivation systems, nurseries etc. for selling.

Compensation covers are available to farmers only on crop produced from

seed procured through authorised seller/ licensee/ agent/ registered breeder. Right of claiming compensation is available to a farmer in the event of a variety not performing as per label claim on a registered variety after adopting standard production protocols. But a farmer who has used his own saved seed or who has purchased or procured unbranded seed from another farmer does not have any right to seek compensation.

Liability to pay compensation is transferable to a licensee or an agent by a registered breeder provided the MoU has the clause and packet has either licensee wise denomination/ licensee identity with clarity to determine the source of seed purchased by farmer. But in case the registered breeder only authorises a person to produce or sell or market a registered variety, then the liability of paying compensation is retained by the registered breeder only.

Modern plant breeding has been made precise and specific to target through genomics tools for the selection and varietal development. New products can be developed using MAS or genomic selection or genomic edited mutants containing introgression or involving such different parents either as recombination or hybrid products. A variety is eligible for registration under the Act if it essentially fulfils the criteria of Distinctiveness, Uniformity and Stability (DUS).

Coexistence of farmers rights and breeders' rights ensures mega returns to right-holder breeder. Example of wheat variety HD 2967 where it was shared with 16000 farmers informally (by giving 2kg each) in 2008 and was licensed to 39 companies in 2010 with the spread of word about its high production became mega variety by 2013.

Another example is of wheat variety HD 3086 in 2012 ,which was shared with 8000 farmers informally but licensed to 220 seed companies in 2014, farmers producing and selling the seed never come in the way, because farmer will again buy the fresh seed from the registered company knowing its benefits.

This dramatic influence of licensing only two wheat varieties within five years added estimated 12.07 million tonnes to foodgrains production with average of 46.9 per cent increase in productivity. It is perfectly possible not to compromise on farmers rights while granting plant breeders rights on plant varieties in recognition of the great service they do for humanity and nation prosperity.

Key takeaways

- Planting material from a registered company should only be used.
- Create awareness among all stakeholders regarding farmers and breeders' rights.

FARMERS' RIGHTS
A CORNERSTONE FOR FOOD SECURITY AND MANAGEMENT OF SEED DIVERSITY

Svanhild Isabelle Batta Torheim

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Farmers rights are vital for conservation and sustainable use they are a precondition for the maintenance of the crop genetic diversity, which is the basis of all food and agriculture production in the world. They are crucial for ensuring present and future food security, in general and in the fight against rural poverty, in particular.

In 1989, Farmers' Rights were formally recognized for the first time in the Conference organized by the Food and Agriculture Organization (FAO) and in 1991 it was decided to set up a fund for the realization of these rights. Then the Convention on Biological Diversity was adopted in May 1992 and with it a resolution on the interrelationship between the Convention on Biological Diversity (CBD) and the promotion of sustainable agriculture was set up.

Agenda 21 also voiced the demand to seek solutions to outstanding matters, including the question of Farmers' Rights. This marked the start of negotiations which led finally to the International Treaty. In 1996, the Global Plan for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture was adopted by the International Technical Conference on Plant Genetic Resources. It, too, addressed the issue of Farmers' Rights. With the adoption of the International Treaty on Plant Genetic Resources for Food and Agriculture in 2001, a legally binding international agreement was established for the management of plant genetic resources for food and agriculture. Finally, farmers rights were adopted in 2001. The realization of Farmers' Rights has been a cornerstone in the implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture. This has been a must for the conservation and sustainable use of these vital resources in situ as well as on-farm. This constitutes the basis of Farmers' Rights. According to Article 9, governments are to protect and promote Farmers' Rights, but can choose the measures to do so according to their needs and priorities. Measures may include the protection of traditional knowledge, equitable benefit-sharing, participation in decision-making and the right to save, use, exchange and sell farm-saved seeds and propagating material. The Governing Body of the International Treaty has taken steps to promote the realization of Farmers' Rights.

Approaches to protect farmers' traditional Knowledge

Stewardship approach: Its goal is to protect farmers crops, varieties and knowledge from extinction and to encourage their further use. Benefits are to be shared between custodians of agrobiodiversity and society at large through national and international measures. Legislation should shape/ uphold legal space for farmers to continue maintaining crop genetic diversity.

Ownership approach: Its goal is to protect farmers varieties and knowledge from misappropriation and enable its holders to make decisions over use. Benefits are to be shared between purported owners and buyers of genetic resources upon prior informed consent. Legislation should balance intellectual property rights for farmers with plant breeders right.

Whatever approach, a stewardship approach or an ownership approach or a combination is chosen, it should not create any hindrance in the sharing of knowledge and genetic resources among farmers, nor should it contribute to genetic erosion or the loss of the traditional knowledge. That would be against the intentions of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

Farmer's Rights to save, use exchange and sell farm saved seed ensure legal space for farmers with regard to the Intellectual property rights (IPR) and the seed laws,

enabling the formal and farmer's seed systems to make their contributions to the global genetic pool and food security—examples are pioneering legal space in India, Basic for food sovereignty and food. Farmers, particularly small farmers, are involved in multiple kinds of seed systems, which help them produce and obtain the seed they need. These systems can be broadly divided into two — a formal seed system and a local system.

Formal seed system: It is easier to characterize, as it is a deliberately constructed system that involves a chain of activities leading to clear products that is certified seed of verified varieties. Principles in the formal system are to maintain varietal identity and purity and to produce seed of optimal physical, physiological and sanitary quality. Certified seed marketing and distribution takes place through a limited number of officially recognized seed outlets, usually for financial sale.

Local seed system: It is basically what the formal system is not. Encompassing a wider range of seed system variations, what characterizes the local system most is its flexibility. Varieties may be landraces or mixed races and may be heterogeneous (modified through breeding and use). In addition, the seed can be of variable quality (of different purity and physical and physiological quality). The steps do not flow in a linear sequence and they are not monitored or controlled by government policies and regulations. Rather, they are guided by local technical knowledge and standards and by local social structures and norms. Despite, their variability and local specificity to needs and preferences, local channels (e.g. household stocks, markets and social exchange networks) provide most of the seed that most small farmers' use.

The rise of international treaties awarding intellectual property rights in the plant genetic resources to plant breeders had resulted an erosion of agricultural biodiversity as well of indigenous farmers' lifestyle.

Farmers' Rights has emerged in recognizing the role that traditional farmers play in conserving, creating and promoting genetic diversity in the food supply and the importance of maintaining traditional agriculture practices.

According to the FAO, food security results when people "at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Arguably, the most effective way for a group to ensure its food security is to have control over the production of its own food. The continuous development of new varieties ensures genetic diversity in the food supply and enables communities to achieve food security.

Farmers' Rights need to co-exist with intellectual property rights over new

varieties and propagating material generated by (formal) breeders. Seeking to assure a market, recognize investments and promote innovation, the rights grant exclusive rights limiting free access and use of plant genetic resources in specific circumstances. The mutual interface of Farmers' Rights and Breeders' Rights becomes a daily challenge. The recognition of both forms of rights and their importance in achieving food security and alleviating poverty, needs to be a priority and a reality for the public and private sectors.

Key takeaways

- The farmers rights enable the farmers to continue in maintaining, developing and managing their crop genetic resources.
- Farmers' Rights help them for their indispensable contribution in recognizing and rewarding farmers in the global pool of genetic resources.

PRAKRITI
AUR PRYAVARAN

Anil Prakash Joshi

Dr Anil Prakash Joshi is an Indian green-cover activist. He is the founder of the Himalayan Environmental Studies and Conservation Organisation (HESCO). He has dedicated himself to resource-based rural development for almost 36 years and he focuses on the economic independence of the rural India through community empowerment.

Dedicated efforts of the ICAR scientists, farmers and the government policies have made India a food secured nation. Inclusive growth of the community by economy and ecology through "Local need, meet locally" has become popular across the mountains and other regions. Local farmers are encouraged to grow fruits, vegetables, grains and spices specific to the locations for the local consumption. This has been a major step to make the rural India economically independent.

It is high time that along with Gross Domestic Product (GDP), which indicates economic health, the country and the states should collect data on forests, water sources, quality of air and soil to measure the Gross Environmental Product (GEP) to know the health of our ecosystem. Government of Uttarakhand is working on the GEP for the state. This is the first time in the world when Annual Ecological Growth would also be measured along with the economic growth. Gross Ecosystem Product (GEP) aims at specific indicators to measure total economic value of all ecosystem products and services. The GEP is the total value of the final ecosystem goods and services supplied annually for human well-being in a region. It can be measured in terms of biophysical value and monetary value. Ecosystems measured include

natural ecosystems such as forests, grassland, wetland, desert, freshwater, ocean and artificial systems based on the natural processes like farmland, pastures, aquaculture farms urban green land, etc.

Climate change impacts are very alarming a massive chunk of ice broke off of the Antarctica in May 2021, which is the largest iceberg of the world. Since 2000, the world's glaciers have lost on an average 267 billion metric tons of ice every year and the rate at which these are melting is accelerating consistently. These glaciers are the source for our 70 per cent fresh water demand. The major reason of melting of these glaciers is global warming. The only way to slow rapid glacial melting is to contain global warming.

Global warming can be reduced by using renewable energy; by reducing, reusing and recycling; by reducing water and food wastage.

Key takeaway

- Adopt organic farming to protect the environment for posterity.

FPC MOVEMENT
CHALLENGES AND WAY FORWARD

Vilas Shinde

Mr Vilas Shinde is a Chairman & Managing director Sahyadri Farmers Producer Company Ltd. dreamt to work for the betterment of farmers and succeeded in his efforts. In 2010, he had started Sahyadri Farms with an investment of Rs 1 lakh and 100 farmers as a Farmer Producer Company (FPC).

A Farmer Producer Company (FPC) can be formed by any 10 or more primary producers or by two or more producer institutions, or by the contribution of both. An FPC is a hybrid between cooperative societies and private limited companies. The FPC get registered under the Indian Companies Act, 2013 and have democratic governance. Each producer or member has equal voting right, irrespective of number of shares held.

FPC have been established to overcome challenges faced by farmers. Major challenge in Indian agriculture is shrinking land holding pattern as more than 90 per cent farmers are either small or marginal farmers having 1 ha or less land. Second problem is of unpredictable weather. Capital is also important factor in agriculture then the next major factor is lack of infrastructure and resources. Besides there are certain farm level challenges for small farm holders such as low productivity due to lack of technical knowhow or unpredictable weather, inconsistent produce quality, inconsistent income or lack of assured income, input availability such as quality planting material, high cost of production as all the

cost are increasing leading to increase in cost of production, weak finance system, problem in getting crop insurance and most importantly lack of skilled work-force. Post-harvest losses also are a challenge (approximately 50 per cent of the produce is wasted due to improper handling). Another major challenge is in sales and marketing there are multiple layers; farmers are not directly linked with consumers and the global linkage is also weak (it needs to be improved like China). In India, 90 per cent of marketing is through APMC only and farmers have issues with pricing. 70-80 per cent retail in Europe is properly organized, consumers are getting better quality, we need to organize these chains which are presently 1-2 per cent in India. Scattered processing is also big challenge we need to build the proper processing chains for horticultural and agricultural produce.

Why a need for a farmer produce company Individual farmers lack risk taking ability due to small land holding, cannot compete with global market, cannot create brand alone for value better value realization for farm produce and individual farmer do not have negotiation power. Farmer produce companies can find sustainable solutions to problems of small farmers, make farming as a profitable venture in all circumstances with sustainable development of agriculture and rural community and to create integrated crop/ commodity specific value chain owned by small and marginal farmers.

FPC models and prospect and current initiative to strengthen At present 7000 + FPCs exists in India. Government of India has announced to create new 10000 FPO's in next 5 years to boost the sector, NABARD, SFAC, NCDC, NAFED are implementing agencies promoting new FPC in India, Community based business organization program is being executed to create and strengthen new FPCs.

Why current FPCs not sustainable

FPC leadership lacks vision and growth mindset. There are different challenges in FPC segment wise—Capital: lack of financial literacy, identification of capital requirement, statutory provision for outside investment. Human capital: FPC have not the professional talent as professionals t don't want to shift in rural area.

Indian agriculture can transform only through "Value Chain Model" which includes farmers, farmer producer companies, farmer owned product aggregator and farmer owned market aggregator (value chain). Farmers focus on production of 2-3 major crops, quality improvement and improved productivity. Farmer producer companies focus on technical support to farmers, input supply and credit support to farmers. Farmer owned product aggregator focus on core post-harvest infrastructure, primary processing, logistics, storage and mentoring FPOs and FPC's. Farmer owned market aggregators focuses on branding & marketing, B2B domestic sales, export, B2C sales through retail outlets/ online platform. Value chain model focus on

local, national and global markets, local retailers, international retailers, brands, food processors, traders APMC and finally meet supply of consumers across various geographies.

Proven cooperative models globally are Zespri green kiwi fruit from New Zealand based Co-op company with a turnover of Rs. 15767 Cr.; Fruit Masters from Netherland based 117 years old company with a turnover of Rs. 7800 Cr. Indian Cooperative models are: Amul the taste of India India's Co-op company with a turnover of Rs. 40,000 Cr and Sahyadri Farms, Seedling goodness, India's largest horticulture farmer collective (FPC) with a turnover of Rs. 600 Cr.

Leadership qualities

Following are leadership qualities—purpose & vision development, self-development, ownership, social value, mindfulness, stakeholder management, making strategic thought process, team building maintaining partnership, collaboration, networking, negotiation etc. and should know conflict management and risk management. Organization focus are on pillars which include business, finance, farm operations, market, business operations & process, technology & innovations, post-harvest management, compliance & governance and human capital.

Key takeaways

- Government should focus on commodity-wise federation and budget allocation for global brand development.
- While allocating funds or designing schemes, Government should focus on impactful allocation.
- A type of Cluster Based Business Organization (CBBO) support program needs to be refined. NGOs can't build the brands.
- Incubation/ acceleration centre should be on a divisional level with adequate fund support to build sizable/ scalable value chains.
- Government intervention is needed in market where FPC get cheated by buyers/ traders.
- Government should allow FPCs for external investment.
- CBBO kind of scheme supports for CEO's, like wise it may support for other key positions.
- FPC movement's objective should not be on number of the FPOs but it should be on the number of farmer families.
- Existing closed infrastructures/ facilities need to be allotted for good FPOs based on certain criteria.

Contemporary Agricultural Research


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AZADI KA AMRIT MAHOTSAV
Tuesday, 28th June 2022 | 3:00 PM
Assessing Animal Science Technology Contributions to
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Dr. K M Bujarbaruah
Former Vice-Chancellor, Assam Agricultural University and
Former Deputy Director General (Animal Science)
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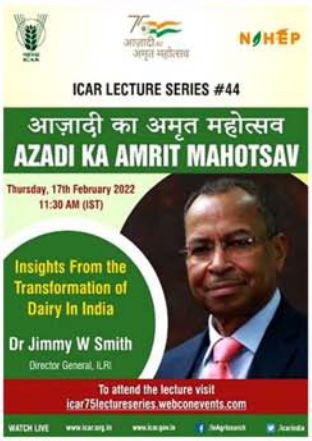
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AZADI KA AMRIT MAHOTSAV
Thursday, 17th February 2022
11:30 AM (IST)
Insights From the Transformation of Dairy In India
Dr Jimmy W Smith
Director General, ILRI
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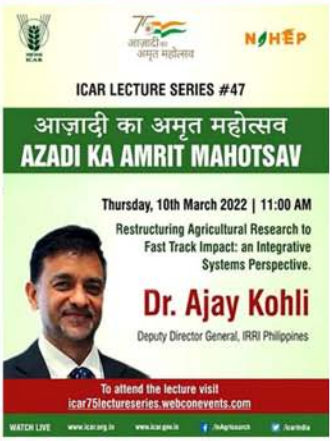
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ICAR LECTURE SERIES #47
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Thursday, 10th March 2022 | 11:00 AM
Restructuring Agricultural Research to Fast Track Impact: an Integrative Systems Perspective.
Dr. Ajay Kohli
Deputy Director General, IRRI Philippines
To attend the lecture visit
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BHARAT KA AMRUT MOHATSAV: ICAR Lecture Series #5
Aquaculture: Avenue for Assuring FISH
(FoodSecurity, IncomeGrowth, SocialUpliftment & HealthyLife)
Friday, 16 April, 2021
10:30 to 11:30 am
Dr. Joykrushna Jena
Deputy Director General
(Fisheries Science), ICAR
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ICAR LECTURE SERIES #4
Bharat Ka Amrut Mahotsav
CONTAINING MALNUTRITION THROUGH HORTICULTURE
Monday, 5th April at 3 pm
DR ANAND KUMAR SINGH
Deputy Director General
Horticultural Science, ICAR
Watch Live: www.icar.org.in/www.icar.gov.in
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ICAR LECTURE SERIES #11
भारत का अमृत महोत्सव
BHARAT KA AMRUT MAHOTSAV
Know Your Dairy Food
Thursday, 17th June 2021 | 02:30 PM
DR. A.K.SRIVASATAVA
Member, Agricultural Scientist Recruitment Board
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ICAR LECTURE SERIES #3
Bharat Ka Amrut Mahotsav
Commemoration of 75 years of India's Independence
Agricultural Mechanization for India in the 21st Century
Prof Virendra Kumar Tiwari
Director
Indian Institute of Technology
Kharagpur
Wednesday, 31st March @ 11 am
Live: www.icar.org.in/www.icar.gov.in
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RESTRUCTURING AGRICULTURAL RESEARCH TO FAST TRACK IMPACT
AN INTEGRATIVE SYSTEMS PERSPECTIVE

Ajay Kohli

Dr Ajay Kohli is the Deputy Director General at the International Rice Research Institute, the Philippines. He is reorienting research quality and delivery strategy of the institute to meet needs and expectations of the donors, investors, partners and stakeholders. He is experienced in upstream research and innovation in the agriculture sector.

The restructuring of the International Rice Research Institute (IRRI) research strategy is vital to be impactful. There is a 5-D circular research model which depends on demand, discovery, development, dissemination and distinction. Distinction here means distinctness of the product or process or policy which is part of monitoring and impact assessment. Start is from the demand and based on that demand we can take the process ahead to find ways of satisfying the demand. The specific demand would lead to discovery and development of the varieties/products/policies that go to dissemination. At the IRRI, after developing

variety, further study is how it will be more beneficial and has it been impactful. This creates distinctiveness. A research strategy for the next generation rice based agri-food system to address climate change includes predictive and fast-track breeding. More and more tools and technologies are required where the time period for variety release can be reduced.

SWOT analysis can be extremely important in deciding what we want to address. In the systems approach, society, environment and economy, all these are combined together to get integrated solutions. This system approach depends on strategic partnership of public sector, private sector and NGO. Systems approach gives us the understanding of the system itself and on the other hand it also gives the understanding of the consequences which otherwise would remain unattended. So we have to think how do we build in the risk assessment through SWOT analysis and then decide what will be the thrust. This will keep us ready to deal with unexpected changes in any system. For example, decrease in crop yield would lead to poverty, hunger and malnutrition, which would impact socially led urban immigration, gender imbalances, exploitation, corruption and can lead to increase in crime, which in turn can lead to national movements impacting national economics. This shows how all are interlinked and how small changes can lead to severe impacts.

At the IRRI, rice breeding is directly aligned with agronomical goal to meet food security. Breeding is done to develop high yielding varieties, biotic and abiotic stress resistant varieties. At present, more focus is on nutrition and grain quality such as low glycemic index and high protein rice. Genetic studies on glycemic index are very important and work on this is to obtain the requisite genes that can be used to turn any variety into low GI variety. By using integrative omics (omics refers to a field of study in biological sciences that ends with-omics, such as genomics, transcriptomics, proteomics, or metabolomics), we can improve grain quality and quantity. Advancements in omics technologies have provided a strong platform for reliable exploration of genetic resources involved in rice trait development. The most effective way to improve rice grain yield is to increase the number of grains filled per panicle (FGN) through breeding. Understanding the mechanisms controlling FGN has become an important research field in rice biotechnology and breeding. The regulation of rice FGN is coordinately controlled by panicle architecture and branch differentiation and the FGN-associated genes showed pleiotropic effect in regulating tillering, grain size, flowering time and other domestication-related traits. Predictive models are needed to predict crop yield even before the experimentation taking into consideration such pleiotropic genes.

Seed cast is an app based digital tool

designed to reliably and quickly collate seed demand from dealers leveraging dealer farmers network, this app also has other use cases fulfilling the farmers and dealer's requirement. Seed cast helps in communication and linkages between producers, distributors, regulators and users of seed.

There are some bottlenecks to grow more rice which include greenhouse gas emission from rice field, biotic and abiotic stresses and post-harvest losses due to climate change. Climate-Smart Agriculture (CSA) approach can help to manage agricultural systems responding effectively to climate change.

Key takeaways

- Understanding the gaps between science and technology and then integrating them in plan would lead to progress.
- Collate genotypic and phenotypic data from all institutes on to one platform for development of varieties.

EFFICIENT WATER FOR AGRICULTURE

Suresh Kumar Chaudhari

Dr Suresh Kumar Chaudhari is Deputy Director General (Natural Resource Management), ICAR. His focus areas have been: dynamics of irrigation induced land degradation, soil hydraulic properties under different quality waters, influence of poor and marginal quality waters on soil properties and plant growth, direct and indirect estimations of soil hydraulic properties, pedo-transfer functions to predict soil hydraulic properties and irrigation water management in field crops.

Though water is considered as an infinite resource, but only a fraction of one per cent of earth's freshwater is readily accessible for human needs. The world's water systems are threatened by overuse, pollution and climate change. India has 4 per cent of world's freshwater and 80 per cent of this is used in agriculture. Per capita availability of water in the country per year is declining (from 5,177 m^3 in 1951 to 1,820 m^3 in 2001, 1,588 m^3 in 2010) and it is expected to decline to 1,341 by 2025 and 1,140 m^3 by 2050. The situation may aggravate with anticipated impact of climate change. Thus, valuing and managing water effectively present a transformative opportunity to convert risk to resilience, poverty to well-being and degraded ecosystems to sustainable ones.

Major irrigation source in India is groundwater, (60 per cent), followed by canal irrigation (26 per cent). The growth of irrigated area is mainly due to increase in tubewells. The average stage of groundwater development at country level is ~62 per cent. Out of 6,584 assessment units (Blocks/ Mandals/ Talukas), 1,034 have been categorized as 'Over-exploited', 253 are 'Critical' and 681 are semi-critical. Excessive extraction

of groundwater is in the North Indian states. Groundwater development is less than 50 per cent in most of the East Indian states, this indicates a huge untapped potential of groundwater in the eastern region.

The major challenges in the irrigation sector are low water-use efficiency, water-energy nexus, growing of water guzzling crops in water deficit areas, imbalanced groundwater use, poor quality water and toxicities, poor rainwater management, etc. Enhancing irrigation efficiency needs to be given a top-priority. Current efficiency is about 30-40 per cent, which can be increased to 60 per cent. There exists a significant gap between the actual and the maximum water productivity and if this gap is lessened, that itself would reduce additional need for irrigation water. Both supply and demand side management strategy along with local needs is essential to determine irrigation water management plan. There is an urgent need to raise awareness on value of water and in promoting collaborative actions by national and local governments, industry, civil societies for incentive-based approach and identifying opportunities to improve efficient practices. Some of the major policy interventions that merit immediate attention are irrigation efficiency and water productivity improvement; groundwater management; wastewater management in Agriculture and a vibrant policy on water pricing.

Key takeaways

- Use drip irrigation to increase water - use efficiency.
- Focus should be on water conserving and valuing water.
- Scaling up of the program for educating farmers— "Jal Shakti Abhiyan"; based on this theme.

PRECISION MECHANIZATION

K. Alagusundaram

Dr K. Alagusundaram is Former Deputy Director General (Agricultural Engineering and Natural Resource Management) in the ICAR, New Delhi. His research areas are grain storage research, heat and mass transfer, numerical modelling, food engineering, refrigeration and air conditioning.

India has witnessed phenomenal growths in agricultural production and productivity in the last 4 to 5 decades. Introduction of high yielding varieties, efficient water management, intelligent use of fertilizers and plant production chemicals are some major factors that contributed this growth. In addition to these factors, consistently mechanizing Indian farms has supported the agricultural growth in the country. We have increased our farm power availability from a meagre 0.28 kW ha^{-1} in the early sixties to the current levels of about 2.5 kW ha^{-1}. Nearly 50 per cent of farm operations have been mechanized.

Mechanization not only saves time and labour but also supports in efficient use of inputs. We have always focused on introducing efficient machines into our farms to save agricultural inputs like the seeds, fertilizers, water, plant protection chemicals, the land resources used; the energy and the time spent. To achieve this goal, we have shifted our farm tools and machines from man-tool interface to animal-machine interface, to man-machine interface and to the current machine-machine interfaces. This process has relieved farmers from arduously using muscle power to mechanical power to electrical power and now to electronic power for agricultural production systems.

Our focus is on improving our productions from the limited land area,

without compromising on sustainability; saving on money spent on inputs; saving on the energy for agricultural production and post-production systems; protecting environment by scrupulously using different inputs. This necessitates mechanization to help in improving utilization efficiency of all inputs, safety and comfort of agricultural workers, improvement in the quality and value-addition of the produce.

The future of agriculture would be moving towards the precision mechanization. The farm sizes will shrink further and the land area available for agriculture may remain constant with time or may shrink depending on how much of land we will bring to other uses. Therefore, productivity enhancement within the constant land area would be critical in future. This indicates that agriculture requires a massive infusion of technology. But every farmer cannot purchase machine due to high costs. Custom-hiring is, perhaps the best alternate option for mechanization. By way of custom hiring, farmers can afford to have access to large and efficient machines.

Some obvious examples of how the precision machines will improve our production efficiencies are: precise and selective spot fertilizer applicators have improved fertilizer use efficiencies, laser levelled lands require lesser water than non-precisely levelled lands and have helped in increasing the crop intensities. The newly coming up technology like the use of drones for pesticide application will help in phenomenal saving on fertilisers and application time and labour costs.

Introducing precision machines in our farms and saving on inputs will reduce the production costs, increase productivities and production and will certainly supports doubling farmers' income.

Key takeaways

- Precision machines will save on inputs required for agriculture and would improve production and productivity.
- Scrupulous use of chemicals and other inputs in agriculture would protect environment and make agriculture sustainable.

ALLEVIATING MALNUTRITION THROUGH HORTICULTURE

Anand Kumar Singh

Dr A.K. Singh is Deputy Director General (Horticulture), ICAR. His research areas are genetic improvement of fruit crops, plant tissue culture and transcriptome analysis of mango.

Malnutrition refers to deficiencies, excesses and imbalances in a person's intake of energy and nutrients. It includes undernutrition leading to stunting, wasting or underweight, micronutrient deficiencies or insufficiencies and overweight, obesity and diet-related noncommunicable diseases. Around 1.9 billion adults worldwide are overweight, while 462 million are underweight. An estimated 41 million children under the age of 5 years are overweight or obese; some 159 million are stunted and 50 million are wasted. Adding to this, are 528 million or 29 per cent of women of reproductive age affected by anemia globally. The recent Global Nutrition Report-2020 indicates that India is falling short of targets for all four nutritional indicators — stunting among under 5 years of age children, anemia among women of reproductive age, childhood overweight and exclusive breastfeeding women. Undernutrition includes protein-calorie malnutrition and micronutrient deficiency. Malnutrition usually can be contained by a balanced diet. Emphasis should shift from dependence on the three food crops (wheat, maize and rice currently supplying more than 50 per cent of human calories) to horticultural crops for a better balance between carbohydrates, protein, minerals and micronutrients. In fact, the consistent and rapid increase in production and availability of horticultural crops over the last decade is ensuring nutritional security.

Though, fruits and vegetables are naturally rich in vitamins and minerals;

several varieties possessing significantly better nutritional qualities have been developed by the ICAR. Some of them are 'Arka Rashmi' of guava (ascorbic acid), 'Solapur Lal' of pomegranate (iron, zinc and Vit C), 'Kufri Manik' of potato (iron, zinc and carotenoids), 'Pusa Kesari' (Vit A-1) of cauliflower (beta carotene), 'Bhu Krishna' of sweet potato (Anthocyanin) etc. Improved varieties in native crops with nutritional and nutraceutical values such as CISH A-33 (vit. C) of aonla, 'CISH Jamwant' of jamun, 'Shankara' of jackfruit and 'Bhagya' variety of moringa have also been developed. Fortification and probiotication through value addition is being intensely pursued. Immunity boosting cucurmin-rich milk and milk powder has been recently commercialized under the name 'Golden milk'. Mushroom fortified instant rasam mix and protein-rich instant moringa soup mix have been commercialized. Similarly, anthocyanin rich micro-encapsulated product from Garcinia indica and probioticated pomegranate fruit juice have been developed. Apart from the nutritive value, numerous pre-clinical studies carried out in recent years have identified beneficial effects of fruits and vegetables on health, resulting from the nutritional and non-nutritional phytochemicals. Importantly their effect on controlling and managing diseases/disorders like diabetes, cardiovascular diseases, intestinal disorders, cancers and mental health have been widely documented.

Key takeaways

- Present focus should be from food security to nutritional security.
- Crop diversification has to be promoted.

AQUACULTURE AS AVENUE FOR ASSURING FISH (FOOD SECURITY, INCOME GROWTH, SOCIAL UPLIFTMENT AND HEALTHY LIFE)

J.K. Jena

Dr J.K. Jena is working as Deputy Director General (Fisheries Science), Indian Council of Agricultural Research and his areas of research include Freshwater aquaculture and Population genetics.

With the increasing population and awareness, the demand for fish is increasing. It is known that there is no single food that can offer all the nutrients and there are only a few foods that can provide important nutrients and are being called 'Superfoods'. Fish is one of the superfoods for a healthy diet. More than 3.3 billion people depend on fish for 20 per cent of their total animal protein intake and further 1.0 billion for 15 per cent animal protein. Globally, fish consumption increased from 9 kg/capita in 1961 to 20.5 kg/ capita in 2018. As an excellent source of Omega-3 PUFA, fish contains high contents of fat-soluble vitamins and is also a good source of important minerals. Fish as a food has more than 50 different health benefits including cardiovascular protection, diabetes and arthritis control,

improved brain function and increased cognition development. Around 59.5 million people are engaged in the primary sector of fisheries and aquaculture. Global fish production during the last seven decades has shown a phenomenal 9-folds growth i.e. from <20 million tonnes (mmt) in 1950 to 178.5 mmt in 2018 with a first-sale value at US$ 401 billion. At a time when production from capture fisheries has stagnated, aquaculture has been growing at a steady pace, contributing 46 per cent of total fish production valuing US$ 250 billion.

The contribution of India to global fish production during these seven decades has also shown a steady increase, from about 3.7 per cent in 1950 to about 7.3 per cent at present. Over 19-folds increase in fish production, i.e. from 0.75 mmt in 1950-51 to 14.7 mmt at present justifies the importance of the Indian fisheries sector. Today the country exports 1.4 mmt of fish and its contribution to agri-exports is about 18.0 per cent. Aquaculture has become a savior for meeting the increasing fish demand of the country when the capture fisheries production has almost stagnated. Besides providing protein and nutritional security for the increased population, it also helps in raising farm income and contributions to the national economy. With a 25-folds increase in production in just four decades, aquaculture has placed itself as the 2nd largest producer in the world. The drivers for such growth in fish production are need-based technology development, dissemination, adoption, investment, policy and partnership. While the freshwater sector shares over 90 per cent of total aquaculture production it is largely contributed by carps meeting the domestic demand. On the other hand, shrimp-centric brackishwater aquaculture is contributing to about two-thirds of the country's seafood export. A major share of 8.0 mmt of freshwater aquaculture production is by Andhra Pradesh and West Bengal. Lately thrust has been on species diversification including exotic pangas, paku and tilapia. While carp polyculture and monoculture of exotic pangas catfish have been steering freshwater aquaculture production, new technologies such as cage culture, recirculating aquaculture system (RAS) and biofloc systems have been considered valuable for entrepreneurship. The development of breeding and seed production technologies of over 65 cultivable finfish and shellfish species of freshwater, brackishwater and marine origin has been instrumental for culture diversification. While brackishwater farming is largely confined to Pacific white shrimp, with the availability of breeding and seed production technologies of important finfish species like seabass, milkfish and mullet, the farming of these species is likely to grow in the coming years. In the coastal fronts, there has been a significant development in the adoption of open-sea cage culture with high-value species like cobia, pompano, seabass and groupers. With the thrust given by the Government, seaweed farming has seen increasing

adoption recently. The scale-neutrality of the technologies of freshwater and marine ornamental fish breeding and culture is likely to help in the expansion of the activity from the present practice only in areas adjoining cities/towns. It is expected that with the continued R&D efforts by fisheries research institutions, initiation of new programmes of the Government of India like Pradhan Mantri Matsya Sampada Yojana (PMMSY), increasing thrust on technology dissemination and convergence between the organizations & government agencies, increased private investments, etc., the fisheries sector would continue to keep the growth pace and able to achieve the national target fish production of 22 mmt and export value of US$ 14 billion by 2025. The saying "Give a man a fish and you feed him for a day; Teach a man to fish and you feed him for a lifetime" is more relevant today when the future increase in fish production needs to come largely from aquaculture and in this endeavour dissemination of scientific technologies has to be the main key.

Key takeaways

- Adoption of diversification of species and of culture systems for increasing fish production.
- Non-conventional farming systems including cage culture, ornamental fish farming, seaweed farming, etc. have to be focused on for entrepreneurship development.

KNOW YOUR DAIRY FOOD

A.K. Srivasatava

Prof. A.K. Srivastava, Former Member ASRB, Currently Vice Chancellor U.P. Pandit Deen Dayal Upathyaya Pashu Chikitsa Vigyan Vishwavi dyalaya Evam Go-Anusandhan sansthan (DUVASU), Mathura is a distinguished animal and veterinary scientist. He has a vast experience in research management in dairy science for overall dairy development.

India produces 22 per cent of world milk. In early 1970's India's milk production was 1/3rd of the US and 1/8th of the European Countries. At present it is twice of the US and 25 per cent more than EU. In India, every fifth rupee generated in farm sector is from milk. By 2024, livestock sector is predicted to produce more than half of the total agricultural output. Cattle population is second largest in the world and 36.04 per cent of the total Indian livestock population. Over 70 million of 147 million Indian households depend on dairy and out of these 75 per cent are small marginal and landless milk producers. Milk processing scenario indicates 50 per cent milk consumption is fresh; and only 5 per cent is for value addition. Technologies for detection of adulterants in milk and milk products have also been developed

Recently there has been increased interest in nutritional and therapeutic virtues of milk of non-bovine (sheep, goat, camel donkey) and minor bovine (mithun, yak) animals. Consumption of non-bovine milk production has increased by 20 per cent in the last 4-5 decades. Milk is an excellent source of quality proteins, good fat important source of Ca, Mg, P, K, iodine, Se, vitamin A, D, B12, K, Riboflavin, Biotin and pantothenic acid. There are two probiotic dairy products—one for cardiovascular health (Cardioviva-world's first disease specific probiotic to maintain cholesterol level) and Glucoviva for treating diabetes 2. Lately, there is

increased consumption of camel milk as it is low in cholesterol, contains three times higher vitamin C and ten times higher iron than cow's milk. Its role in liver disfunction, diabetes, arthritis, long bone pain, allergy, autism, tuberculosis and as aphrodisiac has been established. We have to process large quantities of the milk and we use cheaper and easy way of pasteurization, there is one technology developed by NDRI for testing A1 & A2 milk and farms are using these technologies for selling milk as A1 & A2. Even if it is to believe that A2 is good and A1 is bad milk, all Indian cattle, buffalo, sheep, goat milk are A2.

Key takeaways

- Utilization of milk for nutritional security and to address hidden hunger.
- Child should be given milk during initial 1000 days; specially at two years after birth.

ASSESSING ANIMAL SCIENCE TECHNOLOGY CONTRIBUTIONS TO LIVESTOCK AND POULTRY SECTOR GROWTH-NEED OF THE HOUR

K.M. Bujarbaruah

Dr K.M. Bujarbaruah Former Vice Chancellor Assam Agricultural University is known for his scientific and administrative acumen. His areas of interest include agriculture and allied sciences (Livestock Production & Management).

Animal scientists have transformed livestock sector from the deficiency to near sufficiency. Today (2021), India is first in milk production in the world with 210-million-ton production which is 11 times higher than the production in1951 and per capita milk consumption has also increased from 113g/day to 437g/day. The country also ranked 3rd in egg production with around 100 billion eggs production and 5th in broiler production with 4.20 million ton and 8th in total meat production with around 6.3 million tonnes meat production. Such growth in livestock sector has been possible with the injection technology developed by animal scientists combined with policy decisions by the government from time to time. However,

questions are being raised as to what is the contribution of technology in terms of its adoption and economic value or what is the per cent share of technology in this growth? Paradoxically, many a times we cannot quantify it for want of quantifiable data and their analysis.

In this digital era, we need digitised information and data to substantiate our share of claims as well as to apply emerging technologies like all forms of artificial intelligence tools and techniques so that we can claim commensurating resource needs to lead a technology-driven production to consumption chain of livestock products.

Technology-led growth

Egg and meat production: Directorate of Poultry Research, Hyderabad, for example, has developed 4 backyard poultry breeds and another 5 breeds through its All India Coordinated Research Project (AICRP) centres. As per information gathered, Directorate of Poultry Research supplies 45 lakh germplasm per year which is around 4.5 crore in the last ten years. These germplasm further got multiplied by those institutions including private agencies who received them from the Institute. If the relevant data were available, we could have clearly claimed our share to the National backyard poultry egg and meat basket, that too from the contribution of one Institute. If we take into consideration such contributions by other institutes like Central Avian Research Institute (CARI) and State Agricultural universities/Veterinary colleges, the number would be quite high. Because we do not have authentic records on their contribution to rural poultry growth and resultant income by the farmers, we fail to project impressive data set. Collection of these information needs to be taken up on priority.

Vaccine for livestock: In the recent years, IVRI produced 9 vaccines and commercialized each one of them to 28 companies and earned Rs 3.50 crore as revenue. The institute also produced 5.7 million doses of Foot and Mouth disease (mono + polyvalent), 0.5 million doses of PPR, 0.22 million doses of CSF etc. vaccines. 08 number of companies to which PPR was commercialized are stated to have a target of 420 million doses of PPRV production and similarly, 06 companies are to produce 80 million doses of Goat Pox Vaccine. This data shows that we have protected 5.7 million animals from foot and mouth disease. If we assume the production of these vaccines by other institutions and companies to whom the mother seed viruses were outsourced, the contribution could be quite a million doses sector wise, protecting quite a huge number of animals from mortality and morbidity. A time has come to assess, in real terms, the impact of these vaccines and also the diagnostics in both production and farmers income point of view so that we can claim the contribution of generated technologies.

Milk production aspects: The ICAR including the veterinary universities and colleges under state agricultural universities have developed different

varieties and selection lines of milch animals. What is the number of such varieties/ selection lines in the institutes of their origin? What is the number of NGOS, companies who took up in vitro fertilization (IVF), Multiple Ovulation Embryo Transfer Technology (MOET) and Cloning Technology? Similarly, the number, quality and adoption of antibiotic residue, milk adulterant and pesticide residue detection kits developed by institutions like National Dairy Research Institute are to be collected and documented. Also, to what extent our technologies could check on methane emission is important. Now, ICAR has developed an anti-methanogenic feed supplement 'Harit Dhara' (HD), which can cut down cattle methane emissions by 17-20 per cent and it can also result in higher milk production. When such technologies are adopted, what will be the total reduction and resultant positive impact of dairy sector in mitigating the negative impact of climate change need to be assessed and adoption of such technologies popularised.

Animal Variety development and release issue: Unfortunately**,** we do not have a proper mechanism to release animal varieties developed from time to time. We do not have a system like Initial/ advanced varietal trials, State or Central variety release committees for which it is nobody's responsibility to mass produce their seeds – be it semen or young germplasm like piglets etc. This aspect needs a focussed attention so that the farmers get the seeds of the released varieties.

In this era of data centric planning, it is very important to collect and collate the information on the contribution of our generated technologies thus far, that facilitated in the stated growth of livestock and poultry sector and then carry out a Meta analysis of the data so collected to arrive at a clear picture on the data-backed technology contribution to the sector's growth as well as to use the same in programming machine learning, block chain etc technology use in animal sciences for its continued growth.

Key takeaways

- There is need to collate and compile data for near accurate assessment of total contributions of technology, right from seed/ germplasm, vaccines, diagnostics to production packages, on livestock sector growth.
- Carry out meta analysis of the data to improve production to consumption touch points as well as to develop data centric research and development agenda.
- Streamline animal variety release chain, and subsequent percolation of the benefit of the developed varieties to end-users.

AGRICULTURAL MECHANIZATION IN INDIA FOR 21ST CENTURY

Virendra Kumar Tiwari

An alumnus and Director, IIT Kharagpur, Prof. Tewari's core research areas are —Tractor system design, Ergonomics and industrial safety, Design of agricultural machines, Precision agriculture and Machinery system management.

In India, population has increased from 55.52 crores in 1970-71 to 132.45 crores in 2015-16, and average land holding has decreased from 2.20 ha in 1970-71 to 1.02 ha in 2015-16. Because of the increased population, food grain demand, which was 250 million tonnes in 2016, is estimated to reach 355 million tonnes by 2030. In order to meet this demand, land productivity has to be improved. In India, agriculture and allied sectors contributed around 15.9 per cent to the GDP in 2017-18. The farm mechanization level and food grain productivity of the country are about 40 per cent and 3248 kg/ha, respectively. Whereas, in countries like USA, Brazil and China, farm mechanization level is about 95 per cent, 75 per cent and 50 per cent, respectively, and their food grain productivity is about 8692 kg/ha, 4806 kg/ha, and 6081 kg/ha, respectively. Stagnancy in productivity and shortage of agricultural labour are two major bottlenecks of Indian agriculture. Several studies have suggested a direct correlation between farm mechanization and crop productivity. The increasing trend of farm mechanization, coupled with the implementation of sustainable agricultural practices, is crucial for

ensuring long-term food security and sustainable use of natural resources. Farm mechanization is needed to increase land productivity, maximize farmers' income, and precisely utilize input resources and value-addition of food for storage. It saves on inputs like seeds and fertilizers by 15-20 per cent, labour requirement and operational time by 20-30 per cent, and increases cropping intensity by 5-20 per cent and crop productivity by 10-15 per cent.

At present, Indian farmers are adopting farm mechanization rapidly. Farm power availability has grown from 1.1 kW/ha in 1995-96 to 2 kW/ha in 2015-16 and is estimated to reach 4 kW/ha by 2030-31. Simultaneously, the food grain yield has also increased from 1.4 tonnes/ha in 1995-96 to 2.4 tonnes/ha in 2015-16 and is further estimated to reach 4.2 tonnes/ha by 2030-31. It is estimated that the percentage of farm workers to the total workers in India will reduce to 49.9 per cent in 2033 and 25.7 per cent in 2050 from 54.6 per cent in 2011. Therefore, there is a need to focus on 'Precision Agriculture' to maintain crop productivity. Precision agriculture is a farming management concept that utilizes various technologies to enhance the decision-making process in agriculture to increase productivity by improving farm input utilization efficiency. Some of the key technologies used in precision agriculture include geographic information systems (GIS), global positioning systems (GPS), remote sensing, variable rate application, artificial intelligence (AI), machine learning, and deep learning. These technologies enable collecting, processing, and analyzing large amounts of data related to soil, crop and climate conditions, which can be used to make informed decisions about planting, fertilizing, and harvesting crops. Some of the advanced technologies developed at IIT Kharagpur are tractor-mounted variable rate fertilizer applicator, variable rate herbicides applicator, sugarcane bud planting technology with automatic fungicide applicator, and the ultrasonic sprayer-based orchard sprayer. In addition, the integration of emerging technologies such as drones, robotics, the Internet of Things, automation, and artificial intelligence is revolutionizing crop input management and leading to increased efficiency and sustainability in agriculture. The time has now arrived to adopt all modern tools available by bringing information technology and agricultural science together for improved economic and environmentally sustainable crop production.

Key takeaway

- Farm mechanization coupled with advanced technologies for enhanced productivity.
- Focus on precision agriculture technologies for sustainability in agriculture.
- Focus on a business-like approach for agriculture for enhanced income.

INSIGHTS FROM THE TRANSFORMATION OF DAIRY IN INDIA

Jimmy W. Smith

Dr Jimmy W. Smith is the Director General, International Livestock Research Institute (ILRI), Kenya, and Senior Director of one of the CGIAR Livestock-based Systems. He has extensive experience in livestock research for development.

India is the largest milk-producing country, contributing 23 per cent of the global milk production. The commodity value of the dairy market in India was INR13,174 billion in 2021 and is expected to rise up to INR 30,840 billion by 2027. Operation Flood was the world's largest dairy development programme and has been a landmark project of India. It transformed India from a milk-deficient nation to world's largest milk producer in 2018. Productivity grew faster with operation flood — in 1961 production was 255 litres per animal which increased to 1328 litres per animal in 2019. The investment on dairy production had increased over 30-fold between 1970 and 2011, but consumption expenditure share remained consistent at 38 per cent in rural India and 62 per cent in urban India. Per capita availability (grams per day milk) also showed a raise— it was 125 grams per day during 1961 and increased to 390 gram per day during 2019. This programme was launched to help the farmers direct their own development and gave them control of the resources they created.

Milk yield can be doubled through better feeding, genetics and health. The production of livestock, including

stages of growing, transport, processing and consumption, has a relatively larger impact on climate change. The greenhouse gases emitted are methane and nitrous oxide through agriculture. Methane, mainly is produced by enteric fermentation and manure storage and has affected global warming 28 times higher than carbon dioxide. Soil carbon-dioxide emissions are due to soil carbon dynamics (decomposing plant residues, mineralization of soil organic matter, land use change, etc.), manufacturing of synthetic fertilizers and pesticides. Also, the feed production and processing contribute about 45 per cent of the whole livestock sector to GHG emission.

Nutrition of dairy animals has improved substantially production via use of total mixed-rations balanced for nutrient and energy requirements depending on each animal's age and stage of lactation. A little change in crop residue quality had a significant impact on milk production. 1 per cent increase in the digestibility of sorghum fed to dairy cows led to 6-9 per cent increase in milk production. Improvements in nutrition and genetics, in conjunction with improvement in management practices, have resulted in increased milk yield. A small change in crop-residue quality has shown a significant impact in milk production. Using spin-off technologies from second-generation biofuel production may turn crop residues from 'waste' into high-quality concentrates. These technologies of deconstructing ligno-cellulosic biomass increase digestibility of feed. Increased digestibility would lead to increased milk production. This combined effort of breeding and processing can unlock more feed resources for Indian dairy industry.

The One-Health concept recognizes that human health is connected to the health of animals and environment. This approach has been recommended to facilitate communication and collaboration across research disciplines in responding to challenges in human, animal and environmental health.

In the Indian context, this approach is very important and in this, ICAR and ILRI can work together.

The ICAR and ILRI is conducting research on the following three key issues at the animal human health interface.

1. Diagnosis zoonoses: Zoonotic diseases associated with the consumption of milk have been due to bovine tuberculosis and brucellosis. Both of these diseases cause severe illness in humans and are difficult to be diagnosed and controlled in animals.
2. Diagnosis of antimicrobial resistance (AMR): To reduce its risk one-health approach at all levels is important. Creating awareness, motivation, good production practices and vaccination can help in maintaining health.
3. Food safety: It is essential to improve quality and safety of milk without

jeopardizing livelihood. Improvement in this informal market can be by improving knowledge, attitude and practices to increase productivity to produce safe milk.

India is a growing country and so is Africa and there are great opportunities for South-South learning. The lessons learnt from India can be valuable in Africa to develop a sustainable dairy sector.

Key takeaway

- Improvement in informal markets through improved knowledge, attitude and practices to produce safe milk.

Cutting-edge Research

ICAR LECTURE SERIES #19

आज़ादी का अमृत महोत्सव

AZADI KA AMRUT MAHOTSAV

45th Foundation Day of NBPGR

Monday, 2nd August 2021 | 09:30 AM

Challenges to the Utilization of Genebanks

Prof. Paul Gepts

Distinguished Professor, University of California, Davis

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #24

आज़ादी का अमृत महोत्सव

AZADI KA AMRUT MAHOTSAV

Tuesday, 24th August 2021 | 11:00 AM

Harnessing the Benefits of Modern Agricultural Biotechnology in the Asia-Pacific Region - Challenges and Way Forward

Dr. Rishi Kumar Tyagi

To attend the lecture visit
icar75lectureseries.webconevents.com

ICAR LECTURE SERIES #18

आज़ादी का अमृत महोत्सव

AZADI KA AMRUT MAHOTSAV

Wednesday, 28th July 2021
11:00 AM

Translational genomics for improvement of horticultural crops

Prof. UMESH K. REDDY

Professor of Biology, West Virginia State University, USA

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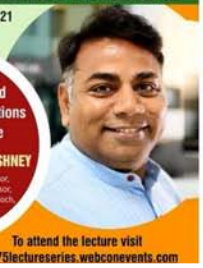
ICAR LECTURE SERIES #14

आज़ादी का अमृत महोत्सव

AZADI KA AMRUT MAHOTSAV

Tuesday, 6th July 2021
02:30 PM



Genomics and breeding innovations in agriculture

DR. RAJEEV K VARSHNEY

Research Program Director, ICRISAT & Adjunct Professor, Murdoch University, Murdoch, Australia

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ICAR LECTURE SERIES #57

आज़ादी का अमृत महोत्सव

AZADI KA AMRIT MAHOTSAV

Wednesday, 11 May 2022 | 11:00 AM

AI and IOT: Enabling Sustainable Digital Agriculture

Prof. Santanu Chaudhury

Director, IIT Jodhpur

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ICAR LECTURE SERIES #68

आज़ादी का अमृत महोत्सव

AZADI KA AMRIT MAHOTSAV

Monday, 11 July 2022 | 12:00 PM

Blockchain Technology: Concept and use cases

Mr. Gaurav Somwanshi

CEO, Emertech Innovations Pvt Ltd

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ICAR LECTURE SERIES #71

आज़ादी का अमृत महोत्सव

AZADI KA AMRIT MAHOTSAV

Wednesday, 20 July 2022 | 11:00 AM

Designer Technologies for Productivity Increase Among Livestock

Dr. M. L. Madan

Padam Shri Awardee

Formerly: DDG (AS), ICAR; Vice Chancellor, SVARSU, Mathura & PDKV, Akola

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ICAR LECTURE SERIES #27

आज़ादी का अमृत महोत्सव

AZADI KA AMRIT MAHOTSAV

Sunday, 5th September 2021 | 09:00 AM

29th Foundation Day of ICAR-Indian Institute of Pulses Research, Kanpur

Improving phosphorus use efficiency using large set of chickpea germplasm

Prof. Dr Kadambot Siddique

The Hackett Professor of Agriculture Chair and Director of the UWA Institute of Agriculture, The University of Western Australia

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ICAR LECTURE SERIES #39

आज़ादी का अमृत महोत्सव

AZADI KA AMRIT MAHOTSAV

Friday, 7th January 2022 | 03:00 PM

Indian Crop Improvement Programme: New Vistas

Dr. T.R. Sharma

Deputy Director General (Crop Science), ICAR

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ICAR LECTURE SERIES #61

आज़ादी का अमृत महोत्सव

AZADI KA AMRIT MAHOTSAV

Monday, 13th June 2022 | 11:00 AM

Accelerated Breeding by de novo Domestication of Crop Plants

Dr. Götz Hensel

Head of Centre for Plant Genome Engineering at the Institute of Plant Biochemistry of the Heinrich Heine University Düsseldorf.

GENOMICS AND BREEDING INNOVATIONS IN AGRICULTURE

Rajeev K. Varshney

Prof. Rajeev K. Varshney is a specialist in genomics and molecular breeding. He has worked as Research Program Director Genetics Gains and Director, Center of Excellence in Genomics and Systems Biology at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Presently, He is Director, Centre for Crop & Food Innovation, Murdoch University Australia.

Genomics is basically the study of whole genomes of the organisms. Since a couple of centuries, plant breeders have been using conventional breeding technologies to improve agronomic qualities of cultivated crops (wheat, maize, rice, barley etc) to increase food production. The challenge of feeding increasing human population can unlikely be met by these technologies alone. Fortunately, the science underpinning plant breeding is being revolutionized by the development of rapid, cheap sequencing technologies and growth of genomics is allowing detailed analysis of plant genomes and dissection of genetic basis of agronomic traits. Genomics is now the focus for crop improvement, including identification of genetic variants and identification of additional sources of novel traits and characterization of molecular pathways involved in biotic and abiotic stress tolerance. The rate of malnutrition and poverty in India has declined from approximately 90 per cent at the time of country's independence to less than 40 per cent at present. This has been possible by the use of genomic sequencing. ICRISAT had established Centre of excellence in Genomics & Systems Biology in 2007 with broad partnerships and sequenced the genes in pigeonpea in 2012, chickpea in

2013, pearl millet in 2017, wild ancestors of ground nut in 2016 and cultivated groundnut in 2019. Gene India has contributed in decoding gene sequences of rice, tomato, chickpea, pearl millet, pea and wheat etc. ICRISAT is working on pearl millet as it can set seeds even at 42°C and with gene sequencing of pearl millet, the mechanism of heat and drought resistance can be understood and can be used to increase yield and to produce heat and drought resistant varieties not only in pearl millet but also in rice and wheat by gene editing. Pigeon-pea which is resistant to Asian soyabean rust can be used in soybean to create Asian soybean rust varieties. In chickpea, 430 lines have been sequenced for high yield under drought and heat stress. With sequencing data and trait data linkages mapping and association mapping can be done. Genetic mapping (also called linkage mapping) can be confirmatory that a disease can be transmitted from the parent to the child through one or more genes. Various genomic and crop breeding techniques — marker-assisted selection, genomic selection, gene editing and speed breeding—have promised enhanced crop performance. Genetically modified crops varieties — Geletu a drought resistant chickpea , Pusa chickpea, Super Annigeri 1 is fusarium resistant, Pusa Chickpea Manav if enhanced fusarium resistant variety and gives 28 per cent higher yield, improved HHB 67 pearl Millet hybrid and fortified ground nut variety Girna 4 &5 were produced. Molecular breeding varieties in wheat are: MACS 4048, HI 8737 and Pusa Tejas. Many molecular breeding varieties resistant to diseases such as Pusa Basmati-1, PB1609 and Pusa 1592. superior lines have been developed in rice for: (a) bacterial blight resistance- Improved Pusa Basmati I, Improved Samba Mahsuri, Pusa 6A, Pusa 6B, Improved Lat, Improved Tapaswin, similarly using MABC in the genetic background of Pusa 372, a high yielding drought tolerant variety, Pusa Chickpea 10,216 was released in 2019 in India. Several improved Quality Protein Maize cultivars like Vivek QPM-9, Pusa HM-4 Improved, Pusa HM-8 Improved and Pusa HM-9, CML244Q, CMl246Q, CML349Q, CML354Q have been developed. Improved, HQPM-1, HQPM-4, HQPM-5 and HQPM-7 were released for commercial cultivation in India. These are some success stories telling how we can take genomic interventions to a new horizon. Biofortified Maize-9 is a success story of translational genomic breeding. All these varieties reaching farmers can double their income; for these some policies would be required. Because of these very policies, during covid pandemic agriculture sector showed growth. Some of the Govt. policies are 'Pradhan Mantri Fasal Bima Yojna' and 'Drought Management Scheme' for risk management in agriculture; 'Soil Health Card' and 'PM Krishi Sinchai Yojana' for water management for crops.

Over the past decade, genomic assisted breeding has been instrumental in harnessing potential of modern genomic resources and characterizing and

exploiting allelic variation for germplasm enhancement and cultivar development. Sustaining genomic assisted breeding in future will rely upon suitable new approaches that fast-track targeted manipulation of allelic variations for creating novel diversity and facilitating their rapid and efficient incorporation in crop improvement programs. Genomic breeding strategies that optimize crop genomes with accumulation of beneficial alleles and purging of deleterious alleles would be indispensable for designing future crops. In coming decades, genomic assisted breeding is expected to play a crucial role in breeding more climate smart crop cultivars with higher nutritional value in a cost-effective and timely manner. Genomics will be applied in the future to clinical disease diagnosis and prognosis. We are hopeful to see the plant breeding community armed not only with a vast array of data, but also with the proper tools and technologies to decipher and implement the knowledge to feed 10 billion people by 2050.

Key takeaways

- In the next 5-10 years, there would be huge genetic and phenotypic data for plant breeding programmes for developing new varieties with high yields.
- Maintaining a whole agri-value chain is a must.

INDIAN CROP IMPROVEMENT PROGRAMME
NEW VISTAS

T.R. Sharma

Dr T.R. Sharma, Deputy Director General (Crop Science), ICAR, New Delhi, has contributed extensively in plant genomics, improvement of rice and also in mapping, cloning and functional validation of a rice-blast resistance gene and its alleles.

Major achievements in crop improvement in post independent India

Rice: Release of first rice biofortified varieties (high zinc rice variety DRR Dhan 45 and high protein rice variety CR Dhan 310); and of first herbicide-tolerant (Imazethapyr) basmati varieties through Marker Assisted Selection (Pusa Basmati 1979 and Pusa Basmati 1985) in 2021.

Wheat: WB2 and HPBW01, first biofortified wheat varieties. Wheat variety HD 2967 generated Rs 12,889 crore (at 2018 prices) economic surplus in 2018-19.

Maize: Quality Protein Maize composite variety Shakti; the first Quality Protein Maize hybrid Shaktiman-1; India's first public sector PUSA HM4 male sterile baby corn hybrid (Shishu).

Pulses: First biofortified variety of lentil ' Pusa Vaibhav' (1996); First inter-specific hybridization in urdbean 'Mash 114'; first extra early variety of mungbean Virat maturing in 55 days.

Oilseeds: Pusa mustard 25 generated Rs 14,323 crores economic surplus (2021); Indian Canola (Indola), country's first double zero mustard variety 'Pusa Double Zero Mustard 31'; Pusa Double

Zero Mustard 33;, RCH 1 is country's First Canola.

Cotton: Bt-cotton approved for commercial cultivation (2002) and release of Bt cotton varieties and at present more than 93 per cent area is under Bt cotton.

Jute: Development of high yielding variety of jute JRO 204; JRO 525 is strengthening jute industry in India and Bangladesh. Annually, 3500-4000 tonnes of seeds of JRO 525 are exported to Bangladesh

With all these attainments, the question still arises; can we sustain food grains production? Our total food grains production was 308.65 MT (2020-21) and in global hunger index India ranked 100th out of 119 countries. India ranked 112th out of 132 countries in stunting among children aged under 5 years; 39 per cent of children under 5 years of age were underweight and many suffered from deficiencies of micronutrients such as iron (>70 per cent), vitamin A (65 per cent) and zinc (45 per cent).

This scenario demands that we have to have new breeding technologies to increase crop production. Some important new technologies are as follows.

Plant genomics is the study of complete genome which was started with sequencing of DNA by Sanger's method. After 2005, next generation sequencing with different platforms such as Solexa, Ion Torent, Oxford Nanopore etc. were developed.

Marker-assisted breeding is the application of molecular marker linked to the gene of interest for improving plant traits on the basis of genotypic assays.

Genomics-assisted breeding, resulted 71 varieties of rice, wheat, maize, pearl millet, chickpea, soybean and groundnut have been bred for specific traits including biotic (Bacterial blight, blast, rust, down, mildew, wilt, brown plant hopper) and abiotic (drought, sub-mergence) stresses as well as improved nutritional profile.

Genetically modified crops: A transgenic plant contains a gene (a segment of DNA) or genes of a different species artificially inserted into the plant genome. The transgenic crops can increase productivity, help conserve biodiversity, reduce agriculture's carbon foot print and mitigate climate change.

Genome editing is the ability to make highly specific changes in the DNA sequence of a living organism, essentially customizing its genetic makeup and is done by CRISPR/ Cas 9 technique. Through this, herbicide resistance in canola (2012), blight resistance in rice (2016), powdery mildew resistance in wheat, soybean with reduced trans fats, non-browning mushroom (2017), potatoes with altered starch (2016), virus resistance in cucumber (2017), high yielding rice (2017) and gluten-free wheat have been developed.

Future pointers

- Genetic gain in major crops is only 1 per cent, which needs to be increased to 2.4 per cent for meeting global

food demand by 2050. This demand can be bridged by the application of pre-breeding, genomic selection, speed breeding and genome editing technologies for genetic enhancement of crops.

- Development of novel crop production, protection and processing technologies for enhancing crop production in the realm of global climate change also require the urgent attention.

Key takeaway

- An integrated approach is required for making crop production remunerative and market-driven through the use of new breeding techniques, better management practices, artificial intelligence, internet of things, sensors and big data analytics.

ACCELERATED BREEDING BY *DE NOVO* DOMESTICATION OF CROP PLANTS

Goetz Hensel

Dr Goetz Hensel is Head of Centre for Plant Genome Engineering at the Institute of Plant Biochemistry of the Heinrich Heine University, Dusseldorf. He has experience in genetic transformation, developing expression systems in plants and molecular farming using chloroplast engineering to develop stress-tolerant crop plants.

Domestication is a sustained multi-generational relationship in which humans assume a significant degree of control over the reproduction and care of another group organism to secure a more predictable supply of resources from the group. One needs to take care of organisms to be beneficial to all. It started when farmers started collecting fallen seeds to grow in the next season and started looking for different traits in crops—in cereal crops, desired features are increased grain number, reduced seed shattering, reduced height and reduced dormancy; in other crops include no fruit abscission, more and bigger fruits, photo-insensitive plants and colour variations. And breeders' toolbox contains different breeding methods from classical to genomic-assisted breeding. To achieve desired traits, breeders started with traditional selection breeding when the population was small and wanted characteristics were lesser. Then came the classical hybrid breeding, where two parents with desired traits were crossed to get progeny with desired traits. But in the breeding biggest challenge has

been the time involved. Developing new variety through classical breeding needed 8-10 years. Other method of breeding has been classical mutation breeding using chemicals or irradiation to induce changes. Induced mutations can be both favourable and unfavourable and have to go for several rounds of crossing before getting the desirable traits. In Barley, 307 varieties based on mutation breeding have been developed since 1955. Recently (2019), in banana Pirana variety was released and developed using radiation experiments. In 1980 genetic engineering was created, i.e., Genetic engineering uses laboratory-based technologies to alter the DNA make-up of an organism. The genetic engineering process starts with locating an organism with a specific trait and extracting its DNA, cloning a gene that controls the trait, designing a gene to express in a particular way, transforming, inserting the gene into the cells of a crop plant and/or crossing the transgene into an elite background. This technique is of a shorter period of 4-6 years for a variety release. Presently, gene editing has evolved. It is a type of genetic engineering in which DNA is precisely inserted, deleted, modified or replaced in the genome of a living organism. Unlike early genetic engineering techniques that randomly insert genetic material into a host genome, genome editing targets insertions to site-specific locations.

Three different endonuclease platforms are used for gene editing — zinc finger nucleases (ZFN), transcription activator-like effector nucleases (TALEN) and clustered regularly interspaced short palindromic repeats (CRISPR). ZFNs and TALENs are entirely protein-based and CRISPR-Cas9 has both protein and RNA components. ZFNs and TALENs are modular proteins comprising an array of domains, each recognizing specific nucleotides and a nuclease domain; for each new DNA sequence to be targeted, new proteins must be assembled. By contrast, for CRISPR-Cas9, the RNA component confers specificity for the target sequence. Approximately the first 20 nucleotides of the "guide RNA" direct the Cas9 nuclease protein to the target sequence through RNA-DNA hybridization of the sequence. For all three tools, the typical consequence is the introduction of a double-strand break (DSB) at the site of the target sequence. CRISPR is used for easy cloning. The critical strength of CRISPR breeding is that it allows for faster and more targeted development of crop varieties. Crops modified by gene editing include alfalfa in feed crops; cotton in fibre crops; apple, banana, barley, basil, chickpea, wheat etc. in food crops; jatropha, Millet, sugar cane etc. in industrial crops; canola, flax, sunflower, etc. in oil crops; Lily, Lotus, petunia, rose, etc. in ornamental crops.

To meet increasing food demand, breeders and scientists aim to improve the yield and quality of major food crops. CRISPR has introduced important agricultural traits, including heat, cold and herbicide tolerance; viral, bacterial

and fungal resistance; and increased grain size and weight into many economically important crops, such as rice, wheat, maize, tomato, potato, tobacco, cotton, soybean and brassicas. With precise genome engineering and transgene-free applications, CRISPR would resolve the significant challenges of crop improvement.

Key takeaways

- *De novo* domestication using CRISPR is important in breeding.
- Gene editing is a crucial facilitator to develop varieties with desired agronomical traits.

CHALLENGES FACED IN THE UTILIZATION OF CONTEMPORARY GENE BANKS

Paul Gepts

Prof. Paul Gepts is a Distinguished Professor at the University of California, Davis. His areas of expertise include research and teaching on the topics of crop evolution and crop agrobiodiversity to conserve germplasm and furthering their application in breeding programmes.

Gene banks around the world are real facilitators in the conservation and improvement of valuable germplasm resources. Plant germplasm in gene banks is stored by freezing their seeds (e.g., in a seedbank), maintaining their parts in test tubes (in vitro), or growing individuals in live collections (clonal repositories).

The challenge to enhancing and accelerating utilization of plant genetic resources in crop improvement programmes can be met through gene banks. But there are many bottlenecks in utilization of these very gene banks. Some are as follows. **Black box**: We do not know what is in the gene bank. And specific action points for enhanced use of plant genetic resources from gene banks include high-throughput phenotypic and genotypic characterization. Thus, we need to ensure that gene banks do not remain black boxes.

Lost in the woods: We receive germplasm but if that germplasm lacks basic adaptations and does not adapt well in different climates then we cannot evaluate it and it would have little purpose. For example, 280 accessions of lima bean (Phaseolus lunatus) were collected from the USDA gene bank for

the species (Western Regional Plant Introduction Station, Pullman, WA), the lima bean breeding program at UC Davis and the Phaseolus World Collection at CIAT (Cali, Colombia). Only 10 per cent flowered at UC Davis and only some set seeds, which could be used in subsequent evaluations. For the remainder, no useful information could be gained, except for their photoperiod sensitivity. What we need is mapping and identification of these basic adaption traits, domestication genes, flowering and photosynthetic genes, growth habits etc. before selecting a crop.

Sampling: To assure an adequate representation of the in-situ populations, activities should include agro-ecological explorations covering the range of habitats, where these beans are growing to represent that diverse environments in which wild and domesticated types grow and need to include pathogens, pests and beneficial microorganisms. These explorations should be repeated to capture the dynamic state of plant germplasm in situ.

Targeting populations, traits and environments: Success in using plant germplasm will depend on a careful choices of populations, traits and testing and selection environments. Because domestication induced a genetic bottleneck, there is a renewed emphasis on wild types. These are actually very difficult to evaluate for traits such as yield, growth habit and pod shattering etc. because natural selection imposed different selection regimes compared to those present in cultivated fields. Hence, it is very difficult to choose high-yielding populations as parents for introgression into domesticated beans. Introgression of genes for drought tolerance from wild beans into domestic beans can increase yield but only when the populations originated in dry environments in the centers of origin and are being grown under drought-stress conditions because these genes are specific and only show their character when grown in the dry climate. It is also important to keep into account traits representing consumer preference such as cooking time and organoleptic traits.

Database: Genotypic and phenotypic data need to be integrated into germplasm databases, such as those of the National Bureau of Plant Genetic Resources, Genesys, Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), CIAT (International Centre for Tropical Agriculture) and GRIN-Global of the USDA National Plant Germplasm System. These databases are useful mostly for basic data could be improved through the addition of more extensive phenotypic data and linkages to genome databases (e.g., National Center for Biotechnology Information, Legume Information System).

Lastly, the access and utilization of plant germplasm is made more difficult because of a **thicket of intellectual property rights and international treaties**. This situation prevents or slows down the active interchange of germplasm and associated

information. International treaties could ease the exchange of germplasm among countries and encourage further agro-ecological explorations.

In a nutshell, gene banks are valuable resources for crop improvement through the acquisition, ex-situ conservation and sharing of unique germplasm among plant breeders and geneticists. Gene banks need efficient characterization and up-to-date curation to make them more accessible and usable to the crop improvement community.

Key takeaways

- Phenotypic and genetic evaluation is needed to remove black box of gene banks.
- Mapping domestic genes based on genotypic and phenotypic characters would help in marker-assisted germplasm conversion and breeding.

TRANSLATIONAL GENOMICS FOR IMPROVEMENT OF HORTICULTURAL CROPS

Umesh K. Reddy

Prof. Umesh K. Reddy is the Professor of Biology at West Virginia State University, West Virginia. His research interest areas are genomics, heavy-metal stress, biotic stress, polyploidy, molecular changes pertaining to grafting in plants, evolution and domestication and breeding and quantitative genetics of cotton, peppers, tomato, watermelon, blueberries and pomegranate.

All the modern cultivars are domesticated from their wild relatives which possess several genes that resist, tolerate and bear with extreme biotic and abiotic stresses. In the process of domestication, the farmers had also developed landraces from wild populations, which are presently the part of the germplasm resource for several horticultural crops. Genomic research involving these resources allow understanding of natural variations for different important traits and genetic bottlenecks associated with domestication and modern plant breeding efforts.

Genomic selection is done by prediction of total genetic value using genome-wide markers. There were differential DNA methylation patterns among diploid and tetraploid watermelons when they were sequenced. Tetraploid progenitors of triploid watermelon plants, compared with their diploid counterparts, exhibit wide phenotypic differences. The exploitation of synthetic polyploids for producing seedless fruits is well known

in watermelon. Tissues of leaf, stem and fruit of diploid and tetraploid sweet watermelons were used to understand gene expression.

Fruits have abundance of different bioactive compounds — phytochemicals (phenolic acids, flavonoids, carotenoids, tannins, lignans and stilbenes); vitamins (provitamin A, C, E and K); minerals (potassium, calcium and magnesium); and dietary fibres — which play a vital role in human health by checking on several chronic diseases, mainly coronary heart diseases, cancer, diabetes and cataracts etc. Capsaicinoids present in pepper produce pungency which have anti-oncogenic and anti-diabetic pharmacological properties and can be used to cure these diseases. Translational genomics represents a broad field of study that combines genome and transcriptome-wide studies in humans and model systems to refine understanding of human biology and ultimately in identifying new ways to cure and prevent diseases.

Population diversity analysis and genome-wide association study (GWAS) of locule number and fruit shape traits (perimeter, area, obovoid, ellipsoid and morphometrics) in Capsicum chinense pepper has shown significant single nucleotide polymorphisms (SNPs), located in candidate genes such as WD-40, CLAVATA1; and Auxin receptors affect fruit shape in tomato. This knowledge of genes that control these agriculturally important traits will lead to developing varieties with desirable fruit characteristics and higher nutritional value in horticultural crop breeding programmes. Various bioinformatics tools such as the Basic Local Alignment Search Tool (BLAST) and CLUSTAL can help further exploring various horticultural crops with nutritive value and can identify relevant biochemical pathways to tune the production of compounds of interest. Experiments have shown that pepper containing diets can significantly effect body weight and triglyceride content in Drosophila.

Recent advances in genome and molecular analyses have made it possible to dissect and understand the hidden cues of trait diversity at the molecular level. These developments offer new opportunities to improve valuable traits in crops using genomic tools. The combination of rapidly advancing genome-editing technology with breeding will greatly increase horticultural crop production and quality.

Key takeaway

- Precise genome editing technologies along with enhanced trait architecture would enable innovative solutions for improving horticultural crops.

IMPROVING PHOSPHORUS-USE EFFICIENCY USING A LARGE SET OF CHICKPEA GERMPLASM

Kadambot H.M Siddique

Prof. Kadambot H.M Siddique, Hackett Professor of Agriculture and Director of The University of Western Australia's (UWA) Institute of Agriculture, has significant expertise in agricultural research, teaching and management.

Global phosphorus reserves have a lifespan of 207 global years (taking 300–400 years to convert into fertilizers). Thus, the limited phosphorus sources must be used judiciously. Phosphorus is a non-renewable source, with its fixation in soil further reducing its availability. There is a global agronomic phosphorus imbalance, with 30 per cent of the cropland area phosphorus deficient and 70 per cent phosphorus surplus.

Phosphorus is an essential nutrient for plant growth required for photosynthesis, a key component of nucleic acids and phospholipids and important in cell division and new tissue development.

Phosphorus acquisition in chickpea can increase by developing genotypes with improved phosphorus acquisition, optimizing phosphorus management and researching below-ground traits

associated with phosphorus acquisition. Since genes related to shoot phosphorus concentration, physiological phosphorus-use efficiency and specific root length have been identified in chickpea genotypes with improved phosphorus acquisition is an ideal strategy for increasing phosphorus-use efficiency. The existing genetic base of chickpea is very narrow— with only 300 genotypes gathered from 29 countries. Among the various studies, 266 chickpea genotypes have been used (203 desi type, 53 kabuli type and 10 pea-shaped).

Phosphorus is locked in the soil, with its mobilization dependent on root architecture, morphology, physiology especially, root biota interactions with mycorrhizal fungi. Chickpea genotypes with high root lengths and root carboxylate exudation have greater phosphorus acquisition. Adopting good agronomic practices, such as the appropriate amount of phosphorus fertilizer applied to the right crop, at the right time and in the right place, will improve phosphorus-use efficiency, prolonging and increasing the productive use of phosphorus in photosynthesis.

Key takeaways

- Chickpea core collection would facilitate improvement in phosphorus-use efficiency.
- Novel genes and genetic loci associated with root traits, phosphorus acquisition efficiency and phosphorus-use efficiency should be used in chickpea breeding programs.

HARNESSING BENEFITS OF MODERN AGRICULTURAL BIOTECHNOLOGY IN THE ASIA-PACIFIC REGION **CHALLENGES AND WAY FORWARD**

Rishi Kumar Tyagi

Dr Rishi Kumar Tyagi is Senior Coordinator in the Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB) in Asia-Pacific Association of Agricultural Research Institutions (APAARI), Bangkok, Thailand. He deals with the promotion of agricultural biotechnology and conservation and use of bioresources for sustainable agricultural development in the Asia-Pacific region for the benefit of smallholder farmers through greater stakeholder partnerships, through policy development and advocacy, enhanced capacity building and greater public awareness.

About 60 per cent of the world's population lives in the Asia-Pacific region (APR). Nine out of top 20 populated countries of this region belong to Asia.

Population pressure and varied resources challenges in agriculture of climate change, water shortage and salinity, restricted arable land, to grow more food from less resources and new biotic stresses are also becoming visible in the region. To mitigate the challenges, the region is adopting biotechnology and its applications. Agricultural biotechnology has developed several biotech products for the benefits of smallholder farmers to improve their livelihoods and food crops productivity.

Use of biotechnology is not new but genome editing, genetically modified (GM) crops and bioinformatics are relatively the modern technologies. In 2019, global area of biotech crops was 190.4 million hectares with a slight decline of 0.7 per cent from 2018. In 19 countries, more than 50,000 hectares are under biotech crops; and 9 countries are from the Asia-Pacific region. Top 5 countries cultivating GM crops are USA, Brazil, Argentina, Canada and India. Biotech crops would alleviate poverty and hunger by contributing towards sustainable development goals (SDGs) 1, 2 by providing better food and income along with fulfilling SDGs 3, 6, 13, 14, 15 by safeguarding environment and conservation of biodiversity.

Gene editing is simpler and more efficient technique used in crop sector. Gene editing tools like CRISPR-Cas9 allow scientists to develop more nutritious, climate-resilient crops for sustainable farming systems without introducing any foreign DNA from other plant species. Scientifically speaking, gene-edited products need to be treated similar to the products obtained from the traditional breeding with the highest precision.

There is an active debate at the global level and particularly in Asian and African countries for regulation of gene-edited products with major questions (i) how to do a risk assessment for a gene-edited product? (ii) Is the existing risk assessment framework necessary for the safety assessment of gene-edited products? (iii) Can genetic detection techniques be employed to differentiate between the gene-edited product and a similar product obtained by the conventional breeding? For the past over 25 years, GM crops are being cultivated and consumed in several countries including in Asia with no adverse effects on the health and environment, therefore, they appear to be safe to grow and consume. However, debate is still on. Enforcement of any regulation would be very difficult in most gene-edited products (SDN 1) as the detection of the change(s) at gene level is not possible by examining phenotype without information of specific gene edits. Only those products such as SDN 2 and 3 with foreign DNA where detection is possible may have to be subjected to safety assessment. To save the cost, time and energy to provide solutions through gene editing to the contemporary issues related to production and productivity, harmonization of regulation would be a win-win situation for governments and regulators, product developers and public and consumers.

Agri-biotechnology offer opportunities for the transformational change in agriculture. All the crops are affected by adverse climate, diseases and pests due to which there are almost 50 per cent pre- and post-harvest losses which decrease farmers income. Agri-biotechnological crops produced through gene editing will allow disease-resistant crops to manage the pest infestations and will help in withstanding climate change. The concept of developing disease resistance and climate-resilient traits is not new in breeding but being capable of doing it in a fraction of time as compared to conventional approaches makes it a revolution worth considering in the world of biosciences or agricultural science.

Key takeaways

- Agricultural biotechnology acts as a platform for transformational changes in agriculture.
- Development of enabling regulatory policies would help smallholder farmers to adopt agri-biotech products and increase production and thus secure their livelihood.
- Creation of a knowledge platform for sharing information is important for harnessing benefits of modern agricultural biotechnology.

DESIGNER TECHNOLOGIES TO INCREASE PRODUCTIVITY AMONG LIVESTOCK

M.L. Madan

Dr M.L. Madan is a distinguished veterinarian, agricultural expert, animal biotechnologist, academician and a research manager. He has contributed significantly in the national agricultural development in different agri-ecoregions across India. He pioneered research in animal biotechnology and his research contributed in transformation of several protocols for animal reproduction and health.

Since domestication of animals, natural selection was leading to production and selection. Animal improvement over centuries has mainly been due to selection of animals on the basis of their phenotypes. Lately, however, the gene technology has brought in the possibility of selecting animals on the basis of the genotype along with the phenotype. Using animal gametes, it has become possible to manipulate reproductive events to produce customized young ones. Embryo transfer technology (ETT) where embryos are collected from the donor females and transferred into the uterus of the recipient has resulted in faster genetic change, along with increasing number of offspring sired from superior females and can even have offspring from old or injured animals incapable of breeding or calving naturally and thus would increase in farm income from the sale of embryos. Embryo technology using electric manipulators can produce identical twins. IVF technology or In Vitro Fertilization is a procedure that can be used to treat

infertile animals that are with blocked tubes and low sperm counts. Worlds first IVF buffalo calf 'Pratham' was developed in 1990 at the National Dairy Research Institute, Karnal. A rich source of animal biodiversity exists in the local species and breeds, which possess quality genes with excellent traits. Molecular markers are being used increasingly to identify and select genes with desirable traits. Artificial insemination, embryo transfer and other assisted reproductive technologies have been used in the genetic improvement of livestock, particularly cattle and buffaloes; and the economic returns have been enormous.

The knowledge of the genome has brought in another dimension of predicting performance of the animal in terms of series of traits.

Technological interventions such as transgenics have become tools to design an animal genotype through transgenic production and introduction of new traits for increasing productivity of the animal. Production of transgenics has led to a dramatic increase in growth rate, in containing diseases and in developing muscle mass. With the help of transgenics, we can produce cattle with desired traits such as no horns, more muscle and enriched milk production. In pigs, we can induce resistance to African swine fever virus, can increase omega-3 fatty acids and can increase muscle weight.

In catfish, production of transgenic fish has led to dramatic (30-40 per cent) increase in growth rate.

Lately, CRISPR Cas9 method for editing genes has revolutionized animal reproduction and selection technology for the future. Technologies of genetic editing such as the CRISPR/Cas system would easily help overcome reproductive barriers and would introduce desired genetic variations within the breed. Being highly specific and efficient, CRISPR/Cas system offers breeders the scope to manipulate animal's genome to suit the need of the hour. Manipulations may involve deletion of genes related to undesired traits (e.g., susceptibility to disease, aggressive behaviour, etc.) or insertion of genes linked to desired phenotypic traits (e.g., disease resistance, absence of horns, heat tolerance, production of leaner meat, etc.). CRISPER applications include efficient generation of myostatin knock-out sheep using Cas9 technology and microinjection into zygotes. CRISPR-based genetic manipulations can help increase nutritional value of animal products and eliminate allergens from them.

Designer bio-farming through regeneration of organs can produce artificial organs such as udders of cows. Organoids provide a well-defined, accessible research model to be used to obtain phenotypic information on defined underlying cellular and molecular aspects of important complex traits such as feed efficiency and disease resistance. Thus, organoids can be of great value in livestock and veterinary research.

Organoids are important in-vitro research tools and have distinctive advantages over other in vitro models, as they accurately

emulate the structure and function of the organs from which they are derived. Compared to intact organs they can be as models to study developmental biology and diseases, which may be a real advantage for studying specific mechanisms and would also confers clear limitations to the model.

Key takeaway

- National initiative with international participation in reproductive biotechnology is required for making designer animals.

AI AND IOT
ENABLING SUSTAINABLE DIGITAL AGRICULTURE

Santanu Chaudhary

Prof. Santanu Chaudhary, Director, Indian Institute of Technology (IIT), Jodhpur, is a keen researcher and a thorough academician. His areas of expertise include computer vision, computational intelligence, multimedia systems and robotics.

Digital agriculture is the use of new and advanced technologies integrated into one system to enable farmers and other stakeholders within the agriculture value chain to improve food production. Technologies used in digital agriculture include sensors, communication networks, Unmanned Aviation Systems (UAS), Artificial Intelligence (AI), robotics and other advanced machineries and often draws on the principles of the Internet of Things. Each brings some valuable data collection for farming for management and processing, as well as for guidance and direction. This integrated system would offer new insights to enhance decision-making.

Key points in the digitalization are the collection of the data and what is to be done with the collected data. The data can be collected with sensors. The inertial sensor, also known as the inertial navigation system (INS), uses an accelerometer and gyroscope to determine spacecraft attitude in relation to the inertial system. The accelerometer is used to test the motion acceleration of the carrier, which is then used to calculate the real-time location of the carrier. which are used to collect data and can help monitor working of machines in the field (e.g. pressure sensors, accelerometer and acoustic sensors); biochemical sensors

are convert a chemical quantity into electric signal (e.g. gas sensors) and lately NPK sensors, which can work reliably at field. A digital agriculture system gathers data frequently and accurately; often combined with external sources (such as weather information). The resulting combined data can be analyzed and interpreted so that the farmer is able to make appropriate decisions. The decisions can be implemented with greater accuracy through robotics and advanced machinery and then farmers can get real-time feedback on the impact of varied actions.

Digital agriculture has the potential to make agriculture more productive, consistent and in using time and resources more appropriately. This would bring critical advantages to farmers. However, this approach is still new and its costs are high and the details of the long-term benefits are not so far available.

Artificial intelligence uses

- It would facilitate crop and soil monitoring, prediction and mini-mization of post-harvest losses.
- It would help farmers analyze weather and then they can plan the type of crop to be grown and when sowing of seeds to be done.
- The artificial intelligence interventions would help in soil and crop health monitoring through identifying stress, drought, diseases, pest attack, helps in planning optimal inputs for optimal production and market intelligence. This would help in reducing time and also cost of diagnostics.

To meet the challenges of global food security in the changing climatic scenario, it is imperative to enhance crop productivity. It is estimated that approximately 70 per cent of reduction in crop yield is due to the direct impact of abiotic stresses such as drought, salinity and extreme temperatures. In the present context, one of the major challenges is large-scale screening of crop performance as a consequence of its genetic make-up. The development of advanced biotechnological and next-generation sequencing tools has led to accumulation of enormous data on genomics; nevertheless, the data on phenotype and functions are yet to be fully explained.

High-throughput phenomics studies offer strategies to screen large-scale population for a particular phenotype employing advanced robotics, high-tech sensors, imaging systems and computing power. Advanced bioinformatics tools would further facilitate the analysis of large-scale multi-dimensional, high-resolution data collection through phenotyping. With the integrated approach of genotyping and phenotyping, gene functions and environmental responses can be well understood. It would help in finding relevant solutions for the major problems limiting crop production. High throughput phenotyping has unlocked new prospects for non-destructive field-based phenotyping.

While the Internet of Things (IoT) make real-time monitoring and widespread distribution of information possible, AI can improve productivity and efficiency by helping farmers to make decisions on the basis of the collected data. Responsible application and adoption of AI technology can help to empower rural farmers. And if the cost of enabling this technology can be reduced substantially it can inspire youth entrepreneurship in food and agriculture and can lead to greater security, profitability and sustainability. IoT and AI can ensure sustainability, satisfy sustainable development goal (SDG) to meet hunger and empower farmers at the grass-root level.

Key takeaways

- Artificial Intelligence facilitates effective analyses of the data and fast assessment of the situation.
- IoT and AI are the pathways towards sustainability.

BLOCKCHAIN TECHNOLOGY
CONCEPT AND USE CASES

Gaurav Somwanshi

Mr Gaurav Somwanshi is the CEO and co-founder of EmerTech Innovations Pvt Ltd. He worked extensively in Chhattisgarh where he conducted the state's first pilots using Blockchain for e-governance, land record management, health record management and other uses. His current project focusses on implementing end-to-end Blockchain solution for India's largest Farmer collective with over 13,000+ farmers for using it on daily basis.

Blockchain is a shared, immutable ledger facilitating process of recording transactions and tracking assets in a business network. Blockchain's popularity and its increasing industrial applications are because of its innate qualities. The person who invented blockchain is Satoshi Nakamoto. In 2008, Nakamoto released a whitepaper detailing principle behind blockchain and the first cryptocurrency, Bitcoin (BTC). The paper conceptualized blockchain as a public ledger that would facilitate Bitcoin transactions without intermediaries. First, we have to understand the ledger. Ledger is used by accountants to keep and to organize financial data used to develop company's financial statements. Transactions are posted to specific sub-ledger accounts as per the company's chart of accounts. The bookkeeper creates a trial balance, which reports available balance in each ledger. The trial balance is checked for defects and errors are adjusted by submitting additional required entries; Thus, a financial statement is made. After the digital ledger is prepared, digital signature is added to solve the problem of tampering and impersonation in digital communications. Digital signature can provide the evidence of origin, identity and status of electronic documents,

transactions, or digital messages. Signers can also use them to acknowledge informed consent and it cannot be copied by another person. After adding digital signature, time stamping used as transaction ID prevents fraud in copying of transactions. When the information is signed a unique ID to that massage is added which would stop it from repeating; thus data are secured from fraud.

Blockchain types

1. Public Blockchain

A public blockchain is a non-restrictive, permission-less distributed ledger system. Anyone who has access to the internet can sign in on a blockchain platform to become an authorized node and be a part of the blockchain network. A node or user which is a part of the public blockchain is authorized to access the current and the past records, verify transactions or do proof-of-work for an incoming block and do mining. The most basic use of public blockchains is for mining and exchanging cryptocurrencies.

2. Private Blockchain

A private blockchain is a restrictive or permission blockchain operative only in a closed network. Private blockchains are usually used within an organization or an enterprise where only selected members are participants of a blockchain network. The level of security, authorization, permission, accessibility is in the hand of the controlling organization. Thus, private blockchains are similar in use as a public blockchain but have a small and restrictive network.

3. Blockchain in agriculture

Blockchain is valuable due to its traceability, ease of transaction, ease of claim of crop insurance and optimization of food supply chain.

Traceability: The food supply chain is extremely complex and at the same time, consumer needs and awareness for fresh, safe and quality food are continuously growing. Traceability systems offer many advantages, including the decrease in the time needed to recall and withdraw products harmful for the public health—thus improving consumers' safety and confidence. It provides agriculture supply chain with transparency and reliability, attributes of outmost importance considering the complexity nowadays of the food supply chain. Examples are TE-FOOD, ripe.io and EMERTECH.

Optimization of food supply chain: Allows the farmers to set their own prices and optimize quantities of products. Corrects the pricing imbalance by recording transaction in the real time. Provide up to date supply and demand information to stakeholders. Examples are agridigital and AGRICHAIN.

Crop insurance: It provides more visibility across the supply chain. Registers the parties involved, price date, location, quantity and state of art product. Secure insurance documents, dot numbers and pick-up documentation. Examples are ETHERISE and Worldcover.

Transactions: This helps farmers to sell commodities, lowering transaction fees. Prevent price coercion and retroactive payments. Provide an opportunity to receive payments and micro-financing. Provide lower cost and faster payments options to agro-commerce participants.

Blockchain in agriculture can also be used to overseeing farm inventory, enhancing supply chain, modernizing farm management software, fair pricing, help in agricultural subsidies oversight, community supported agriculture, mobile remittance for small farmers, greater accountability for multinationals.

Challenges of Blockchain Technology

Although blockchain technology can be applied across many industries, there are still many challenges ahead.

High implementation cost: Blockchain is expensive to implement. It requires a large amount of computing power and resources to build a blockchain ecosystem.

Insufficient technical expertise: Blockchain technology is relatively a new and highly specialized field. Not many people have the technical expertise to be responsible for engineering and connecting blockchain applications.

Key takeaways

- Post-harvest losses in agriculture sector can be reduced with the help of blockchain technology.
- Consumers can check the origin of the product with blockchain and this would result in their ultimate satisfaction.

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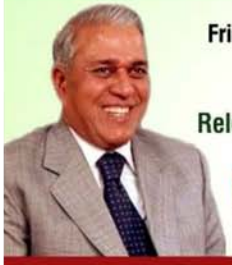

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BHARAT KA AMRUT MAHOTSAV

ICAR Lecture Series #6

Environmental Education in India

22 April 2021, 10.30AM

Dr. Erach Bharucha

Director, Institute of Environment Education and Research, Bharati Vidyapeeth

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ICAR

आज़ादी का अमृत महोत्सव

NAHEP

ICAR LECTURE SERIES #66

आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV

Tuesday, 5 July 2022 | 11:00 AM

The story behind building a brand like Policybazaar as motivation for Agri Graduates

Alok Bansal

Co-founder & Executive Vice Chairman, PB Fintech Limited

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YOUTH PARTICIPATION FOR A SECURE AND SUSTAINABLE AGRICULTURE

R.S. Paroda

Dr R.S. Paroda is the founding Chairman of the Trust for Advancement of Agricultural Sciences (TAAS) and former Secretary, Department of Agricultural Research and Education (DARE) and Director General of the Indian Council of Agricultural Research (ICAR). He has contributed enormously in agricultural development both as a researcher and as an agile administrator. His contributions in plant breeding and genetic resource management are well recognized globally.

India is the Krishi Pradhan country and so our Krishaks have to be Pratham(first). To make our farmers' first can be possible only when our youth are enthused to take the challenges of embracing agriculture.

Presently, India has the largest population of 356 million of youth between 10 and 24 years of age. Almost half of this population (nearly 200 million) lives in the rural India, who can be motivated to agriculture and allied fields. Contrary to this, only around five per cent of the rural-youth are currently engaged in agriculture. This is all because they do not find agriculture very lucrative and profitable; and above all, it to be a respectable profession to provide better means of living . At present, we are lacking a clear strategy and an enabling environment to motivate and attract youth in agriculture.

What lacks to attract youth in agriculture: Following are some pointers.

- Lack access to relevant knowledge — need institutional backing for providing knowledge.

- No exposure to agriculture in schools; so students do not know what is agriculture, who don't belong to farming community . But now with the new education policy, agriculture would be taught in schools and this may create their interest in agriculture.
- Limited access to land — as 85 per cent farmers have small land holdings and thus returns are not going to be profitable.
- Lack of financial resources; as they are not aware of government schemes and do not know from where they can get financial support.
- Difficulties in linking to markets (the markets are far).
- No voice in decision-making, as elders do not listen to them.
- Poor social image of agriculture due to poor income and lack of infrastructure and lack of infrastructure facilities in rural areas.

There also exists aspiration attainment gap due to lack of hand-holding, mentorship and funding support.

General challenges in agriculture: Agriculture is currently facing numerous challenges such as overexploitation of natural resources (land, water and agrobiodiversity), decline in factor productivity, costly inputs, low income and production uncertainties due to adverse effects of climate change.

Under such a scenario, involvement of youth in agriculture would play an important role as they are energetic, innovative and are more receptive to new ideas and adoption of advanced technologies. In addition, they have the courage to take risks, which is a critical step for any new enterprise.

Government initiatives for youth: Certain initiatives have been taken by the government to benefit youth. To harness the potential of youth and to take the benefit of demographic dividend holistically, Government of India has announced multifarious schemes. These schemes are based on the principle of social inclusion, gender equality and sustainable development of rural areas.

- Project ARYA focuses on empowering and involving the rural youth in various agricultural and allied sector entrepreneurial activities. The aim of the project is to generate employment, ensure sustainable income and further develop agriculture and allied activities in rural areas.
- Student READY (Rural Entrepreneurship Awareness Development Yojana) programme initiated by the ICAR aims to provide rural entrepreneurship awareness, practical experience in real-life situation in rural agriculture and creating awareness to undergraduate students about practical agriculture and allied sciences.
- Start-up India a Ministry of Commerce and Industry initiative intends to build a strong ecosystem conducive for the

growth of start-up businesses, to drive sustainable economic growth and to generate large scale employment opportunities.

- Stand-up India initiated by the Department of Financial Services (DFS) is for encouraging youth from scheduled caste and scheduled tribes to become entrepreneurs. The objective of the Stand-Up India scheme is to facilitate bank loans between 10 lakh and 1 Crore to at least one Scheduled Caste (SC) or Scheduled Tribe (ST) borrower and at least one-woman borrower per bank branch for setting-up a Greenfield Project.
- National Skill Development Mission has been launched for creating convergence across various sectors and different states with respect to activities relating to skills training.
- Make in India-Ministry of Commerce and Industry, aims to provide Indian consumers access to quality goods at competitive prices.
- Skill India Mission –Ministry of Skill Development and Entrepreneurship initiative chief objective is to empower the youth of the country with adequate skill-sets that would enable their employment in relevant sectors and also improve productivity.
- Pradhan Mantri Kaushal Vikas Yojana (PMKVY) initiative by the Ministry of Skill Development and Entrepreneurship is to provide country's youth training for meaningful industry-relevant skills.
- PM-YUVA-(Yuva Udyamita Vikas Abhiyan) is a centrally-sponsored scheme related to entrepreneurship, education and training for youth (both men and women).

But the youth are not aware of all these initiatives, so creating awareness will help in attracting youth towards agriculture. Hence, the future strategy should be to motivate the youth to become job-providers rather than remaining job-seekers This can be achieved only when required knowledge and education, technical skills, sustained encouragement and the enabling policy environment are provided.

In addition, the required policies, incentives and rewards need to be put in place to attract young talents to undertake innovative farming, which is profitable and sustainable and also respectable.

Future Road Map

- Creation of a separate 'Department of Youth in Agriculture'
- To start a 'National Mission on Youth in Agriculture'; under this mission youth can be encouraged to set-up Agri-Clinics and Custom-hire Service Centres to help farmers.
- Involving youth in e-NAM, start-up, stand-up and skill development schemes, agri-business enterprises. Farmer Producer Organizations (FPOs) will help in market linkages and they can get better prices for their produce,

it will also help in increasing farmers' income.

- A paradigm shift from narrow focus on 'youth as a farmer' to 'youth as a value-chain developer'.
- Creating an enabling policy environment for incentives to entrepreneurs, institutional backstopping, easy and soft credit, exemption of GST on value added products, etc. will attract youth towards agriculture.

Key takeaway

- Youth, the future of the country, need to be oriented towards agriculture by making them aware of the possibilities in agriculture as a remunerative enterprise.

TALENT SEARCH FOR MANAGING AGRICULTURE TREE

C.D. Mayee

Dr C.D. Mayee, Former Chairman, Agricultural Scientists Recruitment Board (ASRB), New Delhi, is a renowned cotton scientist. He was associated with the first commercial release of Bt cotton in India from time of conduct of biosafety and bio-efficiency evaluation till its release by the Genetic Engineering Appraisal Committee. He also served Government of India as Agriculture Commissioner after a successful term as Director, ICAR-Central Institute for Cotton Research, Nagpur.

Education is a comprehensive, holistic, all compassing endeavour to elevate one's consciousness level to the point where one is able to embark on to the journey of self-development and fulfilment. The talent search is the most vital component in education. The TREE stands for Teaching, Research and Extension Education.

Agricultural education has led to in enhancing economic growth, removing inequality, poverty and hunger, rural development and also in reducing urban migration.

The National Agricultural Research System has been a facilitator for excellent growth in food production; exploitation of newer techniques of crop improvement such as gene transfer; golden, white, blue and yellow revolution; and has created a close binding between SAUs and ICAR without any formal statutes. But its major shortfalls include: Technology vs. policy fatigue; and its quality of education is not resulting in standard scientists, teachers, extension specialists; present-day salary, promotion, recruitment also provide

no incentives; Governance of ICAR/SAU is still bureaucratic and CEO centred; unacceptable profile for change.

Talent Search by the ICAR for NARS

The major focus and objectives include increasing target of growth rate; required trained manpower for TREE and develop NARS system for backstopping national efforts.

The Agricultural Scientists' Recruitment Board is a most respectful, reliable and durable independent system for providing scientific manpower in agriculture with true national character. To attract talent in agriculture we have to offer free education from routine set-up and allow reforms in SAUs in the new education policy and also develop independent long-term linkages with foreign institutes. The ICAR-SAU's must shed away rigid rules and bureaucratic environment—exchange teaching and learning materials with SAUs and promote e-learning.

Key takeaways

- Shift in focus is required on polices from subsidies to investment in the R&D.
- Funds allotments have to be need-based.

ENHANCING QUALITY AND RELEVANCE OF AGRICULTURE EDUCATION

K.K. Aggarwal

Prof. K.K. Aggarwal is the Chairman of the National Board of Accreditation. He has been widely consulted by the industry and his most-salient contribution is in the Reliability Analysis for the PSLV (Polar Satellite Launch Vehicle).

Agricultural education is one of the most user connected professional education, after medical education. Agricultural education has come formally into professional education track much later than the medical and the engineering education. But it has developed fast as the country is agriculture-based — we have had '**Green**' and '**White**' revolutions. Earlier to these, we used to have shortage of grains and had long queues for getting milk but now we have surplus food grains and milk. The national ranking list of the universities shows that the first 7-8 universities out of 10 are technical universities. This happened in India as the technical universities were better connected with servicing sectors, with high productivity. Service sector got a boost and it also led to the growth of engineering/technical sector and per capita income also increased in the service sector but was limited to a few people. When service sector is compared to agriculture, it shows that only 5 per cent boost or improvement in agriculture can give employment to a greater number of people. For enhanced quality of agricultural education, universities were required with specialization and thus a lot

of departments with specific areas were created.

Lately, the education has become more and more specialized, but students are not aware of their surroundings. They may have high Cumulative Grade Point Average (CGPA) but their knowledge is limited to a subject only. This has created a gap among different disciplines. To fill the gap in disciplines we need to establish multidisciplinary universities. Now, with the new education policy (NEP,) it is possible to reduce this gap. Earlier, if someone wanted to join medical college, one needed to study PCB and if wanted to become an engineer, one was to study PCM. In the university system, there are some landmark changes with the new policy, now they can study inter-disciplinary courses. There will not be a rigid demarcation for a degree. Depending on the interest of the student, he/she can choose from a variety of subjects— it is possible to choose some subjects of arts and others of science and design a degree for oneself; which was not possible previously. Similarly, in engineering, instead of studying just mechanical engineering, the student is in a position to learn about electronics too thereby being able to specialize in mechatronics and to design robots. Hence, students will be able to do reverse engineering for their degree, depending on what they wish to pursue.

It is now widely believed that while the depth of specialization is important, the breadth of knowledge is equally so. Every agricultural student should have '**T**' shaped growth; it should have the depth of one subject and width of several subjects. Takshila world's first and oldest university had many courses and one course taught there was on snake-charming because; there used to be a lot of snakes in that area and it was the demand of the time. So, the courses taught must have relevance and this is now possible with the new education policy. Students can choose courses which they think are related to their goal and would help them in their career.

Our life style before Corona and after Corona has changed due to the need and same would happen to education. Corona has taught us so many things. Knowledge is now universal; it does not matter where you study. Quality education can be provided near home and that will be for the betterment.

Educationists have to be creative and innovative, only then students would be innovative. As educationists we have to think out of box and there can be more solutions to one problem and students should be encouraged to give innovative solutions.

The National education policy emphasizes to keep your individual identity, to respect diversity, respect differences, design relevant education and this is the opportunity where we can do all this. The

basic aim is that the student must be able to pick-up all that he/she wishes to design for himself/herself, which was lacking till now.

Key takeaway

- Every agricultural student should have a T shaped growth. He must have the depth in knowledge of one subject and be aware of the allied subjects for understanding the core subject well.

FOSTERING ENABLING ENVIRONMENT FOR AGRIBUSINESS

Farbod Youssefi

Dr Farbod Youssefi is the Senior Agriculture Specialist, South Asia, World Bank. He is a specialist in horticulture, mineral nutrition and crop systems, post-harvest handling, food quality and safety and agribusiness value-chain, training, capacity-building and community development.

Providing an enabling environment for the enterprise to be started and to be able to thrive is a prerequisite for economic development and in reducing poverty. Fundamentally driven by private sector, this holds truer regarding agri-food sector. Agriculture plays a huge role in providing food and employment. The share of the agriculture in the GDP gets reduced when we progress from agri-based country to pre-transition, transition, urbanization and to developed country. Agriculture-based countries have as much as 30 per cent value-addition from agriculture and 20 per cent value-addition from agribusiness. Developed countries have lesser value-addition from agriculture and agribusiness and as the agriculture sector transforms, share of the other sectors would get reduced. Major issue in the food system at the global level is the hidden cost of the global food production and the land-use system; which is $ 12 trillion annually. Staying on the current course, this cost would rise to $ 13 trillion by 2030. The current food system is costly and is costing more than the output benefits. Mobilizing private

investment in agriculture for sustainable development goals (SDGs) is important, presently to attain SDGs, 4.5 trillion/year are needed—140 billion/year are provided by development assistance and 4 billion/year are provided by philanthropists. The private investments can bridge the gap and can help in achieving the goal. The investment from the private sector can make the system more efficient and less costly by their contributory investments.

In agriculture sector, presently 140 billion/year additional financing is needed — 90 billion/year from public sector and 50 billion/year from private sector.

Mobilization of the private investment in agriculture and for enabling environment, there are location-specific factors that are creating opportunities and incentives for the private sector (this includes millions of farmers who invest, produce and seek profitability) for beneficial investments, to create jobs and expand. The factors which need to be in place for such investments to take place include — policies, regulatory framework, institutions, support service, infrastructure and social capital. In agriculture, smart/balance regulations mean that they should provide information (registries and catalogues), provide regulations for safety (food and tractor safety), regulations for quality and standards (seed or fertilizer), regulations for property and management of property (land or intellectual property rights), regulations for environment safeguards (water extraction) and simultaneously these regulations should not be imposing excessive cost (high business entry costs), should not be burdensome process (decreased trade volume), should not be informal (increased unregistered inputs) and should not have reduced access (limited access to financial services). The key concept is to be able to measure and monitor — improving only managing and not measuring would not be beneficial for the agribusiness. Such a concept would not be effective when it comes down to policy or legal framework needed. For the development of policy or legal frame work, we need indicators. Indicators are basically synthetic information or crucial information synthesized into quantitative/measurable indicators (allowing measurable elements for the legal framework).

World bank is working on Enabling Business in Agriculture (EBA) since the last seven years; EBA had started in 2012 as the pilot data collection in 10 countries and presently 101 countries are working collectively. Provision of evidence received with the help of indicators on various issues can lead to creating awareness, increased awareness can lead to interest generation in improving enabling environment, which can then be integrated into projects and these projects can lead to change or reform in policies and regulation which can then lead to improved value chain in agribusiness. Improved value chain in agribusiness can lead to increased income and employment generation and reducing

poverty. Better regulations in agribusiness can lead to increased productivity and can help in reducing malnutrition and can lower poverty head count.

Key takeaway

- Better regulations would help in increasing agricultural productivity by enabling environment for agribusiness.

THE STORY BEHIND BUILDING A BRAND LIKE POLICY BAZAAR AS MOTIVATION FOR AGRI GRADUATES

Alok Bansal

Mr Alok Bansal is Co-founder and Executive Vice Chairman of PB Fintech Limited. He leads inorganic growth and investment initiatives for the group companies along with investor relations.

Policybazaar is a homegrown brand that solves a problem unique to India. Barely 15 years old, this InsurTech is an inspiration to budding entrepreneurs across the country. Policybazaar operates as an online insurance marketplace – users can compare and analyse different products such as medical, life, travel and motor insurance, ULIPs and other investments products. Data indicates that Policybazaar accounts for almost 25 per cent of life coverage and over 7 per cent of the local health insurance in India. Start-up founders can follow two approaches — you want to do something but don't have a clear idea what to do and thus depend on joining a team; other is you have an idea and know what to do. Either ways you have to analyse the problem which you want to solve and the solution should address an important customer pain point. Unless you are able to define your unique and differentiated value proposition clearly, it would be a challenge to build the solution. In 2008, when we started Policybazaar, internet

was still relatively new and people were not so conversant with it. Also, the founding team had very little or zero experience in the insurance industry, or even in the allied financial industries. They were simply driven by a common vision that went way beyond just financial metrics and almost became a mission, which was to solve for the financial risk due to Death, Disease and Disability for the middle class Indian family.

What worked for us perhaps was that we were never scared to ask stupid questions and question the status quo. At that time, most of the policies sold were for investment purpose or for compulsory insurance cover like for motor insurance. That was also the phase when insurance sector had increasing participation from private sector companies. Policy bazaar became a marketplace to compare products across all categories for all retail customers; and eventually Policy bazaar moved to an end-to-end model to enable purchases as well.

We focused a lot of protection categories of Term Life Insurance and Health Insurance, which were not widely popular at that time. Specifically, the health policies offered were with low sum insured which may not be sufficient given the high cost of healthcare. Policy bazaar started to promote health insurance through mass media campaigns and also worked closely with Insurance companies to work on different product constructs. Today, health insurance policies up to INR 1 Cr cover are available (these can cover almost every ailment). Also, earlier physical medical tests were mandatory but now there is an option to do tele/video medicals as well. The disclosure rate observed is much higher when customers share these details themselves as compared to the forms being filled offline with guidance from the offline agents. This results in sharp risk assessment and thus right pricing of the risk, eventually benefitting the insurance providers. The customers get unbiased and nuanced advisory and therefore are able to research better which results in informed and convenient purchase. The digital way of buying insurance has ensured convenience, speed and transparency for the customers.

As mentioned above, value proposition is a very important concept for start-ups. It is a simple statement that summarizes why a customer would choose your product or service. It communicates the benefits that customers would receive by giving you the business. Differentiation (uniqueness) in value proposition is the key. A Differentiated Value Proposition (DVP) is one that makes your product or your service stand out against the competition. One important measure of success is how many people recall your brand or come to your platform without marketing spend. Branding is a time-consuming process which goes much beyond just spending money and is built with time and trust. There are a lot of other factors which affect successful ventures. Self and team motivation has to be

aligned before we can solve any customer problems. Flexibility in decision making is another factor important for success as many a times, we have to take decisions outside of our comfort zone. Always value your team and give them credit for the hard work. In most start-ups, survival is more important than anything else especially at an early stage. Elaborating on what makes a start-up stick, he added that they "never had a number in mind" in terms of generating revenue or becoming a unicorn. PB's founding team had simply identified a problem in the way India understood insurance. The only thing on their mind was "Can we solve this problem? Can we become meaningful players in the industry?" Hustle has to be always there, this will help you to evolve continuously. Rethinking about own business model to identify and eliminate weak points before someone else does is of utmost importance. Never sit idle with any solution, start working on it. India with increasing consumption and young customers is the best place for start-ups.

Key takeaway

- Motivation, teamwork, employee ownership are pointers to success.

ENVIRONMENTAL EDUCATION IN INDIA

Erach Bharucha

Dr Bharucha, Director, Institute of Environment Education and Research, Bharati Vidyapeeth, Pune, Maharashtra is actively involved in wildlife and nature conservation for almost fifty years.

Through environmental education a deeper understanding of environmental issues can be developed and individuals can develop skills to make informed and responsible decisions. Environment education is not a new concept in India. It has been furthered through ancient Vedic Period and progressed across ages as part of ethos and diverse cultural approaches to life and human well being. Evidences of references to environment and biodiversity conservation are imprinted in Emperor Ashoka's stone edicts.

Non-formal Nature Education had begun by the Bombay Natural History Society in 1930. The scope of Nature and Wildlife is a part of our constitution; environment protection is thus a duty of every citizen. MC Mehta, an eminent environment lawyer, had placed a PIL in the Supreme Court as air pollution was yellowing white marble of the Taj Mahal. And the Supreme Court has taken a strict action in this regard. The Supreme Court had asked the concerned ministries to include formal environment Education in schools and colleges and in the Text-Books of different subjects.

Environmental education promotes critical and creative thinking skills and inspires kids to become engaged with their community. It helps kids understand why environment is important. At present, Environment Education is being taken up in the context of a Sustainable future.

Key takeaways

- Education for Sustainable Development (ESD) needs to be introduced in schools and colleges.
- Efforts for reversal of lost indigenous cultivars and traditional livestock breeds are of paramount importance for sustainable food security.

Climate Smart Agriculture


ICAR LECTURE SERIES #30
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Tuesday,
5th October 2021 | 10:30 AM
Future Proofing the Drylands
Dr Jacqueline d'Arros Hughes
To attend the lecture visit
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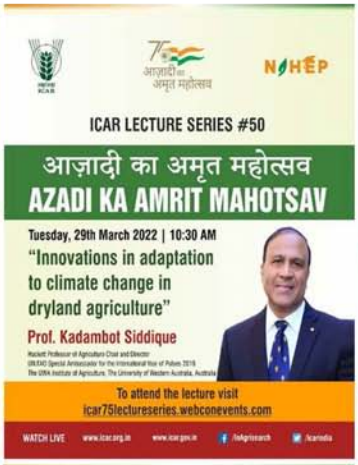
ICAR LECTURE SERIES #50
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Tuesday, 29th March 2022 | 10:30 AM
"Innovations in adaptation to climate change in dryland agriculture"
Prof. Kadambot Siddique
To attend the lecture visit
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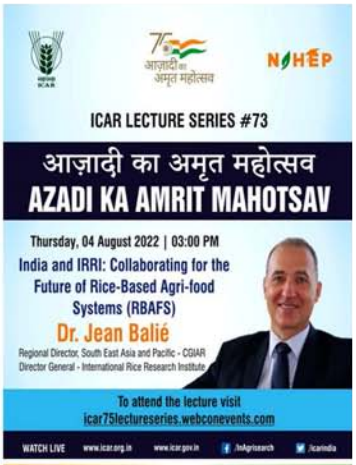
ICAR LECTURE SERIES #73
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Thursday, 04 August 2022 | 03:00 PM
India and IRRI: Collaborating for the Future of Rice-Based Agri-food Systems (RBAFS)
Dr. Jean Balié
To attend the lecture visit
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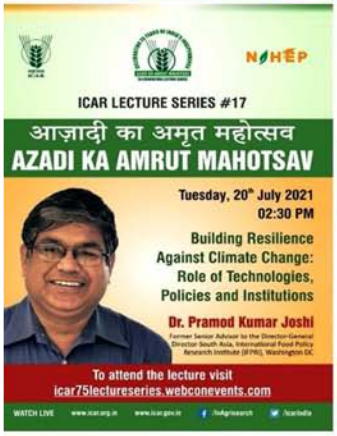
ICAR LECTURE SERIES #17
आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
Tuesday, 20th July 2021
02:30 PM
Building Resilience Against Climate Change: Role of Technologies, Policies and Institutions
Dr. Pramod Kumar Joshi
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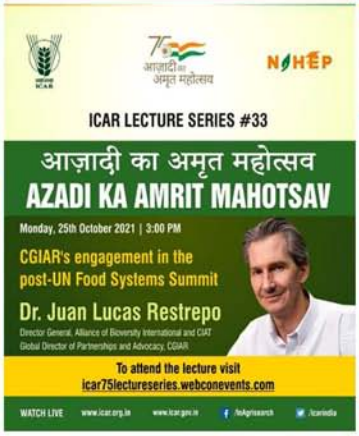
ICAR LECTURE SERIES #33
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 25th October 2021 | 3:00 PM
CGIAR's engagement in the post-UN Food Systems Summit
Dr. Juan Lucas Restrepo
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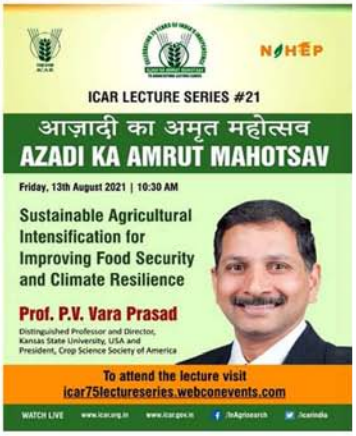
ICAR LECTURE SERIES #21
आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
Friday, 13th August 2021 | 10:30 AM
Sustainable Agricultural Intensification for Improving Food Security and Climate Resilience
Prof. P.V. Vara Prasad
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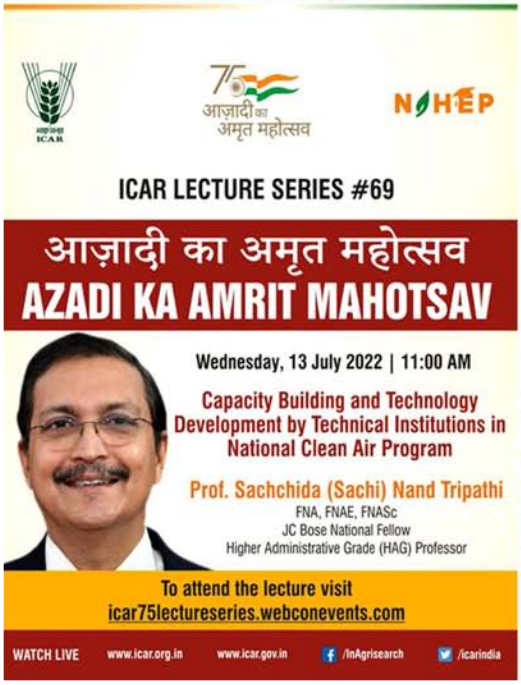
ICAR LECTURE SERIES #69
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Wednesday, 13 July 2022 | 11:00 AM
Capacity Building and Technology Development by Technical Institutions in National Clean Air Program
Prof. Sachchida (Sachi) Nand Tripathi
FNA, FNAE, FNASc
JC Bose National Fellow
Higher Administrative Grade (HAG) Professor
To attend the lecture visit
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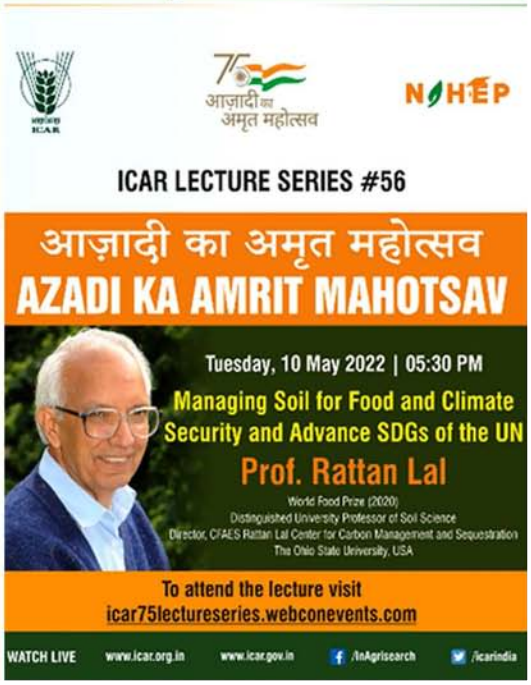
ICAR LECTURE SERIES #56
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Tuesday, 10 May 2022 | 05:30 PM
Managing Soil for Food and Climate Security and Advance SDGs of the UN
Prof. Rattan Lal
World Food Prize (2020)
Distinguished University Professor of Soil Science
Director, CFAES Rattan Lal Center for Carbon Management and Sequestration
The Ohio State University, USA
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MANAGING SOIL FOR FOOD AND CLIMATE SECURITY AND ADVANCE SDG'S OF THE UN

Rattan Lal

Prof. Rattan Lal, World Food Laureate (2022), is globally recognized as a pioneer in the soil centric agricultural management to improve food security and develop climate-resilient agriculture through soil carbon sequestration, sustainable intensification, efficient utilization of agroecosystems, sustainable management of soils and soil health.

Growth in India's agricultural productivity since independence is a unique success story. Between 1947 and 2021, population of India increased by a factor of 4.23 from 330 million to 1398 million while the food grain production increased by a factor of 6.3 from 50 million tons to 314.5 million tons along with per capita increase of K Cal/day from 2000 to 2450.There was a similar increase in horticultural production by a factor of 10, milk by 9 and fish by 13. The grain export increased to 20 million tons per year for US$ 40 billion and the grain buffer stock to 50 million tons. Accordingly, the poverty was reduced from 70 per cent to 20 per cent ,and there is a trend of poverty reduction over time. Thus, there is a very good reason for celebration of the Azadi Ka Amrut Mahotsav.

Because of poverty and lack of access to an adequate amount of safe and nutritious food, there are almost 190 million (14 per cent or one in seven) people who are prone to undernourishment and vast majority of adults (along with mothers and children under five) are malnourished because of the deficiency of micronutrients

and protein. Furthermore, there is a serious problem of soil degradation (by accelerated erosion, salinization, depletion of soil organic carbon concentration in the root zone and nutrient imbalance), excessive with draw of water and eutrophication, pollution of air and ever increasing emission of greenhouse gases and severe loss of biodiversity. Similarly to Millennium Development Goals, the Sustainable Development Goals of the Agenda 2030 of the United Nations are also not on track.

The future priority must be on food systems rather than just on agricultural production. Agricultural practices must be nature-positive and aimed at reconciling the need for improving food systems with the necessity of enhancing and sustaining the environment. Food systems of the future must strengthen ecosystem services and minimize disservices. Innovative food systems, while producing more from less (land, water, input and emission of greenhouse gases) by enhancing productivity and use efficiency, must also be based on the "One Health Concept". The latter implies that "health of soil, plants, animals, people, ecosystems and planetary processes is one and indivisible". Innovative food systems must avoid some pitfalls such as over and unbalanced use of fertilizers, indiscriminate use of pesticides, excessive plowing and flood-based irrigation, in-field burning of crop residues, uncontrolled grazing, excessive losses of food and brick making by scalping of top soil.

Some examples of innovative food systems include diverse farming systems rather than simple rotations, system-based conservation agriculture rather than plow-based tillage, environmental-friendly rather than degradative agricultural practices, soil restorative and regenerative systems, climate-resilient options aimed at re-carbonization of soil and vegetation by creation of positive soil/ecosystem carbon budget, aerobic dry seeded rice rather than puddled and flooded paddies, drip sub-fertigation systems which save water and fertilizers rather than flood based irrigation and broadcasting fertilizers. Such systems, which restore soil health and improve the environment, may reduce crop yield but have higher productivity/sustainability.

In this context, soil health must also include ethical relations with non-human (biodiversity) which improves livable environment. Thus, while soil health practices may not always improve crop yield but haveco-benefits for human wellbeing and nature conservancy. The ethical issue of improving soil health must not be ignored.

Innovative systems must also be aimed at carbon farming, which involves management of carbon pools, flows and greenhouse gas emissions (CO_2, CH_4 and N_2O) at farm level with the purpose of mitigation and adaptation of climate change. Expected deliverable of carbon farming are :1. removing carbon (sequestration) and subsequent storage I biomass (above and below ground) and soils as soil organic carbon and soil

inorganic carbon, 2. reducing or avoiding any future emission of CO_2 and other greenhouse gases and 3. decreasing emission of greenhouse gases from farm operations. Carbon farming is a new business model for farmers, foresters and ranchers. Land managers can be rewarded for taking up farming practices that deliver a carbon benefit at farm level. Payments may come from public funds, private sector and/or combination of both. There may be two mechanisms of payments :1. voluntary markets (offsets and insets) and 2. payments for ecosystem services. In the second mechanisms, farmers should be paid at a price which is based on the societal value of carbon (US$ 30 per credit or US$ 120 per metric ton of C). Private sector can play a critical role in translating science into action by :1. promoting nature positive agriculture, 2. increasing access to inputs and 3. improving investments in agricultural research, education and extension.

Key takeaway

- Soil health management must connect science with business leaders, policy makers and public. There must be a strong connection between soil and humanity.

CGIAR'S ENGAGEMENT FOLLOWING THE UN FOOD SYSTEM SUMMIT

Juan Lucas Restrepo

Dr Juan Lucas Restrepo is the Director General of the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT). He has been in the agricultural domain for the past 25 years and has a rich experience in policymaking, value chains and marketing.

The Consultative Group for International Agricultural Research (CGIAR) was heavily involved in the United Nations Food Systems Summit throughout 2021. The CGIAR participated in a number of global dialogues with different stakeholders aiming to identify the most powerful ways to make our food systems stronger and more equitable. As the world's largest public agricultural research network, CGIAR's contributions are invaluable to the Summit, providing 2,200 solutions collected from civil society, academia and stakeholders that can direct the way forward to achieve sustainable food systems.

In India, the National Dialogue on Agri-Food Systems-"Advancing Equitable Livelihoods"-has identified the following priority areas: Strengthening a research and tools mechanism for restoring soil productivity; Promoting organic farming practices and crop diversity based on the needs of Indian society; Empowering women by institutionalizing rights to agricultural land; Emphasizing the importance of switching to local foods and traditional diets; and Linking food

and farm subsidies to nutrition and the environment.

By focusing on these priority areas farmers can both support themselves and on a larger societal level contribute to a sustainable ecosystem. The outcomes of the United Nations Food Systems Summit point us towards a way forward through the National and Regional Pathways for Food Systems Transformation**.** Five action areas are: Nourish all people; Boost nature-based solutions for agricultural production; Advance equitable livelihoods; Ensure decent work and empowered communities; and Build resilience amidst vulnerabilities.

Under these areas, there are several coalitions of action; with 30 countries part of these ecology coalitions. At the global level, CGIAR through its centres is signing up to coalitions relevant to the mandates of zero hunger, school meals, agricultural innovation on climate, sustainable livestock, aquatic and blue foods and agroecology. This would provide knowledge and support, strengthen and build new partnerships.

The CGIAR is ready to support member countries in the elaboration and implementation of their national and regional pathways for food systems transformation, connecting them through its new research and innovation portfolio**.** The CGIAR's new framework is organized around five impact area platforms: (i) Nutrition, health and food security to achieve positive measurable benefits; (ii) Poverty reduction, livelihood and jobs; (iii) Gender equality, youth and social inclusion; (iv) Climate adoption and mitigation; (v) Environmental health and biodiversity. CGIAR research programmes and platforms have been consolidated into four coherent groups (three global and one regional) to effectively work towards the five impact areas by prioritizing system transformation, resilient agri-food systems and genetic innovations. By drawing on the global network's best capabilities and ways of working and by rethinking engagement with traditional and new partners, it is possible to improve the CGIAR's efficiency and reach and deliver impact in the epilogue of the Food Systems Summit.

Key takeaways

- All agriculture in the future must be nature positive; not only in the developing countries but at the global level.
- Land, food and water systems can be transformed by using strategic alliances and investments in research partnerships.

FUTURE PROOFING
THE DRYLANDS

Jacqueline d'Arros Hughes

Dr Jacqueline d'Arros Hughes is the Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India. Her main interests are in plant health, epidemiology, gender equity, nutrition and remote sensing/digital agriculture.

The drylands are the home to 2.1 billion people; and produce half the world's grains and meat. While the global aggregate production is more than enough to ensure that the world population can be fed; yet endemic hunger and malnutrition persists across poorer regions of the world, especially in the drylands. Climate change and extreme climatic events are leading to big shifts in food systems such as rapid urbanization and lifestyle changes, demographic transitions, greater food awareness and the degrading ecological base of agriculture. Dryland agriculture in Asia and sub-Saharan Africa is constrained by fragmented land holdings, resource-poor farmers, low availability of water and other resources, lack of adequate agriculture infrastructure, weak seed systems and value chains and also poorly resourced research in dryland crops

Future technologies for drylands

Precision agriculture: If 15-25 per centt of farms are able to adopt precision agriculture globally, yields from the fields could increase by 10-15 per cent, greenhouse gas emissions could be reduced by 10 per cent and water use could be reduced by 20 per cent.

Artificial intelligence and blockchain: About 30 per cent of food produced is lost or wasted along the value chain. Farmers need access to the right inputs

for their farms and also access to the right data in a timely manner. Predictive analytics could be a game changer for agriculture. Artificial intelligence would make faster data collection, collation and processing and blockchain would improve traceability, would strengthen supply chains, would build consumer trust and help ensure more remunerative prices for farmers.

Agribusiness Investment

Agriculture is the last sector to benefit from recent technological innovations which have revolutionized sectors such as health care, education, banking and financial services. The disparity is stark. Most agtech innovations and investments have been in the developed world, but things are changing. In 2019, investment in digital technology (combining imagery, precision agriculture and sensors and farm equipment) made up a significant proportion of venture capital investment. This continuing increase in attention to investment in agriculture must be encouraged.

Modern breeding: Modern technologies help speeding up the breeding process (speed breeding including single seed descent and the use of molecular markers) thus shortening the time to develop new varieties and to produce biofortified crops to contribute to improved nutrition of consumers. Biotechnology contributes to innovations in crop improvement, leading to development of traits faster, solving intractable or novel problems in a targeted manner by using gene editing, genetic resource sequencing for faster access to new traits. Biotechnology can also contribute to novel foods, for example using plant-based proteins or laboratory-based products. Policy makers must closely track innovations, put in place policy frameworks to support and manage innovations in future food systems.

Future of Dryland Agriculture

This should focus on inclusive, sustainable, efficient, nutrition sensitive and profitable approaches. Inclusive means smallholders in the drylands must be fully integrated into food systems — they should have access to inputs, markets, finance, storage etc. For farmers to be equal partners, they need an appropriate supportive environment, infrastructure, services, policies and regulations.

Agriculture should be sustainable and for this we need collective efforts such as with circular agriculture (in circular agriculture, waste is seen as a raw material to produce new valuable products, including crops, food, feed and energy. Another characteristic of the concept is the need to reduce resource consumption and discharges into the environment). and regenerative agriculture (system of farming principles and practices that seeks to rehabilitate and enhance the entire ecosystem of the farm by placing a heavy premium on soil health with attention also paid to water management, fertilizer use, etc.)

The drylands predominately remain under the subsistence agriculture and investments in them are low and consequently produce is often of poor quality and yield are unreliable. Policies are not always focused on, nor supportive, of the needs of the dryland agriculture. Many dryland crops are highly nutritious and with climate change and increasing desertification, productive and profitable agriculture in the drylands is the need of the hour. I have shared a vision for dryland agriculture that can meet both human needs and planetary boundaries which is "to transform dryland agriculture from its current subsistence level to a profitable enterprise".

Both Africa and Asia have young populations who are far more comfortable with technology compared to older, more traditional, generations and this can pay rich dividends to the countries in these regions if harnessed properly. As the current level of agriculture intensification is less in the drylands, the ecological damage caused by agriculture is also correspondingly low and we can build on relatively undamaged agro-ecologies. Growing crops that are adapted to the harsh dryland environments such as the dryland cereals (sorghum and millets) and grain legumes (chickpea, pigeonpea and groundnut) will help assure food and nutrition security in the drylands.

To transition our dryland food systems, they must be:

- Inclusive – farmers – women, men, youth – must be equal partners in the drylands food systems.
- Sustainable – circular/regenerative agriculture, understanding the contributions of the environment and climate change – capacity development and south-south exchanges is vital.
- Efficient – make information available and understandable using the best of disruptive technologies – this will empower drylands farmers.
- Nutrition-sensitive – an ideal time to partner in the drylands food systems in Africa and Asia.
- Profitable – increase the market share (nationally, regionally, globally) for these dryland crops, add value to the farm produce and work on better and supportive policies.

Key takeaways

- Focus on drylands should be for inclusive, sustainable, efficient, nutrition-sensitive and profitable approach.
- Use modern breeding technologies for producing climate resilient varieties for the future.

INDIA AND IRRI
COLLABORATING FOR THE FUTURE OF RICE-BASED AGRI-FOOD SYSTEMS

Jean Balié

Dr Jean Balié is the Director General of the International Rice Research Institute (IRRI) and the Regional Director for Southeast Asia and the Pacific of Consultative Group for International Agricultural Research (CGIAR). He has over two decades of experience in leadership and expertise in developing policies for agriculture, food and rural development. As Director General, Dr Balié set the global strategic direction of the institute and manages its affairs in accordance with the policies and decisions of the IRRI Board of Trustees.

IRRI played a significant role in the global rice sector by contributing to demand-led policy research, providing insights into rice markets and policy futures and by engaging with national partners and policy makers to define credible and relevant policy scenarios. The partnership between India and IRRI catalyzed some of the most significant milestones in the agriculture sector. In 1967, Benjamin Pearey Pal, the first Director General of the ICAR, became a member of the IRRI Board of Trustees. In 1982, M.S. Swaminathan became IRRI's 4th Director General. In 2006, the second International Rice Congress was held in New Delhi and was attended by almost 1400 participants worldwide. As a signal of the strong partnership between IRRI

and India, Prime Minister Narendra Modi himself inaugurated the Resilient Rice Field Laboratory in the IRRI headquarters (2017) and the IRRI South Asia Regional Center (ISARC) in Varanasi (2018). More recently, on 23 December 2021, the IRRI Speed Breeding Facility (SpeedBreed) at ISARC was inaugurated by the Prime Minister. The collaboration continues to bring value for mutual benefits through various initiatives such as contribution to germplasm. India has contributed to the germplasm that is preserved in IRRI's Rice Gene bank, which has 132, 290 accessions. India is the number one contributor with 17,595 accessions, which is 13 per cent of total.

Improved varieties through International Rice Gene Bank

According to the study, Farm-Level Impact of the International Rice Gene bank (IRG) on Improved Rice Varieties, evidence from Eastern India shows that 45–77 per cent of the genetic composition of an improved rice variety comes from the genes of IRG accessions and a 10 per cent increase in the definite genetic contribution of the IRG is associated with a 27 per cent increase in rice yields. Germplasm from the IRRI has played an important role in India's annual rice output by increasing the average additional rice production by 18 million tons/year, which is 17 per cent of the country's annual rice output. Net contribution of the IRRI germplasm alone is nearly 9 per cent of India's annual rice output. Overall contribution of the IRRI germplasm based high-yielding rice varieties (HYVs) to yield growth was 18 per cent. The number of high yielding rice varieties released in India was 1066 from 1966 to 2015.

One IRRI Breeding Strategy

IRRI developed the One Rice Breeding Strategy to create a demand-driven, region-specific breeding framework that provides global breeding centers with common terminology, procedure and implementation systems that help CG-NARES to breed climate resilience, nutritionally rich rice varieties with the speed of climate change. In order to implement the breeding strategy, IRRI also developed One IRRI Breeding Network through a close partnership with >50 Universities and Institutes in South Asia and mapped 7 out of 9 breeding pipelines for early, medium and late duration of pipelines for transplanted and DSR situations.

A comprehensive research and development program in the Indian State of Odisha is based on the drought and submergence tolerant rice varieties in the seed system, facilitating targeted production and sale using a digital estimation tool and providing site-specific nutrient recommendations through ICT based tool-Rice crop Manager (RCM) to the rice farmers of the state. The project Productivity and Profitability of Small and Marginal Farmers in the Rice-based Cropping Systems Under the Assam Agribusiness Rural Transformation Project (APART) is based on four objectives: 1) Enhancing adoption of stress tolerant

rice varieties (STRVs) and strengthening seed supply system in Assam; 2) Raising productivity, profitability and resource-use efficiencies of rice-based systems in the state; 3) Strengthening post-harvest management; and 4) Development of extrapolation domains of the cropping systems. IRRI is also supporting the Government of Bihar through Bihar Agricultural University (BAU) in developing their capacities under climate resilient agriculture (CRA) project. Researchers, academicians, extension professional and other stakeholders under CRA project getting capacitated around climate resilient rice based agri-food systems based on IRRI's innovations and research. Another program is on securing the food systems of Asian Mega-Deltas for climate and livelihood resilience (AMD). New CGIAR Climate Change initiative focuses on deltas as these are called the food baskets and are now facing a threat due to climate change. For AMD, the new CGIAR is focusing on India, Bangladesh (Ganges Delta), Myanmar (Irrawaddy Delta) and Vietnam, Cambodia (Mekong Delta). Food systems in deltas can be secured by adopting deltaic production system, making smart investments and by digital solutions to de-risk value chains, inclusion of natural resources in governance and policy and following evidence-based delta development planning.

Apart from the technological innovations, training the next generation of scientists is also a priority for IRRI. In IRRI Education, there are five main modalities of intervention for capacity development and all are available at the IRRI South Asia Regional Center (ISARC) in Varanasi such as short & long courses, scholars & youth engagement, online learning, knowledge platforms and advisory around capacity development impacting individual and institutional capacities. Education and capacity development during 2020 and 21 shows that 1667+ senior level participants were trained as a part of IRRI's institutional trainings at ISARC. A total of 93,807 beneficiaries were trained through research projects, developed self-paced e-learning modules for short term courses and trainings via online learning in 2020 and 2021. IRRI Education also hosted 75 scholars from 7 countries were hosted for PhD, MS, BS, internship and on-the-job job trainings. Rice Knowledge management and sharing through localized Rice Knowledge Bank in Assam and Odisha has been supported. Under south-south collaboration, knowledge exchanges and other events have been held to support capacity development in Asia and Africa.

IRRI is ready to innovate not only in research but also in research procedures and efficiency, by providing widely acclaimed models on breeding and breeding services, Business Development, Portfolio Management, Technology Transfer, Education and Training and Extensive and active role in precision farming. IRRI policy work enables them to create impact on the ground and Seeds Without Borders, which ensures

rapid release & deployment of rice/other crop varieties across the border, helps in recognizing seed certification system across signed countries for accelerated varietal acceptance and seamless sharing of data on varietal evaluation for commercialization. Under this policy, varieties were exchanged between Bangladesh and India where 6 varieties were imported and were scaled up. Seeds of 2 varieties were also exchanged from Nepal to India and another 4 are under import by 2021.

Strategic collaborative research areas

- Monitoring, Reporting and Verification tools to support rice carbon credits
- Management options to reduce GHG emissions and to adapt to climate change
- Smart policies to support food systems transformation
- Farm diversification to increase nutrition security and resilience to climate change

On-going IRRI work in India

IRRI continues to work with the Government of India and its stakeholders on many different initiatives. These projects include, but are not limited to, the following:

- Creating Livelihood Opportunities through Mechanization, post harvest and rice value chain development in Assam (APART). The APART has focused on the resilience technologies of rice value chains by increasing access to updated knowledge and technologies. The Project is trying to empower farmers for better decision-making so that yield gaps are minimized, farmer's income is increased and a sustainable rice-based agri-food system is developed.
- Achieving Impact at Scale through Direct Seeded Rice Agronomy (DSRC, CSISA, DSR-Odisha)
- Strengthening extension and Agro-advisory Services (EiA South Asia use case). This project aims to empower poor smallholder farmers in Asia-Pacific Region through access to improved, more effective and demand-driven Agriculture Advisory Services
- Enhance Resilience and Yield in Rainfed Environment in South Asia
- Conservation and preservation of Local Landraces & Tailored management practices for specialty rice
- Regenerative agricultural practices in rice-based systems for soil health and environment sustainability
- Rice-fallow management in Odisha and Assam where rice (3.5 mha) and fallow (2.0 mha) systems are mapped.
- Development of climate resilient rice
- Landrace improvement/breeding for improved grain quality
- Digital agriculture for scaling and system transformation

IRRI works with partners to strengthen the national research capacity of rice growing countries in South Asia and sub-Saharan Africa. The goal is to deliver advanced research, education and services to improve crop production, grain quality and the nutritive value of rice. As India is going to be the third largest economy in the world by 2030, IRRI will work together with NARES partners to develop a comprehensive South-South program for collaboration with the IRRI South Asia Regional Centre at its core.

The partnership can generate even more milestones as IRRI transitions to One CGIAR. Under the One CGIAR, the scientific innovations are deployed faster at a larger scale and at reduced cost and would have greater impact where there is utmost need. By providing integrated and trans-disciplinary approach for bigger impacts, by leveraging capacities from across the CGIAR system to support local partners transform regional systems as they have a network of more than 3,000 partners globally.

More projects are in the pipeline, including new strategies and innovations that can further improve the lives of India's smallholder farmers.

Key takeaways

- South-South collaboration aims to strengthen national research capacity of rice-growing countries in South Asia and sub-Saharan Africa.
- India and IRRI will continue its partnership to deliver advanced research, education and services to improve crop production, grain quality and rice nutritional value in the country and of the region in particular.

BUILDING RESILIENCE AGAINST CLIMATE CHANGE

ROLE OF TECHNOLOGIES, POLICIES AND INSTITUTIONS

Pramod Kumar Joshi

Dr P.K. Joshi is former Director-South Asia, International Food Policy Research Institute, Washington DC. His research areas include technology policy, market and institutional economics.

During 1951 and 2010, human influence has been the major cause of global warming. Human-driven changes in land-use and land cover such as deforestation, urbanization and shifts in vegetation pattern have altered the climate, resulting in changes on the reflectivity of the Earth surface, emissions from burning forests, urban heat island effects and changes in the natural water cycle. Due to climate change, 2019 was the second hottest year in last 140 years. In India, greenhouse gas emission in 2019 was 6.55 per cent of the global greenhouse gas emission—70 per cent was from the energy sector, 20 per cent from agriculture, 5 per cent from industrial processes, 3.8 per cent was from land-use changes and 1.2 per cent was from waste.

Climate change is adversely affecting agricultural production, food security and livelihood opportunities. Climate change is weakening resilience and increasing vulnerability due to environmental shocks, leading to food insecurity and economic instability. Around 10-40 per cent losses in crop production are due to rise in temperature.

Concerted efforts at the global and at the national levels are underway to minimize impact of climate change. The Paris Agreement is committed to limit global warming to below 2 degrees Celsius; preferably 1.5 degrees Celsius. Sustainable Development Goal 13 (Climate Action) would focus on taking urgent action to combat climate change. Technologies, policies, institutions and infrastructure would play a key role in minimizing impact of climate change and building in resilience in the agriculture sector.

Climate smart interventions would lead to increased yields and farm incomes, besides reducing risk arising due to climate change and mitigate greenhouse gas emission. With climate smart agriculture, yields can be increased to 10-17 per cent and cost reduction would be up to 10 per cent. It would also save energy and increase rate of returns on investment in agriculture. Policies such as 'Prime Minister's Irrigation Scheme', 'National mission on Micro Irrigation', 'Soil Health Cards' and Prime Minister's Crop Insurance Scheme, would increase farmers' incomes, minimize risk and reduce greenhouse gases to minimize climate risk.

Key issues in upscaling climate smart agriculture (CSA) include limited resources; as government has limited resources to allocate in multiple areas and CSA being a new concept, there is lesser expertise in this area and thus project formulation and implementation would be different and chances of failure would be relatively more. CSA is location specific and thus results would vary from location to location. Also, upscaling processes and mechanisms are to be evolved; as there are no guidelines so far for CSA. There is a need to mainstream climate actions in development activities, research and extension agenda and investment priorities through convergence of government programmes and policies. A strong partnership at the global and regional levels would facilitate exchange of best practices, attract climate finance and enhance capacity of all stakeholders.

Key takeaways

- A strong partnership at the global level and at the regional level can facilitate exchange of best practices and enhance capacity of all stakeholders to minimize impacts of climate change.
- Need is to explore and focus on promising efficient, sustainable, resilient and eco-friendly climate smart technologies.

Azadi Ka Amrit Mahotsav

SUSTAINABLE AGRICULTURAL INTENSIFICATION FOR IMPROVING FOOD SECURITY AND CLIMATE RESILIENCE

P.V. Vara Prasad

Dr P.V. Vara Prasad is a Professor of Crop Ecophysiology and a Director of Center for Sorghum Improvement in the Department of Agronomy at Kansas State University. His research mainly focuses on understanding responses of food grain crops with changing environments (temperature, water and climate change factors) and developing crop management strategies for the efficient use of inputs.

Sustainable agricultural intensification (SAI), an all-inclusive platform and approach, focuses on increasing agricultural productivity from the existing farm lands without any negative impacts on environment. The terms sustainable and intensification indicate desirable outcomes of more food and also improved environment simultaneously. Sustainable agricultural intensification components include socio-economic intensification, agro-ecological intensification and genetic intensification. Socio-economic Intensification involves a greater variety and range of farmers in the social and economic processes and of the institutions

on the farm, in the community and also across the regions and the nations. Adoption of new practices and technologies by farmers would only happen and persist if an appropriate enabling environment favours intensification of agriculture and its sustainability also. This would lead to income generation, entrepreneurship development and private sector engagement.

Agro-ecological intensification includes building natural capital, precision agriculture and diversification. Natural capital (biophysical assets within natural environment delivering economic value through ecosystem services) can be conserved and enhanced through varied approaches — organic agriculture, water conservation and conservation agriculture. In precision agriculture, inputs whether nutrients, pesticides, seeds or water are used in a precise and strategic way to ensure their minimal use with minimal environmental impact.

Genetic Intensification includes 'conventional plant breeding,' 'biotechnology,' and 'livestock breeding'. Conventional and modern plant breeding can be through participatory plant breeding, improving seeds through hybridization or enhancing their nutritional properties with biofortification or creating resistance to pests and diseases.

Sustainable agricultural intensification is the interaction between genotype, environment, management and social aspects. It is estimated that 163 million farms (29 per cent worldwide) all over the world are practicing SAI on 453 million hectares of agricultural land.

Investments in innovations in the SAI in the Global South are extremely low and require attention to meet Sustainable Development Goals and climate targets of Paris agreement.

Focus should be on systems approaches with broader one-health concept— earlier only humans and animals were included but now soil and plant health are also inclusive to this. Focus should be on the soil health because if the soil is healthy, it would produce healthy plants, leading to healthy animals and humans; ultimately ecosystem would be healthy. This one health concept is based on the principles on improving efficiency, zero losses or waste, lifecycle analysis and lowering carbon, water and energy footprint.

Due to climate change, the mean temperature in the last decade has become significantly warmer (with an increase of 1 to 2°C in annual temperature in most areas). In year 2020 Europe had one of the warmest year, Bangladesh experienced floods. US experienced severe drought and it also had largest storms. These extreme events due to climate change are negatively impacting productivity and quality of food crops. There is an urgent need to develop and scale climate smart agricultural practices to increase resilience of cropping systems through adaptation and mitigation strategies.

Climate Change Mitigation refers to efforts for reducing or preventing emission of

greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior.

Sustainable agricultural intensification provides a holistic approach to address global challenges (food security, nutrition, climate change and resilience) and offers local solutions for impacts and outcomes.

Key takeaways

- A comprehensive framework is needed to measure impacts of innovations across multiple domains (productivity, environment, economic, social and human condition) to understand better trade-offs and synergies.
- Investments in innovations, human-resource building, social capital and institutional capacity are crucial.

CAPACITY-BUILDING AND TECHNOLOGY DEVELOPMENT BY TECHNICAL INSTITUTIONS IN NATIONAL CLEAN AIR PROGRAM

Sachchida (Sachi) Nand Tripathi

Prof. Sachchida (Sachi) Nand Tripathi is presently working in the Department of Civil Engineering, IIT, Kanpur. He has contributed significantly to address challenges of air pollution and climate change. He is also a National coordinator of National knowledge network of clean air programme, Ministry of Environment, Forest and Climate Change. His pioneering work in aerosol-induced cloud invigoration effect (AIvE) would contribute significantly to avoid flash floods in future urban planning.

The clean air programme was launched during 2019 to deal especially with PM (particulate matter)10 (dust particles less than 10 micron). The national clean air programme (NCAP) is a pollution control initiative with a major goal of reducing size of 2.5 micron to 1/3rd by 2025. The programme goals are—to enhance research to address it on the scientific base; to create more institutes and to increase capacity-building; and to mitigate sources air pollution (vehicle pollution, agri biomass burning and power generation). is a greater need of

capacity-building. The programme is science-driven and we need to bring in national laboratories.

This programme is spread across 89 institutes of repute (IoRs), which have been identified in 133 non-attainment cities, spanning 24 states and 2 UTs. Non-attainment cities are the ones where the air is polluted and does not meet the standards set by the Government of India. The programme is city-specific. These IoRs have been mapped with the non-attainment cities according to their capacities. Framework for third party assessment of NA cities by IoRs has already finalized. Real-time source appointment of particulate matter and volatile organic gases to know different sources that create particulate matter is very vital in measuring pollution level of PM in specific localities.

Measuring real-time source appointment of particulate matter and volatile organic gases

1. Filter-based source apportionment includes collection of samples on filters stored and analysed to know chemical pollutants source. Filter-based source apportionment is a slow process, is expensive as requires highly trained manpower, equipment and is unsuitable for real-time policy action.
2. Real-time source apportionment collects the data with mass spectrometer. This method is faster, as the time is reduced to a few days. It is expensive but gives complete specialization of PM levels in the air. Hence it is suitable for real time policy action and citizen awareness but is not suitable for hyperlocal monitoring.

A complete experiment on real-time source apportionment was done covering an area from Hisar to Kanpur and recently Lucknow has also been included. It has covered around 1500-square kilometres.

The National Capital Region (NCR) encompassing New Delhi is one of the most polluted urban metropolitan areas in the world. Real-time chemical characterization of fine PM 1 and 2.5 was carried out using three aerosol mass spectrometers, two aethalometers and one single particle soot photometer (SP2) at two sites in Delhi (urban) and one site located approximately 40 km downwind of Delhi in January–March 2018. PM2.5 particles were composed mostly of organics (43–44 per cent) followed by chloride (14–17 per cent), ammonium (9–11per cent), nitrate (9 per cent), sulphate (8–10 per cent) and black carbon (11–16 per cent) and PM1 particles were composed of 47per cent organics, 13per cent sulphate as well as ammonium, 11per cent nitrate as well as chloride and 5per cent black carbon. Organic oxidative aerosol (OOA) constituted a majority of the total oxidative aerosol (OA) mass (45–55 per cent) being maximum during afternoon hours~(70–80 per cent). Significant differences in the absolute OOA concentration between the two urban sites indicated influence of local emissions on the oxidized OA formation. Similar PM chemical composition, diurnal and temporal variations at the three sites

suggest similar type of sources affecting particulate pollution in Delhi and adjoining cities; but variability in mass concentration suggest more local than regional influence.

Another experiment on real-time chemical specialization and source apportionment of organic aerosol (SOA) components in Delhi showed high prevalence of SOA during daytime dominated by aromatic SOA mainly from automobiles emissions. Reversal was during night with hydrogenated organic aerosol (HOA) being the dominant source; overall SOA is substantial fraction of the total PM mass with anthropogenic SOA being dominant factors. The secondary organic aerosols appear major drivers of variation in the intrinsic OP of PM2.5. Although the average PM1 mass concentration at Delhi was 13 times the average PM2.5 mass concentration reported in Illinois, USA, in a similar study. These findings reveal substantial spatial heterogeneity in the redox properties of PM and highlight importance of determining the PM chemical composition along with its mass concentrations for predicting overall health impacts associated with aerosol exposure.

The installation of low-cost sensor networks in multiple cities is in progress. Presently 200-300 such sensors have been installed (the requirement is of 4000 sensors). These can measure carbon monoxide, ozone, sulphur oxide and PM2.5; these can be connected with the artificial intelligence to get the real time data.

Several cities have initiated the implementation process. It is therefore, imperative to build capacity and knowledge for sector-wise and department-wise strategies to achieve objectives of clean air action plan. Over 400 Air quality professionals from urban local bodies, state pollution control board and other organizations have been registered for capacity building. Many human ailments are directly or indirectly the result of deteriorating air quality. The decreasing size of pollutant especially secondary pollutants in air are the major cause of concern. To address the problem adequately we need real time data of particular location about air pollution and for this low-cost sensor would be of great help. The precise measurement of source, size and nature of air pollution would facilitate framing an effective strategy for its mitigation.

Key takeaways

- Measure level of air pollution to know its precise source, composition and effect.
- Low-cost sensors are vital to measure air pollution.
- Capacity-building on various aspects of air pollution, about its source, measurement, source minimization, safe disposal and clean practice would help in cleaning air quality effectively.

INNOVATIONS IN ADAPTATION TO CLIMATE CHANGE IN DRYLAND AGRICULTURE

Kadambot H.M. Siddique

Prof. Kadambot H.M. Siddique is the Hackett Professor of Agriculture and Director of The University of Western Australia's Institute of Agriculture. His forte is in agricultural research, teaching and management.

Dryland systems include dry subhumid, semiarid, arid and hyperarid areas. Drylands comprise 41.3 per cent of the global terrestrial area and are home to 34.7 per cent of the global population. Climate change will reduce agricultural yields in the countries by 2050 under current practices and crop varieties. Temperature, rainfall and carbon dioxide are the main drivers of climate change with Temperatures rising, rainfall declining and evaporation increasing. Agricultural activities do not always produce greenhouse gas (GHG) emissions, as they depend on soil and environmental conditions, resource availability, farming technology, crop inputs and farm managers. Cropping practices that can reduce GHGs include diversifying crop rotations, optimizing fertilizer amount, timing and application rate, incorporating nitrogen-fixing pulses in rotation, sequestering soil carbon and adopting low soil-disturbance practices. Increasing crop yields by decoupling or reducing GHG emissions would improve to social economics, such as farmer profitability, rural employment and farm sustainability.

Australian dryland systems are based primarily on mixed crop and pasture/

livestock enterprises. The University of Western Australia's Institute of Agriculture has developed an integrated cropping system that incorporates four key components: (1) intensified cropping through relay planting or intercropping, (2) within-field strip rotation, (3) soil mulching with available means such as crop straw/plastic mulch and (4) no-till or reduced tillage.

Intensified cropping through relay planting coordinates competition among relay crops and enhances interspecies interactions and water/ nutrient sharing during the co-growth period. The warm-season crop, follows the harvest of the cool-season crop, leading to vigorous growth and resource use from both steps, generating compensatory effects such as increased crop yields and proits and decreased carbon footprint.

Soil mulching of maize (plastic mulch) yielded (7,000–11,000 kg ha^{-1} with water use efficiency of 19 –30 kg ha^{-1} mm^{-1} compared to 2,000–3,500 kg ha^{-1} and 7–10 kg ha^{-1} mm^{-1} for non-mulched maize. Straw mulch produced similar results.

Zero tillage benefits include early sowing, time, machinery and fuel savings, improved yield potential, soil structure (due to increased organic matter) and soil water dynamics (due to increased porosity) and decreased pollution, erosion and increased carbon sequestration (1 per cent carbon = 33 t ha^{-1}).

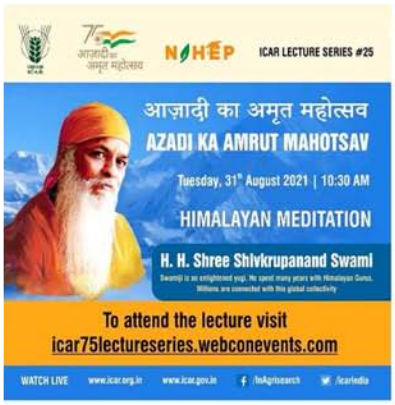
Diversified cropping systems in Australia have increased in recent years. While wheat remains the major crop, the cropping share of barley, canola and chickpea has increased in recent decades. In WA, GHG emissions are low due to efficient nitrogen fertilizer use, low nitrous oxide emissions from the cropping system and reduced methane emissions from good-quality local fodder. Eremophila glarba planted with inter-rows of pasture for livestock grazing reduced methane emissions. The benefits of growing traditional underutilized local crops include food and nutrient security, resilience to climate change (withstanding adverse climatic conditions and requiring low inputs), adaptation to harsh environments and low input agriculture, conserving biodiversity and cultural diversity and heritage, all of which improve livelihoods and rural, economic and social development. Australia needs to tackle the root cause of climate change. Early adaptation of sustainable practices, over the longer term the most important actions that businesses and governments can take would reduce GHG emissions. Deep and lasting cuts to GHG emissions in the food supply chain will deliver long-term benefits to consumers, exporters and farmers.

Adaptations should be based on minimizing the adverse negative impacts of variable climates. For adaptation to climate change, we need to understand past changes and adaptations.

Key takeaways

- Agronomic or genotypic approaches are needed to develop drought-and heat-resistant species.
- Growing traditional, underutilized, local crops would increase food and nutritional security and would develop resilience for climate change.

Health and Good Living


ICAR LECTURE SERIES #25
आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
Tuesday, 31st August 2021 | 10:30 AM
HIMALAYAN MEDITATION
H. H. Shree Shivkrupanand Swami
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आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
Post Covid Reforms
Thursday, 19th August 2021 | 12:00 PM
Dr. Krishnamurthy V Subramanian
Chief Economic Adviser, Government of India
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आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
Monday, 28th June 2021 | 11:30 AM
HOW TO OVERCOME STRESS
GURUDEV
SRI SRI RAVI SHANKAR
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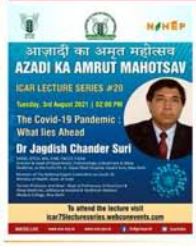
आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
ICAR LECTURE SERIES #20
The Covid-19 Pandemic : What lies Ahead
Dr Jagdish Chander Suri
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आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Wednesday, 27th April 2022 | 11:00 AM
Basics of Goal Setting
Dr. Radha Shankar Narayanan
CRO, Smart Series
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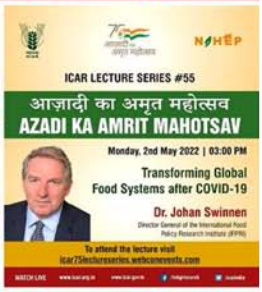
ICAR LECTURE SERIES #55
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 2nd May 2022 | 03:00 PM
Transforming Global Food Systems after COVID-19
Dr. Johan Swinnen
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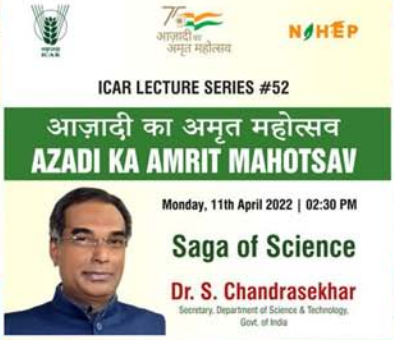
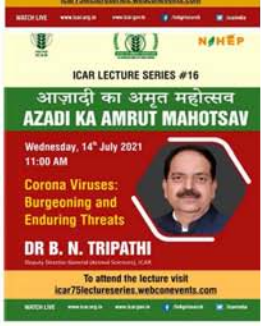

ICAR LECTURE SERIES #52
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 11th April 2022 | 02:30 PM
Saga of Science
Dr. S. Chandrasekhar
Secretary, Department of Science & Technology, Govt. of India


ICAR LECTURE SERIES #16
आज़ादी का अमृत महोत्सव
AZADI KA AMRUT MAHOTSAV
Wednesday, 14th July 2021
11:00 AM
Corona Viruses: Burgeoning and Enduring Threats
DR B. N. TRIPATHI
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ICAR LECTURE SERIES #67
heartfulness
advancing in love
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Friday, 8 July 2022 | 11:30 AM
Krishi Becoming Rishi
Shri Kamlesh D Patel
Fondly known as Daaji
President, Shri Ram Chandra Mission
Spiritual Guide, Heartfulness Meditation
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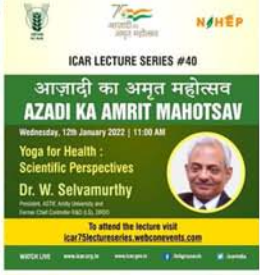
ICAR LECTURE SERIES #8
BHARAT KA AMRUT MAHOTSAV
Food and dietary concepts of Ayurveda--Indian traditional wisdome of food for better Nutrition and Health.
Tuesday, 1st June 2021 | 10:30 AM
DR. S. K. SHARMA
Former Advisor
Ayurveda in the Ministry of AYUSH for Govt. of India


ICAR LECTURE SERIES #40
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Wednesday, 12th January 2022 | 11:00 AM
Yoga for Health : Scientific Perspectives
Dr. W. Selvamurthy
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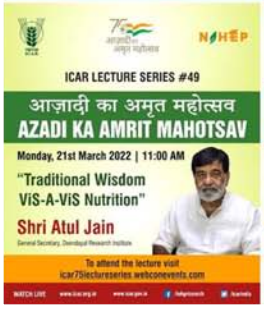
ICAR LECTURE SERIES #49
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 21st March 2022 | 11:00 AM
"Traditional Wisdom ViS-A-ViS Nutrition"
Shri Atul Jain
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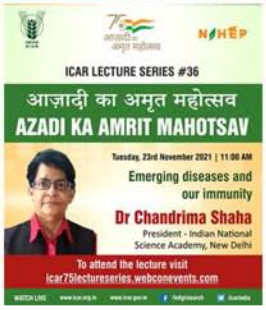
ICAR LECTURE SERIES #36
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Tuesday, 23rd November 2021 | 11:00 AM
Emerging diseases and our immunity
Dr Chandrima Shaha
President - Indian National Science Academy, New Delhi
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ICAR LECTURE SERIES #45
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 21st February 2022 | 04:30 PM
THE SECRETS OF SLEEP
Why Sleep ?
The hazards of not enough sleep.
The benefits of good sleep.
5 tips to get the best sleep possible.
Mr. Khurshed Batliwala
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ICAR LECTURE SERIES #26
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Wednesday, 1st September 2021 | 04:00 PM
46th Foundation Day of NAARM, Hyderabad
Innovations for Transformation
Dr Krishna Ella
Founder Chairman and Managing Director of Bharat Biotech
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KRISHI TO RISHI

Kamlesh D. Patel

Shri Kamlesh D. Patel is the President of the Shri Ram Chandra Mission and a Guide of Heartfulness Meditation. He is well known as 'Daaji' among the students of spirituality. He has travelled extensively and is comfortable with people from all walks of life.

With the population explosion, there is an increasing need for better and more yield. What it means is that we need more hands, better technologies, better agricultural practices and more organic cultivation. When we say 'more hands', we mean more farmers and agriculturists. At present, more and more people are moving to urban centres for white-collar jobs. It's time we educate our society on revolutionizing agriculture as a holistic career – from removing the external gloss and seeking the light within. From the Vedic times, our rishis have laid greater emphasis on agriculture. The great sage Parashara handed down his teachings on agriculture through Krishi-Parashara. His son, Rishi Vashista, advocated sustainable agriculture and organic farming. They are the examples of men who taught us the means of livelihood and yet remained connected with the divinity within.

At Heartfulness, we bridge ancient traditional knowledge with modern scientific understanding and associate ourselves with scientists to study the physiological and genetic effects of meditation and yogic Transmission. We believe in approaching spirituality with a scientific methodology–a practical approach stemming from experience and mastery in the field. I often say, "You are the experimenter, the experiment and also its result."

When we let go of our inhibitions and do our best, we often push beyond our limits and we progress. Keeping an open mind

and an accepting heart to receive spiritual guidance from the inner self helps us move forward. A calm and focused mind is necessary and is the very epicentre of our journey to achieve our goals and aspirations. Distractions, be they emotional, mental, physical, or spiritual, can stray us from our path. Overcoming distractions requires cultivating a conscious habit of developing self-awareness. Being aware and then when we get distracted, we need to gently steer our mind towards the right path and this requires some level of preparedness through inner training. The Gita says, "One who, having renounced all desires born in the mind, one who is content in the self and by the self, is said to be one whose inside is steady – sthita pragya."

We can get all the answers to our questions by meditating. The solutions to our problems can come from within. When the environmental initiative by the Heartfulness Institute known as Green Kanha was started, we committed to nurturing India's mega-biodiversity, indigenous and endangered species. At the time, the land was barren and arid. With natural farming methods for operations and maintenance, the soil quality improved.

Both grey and black waters are being treated with stored charcoal in jute bags and placed in percolation pits to purify the water from residual matter and impurities (charcoal is a natural purifier). Charcoal is also used as biochar to enrich the soil. Biochar increases carbon sequestration and improves soil health. The rainforest species are growing better in Kanha than in their natural habitat. This is all due to charcoal, as it improves soil and water quality.

There is also the effect of positive vibrations on the seeds and plants. The vibratory pattern is made up of our own thoughts. Everything impacts. Creating our environment is in our hands and it depends on how we conduct ourselves. Our own level of thinking and feeling creates a magnetic field around us and it radiates wherever we go. When our head, hands and heart are in complete synchronization, then we become yogis. Don't look for divinity outside; it is within you. We need to move from Krishi to Rishi. India must be the harbinger of a sustainable revolution in agriculture with soul and we are sure that we can spread this message across the world.

Key takeaways

- Right decisions can be taken only with a calm mind.
- Ancient traditional knowledge with a modern scientific understanding is the key to sustainable agriculture.

HOW TO
OVERCOME STRESS

Sri Sri Ravi Shankar

Gurudev Sri Sri Ravi Shankar ji is a Global Ambassador of peace. He has established Art of Living organization and millions of people are being benefitted from his talks and from his centres of Transcendental Meditation and Ayurveda.

Spirituality is seeking a meaningful connection with something bigger than yourself, which can result in positive emotions of peace, awe, contentment, gratitude and acceptance. Spirituality escalates the feeling of love, compassion and enthusiasm. This is not limited to any one religion or culture.

Nowadays the material demands of the people are increasing but the resources are not much and time is limited. All want to do more in lesser time that leads to stress. Stress can be from any event or thought that makes you frustrated, angry or nervous. When stress lasts for a long time, it may harm your health. Human body reacts to stress by releasing hormones. The hormones make your brain more alert, cause tension in the muscles and increase the pulse rate and when have chronic stress, the body stays alert, even though there is no danger. Over time, this leads to health problems high blood pressure, heart disease, diabetes, obesity, depression or anxiety. To reduce stress, we can increase the strength by doing pranayama/ meditation. Originally meditation was meant to help deepen understanding of the sacred and mystical forces of the life. These days, meditation has been commonly used for relaxation and for stress reduction. During meditation, the focus is in eliminating the stream of jumbled thoughts that crowd the mind and cause stress. One can practice meditation wherever one is while walking, riding bus, waiting at doctor's

office or even in the middle of a difficult business meeting. Meditation can give one a sense of calm, peace and balance that can benefit both your emotional well-being and overall health.

The Art of Living organization is working across 156 countries and over 450 million people are being benefitted from this. The term 'art-of-living' refers to enhancement in capabilities for leading a good life. They have various courses — happiness programme, advanced courses, blessing courses, Utkarsh yoga Sudarshan kriya etc.

Sri Sri Ravi Shanker emphasized that India is the country of Rishi Krishi; in ancient times all the rishis were farmers and all the farmers were rishi. But presently many farmers are committing suicides. Use of organic and natural farming may improve soil health and by adopting integrated farming, farmers' income can be increased. Need of the hour is to attract more youth towards agriculture. He also pointed out that India is the only country which gave Ayurveda and Yoga to the whole world.

Key takeaways

- Instil in all faiths in goodness of the society and also in one's ability and faith in one's power.
- Each and every one should follow 10 minutes of yoga, 10 minutes of pranayama and 5-7 minutes of Sudarshan kriya for one's overall development.

HIMALAYAN MEDITATION

H.H. Shree Shivkrupanand Swami

H.H. Shree Shivkrupanand Swami is an enlightened yogi, Indian spiritual teacher, author and Goodwill Tourism Ambassador. He has spent many years of his life in Himalayas with many revered Gurus. Since 1994, he has been sharing this 800 year old holy wisdom of Himalayan Meditation with everyone in the world.

Swami ji being born in a religious Maharashtrian family was inclined towards the understanding of the existence of God. He himself throughout his lifetime stayed connected to meditation. During his deep meditative trance, he envisioned images of the Pashupatinath a temple of Lord Shiva on a hillock located in Nepal.

His spiritual journey started unexpectedly. He was visiting Kanpur as a part of the job and due to certain unfortunate series of events, his work got delayed and he decided to visit Pashupatinath Temple in Nepal. During visit to this holy place, he met an old gentleman who told him that Shiv Baba was waiting for him in Himalyas. Here he encountered the same ascetic whom he had seen in his meditative visions. The Shiv Baba transferred all his spiritual energies into him. This marked the beginning of Swami's spiritual journey. He met several sages and yogis, who became his Gurus. It was during this phase Swami ji received the hidden treasure of the meditation technique, the one for the human soul's 'liberation' (Moksha). That meditation technique operates beyond religion, race, language and gender.

The motto of Shree Shivkrupanand Swamiji's life became spiritual empowerment of all humankind and enlightening them to the path of liberation. A devoted practitioner of meditation, Shivkrupanand Swami has mastered yoga for 18 years by living in the Himalayas and has been

serving a mission bestowed upon him by his holy masters. He is the founder of the Samarpan Dhyanyog, a simple way of meditation, which requires complete dedication of a practitioner to their holy masters or Gurus. Samarpan Dhyanyog serves as the perfect means to build a positive aura around oneself. In this ongoing pandemic situation when the emotional and mental stress has been at its peak, meditation can be a very effective means to achieve peace of mind. It has been scientifically proven to release stress, boost energy, control anxiety, develop concentration and purify the soul and the body.

Shivkrupanand Swami's methodologies include basic meditation and yoga techniques requiring comparatively less efforts. Beginners and practitioners, children and grown-ups can practice Dhyanyog and simple yogasan poses. Doing just 30 minutes dhyana would help one to be calm, relieving stress. The energy or vibrations produced during dhyana can also be used in agriculture. Farmers can use the vibrations on seeds before sowing them and on water tank used for irrigation water. This would increase yield and the produce would be of good quality.

Key takeaway

- To improve overall physical and mental health we must absorb ourselves in 30 minutes of *dhyana* every day.

SAGA OF SCIENCE

S. Chandrasekher

Dr S. Chandrasekher is presently the Secretary of the Department of Science and Technology, Government of India. His significant contributions are in the area of synthetic organic chemistry, especially in chiral chemistry and total synthesis of biologically active natural products (marine natural products with architectural complexity).

Science is an intellectual and practical activity encompassing a systematic study of the structure and the behavior of the physical and the natural world through observation and experiment. In traditional science, there was no organization, such as ICAR or DST and also there was no financial support, even for research. It was driven through personal passion. The researchers or scientists used to spend their own money. The first scientific observations were on sky, stars, planets and supernovas. Discovery of telescope by Galilio Galelei was a facilitator in these studies. Knowledge and understanding of various aspects of creation documented at length in the ancient texts is unmatched till date. One phenomenal Scientist was Sushruta, who taught the world the art of surgery, long before the advent of modern medicine. James Watt's steam engine and his studies of variations in temperature led to start of chemistry as a scientific discipline; John Black discovered carbon dioxide by heating white magnesia; Henry Cavendish identified presence of hydrogen and told that water is not an element, it is a compound; Joseph Priestley identified the presence of oxygen and its importance; Wilhelm Roentgen discovered X-rays (and we all know its importance at the hospitals); Marie Pierre Curie discovered radioactivity (lost her life due to aplastic anemia caused by

the exposure to radiations). It was the strong will of these scientists which led to different inventions. This all was the result of their hard work, farsightedness, passion and determination to never give up even after many failures.

Contributions of the scientists in the field of healthcare and agriculture have increased life expectancy world over. Many diseases which were thought to be non-curable have been brought under control or have been eradicated. By the year 2030, one would expect more targeted therapies; and practitioners would also be able to predict the condition and likely consequences of the patient being diagnosed with a disease or health and there would be shift from treatment of symptoms to prevention measures and complete cure. In future, prevention would play a vital role.

Agriculture has progressed with three major revolutions and made us self-sufficient in food at present— 1. Neolithic – change from hunter /gather's society to farming. 2. British-industrial evolution 3. Green revolution . And selection breeding has increased meat yield and size of maize corn from intermediate to modern type.

In the process of progress, we have also committed some mistakes and now is the time to think and correct them.

Challenges

Increasing population: India's population is expected to grow from 1.3 billion to 1.9 billion by 2050; how we are going to feed the whole population. Increasing numbers of people often raise demand for food, which typically results in additional use of land and water. This is especially true in the absence of adequate food production technology and integrated programmes that simultaneously address community needs for food and reproductive health.

Decreasing per capita availability of land: Per capita availability of agriculture land — it was 0.33 ha in 1951 and was reduced to 0.14 in 2001 and is expected to reduce further to 0.05 ha by 2030.With smaller land at disposal, there is a decrease in farmers' capacity to invest in land. With average land holding halved, the cost of getting inputs and time consumed would be doubling. If these are not resolved now, it will be difficult to maintain agriculture as a feasible profession.

Increased industrialization: The rapid growth of industries is leaving harmful effects on the human life, by polluting water and air. The establishment of more industries would escalate difficulties of degrading water and soil.

Climate change: Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns would increase the likelihood of short-run crop failures and long-run production declines.

All these challenges would lead to food scarcity crisis and rising food prices. High-yielding seeds and biofertilizers

are required to improve agriculture productivity along with better pest control.

Integrated Agriculture System

The Integrated agriculture system is the future. In the Integrated farming system, agriculture can be integrated with livestock, poultry and fish, maintained at the same place to generate employment around the year and also to get additional income. Integrated farming system compasses farm planning and budgeting (help in analyzing plans for of agricultural resources at the command of the decision-maker). In other words, the expression of farm plan needs to be in the monetary terms (through the estimation of receipts, expenses and profit)for animal production and aquaculture, crop protection (Integrated pest management and biological pesticides), vegetable production, traditional crop production, agroforestry and high value crops, soil fertility management (soil sampling, analysis, soil conservation and restructuring). We have to minimize the gap between the rich and poor. History of science is essential to understand the process, trends and future of science for human wellbeing. We have science and have had many revolutions. Revolutions such as Green, Blue, White and many others have generated enough food; famines have become a thing of the past. Now we have to work on happiness and parameters on which happiness of the country depends are GDP per capita, healthy years of life expectancy, social support, trust (absence of corruption in govt. and business), freedom to make life decisions, generosity and environmental social, urban and natural factors. We have to work on these parameters to make everyone happy and to make our planet happy. Our planet is getting angry and its temperature is rising; we have to make the planet cool and happy. If we all are happy, agriculture is taken care of and the planet will become happy.

Key takeaway

- Integrated farming system is the future for sustainable agriculture.

INDIAN TRADITIONAL WISDOM OF FOOD FOR BETTER NUTRITION AND HEALTH

S.K. Sharma

Dr S.K. Sharma is well known in the field of Ayurveda. One of his famous book is on Kshar Sutra Therapy in Ano-Rectal Disorder. His book entitled Medicinal Plants used in Ayurveda is often referred one.

Ayurveda is the science of life. It preserves the health and it cures diseases. Food is very important for life. The origin of human being, their health as well their diseases are all in a way caused by food. The principles of Ayurveda are based on Panchmahabhutas (five element theory). Combination of five elements is signified in Tridosha — Vata (Earth + Air), Pitta (Fire) and Kapha (Water + Earth). Ayurveda has recognized three sub pillars (Upasthambhas) — Ahara, Nidra and Brahmacharya — vital for running healthy and secure life. And Ahara has been deliberated as one of the best sustainer of life (Vrittikaranam Sreshtam). A well-balanced diet in Ayurveda is based on the Panchabhautic composition and Tridoshas impact living being.

The Food Nutrition and Science of Dietetics is interwoven in the matrix of Ayurveda. It is popularly said, if you follow good diet regimen there will be no illness. And during illness and treatment if you don't follow good food & dietary regimen, the

medicine and treatment will be futile. The food items when consumed by a person gives beneficial – wholesome effects (Hitaahara – Pathya) and unwholesome – bad effects (Ahitaahara – Apathaya). Food products can be consumed in four ways — as a drink, as an eatable, as a chewable and as lickable (Linctus). The food has twenty qualities (gunas) in pairs each pair of opposite attributes — heaviness & lightness, cold & hot, unctuousness & Dryness, dullness & sharpness, stability & fluidity, softness & hardness, no sliminess & sliminess, smoothness & roughness, subtleness & grossness, solidity & liquidity. Health-conscious citizens around the globe would benefit from the wealth of knowledge on traditional Indian and ayurvedic health foods of Indian origin. This also in a way would help Indian Farmers to increase their income by cultivating many Ayurvedic herbs.

Key takeaways

- Nutrient secured food is the basis for proper healthy living.
- Traditional Indian and Ayurvedic health foods of indian origin needs to be brought to awareness.

YOGA FOR HEALTH
SCIENTIFIC PERSPECTIVE

W. Selvamurthy

Dr W. Selvamurthy is working with the Amity University as President, Amity Science, Technology and Innovation Foundation. His research and development contributions include development of life-support technologies for soldiers, nano-technology application for defense, application of yoga for armed forces and military psychology.

On the International Day of Yoga, Hon'ble Prime Minister of India in his United Nations address said " Yoga is an invaluable gift of India's Ancient Tradition. This tradition is 5000 years old. It embodies unity of mind and body; thought and action; restraint and fulfillment; harmony between man and nature; a holistic approach to health and well-being. It is not about exercise but to discover the sense of oneness with yourself, the world and the nature. By changing our lifestyle and creating consciousness, it can help in wellbeing. Let us work towards adopting an International Yoga Day."

Yoga means to yoke, body and mind. Yoga means to unite **Jeevatma** with **Parmatma**. Patanjali, the father of yoga, described Yoga as "restriction of the fluctuations of consciousness." The practice begins by sitting and calming fluctuations of the body, breath and senses and then the more elusive whirlings of the consciousness.

India is the lighthouse of yogic science for propagation of yogas; is a tourist destination for healing and rejuvenation. Many people go to Haridwar, Rishikesh and Bengaluru to learn yoga. The yoga study centers in India for disseminating light of ancient wisdom across the world are now certified. Ministry of AYUSH has started Yoga Certification Board there are

300 accredited yoga centers. The yoga certification has been started like NAAC this has raised the standard of yoga across the globe.

We need yoga to be healthy (physically, mentally and spiritually) for spiritual evolution and to raise our consciousness. "We are not human beings having a spiritual experience. We are spiritual beings having a human experience". There are different types of yogas — Karma Yoga, Bhakti Yoga, Jnana Yoga, Hatha Yoga, Tantric Yoga, Kundalini Yoga and Raja Yoga. COVID 19 had brought life to a standstill. As human beings, we are not habitual of living in isolation. So many people faced mental disorders and anxiety. Also fear of losing life and job, working from home and temporary unemployment led to depression to many others. Approximately 200 million people experienced mental disorder, but the persons who were doing Yoga, were comparatively safe and faced almost nil anxiety and mental disorder. Yoga also helped them in fast recovery.

Yoga potentials can be categorized in the following three parts.

1. **Prophylactic potentiates**: In the day-to-day life, we are not regularly exercising. This may lead to diseases, like arthritis and diabetes. There is also disharmony between the body and the mind, increased stress, pollution (water, air) and infections.

Yoga is a total exercise and small movements through this are indirectly linked to mind, which harmonize mind and body. It helps in stress management by optimizing perception and then resulting in optimized response. Yoga strengthens our internal body organs — liver, kidney and spleen. It also promotes cell-mediated immunity and provides stamina to fight back infections.

2. **Promotive potentials**: Yoga gives submaximal level of exercise and increases flexibility of body, concentration, memory, learning efficiency and decreases anxiety and stress.
3. **Curative potentials**: Yoga leads to biochemical changes in the body. Decreased level of blood glucose, blood cholesterol and increased total proteins were observed after yoga. It has been also found to reduce the rate of lactic acid build-up ; thus reducing fatigue as increased levels of lactic acid cause fatigue. Yoga also increases cold resistance of the body by non-thermogenesis.

Yoga brings in stability to mind, body and soul, conserves energy and creates mental tranquility. Rajyoga meditation also helps in reducing anxiety, depression, impulsiveness and vulnerability and increases hope and happiness. Introduction of yoga at school/ college level can lead to holistic personality

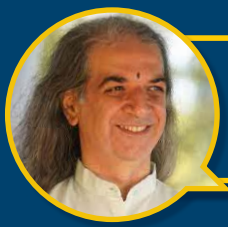
development, in learning healthy lifestyle, promoting creativity and innovation and may help in coping with stress, along with resilience-building.

Key takeaways

- Yoga is a science based way of life, and needs to be promoted.
- Yoga should be adopted in the ICAR Institutions.

THE HIDDEN GEMS OF THE SLEEP

Khurshed Batliwala



Mr Khurshed Batliwala, an Art of Living teacher, interest includes importance of rest (sleep, meditation and mindfulness) for sustainable growth and work-life balance of an individual.

Sleep is a natural recurring state of the mind and the body, characterized by the altered consciousness, relatively inhibited sensory activity, reduced muscle activity and the activity of almost all voluntary muscles during rapid-eye movement (REM) in sleep and with reduced responses to surroundings. When one sleeps well that directly affects ones mental and physical health. Unhealthy habits and lifestyle choices may leave one tossing-and-turning at night and in a way may adversely affect one's mood, brain, heart health, immune system, creativity, vitality and weight.

Sleep is very important for our alertness; there is a road law that stops one to drink and drive but there is no law to check for drowsy driving. More accidents are caused owing to drowsy driving. Even the decision-making ability is affected when one has not had enough sleep. All the brain-related diseases such as Alzheimer are due to lack of sleep.

Greatest inventions have happened only when the person is alert and focused — Newton discovered law of gravity while he was relaxing under the tree. Hard work is very important but after intense work one needs time to unwind and sleep is the best unwinder. Methew Halker said that "Sleep is the nature's best remedy to immortality". Sleep is the first thing which we have to look for and after enough sleep, falling sick would be reduced automatically. Diet and exercise are also important, but sleep is the basic for healthy life.

Five Steps to Sleep Better

1. Avoid white light in the night as it gives illusion of the day. Use of yellow, orange or red light in night helps melanin secretion that induces sleep.
2. Improve sleep environment by reducing noise and by keeping room temperature cool and comfortable, preferably at around 18-24^{0}C.
3. Take a hot shower before sleep at night; it helps one to calm down, improve quality of sleep and induces sleep.
4. Eat dinner three hours before sleep so that energy is rightly used for body recuperation than digestion.
5. Try to sleep and get up at the same time every day.

Key takeaways

- Maintain a regular schedule for sleeping and waking up.
- It is recommended to sleep in East-west direction, not North-south.
- Place *dhub* grass (*Cynodon dactylon*) under the pillow to avoid nightmares.

INNOVATIONS FOR TRANSFORMATION

Krishna Ella

Dr Krishna Ella is the Chairman and Managing Director of Bharat Biotech, which gave India its indigenous COVID-19 vaccine. His areas of interest include veterinary vaccines, food processing and developing biotechnology infrastructure.

In Innovation ranking, India is at the 46th position globally. When an entrepreneur tries resolving a public problem, it leads to innovation. In India, innovation start has been from Hindu mythology (Lord Ganesha is the first example of organ transplanting — xenotransplantation — in the world); Golconda Fort was constructed without the help of engineers (here sound system in each building has a citadel-shape, positioned to transport sound up to three kilometres); discovery of zero (without zero we wouldn't have developed any software); eye surgeries; diamond cutting etc. Albert Einstein also vouched for Indian innovations and once said "we owe a lot to the Indians who taught us how to count, without which no worthwhile scientific discovery could have been made. Human-beings can innovate through imagination and knowledge by applying skills. Major example is of canola oil in Canada where with some innovative research pungency and colour quality was reduced in view of the preference of the European market (now 50 per cent of Canada export of Agri produce is of Canola oil). Innovation is how better we can use existing resources to produce better product to fetch higher returns. Indians have been using sesame and coconut oils since ages; but now with the branding and the innovative promotion of their health benefits, sesame oil (rich in vitamin E, Antioxidants and vitamin B) and coconut oil (helpful in Alzheimer's disease)

are being used in Europe. Branding can add value to produce of Indian farmers.

On the agricultural front, India does not need much innovations in production but need acumen in marketing. He pointed out why is Kollam famous for better production than Nagpur despite the same soil types? Kollam has opted for allied agriculture, while the Nagpur is using the conventional method of growing a single crop. Thus, the wrong choice of agricultural practices leads to suffering of farmers. Simple idea can prove to be a milestone in the start-up journey and with a technological solution, the entrepreneurs and innovators can resolve many upcoming problems of the country. Dr Ella shared his journey as an entrepreneur — how he converted major problems of India into opportunities. At the time of start-up two major problems in India were diseases caused by water and mosquito. He had set-up a lab with a business plan to create a cheaper hepatitis vaccine as there was a heavy demand for it in India. The company supplied 35 million doses for the National Immunization Programme at Rs 10 per dose and supplied 350-400 million doses to more than 90 countries. After launching a cesium chloride-free Hepatitis-B vaccine, which is claimed to be the first in the world, Bharat Biotech received a grant from the Bill & Melinda Gates Foundation to develop vaccines against malaria and rotavirus in 2002. He then developed typhoid conjugate and rotavirus vaccines, both of which were pre-qualified by the World Health Organization (WHO) in 2018— the rotavirus vaccine 'Rotavac', developed by Bharat Biotech is a five-drop vaccine, which is in line with his aim to develop vaccines with simple delivery mechanisms; vaccines "that can be given like polio drops". Bharat Biotech was the first company to identify, purify and sequence Chikungunya during its 2006 epidemic in Kerala and Tamil Nadu and was also the foremost company in the world to predict, work and file the patent on the Zika vaccine; much before the US and World Health Organization (WHO) recognized the problem. Ninety per cent of Bharat Biotech's vaccines are sold in "lower-middle-income countries" with affordable pricing. The path for developing a vaccine against Covid-19 and many others was not an easy task; it took around 20 years to develop Rotavac vaccine, which involved global scale public-private partnerships and a large-scale clinical trial,".

During this pandemic Covid19, Bharat Biotech did extensive research and produced Covaxin, 1st indigenous Covid Vaccine. Bharat Biotech has Biosafety level-3 manufacturing facility—1st efficiency trial in India was also done by Bharat Biotech Pvt. Ltd. Also conducted third phase Covaxin trial in the world with full manufacturing facility in India. Bharat Biotech has done a number of clinical trials and have published more than 80 research papers in high rate journals.

Transformative ideas needed to be addressed are: technology where is

global competition is (in CRISPR (gene editing technology) Chinese are going very aggressively and they are at number one even though the technology was developed by US; China has already done gene editing in 60 crops with CRISPR); need to protect our germplasm that is critical and we should have material transfer agreement before sharing material with others; more focus required on increasing productivity and while establishing export-oriented units emphasis should be on export crops based on the market demand. (We need not focus on mango only but we should also grow pomegranate, guava also for exports). Value-addition and market intelligence is important.

Key takeaways

- Entrepreneurs can compete globally through branding their products.
- Radical thinking is the key to innovation.
- Technologies of genetic modification and gene editing would facilitate better and environment resilient crops.

TRADITIONAL WISDOM *VIS-A-VIS* NUTRITION

Atul Jain

Shri Atul Jain is the General Secretary of the Deendayal Research Institution, Chitrakut. He is an academician, a media consultant and a social worker. He is working towards making policy interventions for the rural development and for validating true Indian philosophy of the Integral Humanism based on the experience gained through field-work and interactions with the rural people of India.

Indian Civilization has prospered for thousands of years by depending on natural, seasonal foods based on the ancient wisdom and the wealth of knowledge of nutrition. There has to be a balanced approach towards Body, Mind, Soul and intellect. Nutrition is not only for body but is equally so for soul. Rishis emphasized the importance of food as what we consume affects not only our physical body but also our state of mind – i.e., the functioning of our brain, our thinking, emotions, etc. In fact, our food habits impact our total personality as the saying goes "Jaisa Ann waisa Mann".

In India tradition (Utsav) is related to food and food is related to Utsav both are related to each other and we call it Poshan Utsav. Presently, when we talk about nutrition-sensitive agriculture to produce nutritionally rich foods, to create dietary diversity and food fortification for overcoming malnutrition and micronutrient deficiencies we need to think what we were utilizing traditionally. The overall objective of the nutrition-sensitive agriculture is to make global food system equipped better to nutritionally enriched products. Nutri cereals millets are lately included in the food — traditionally we were regular eater of this. During celebrations (first menstrual cycle, marriage, pregnancy) songs sung were to spread knowledge

and to create awareness of various physical changes they go through. In villages, the people still follow traditions and know the importance of eating right food at the right time and according to seasons. In Rajasthan, during hottest days of summer they celebrate "Peepal ki Shadi" and have sheetal pay, Gulkand, Rayta, which provide calmness to body and also enhances mood.

In the last two years of corona, we have quite often heard the word immunity and we found colostrum capsules were in a great demand due to its properties to enhance immunity. When calf is born, people used to celebrate it and distribute colostrum to the whole village alternatively. So, the Utsav and nutrition were going hand in hand. Even buttermilk was not sold, it was kept in the pot outside the house and anyone could take it as and when required and was the easy source of probiotics to the poor without cost. Pumpkin was grown easily and in ample quantity and was left outside the house or at crossroads and was called maind ki sabji and anyone could take it. Now we also know how nutritious is this — it contains aurum the gold chemical. Lotus stem/ kamal kakdi (Bhasid) has been used to make sabji and it is highly nutritious and it also served to clean pond and to increase soil fertility of the neighboring soils. Today doctors say "An apple a day keeps the doctor away" but when apple travel from Kashmir to Kanya Kumari, it loses its nutrition. It is very important to use local and seasonal fruits as they have high nutritional value and are easily available in that area. Along with the food, the utensils used for cooking also play a very important role in cooking and is based on the type of food required to cook in them. For example, bajra khichdi was cooked in heavy base utensils as it required more time for cooking. Different type of utensils such as metal, terracotta/ clay pot, stoneware and even leaves were used for cooking. All these traditions were followed with the help of the Dharma. Nutrition was also delivered through prasad in all the religions and places according to the season.

It is time to go back to our roots, to re-discover our glorious food heritage into our daily routine, our lifestyle. It is a firm time-tested belief, passed down from our ancestors, that cooking and eating in a harmonious and calm atmosphere at regular timing, nourishes and enhances our complete well-being. Nutrition security was in our tradition and now we have to think how we can go back to these traditions along with what more we can do to maintain food and nutritional security.

Key takeaway

- All our celebrations have been according to the seasons and in fulfilling the nutritional security of one and all; we have to rediscover the scientific facts behind them.

BASICS OF THE GOAL SETTING

Radha Shankar Narayanan

Dr Radha Shankar Narayanan is the CEO of Smart Series. She is skilled in Neuro-linguistic programming, Life coaching of students and hypnotherapy. She is helping students and teachers of the agricultural universities in changing their minds for better by soft skill trainings on "Personality Development" and "Faculty Development".

Setting goals is very important and their effectiveness and successfulness depends on the personality traits. There are three types of persons 1. Persons who make things happen, they are clear what they want, know what problems they will face, how they can overcome these problems and know who can help them in achieving the goals; 2. Persons who watch things happen, they do set plans but do not come out of their comfort zone to achieve their goals. Even if the goal is small, their journey would not be smooth in case they have to come out of their comfort zone; 3. Persons who will never set any goals, they criticise others. Making things happen is different from just watching things happen. Even watching things happen don't harm but one should not criticise. While watching we can learn and can set the goals accordingly. Some people know the goal but fear of failure and self-doubting stops them from setting goals.

Goal setting allows you to take control of your life's direction and it also points out whether you would actually succeed. Benefits of setting goals are: self-motivation, self-confidence and improved decision-making skills; besides these three, there are many more benefits of setting goals. If you have fear of failure, don't share your goals then there will not be any chance of criticism.

While setting goal we are confused between setting a goal and an objective. Objectives are small steps taken to achieve the goal and are for short-term. Goals are broad in nature and are for long-term. Before setting a goal ask yourself three questions — 1. What would you do and how would you change your life if given one crore money right now ; 2. What you would do when you will come to know that you will only live for next six months; and 3. What is that one thing when you do gives you whole lot of satisfaction? Answering these questions would help in setting goals and this works irrespective of age groups. Always write goals in a positive way positive as they are clearer and motivating. When stated in the positive, goals point us in a specific direction and allow us to measure ourselves continually towards that end. Goals should be SMART (specific, measurable, achievable, relevant /realistic and time-bound).

Set specific goals: The goal must be clear and well defined. You need goals to show you the way. Make it as easy as you can to get where you want to go by defining precisely where you want to end-up.

Set measurable goals: Include precise amount and date in the goal to measure the degree of success. Without a way to measure success you miss out that what you have actually achieved.

Set attainable goals: Make sure that you achieve the goals you set. If you set a goal that you have no hope of achieving, you would only demoralize yourself and erode your confidence. However, resist to set too easy goals.

Set relevant goals: Goals should be relevant to the direction you want your life and career to take place. By keeping goals aligned with this, you'll focus on what you need to get ahead and do what you want.

Set time-bound goals: Your goals must have a deadline. When you are working on a deadline, your sense of urgency increases and achievement would come much quicker.

We need to write the goal and fix it in a place where we can frequently see it, to keep on reminding ourselves—are we following the steps to achieve it? Where are we lacking? People depend on external factors to achieve their goals but it should be from within, we have to think about the ways what we can do to make people help us and what can we do to make circumstances in our favour. Taking responsibility of failure is very important, move from blaming people to supporting people, locus of control is important having internal control is very important in achieving the goals.

Key takeaway

- To succeed, smart goal setting is the priority.

CORONA VIRUSES
BURGEONING AND ENDURING THREATS

B.N. Tripathi

Dr B.N. Tripathi is Deputy Director General (Animal Sciences), ICAR. He has made pioneering contributions on immuno-pathobiology, diagnostics and vaccine development for various infectious diseases. He is Fellow of the Royal College of Pathologists, London.

Coronavirus disease (COVID-19) is an infectious disease, caused by the SARS-CoV-2 virus. Most people infected with the virus experience mild to moderate respiratory illness and recover without special treatment. However, older people and those with underlying medical conditions (cardiovascular disease, diabetes, chronic respiratory disease, or cancer) may require medical attention. There are more than 1,415 human pathogens, out of these 217 are viruses and prions, 538 bacteria and rickettsia, 307 are fungi, 66 are protozoa and 287 are helminths. About 61 per cent existing human infectious diseases are from animals and 75 per cent of the emerging infectious diseases of humans (including Corona, Ebola, HIV and influenza) also are of animal origin.

Coronaviruses are a large family of viruses known to cause illness ranging from common cold to severe diseases such as MERS and SARS. Coronavirus has crown-like spikes on its outer surface; thus, the name Coronavirus. The Corona viruses are enveloped viruses minute in size and contain a single stranded RNA. They are classified as Alpha, Beta, Gamma and Delta

coronaviruses. Human coronavirus (HCoV) infection is zoonotic and has originated from bats. First pandemic of 21st century; Severe Acute Respiratory Syndrome (SARS) killed one in ten of the infected persons. The pandemic was seeded from a single person on a single day on a single floor of Hong Kong hotel and the virus had spread to five countries within 24 hours. The Middle East Respiratory Syndrome (MERS) is of the same family as the SARS, but has some novel biological features. This virus was transmitted from camel to humans. Almost 1,300 people were infected with MERS in Saudi Arabia and other countries and 458 people had died. Natural reservoirs and intermediate hosts are facilitators in inter-species transmission of CoVs. It all had started from one person infected by one wild animal and the global health system is still struggling to cope with COVID-19. Immune response and disease spectrum after viral entry, initial inflammatory response attracts T cells to the site of infection, where the infected cells are eliminated before the spread of the virus. The cardiovascular system is often involved early in the COVID-19 disease consistent with the clinical context of coagulopathy. In COVID-19 patients cytokinens normally mediate and regulate immunity but may cause extensive tissue damage resulting in capillary leak, thrombus formation and organ dysfunction.

Complications of COVID-19 include pneumonia, respiratory failure, cardiopathy, acute kidney injury and viral and fungal infections. The virus can spread from an infected person's mouth or nose in small liquid particles while coughing, sneezing, speaking, singing or breathing. The best way to prevent and slow down transmission is to be well aware of the disease and how the virus spreads. Nasal droplets larger than 10 micro meter can be blocked by surgical mask and smaller once can be efficiently blocked by N 95 masks. Current COVID 19 vaccine development status shows that number of vaccines in clinical development stage are 108, vaccines in pre-clinical development stage are 184 and approved vaccines are 20. Of these 20 approved vaccines 9 are based on inactivated virus, 2 on mRNA, 5 vectored and 4 recombinant proteins. Moderna and Pfizer/ BioNTech are nucleotide-based vaccine candidate and Covaxin is inactivated or wholy killed virus candidate. Covaxin is India's first indigenous COVID-19 vaccine developed by the Bharat Biotech in collaboration with the Indian Council of Medical Research (ICMR)-National Institute of Virology (NIV). The vaccine had received DCGI approval for Human Clinical Trials. According to Bharat Biotech, Covaxin would be at least 60 per cent effective based on the earlier trial results. ICAR institutes (IVRI, NRCE, NIHSAD, ICFMD) are involved in COVID-19 testing. A total of 32 virus identified have been isolated from the first and second waves. The ICAR institutes are working on the inactivated vaccine, the candidate virus has been identified and characterized and fully sequenced.

Key takeaways

- Strong surveillance is required for detecting viruses in animals, wildlife and birds.
- Understanding pathogenesis of SARS-Cov-2 is vital to develop therapeutics, vaccines and supportive care modalities in the treatment of COVID-19.

THE COVID-19 PANDEMIC
WHAT LIES AHEAD

Jagdish Chander Suri

Dr Jagdish Chander Suri is the Director and the Head of Department, Pulmonology, Critical Care & Sleep Medicine, Fortis, New Delhi. He is one of the pioneers for development of advanced laparoscopic surgery in India. He has performed more than 40,000 laparoscopic procedures and has one of the best clearance rates for laparoscopic common bile duct (CBD) surgery.

India has the second highest number of documented cases in the world of COVID-19 at 3.15 crore and has the third highest number of documented deaths at 4.22 lakh. India has suffered from two devastating waves of COVID-19. Causes of the second wave were relaxation of COVID-19 precautions, opening of offices, markets, public transport, public gatherings and the arrival of the mutant strain 50 per cent more infectious and transmissible. And there has been a third wave. Coronavirus mutant variants have been of concern. As COVID-19 is an RNA virus and has a natural tendency to mutate. The more the virus spreads and replicates, the greater is the chance for mutations.

India has set-up an Indian SARS-COV-2 (severe acute respiratory syndrome corona virus 2) genomics consortium in 20 December 2020 to detect emerging variants of COVID-19. Four variants of concern alpha, beta, gamma and delta have been identified

To fully understand the spread and evolution of the SARS CoV-2 virus and to contain its future spread, sequencing and analysing genomic data of this novel corona virus would be required. The study of accumulated mutations in the

viral genomes would enable comparing of virus samples and viral lineages to understand if local outbreaks are caused by transmission of a single or multiple viral lineages. The Indian SARS-CoV-2 Genomics Consortium would help expand whole genome sequencing of SARS-CoV-2 virus across the nation, aiding in understanding of how the virus spreads and evolves.

Any changes to the genetic code or mutations in the virus can be observed based on the analysis and sequencing of the samples done in the laboratories. The labs would identify variants of concern or variants of interests. This information would then be passed on to the Central Surveillance Unit of the Integrated Disease Surveillance Programme for establishing clinico-epidemiological correlation in coordination with the State Surveillance Officers. The new mutations/variants of concern can be cultured and genomic studies would be undertaken to see the impact on vaccine efficacy and immune escape properties.

We can protect ourselves and community from the pandemic by taking COVID appropriate behaviour such as using masks, physical distancing, hand hygiene and by vaccination. Upgrading vaccination drive at a quick but sustainable pace is important. COVID-19 vaccine has been touted as the most effective public health measure to end pandemic. The production of a new influenza vaccine each year demonstrates that it is possible to adapt existing vaccines to keep-up with viral mutations. Each preventive measure may have some disadvantages (no mask is 100 per cent effective, maintaining 6 feet distance is not always practical). Adding extra layers of protection may help overcome the limitations. Besides maintaining healthy habits of sleeping enough, eating healthy food, drinking plenty of water and exercising may keep the immune system strong.

Key takeaways

- One needs to be vaccinated to be protected from infection.
- Use virus-killing disinfectants to clean phones, keyboards, door knobs, handles and faucets.
- Follow quarantine instructions fully when infected.

POST COVID REFORMS

Krishnamurthy V. Subramanian

Dr K.V. Subramanian, Former Chief Economic Advisor, Government of India, is a leading expert on the economic policy, banking and corporate governance. His idea of Thalinomics – what a common person pays for a vegetarian or a non-vegetarian thali – has been acclaimed as the Indian Big Mac Index. Presently is Executive Director at International Monetary Fund (IMF).

India's rich culture and spiritual heritage and social norms play a pivotal role in shaping the behaviour of its citizens. Behavioural economics is a discipline that assesses how emotional, social and other factors affect human decision-making, which is not rational always. It provides necessary tools and principles to understand the norms affecting behaviour and their utilization to effect behavioural changes. C.R. Rajagopalachari once said knowledge that does not issue out in action is useless in Dharma and everybody should think about responsibility before entitlement. Dharma has to become a daily activity in our behaviour and we should build this type of culture and follow our duties which would lead to a prosperous economy. During pandemic it was not just the management of the impact of the pandemic, it started from the health crisis, spilled over to real economy and thereafter even impacted the financial sector. Economy is gradually recovering after Covid-19, but to achieve the vision of Economy@5trillion by 2045, India has to accelerate and sustain a real Gross Domestic Product (GDP) growth rate of 8 per cent. India's economic policy toward a self-reliant India is presently characterized by a triangle or a tripod — (i) sharp focus on economic growth to complement efficient welfare by generating resources to fund welfare programs; (ii) growth

via private sector, occupying the commanding heights of the economy; and (iii) "virtuous cycle" of growth via public investment and structural reforms to enhance both aggregate supply and aggregate demand. Virtuous cycle with investment, especially private investment, as the main driver can enable growth in each of these important macro variables and help in creating more jobs. Economy of the advanced country and emerging countries cannot be compared because there is a conflict between growth and inequality in the advanced economies and there is convergence in growth and inequality in emerging countries. Advanced and emerging economies are different, for advanced countries if they can grow at the rate of 3 per cent annually would be sufficient but in India even the growth rate of per cent is insufficient. In India, number of people who are below poverty line is large and this issue needs to be addressed. Prosperity of a country comes from respecting the individual hand of market and trade; it is utmost to remove all restrictions for economic activity. Investment enhances productivity and creates jobs which would increase purchasing power and thus demand. When demand increases firms invest more and more jobs would be created, more jobs mean high productivity and high investments and likewise this cycle would keep on moving. These above mentioned three sides of the triangle are very important for India's economic development. Labour reforms and farmers reforms are very important for helping small and marginal farmers. Other reforms such as industrial, export, defence reforms, have similar basic philosophy to lead the country towards prosperity as they would increase GDP.

Key takeaway

- Policies should be objective-specific.

EMERGING DISEASES AND OUR IMMUNITY

Chandrima Shaha

Dr Chandrima Shaha was President, Indian National Science Academy (INSA), New Delhi (2020-22) and is the JC Bose Chair Professor at the Indian Institute of Chemical Biology. Her research interests centre around elucidation of processes influencing cell death under varied physiological conditions in different organisms.

Over 30 new infectious agents have been detected worldwide during the last three decades; 60 per cent of these are of zoonotic origin. Emerging infections are either new emergences or are drug-resistant infections, whose incidences in humans have increased in the last two decades. With the emergence of Covid-19 and other pandemics in the past, it is now known how destructive an infection can be. The pandemic of Coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has been classified as a zoonotic disease.

Contributing agents to emerging diseases

Human demographic changes act as a contributor to new diseases as humans have spread to places where earlier they were not present. This may lead to the possibility of humans coming in close contact with animals which are potential host of infectious agents. This can pose a serious threat to human health.

Climate change is another concern. As Earth's climate warms and habitats are becoming altered, diseases can spread into new geographic areas. For example, warming temperature is congenial for mosquito breeding; and mosquitoes can transmit disease-causing agents.

Antimicrobial resistance: Bacteria, viruses and other microorganisms can change over time and may develop resistance to drugs used to treat diseases caused by pathogens. Thus, the drugs which were effective in the past may not be effective in containing the diseases. Another cause of a disease to re-emerge is decline in vaccine coverage, a growing number of people choose not to be vaccinated.

Emergence of a disease may involve an adaptation of the disease agent to the new host — chikungunya virus outbreak occurred in 2005 in La Reunion Island due to mutation in its key position, which led to adaptation to the new host.

It is also important to understand transforming epidemiology of the virus. Mutations may alter pathogen biology such as pathogenicity, infectivity, transmissibility and antigenicity. Mutations can make bacteria resistant to antibiotics.

Ribonucleic acid (RNA) viruses are of major concern as they readily adapt to changing environments. The rate of evolution of SARS CoV-2 from December 2019 to October 2020 was consistent with the virus acquiring approximately two mutations per month in the global population.

The challenge for the immune system

The immune system is a network of biological processes, protecting an organism from a disease. Many species have two major subsystems of the immune system— The **innate immune system** provides a preconfigured response to broad groups of situations and stimuli; **The adaptive immune system** provides a tailored response to each stimulus by recognizing molecules encountered previously.

Immune system is to prevent infections and for vaccine efficacy. It is a double-edged sword it helps the host to fight infections and also cause significant damage in the form of autoimmune diseases. Immune system sometimes also goes in overdrive, known as cytokine storm. A cytokine storm is an uncontrolled inflammatory response caused by an excessive number of small proteins called cytokines. Some types of cytokines promote inflammation and signal for other immune cells to congregate in a certain part of the body. During a cytokine storm, an over activation of other immune cells like T-cells, macrophages and natural killer cells happens; and their uncontrolled activity can lead to tissue damage, organ dysfunction and sometimes death.

A comprehensive national strategy on infectious diseases in the country addressing the challenges of emerging and re-emerging infections cutting across all relevant sectors, both governmental and non-governmental, needs to be in place. Identification of national centres of excellence and their capacity building is of critical importance.

Concerted efforts are also needed to develop advanced countermeasures

such as surveillance tools, diagnostic tests, vaccines and therapeutics through basic, translational and applied research. Sensitive rapid response mechanisms at various levels of health service are the cornerstone to detect public health threats to respond quickly enough to protect human lives.

Key takeaways

- National commitment and comprehensive efforts on health services are necessary to meet threats of emerging and re-emerging infections.
- Epidemiological investigations on emerging diseases within the country should be given high priority to contain their spread.

TRANSFORMING GLOBAL FOOD SYSTEM AFTER COVID-19

Johan Swinnen

Dr Johan Swinnen is the Director General of the International Food Policy Research Institute (IFPRI) Washington, DC, USA and the Global Director of the Systems Transformation Science Group at the CGIAR. He has extensively worked on agricultural and food policies, international development, political economy, institutional reforms, trade and global value chains.

Since approximately 2015, the world has seen a reversal in the longer-term declines in hunger and malnutrition enjoyed in previous years. Currently, 3 billion globally people cannot afford a healthy diet, 2 billion people have micronutrient deficiencies and 2 billion people are overweight or obese. Many countries are facing a triple burden of malnutrition/ underweight, hidden hunger (where children suffer from a deficiency in micronutrients) and overweight. A turnaround in GDP growth per capita in low-income countries is associated with this reversal. But other key challenges continue to strain global food systems. These include COVID-19, conflict and climate change.

COVID-19-related loss of jobs and income had a significant impact on global poverty and nutrition, with a stronger effect on poverty in South Asia than Sub-Saharan Africa. Poor people's food and nutrition security have been disproportionately affected, mainly because the poor spend a large share of their income on food and because their main production

factor and asset is physical labor, which was disrupted. Women have also been especially vulnerable, due to the gendered impacts of income shocks, health measures and children's schooling.

Social protection programs have expanded significantly, which may persist over time, a potentially positive development. The pandemic has had heterogenous impacts on supply chains and food systems, with supply chains being more resilient than expected.

Innovations and entrepreneurship within the private food supply chain is alleviating obstacles to make food supply chains more resilient in the future. Use of information and communication technology (ICT) and e-commerce is proving to be an asset. Some of the most commonly deployed ICTs in agri-food industries include Radio-Frequency Identification (RFID), Cloud Computing Technology, Internet of Things (IOT) and Blockchain technology. These ICT solutions have the power to bring all of the components of complex supply chains, including farmers, processors, wholesalers, retailers and consumers onto a single platform, thereby enhancing transparency, traceability and efficiency in the flow of products, information and finance.

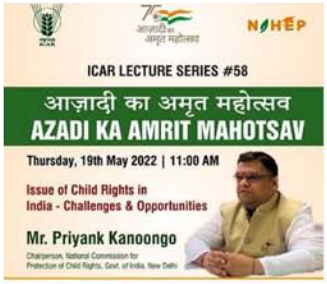
Trade can also play an important role in helping food systems become more resilient. During the 2008 food price crisis, many countries implemented long-term export restrictions. COVID-19 saw a similar wave of export restrictions, but many countries quickly removed them, showing improvements in information about food stocks and an understanding of how to weather these types of shocks. IFPRI and other organizations are currently widely communicating the importance of avoiding export restrictions in response to the 2022 food crisis. The current food crisis, which saw high food prices before Russia's invasion of Ukraine, is particularly challenging: the poor are still recovering from COVID-19; hunger and malnutrition were already on the rise; and many governments have little financial resources to mitigate the impacts.

Global food systems face many obstacles. But with investment into agricultural research and development, innovation, resilience and inclusion, they can be transformed and serve as a solution to many of the challenges of our times.

Key takeaways

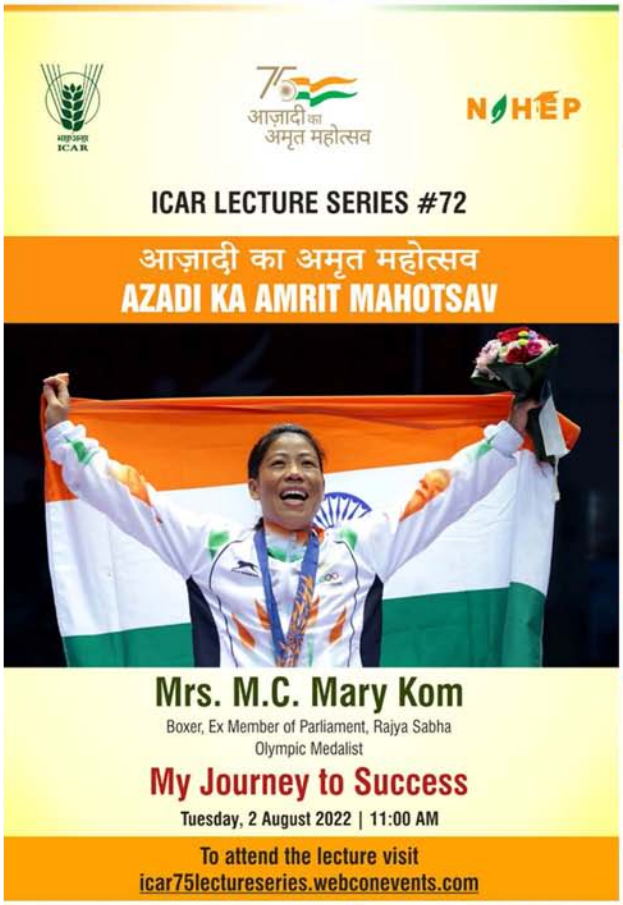
- The COVID-19 pandemic has had significant impacts on poverty and nutrition, on the poor and marginalized groups such as women bearing the brunt.
- We can learn the lessons from COVID-19 on the potential of innovation, trade and inclusion to help global food systems to check on similar or other shocks if they arise in future.

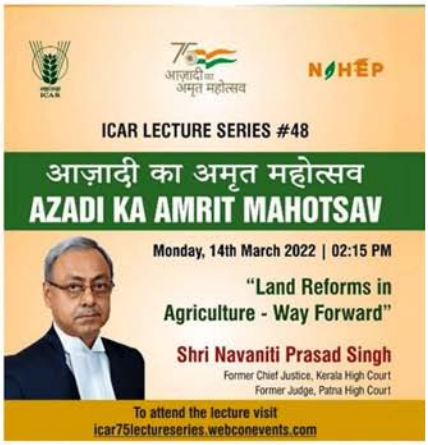
Social Issues and Sports


ICAR LECTURE SERIES #58
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Thursday, 19th May 2022 | 11:00 AM
Issue of Child Rights in India - Challenges & Opportunities
Mr. Priyank Kanoongo
Chairperson, National Commission for Protection of Child Rights, Govt. of India, New Delhi


ICAR LECTURE SERIES #63
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 20 June 2022 | 11:00 AM
Women in Leadership Role in India
Ms. Rekha Sharma
Chairperson, National Commission for Women


ICAR LECTURE SERIES #9
BHARAT KA AMRUT MAHOTSAV
Public-Private Partnerships for sustainable irrigation: Roles of government, users & the private sector
Monday, 7th June 2021 | 02:30 - 03:30 PM
DR. STEVE GOSS
Independent consultant for the World Bank and FAO
WATCH LIVE


ICAR LECTURE SERIES #72
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Mrs. M.C. Mary Kom
Boxer, Ex Member of Parliament, Rajya Sabha
Olympic Medalist
My Journey to Success
Tuesday, 2 August 2022 | 11:00 AM
To attend the lecture visit
icar75lectureseries.webconevents.com


ICAR LECTURE SERIES #48
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Monday, 14th March 2022 | 02:15 PM
"Land Reforms in Agriculture - Way Forward"
Shri Navaniti Prasad Singh
Former Chief Justice, Kerala High Court
Former Judge, Patna High Court
To attend the lecture visit
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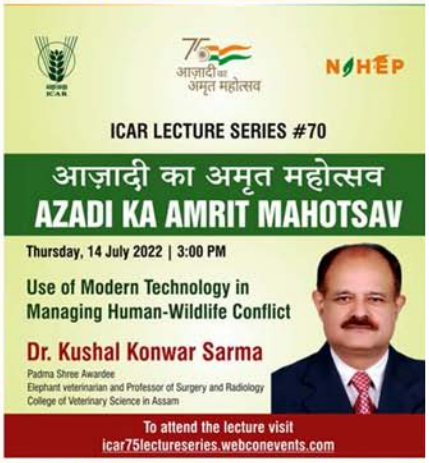
ICAR LECTURE SERIES #70
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Thursday, 14 July 2022 | 3:00 PM
Use of Modern Technology in Managing Human-Wildlife Conflict
Dr. Kushal Konwar Sarma
Padma Shree Awardee
Elephant veterinarian and Professor of Surgery and Radiology
College of Veterinary Science in Assam
To attend the lecture visit
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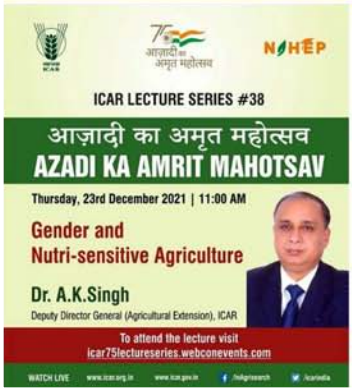
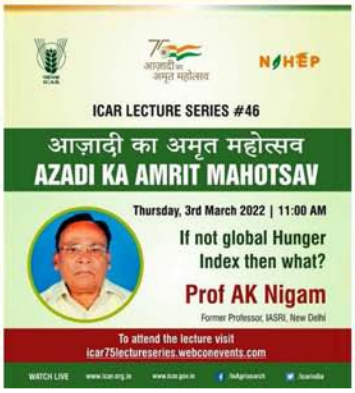
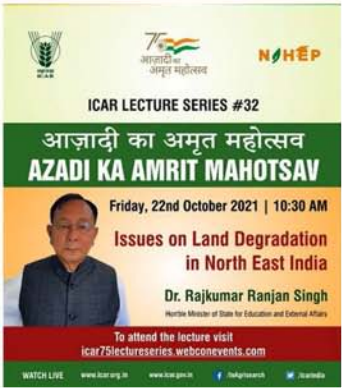

ICAR LECTURE SERIES #38
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Thursday, 23rd December 2021 | 11:00 AM
Gender and Nutri-sensitive Agriculture
Dr. A.K.Singh
Deputy Director General (Agricultural Extension), ICAR
To attend the lecture visit
icar75lectureseries.webconevents.com
WATCH LIVE


ICAR LECTURE SERIES #46
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Thursday, 3rd March 2022 | 11:00 AM
If not global Hunger Index then what?
Prof AK Nigam
Former Professor, IASRI, New Delhi
To attend the lecture visit
icar75lectureseries.webconevents.com
WATCH LIVE


ICAR LECTURE SERIES #32
आज़ादी का अमृत महोत्सव
AZADI KA AMRIT MAHOTSAV
Friday, 22nd October 2021 | 10:30 AM
Issues on Land Degradation in North East India
Dr. Rajkumar Ranjan Singh
Hon'ble Minister of State for Education and External Affairs
To attend the lecture visit
icar75lectureseries.webconevents.com
WATCH LIVE

ISSUES CONCERNING LAND DEGRADATION IN THE NORTH EASTERN INDIA

Rajkumar Ranjan Singh

Dr Rajkumar Ranjan Singh, Minister of State for External Affairs and Education, participates as an active member in many of the Committees on Health and Family Welfare, Science and Technology, Environment and Forest, and Climate Change.

Land degradation is the deterioration or the loss of the productive capacity of the soil and is a global challenge that affects through food insecurity, higher food prices, climate change, environmental hazards and loss of biodiversity and ecosystem services. Manipur and North-eastern India is facing major issues concerning land degradation due to land clearance, poor farming practices, overgrazing, inappropriate irrigation, urban sprawl and commercial development. Large part of the area of the North-eastern states is degraded, says a new draft report on land degradation prepared by the Indian Space Research Organization's (ISRO) National Remote Sensing Centre (NRSC). Among the top seven states with the highest increase in the land degradation in the last 10 years, six are North-eastern states. Nagaland stands third with 47 per cent of its land area under degradation. In Manipur, Mizoram and Meghalaya, 38, 35 and 28 per cent of land is degraded.

One of the major causes of degradation could be increased frequency of high rainfall. Assam, Manipur, Tripura, Mizoram and Nagaland suffered from minor to major floods in 2018. But more than water

erosion, the most common cause of land degradation in these states is acidification of soils which significantly decreases soil productivity. In Nagaland almost 7.5 lakh hectares of land area is acidic (around 45 per cent of the total area of the state); Manipur comes second with 6.3 lakh hectares. In Arunachal Pradesh and Assam, degradation is more by water erosion. Land in the North East is naturally also acidic because of heavy rainfall received every year and the climate change induced high frequency of heavy rainfall would further exacerbate acidification. This situation can be moderated by using lime and organic manures in the soil. Acidification can also be remedied by adopting nutrient management practices and smart crop selections. Sustainable land management (SLM) becomes important for minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources.

Sustainable land management requires collaboration and partnership at all levels– land users, technical experts and policy-makers – to ensure that the causes of the degradation and corrective measures are properly identified. And the relevant policy and regulatory environment would enable adoption of most appropriate management measures.

Key takeaways

- To save north-eastern Indian States, acidification of the soils has to be contained.
- Remedial measures for acidified soils are: using lime and organic manures, managing nutrient practices and smart crop selection.
- Rehabilitate degraded lands and contain degradation of soils.

GENDER AND NUTRI-SENSITIVE AGRICULTURE

Ashok Kumar Singh

Dr Ashok Kumar Singh, Former Deputy Director General (Agricultural Extension, ICAR) has been mostly engaged in teaching and research; along with has national and international exposure in extension management and training. Presently working as Vice Chancellor, Rani Laxmi Bai Central Agricultural University (RLBCAU), Jhansi

Gender refers to the economic, social, political and cultural attributes and opportunities associated with being women and men. The social definitions of the gender, what it means to be a woman or a man differ among cultures and changes over time.

Gender equality across Sustainable Development Goals (SDGs) shows how women and girls are doing in agriculture and in other sectors. There are three components of SDGs — 1. No poverty by 2030: over 150 million women and girls may be pulled out from poverty if Government implements comprehensive strategy to improve access to education, family planning and equal wages for women: 2. Zero hunger: the gender gap in food insecurity has increased 10 per cent higher due to COVID-19 pandemic. Women have also been affected in COVID-19; 3. Gender equality based on data collected in 95 countries have showed that in 2020 more than half the countries lacked quota for women in national parliaments. Almost half of the countries restrict women from working in certain jobs or industries. Our target is to eradicate extreme poverty for all people. (in 2021,435 million women and Girls are found living in extreme poverty). And in low-income countries 41 per cent employed women and 38 per cent men are living in poverty. And globally there are only 36 per cent of seats in

local Governments, 24 per cent seats on COVID-19 task forces, 28 per cent of managerial position in workplace are for women. Gender share in Gross domestic product (GDP) in India has a lower share of women's contribution to the GDP of 17 per cent, than the global average of 37 per cent. The International Monetary Fund (IMF) estimates shows that equal participation of women in the workforce would increase India's GDP by 27 per cent. There is a huge gap in gender literacy 63 per cent non-literate women in 2018 and the proportion has not much changed since 2000 (64 per cent). Urban women are comparatively literate to rural women. Gender Employment Scenario of 2020 indicates that despite growth, less than 20.3 per cent of women aged 15 and older participate in labour force compared to 76.0 per cent of men. Percentage Share of female in agriculture in India is two times in every industry.

Nutrition is another important aspect. One out of nine people fall sick due to food-borne diseases (children are at 40 per cent higher risk and there are around 30,000 deaths each year), 7.0 per cent milk samples were found unsafe (5.7 per cent had aflatoxin M, 1.2 per cent had antibiotic residues and there are hygiene issues in most of the milk product samples); 7.0 per cent of vegetables have higher than prescribed limits of lead and cadmium residues. Malnutrition is also prevalent in India (50 per cent of population is malnourished and 50 per cent women & Children are anaemic). Along with malnutrition obesity and non-communicable diseases are other major issues. Obesity is increasing and is almost doubled from 2005 to 2015. 3.0 per cent of children and 4.0 per cent of adolescents have high cholesterol. One in ten school-age children pre-diabetic and 5.0 per cent of adolescents have hypertension.

Integrating Gender Nutrition in Agriculture confirms that empowering women would help in women's health and nutritional status. Women beneficiaries in development schemes are important and the various schemes are National Horticulture Mission, Pradhan Mantri Kisan Samman Nidhi and Pradhan Mantri Kisan Mann Dhan yojana etc.

ICAR Approach for Integrating Gender and Nutrition

The ICAR is implementing Nutri-sensitive Agricultural Resources and Innovations (NARI) scheme through various Krishi Vigyan Kendra (KVK). The initiative is to grow food what we want to eat. The focus of these programmes is on nutritionally enriching foods. Map the entire food system of village and suggest what they should eat. The ICAR has developed more than 70 fortified varieties and is promoting their production and consumption to alleviate malnutrition. Nutrition Map is another initiative of the ICAR where mapping is done of indigenous regional foods and prescription is done on local food-based recipes (nutri thali) to enrich

the diet. KVK's are training Anganwadi workers to develop Nutri Garden at every household for year-round availability of vegetables and fruits.

Key takeaways

- Awareness and education of the women is required on all facets of life, specially agriculture.
- There is a need to increase some women-centric schemes, technologies and approaches.

ISSUES CONCERNING CHILD RIGHTS IN INDIA
CHALLENGES AND OPPORTUNITIES

Priyank Kanoongo

Mr Priyank Kanoongo is the Chairperson of the National Commission for Protection of Child Rights, Government of India. He has worked on the education and reintegration of the out-of-school children with the mainstream education. He emphasizes on the principle of universality of the child rights.

Every child has the right to have a balanced diet, adequate clothing, sufficient shelter and proper healthcare. Malnutrition is the major challenge which India faces. In India, 44 per cent of children under the age of five are underweight and 72 per cent of infants. Major cause of malnutrition in the country is economic inequality and owing to this, diets often lack both quality and quantity.

Anganwadi's can play an important role in alleviating malnutrition by providing basic healthcare. Each anganwadi should have a herbal garden for providing supplementary nutrition and should be teaching everyone the important of balanced diet. Mid-day meal is another initiative by the Government to alleviate hunger and malnutrition in school children. Even all schools have free space and there herbal and vegetable garden can be developed. This can provide supplementary nutrition.

In India, agriculture is not a business it is our

Sanskriti. The holidays in school should be according to the harvesting season so that the children with agriculture background help their families and may in a way be inculcated with the interest in agriculture.

Education is considered most important for the development of an individual as well as of a country. To make education more inclusive and fulfilling the demands of the minorities, the Constitution under Article 29 and 30 prescribes education in the mother tongue and also provides managerial power of educational institutions in the hands of minorities.

For a child, family is considered as the first source of knowledge. The National level policy 2020 has laid importance on the universalization of early childhood care and education with 2030 target—ensuring that all students entering grade I are school-ready.

Child labour deprives children of their childhood, their potential and their dignity and is harmful in their physical and mental development. According to 2011 Census, there still were around 43 lakh working children; a decline was observed from 1.2 crore according to 2001 Census. Article 24 of the Indian Constitution prohibits the employment of children under 14 years of age in factories, mines or other hazardous vocations. Further, under provision of this article, the Child Labour (Prohibition and Regulation) Act 1986 was enacted to stop engaging children in certain hazardous conditions. Spreading awareness, inspection of the industries and strict implementation of the Act are some measures to check child labour.

Another concern is of child safety even in orphanages. There are 7,123 orphanages in India and 70 per cent are located in only six states. This has become a business for the people as they receive huge foreign donations. They receive approximately 2-4 lakh per child whereas the expenditure per child is much lesser. Some of these lack even in basic facilities such as separate washrooms for girls and boys. Also, the children at orphanage homes are used in riots. This is against the rules; commission has reported such orphanage homes.

During covid-19 pandemic, children have been more exposed at homes and everywhere to internet and have been in a way exposed to addiction, hacking, virus and cheating. To check children from falling in the hands of the cheater, monitoring their internet use is required and check on also their friends in the virtual circle.

Key takeaway

- Issues concerning children are to be assessed properly, and children rights should be protected.

WOMEN IN LEADERSHIP
ROLE IN INDIA

Rekha Sharma

Ms Rekha Sharma is the Chairperson of the National Commission for Women (NCW). She is known for her leadership spirit and for working round the clock for addressing different issues concerning women.

The role of a woman has changed over generations and is different in different parts of the world. Their most basic and traditional role has been bearing children, raising them and managing the household. With time, women have become educated and have entered the workforce. This allows them to support their families financially also.

India is the first country where women ruled the country after Sri Lanka, with 50 per cent of representation in parliament and local bodies. India has more women in leadership role but boardroom representation is still progressing at a snail's pace. In India, women hold 17.1 per cent (2022) of the board seats; this has upgraded by 9.4 per cent from 2014. At present, women are being associated in every sphere of the society — ranging from taking care of their household, bringing their families, to confronting their families, safeguarding borders of the country and heading top-most positions in different ministries of the Government of India. In India, 70 per cent of women are farmers but they are not representing as farmers, as the land is not on their name.

Women are scaling high in the ladder of varied organizations. Women as leaders can come with new views and can bring in structural and cultural diversity in organizations. In the presence of women leaders, men would behave better and working environment and productivity would also increase. Still till-date women have to work harder to make a balance between home and office.

Role of the National Commission on Women (NCW) include the following — Capacity building of women MLA's (as it is important to train women, who are going to make policy decisions for other women); Participating in brainstorming programmes in colleges and schools to encourage women to join politics and Creating awareness about cyber harassment and sexual harassment at work places.

As it is the responsibility of the organization to provide safe environment for working women; there has to be an internal Committee in all organizations. This Internal Committee function is to address varied issues related to women in that organization. But in all organizations, internal committees have not been constituted and even if there are Committees, they have not the idea, how to work. The NCW can help in training internal committee members. The NCW is training women in enterprise development at the Indian Institute of Management also. In agriculture, they are given training in 3 courses (fisheries, dairy farming and agriculture) of 5 weeks each. Participants have not to pay course fee as NCW pays for them. During covid-19, many women with "Pradhan Mantri MUDRA Yojana" (PMMY), which provides loans up to 10 lakhs to the non-corporate, non-farm small/micro enterprises, have started micro and macro businesses.

Every girl needs to be given education, resources and freedom of speech. Let her dream and let her work hard to fulfil her dreams. Every girl should earn, then only she would have the confidence to make her own decisions. And main reason for dowry and domestic violence is that our girls are not self-dependent. Change of mind set is required, we should raise our daughter like we raise our sons and give them equal rights, then only the desired change would come.

Key takeaways

- Society should be gender neutral to give equal opportunities to all.
- In social environment, starting from home, children should be given equal growing opportunities to be good citizens of the country.
- All citizens have to be sensitive to the needs of the weaker sector of the society.

LAND REFORMS IN AGRICULTURE
WAY FORWARD

Navniti Prasad Singh

Justice Navniti Prasad Singh was former Chief Justice, Kerala High Court. He practised in Commercial, Taxation and Constitutional matters and is empanelled as an Arbitrator with the Delhi International Arbitration Centre (DIAC), Indian Institute of Arbitration and Mediation (IIAM), PhD Chamber of Commerce, International and Domestic Arbitration Centre (IDAC).

Land reform is the major step of government to assist people living under adverse conditions. It is basically redistribution of land from those who have excess of land to those who do not possess any land. Uniform ownership of land would prevent exploitation of tenant farmers and in a way would help reducing rural poverty. Land reforms are divided into two groups—pre-Independence and post-Independence.

Pre-Independence

Under the British Raj, the farmers didn't have the ownership of the lands they cultivated; it lied with the Zamindars, Jagirdars etc. Leasing out land was a common practice. Land records were in an extremely bad shape giving rise to a mass of litigation. One problem of the agriculture was that the land was fragmented into very small parts for commercial farming. It resulted in inefficient use of soil, capital and labour in the form of boundary lands and boundary disputes.

Post-Independence

A committee, under the Chairmanship of J. C. Kumarappan was appointed to look into the problem of land. The Kumarappa Committee's report recommended comprehensive agrarian reform measures.

The Land Reforms of the Independent India had four components — The

Abolition of the Intermediaries, Tenancy Reforms, Fixing Ceilings on Landholdings and Consolidation of Landholdings.

Abolition of the Intermediaries: The first important legislation was the abolition of the zamindari system, which removed intermediaries between the cultivators and the state. This reform was relatively the most effective one. In most areas, it succeeded in taking away the rights of the zamindars over the land and also in weakening their economic and political power. However, zamindari abolition did not wipe out landlordism or the tenancy or sharecropping systems, which continued in many areas.

Tenancy Reforms: After passing the Zamindari Abolition Acts, the next major problem was of tenancy regulation. The rents paid by the tenants during the pre-independence period were quite high.

With the enactment of legislation for regulating the rent payable by the cultivators, fair rent was fixed at 20 per cent to 25 per cent of the gross produce level in all states, except Punjab, Haryana, Jammu and Kashmir, Tamil Nadu and some parts of Andhra Pradesh.

Ceilings on Landholdings: In simpler terms, the ceilings on landholdings referred to legally stipulating the maximum size beyond which no individual farmer or farm household could hold on any land. The imposition of such a ceiling was to deter concentration of land in the hands of a few. In 1942, the Kumarappan Committee recommended the maximum size of lands three times the economic holding, i.e., the sufficient livelihood for a family. But the ceiling limits varied from state to state. With these reforms, each state was to identify and take possession of the surplus land (above the ceiling limit) held by each household and redistribute it to landless families and households. The negative impact of this was observed in Bihar. The state used to be surplus in rice, wheat and was known as a sugar bowl of India but after ceiling of landholdings Bihar become food-deficient state.

Consolidation of Landholdings: The growing population and less work opportunities in non-agricultural sectors, increased pressure on the land, leading to an increased trend of fragmentation of the landholdings. This fragmentation of land made irrigation management tasks and personal supervision of the land very difficult. This led to the introduction of landholdings consolidation.

This reform brought down the cost of cultivation and reduced litigation among farmers as well. The multiple subdivisions across generations have reduced even the sub divisions to a very small size.

It has now been argued by the NITI Aayog and some sections of the industry that land leasing should be adopted on a large scale to enable landholders with unviable holdings to lease out land for investment, thereby enabling greater

income and employment generation in rural areas. This would be facilitated by the consolidation of landholdings. Modern land reforms measures such as land record digitisation need to be accomplished at the earliest.

Key takeaways

- To enhance productivity of land along with research, land-use pattern needs to be revisited.
- The need of the hour is innovative and scientific land reforms.

MY JOURNEY TO SUCCESS

M.C. Mary Kom

Mrs M.C. Mary Kom is an Indian boxer, politician and former Member of Parliament, Rajya Sabha. She is the only woman to win the World Boxing Championship six times; the only female boxer to have won a medal in each one of the first seven World Championships; and the only boxer (male or female) to win eight World Championship medals.

Mary Kom's journey is an inspiration to thousands of Indians, especially Indian women. She was born in Kagathei village, Moirang Lamkhai in Churachandpur district of rural Manipur in India. Her parents were tenant farmers, who worked in jhum fields. Kom grew up in humble surroundings, helping her parents with farm-related chores, going to school and learning athletics initially and later boxing also.

As a child, she was interested in sports, but didn't pay much attention to boxing. As a young girl from an economically backward Manipuri household, Mary Kom didn't receive support from her family and society. She kept her interest a secret, as the society discouraged a woman to become a boxer. She faced many struggles as was discriminated throughout her journey. She began boxing in 2000 and was a quick learner who preferred to be put through the same paces as the boys around her. Since boxing was considered unsuitable for woman, Mary Kom never told her parents her interest in boxing. Her father scolded her when a photo of her winning the state boxing championship came in the newspaper. The family was concerned about injuries and about the finances involved. However, this did not stop her from following her dreams and pursuing a career in boxing. In the year 2005, she got married and she took a break from boxing. After a long gap comeback is

difficult; it was difficult for her but her husband and in laws supported her. She started practicing again after having two children. This was not easy for her. Her perseverance and willpower helped her and she became unstoppable. Today, she stands as the only Indian woman boxer to win a medal in the Olympics. She also became the first Indian woman boxer to get a Gold Medal in the Asian Games in 2014 in South Korea. In a country where women are still working towards achieving independence and basic rights, Mary Kom made us understand what a woman can truly accomplish. She pursued her dreams and laid a foundation for many people to take up different routes to achieve success. She has proved that hard work and determination pays well. Her victory and success is a result of her continual efforts and aspirations. Mary Kom is among the few successful people who pushed all boundaries and made it big. In spite of her success and popularity, Mary Kom's journey continues to be challenging. She has started the Mary Kom Regional Boxing Academy with a thought that she has gained so much and now it's her turn to give back to the nation.

M.C. Mary Kom is a near-perfect example of an athlete keeping one's feet firmly planted on the ground. The struggles, hardships she has endured over the years hailing from an economically-disadvantaged family in the North-eastern state of Manipur steeled her so much so that she has learnt to handle 'success' with poise and nonchalance.

"In a sportsperson's life, pressure is always there; you have to learn to deal with it."- Mary Kom

Key takeaway

- Strong will and self-motivation can make anyone to achieve the desired goal.

MODERN TECHNOLOGIES IN MANAGING HUMAN-WILDLIFE CONFLICT

Kaushal Konwar Sarma

Dr Kaushal Konwar Sarma is the Head of the Department of Surgery and Radiology in the Assam University. He is working on wildlife healthcare and management in particular and wildlife conservation in general. He is a well-known elephant expert and is lovingly called the Elephant Man of Asia.

Human-wildlife conflict (HWC) refers to the interaction between wild animals and people and the resultant negative impact on the people and their habitat. When growing human population overlaps with established wildlife territories, it creates reduction of resources of life to some people and/ or wild animals.

Human-wildlife conflict is a global problem which is not restricted to particular geographical region or climatic condition. Dense human population in the close vicinity to nature reserves seems to pose the biggest challenge.

Why conflict is growing? There are only small pockets of high wildlife density surrounded by high human density areas that are choking off corridors and leading to fragmentation of habitat.

Human wildlife conflict (HWC) is not recent. Arthsastra-fame Kautilya documented wild elephant herds raiding crops. In 1903 alone 24, 576 people lost their lives to wild animal attacks in India—806 were killed by tiger, 513 by leopards, 463 by wolves, 907 by other animals and 21,827 died due to snake-bites.

The growing human population, deforestation, loss of habitat and decline in their prey species are major reasons behind the Human wildlife conflict in India.

Rapid urbanization and industrialisation have led to diversion of forest land to non-forest purposes. The expansion of road and rail network through forest ranges has also resulted in animals being killed or injured in accidents on roads or railway tracks. Many human settlements coming up near the peripheries of protected areas and are encroaching forest lands and are causing increased pressure on limited natural resources in the forests.

Human-wildlife conflict can have detrimental and permanent impacts on the ecosystem and biodiversity. People may kill animals in self-defence, or as preventive or retaliatory killings, which can drive species involved in extinction. The most evident and direct negative impacts to people from wildlife are injuries and loss of lives and of livestock, crops and or other property.

Managing Human Wildlife Conflict

Modern technologies for human-wildlife management includes habitat management, restoration of corridors, physical barrier (biological mechanical and electrical), early warning using radio collaring, population management by killing or mass capture, sterilization, translocation and immunocontraception.

Radio collar is a lightweight belt fixed on an elephant's neck. The device is fitted with a GPS device and the data is relayed real time on a computer or a mobile app. The real time monitoring of data helps in early warning whenever the elephant is in the vicinity of the human settlement.

Thermal imaging is a method of improving visibility of objects in a dark environment by detecting the object's infrared radiation and creating an image based on that information.

Physical barrier can be created by forming walls as elephants can't jump over six feet barrier; bamboo plants can be grown as fencing.

Solar-powered fencing is like barbed wire fencing with multiple strands of plain wires and metal/cement/ wooden posts to hold the strands in position. The Fence gives a sharp, short but a non-lethal shock to the intruder and creates psychological fear, against any tampering. The alarm in the system gets activated to alert the inmates of the protected area.

Remote injection tranquilizing gun is used in managing big bulls during translocation to other places. Chemicals at the least strength are used on animals for translocation, drugs can be administrative to animals through injection mostly subcutaneous, intramuscular and intravenous, which would result in the fastest absorption of the drug. Disadvantages of the chemicals is difficulty in getting close to the subject and the body weight is difficult to estimate in a fleeing animal as the dose is based on the body weight.

Sterilization: To control monkey menace in Himachal Pradesh 1,30,000 monkeys were sterilized by using laparoscopic technique on females.

Translocation: The case used for translocation is made up of wood to avoid any causalities. Government guidelines are to be followed during translocation. Holistic HWC management approaches allow species to survive in areas where they otherwise would have become extinct. All species on our planet are essential for maintaining ecosystem health and functions.

Some Initiatives such as advisory for management of HWC, empowering Gram Panchayats in dealing with the problematic wild animals as per the Wildlife (Protection) Act, 1972, utilising add-on coverage under the Pradhan Mantri Fasal Bima Yojna for crop compensation against crop damage due to HWC and augmenting fodder and water sources within the forest areas would help reducing human wildlife conflicts.

Key takeaway

- Adoption of early warning systems, creation of barriers, dedicated circle-wise control rooms, identification of hotspots etc. would help in reducing human-wildlife conflict.

PUBLIC-PRIVATE PARTNERSHIPS FOR SUSTAINABLE IRRIGATION

ROLE OF GOVERNMENT, USERS AND PRIVATE SECTOR

Steve Goss

Dr Steve Goss is Independent Consultant for World Bank and FAO.

Irrigation is essentially an economic activity — farmers irrigate to make money and countries irrigate to make money. Money is the end and water is the means. Whilst irrigated agriculture is carried out mostly by private farms, government needs to intervene in making irrigation possible and sustainable, particularly, where systems are too large and complex for any one farm to manage on its own. The special role of government in irrigation is in providing public goods, protecting the environment, managing water resources, making and managing cross-boundary agreements, providing infrastructure too large for any one farm and making markets work by ensuring fair play in a fundamentally uncompetitive market for irrigation services.

Governments face two challenges (i) implementation of a fair and efficient permit system for individual irrigation; and (ii) building up efficient and responsive institutions for multi-user irrigation. The scope and scale of irrigation projects can vary widely and involve a range of factors, from constructing key infrastructure

(such as primary and secondary canals) to on-farm agricultural development: this involves large-scale farmers on the one hand and small-scale farmers on the other. The private sector has often led innovation in increasing on-farm water-use efficiency but has been much less involved in bringing innovations to the management of public irrigation systems.

While Public Private Partnerships (PPP) are quite well developed in water supply and sanitation, there are still relatively few successful examples in the irrigation sector. Introducing private sector knowledge, technology, capital, incentive structures and management approaches can potentially help improve efficiency and ensure more sustainable management of irrigation systems. PPP arrangements in irrigation can range from simple management contracts, where the private party takes responsibility for operation and maintenance in return for performance-based payment, to complex concession contracts where the private firm is responsible for designing, constructing, managing and in some cases financing irrigation infrastructure assets over a long period of time. A number of management models have been evolved over years, including private-public partnerships and hybrid models. The El Guerdane system in Morocco was the world's first irrigation PPP, created to improve irrigation of a high-value citrus crop with an effective marketing system and high economic returns to water (investment was 48 per cent public, 44 per cent private and 8 per cent farmers). Another case was that the West Delta scheme in Egypt, which aimed to replace depleted aquifers with surface water (investment plan was 84 per cent public and 14 per cent private, but the irrigation area was unclearly defined at 25,000 – 38,000 ha, tendering was unsuccessful and the scheme was never implemented). A third example is the Canal de Navarra in Spain, it a large multi-purpose system with a water supply for 3,50,000 people and to irrigate 59,000 hectares. The major infrastructure was 100 per cent financed by government; the PPP came at the level of irrigation water distribution, with the cost split between the private investor and farms and there was a substantial irrigation subsidy (92 per cent of total costs of distribution + entire conveyance system). Farmers paid an initial subscription fee and a substantial annual fee and most of the water was used for low-value maize. The model was technically and financially successful but economically unprofitable. Understanding the strengths and weaknesses of each model would result in choosing the best for a particular situation.

The scope for PPPs in irrigation supply is limited by the fact that full privatisation is impossible (government always has to subsidise and regulate) but the private sector can design, build and maintain the irrigation infrastructure and support on-farm irrigation. Options are much wider where irrigated agriculture is economically profitable due to high-value crops with effective marketing.

Key takeaways

- First focus of all agencies, government, users and private sector for sustainable irrigation should be on the economic profitability, and then on the funding and financial sustainability.

IF NOT GLOBAL HUNGER INDEX, THEN WHAT?

A.K. Nigam

Prof. Arun Kumar Nigam, Former Professor, Indian Agricutural Statistics Research Institute (IASRI), New Delhi, has been a distinguished researcher of international eminence. His pioneering research areas were design of experiments, survey sampling, child health, nutrition, hunger, sustainable development goals, hygiene and education.

Hunger is defined in many ways: food and nutrition insecurity, reduced food intakes with physical sensation caused by lack of food, constant worries where and when their next food will come from and chronic undernourishment, that is not enough to eat to meet energy requirements.

In the long time it leads to undernutrition/ mortality.

Global Hunger Index (GHI) is used to compare hunger status in different countries. It is calculated and disseminated annually. It is the arithmetic mean of undernourished population, stunted children of under five years wasted children of under five years and mortality rate of under five children.

All the indicators are standardized and assigned equal weights. In India, the question on hunger (two square meals a day) was first asked in NSSO consumption surveys.

Limitations of global hunger index are as follows:

1. Estimates of GHI have an upward bias: hunger implies undernutrition though undernutrition does not imply hunger. Similarly, under 5 mortalities may have reasons other than hunger;
2. Upward bias in GHI has serious implications—It pushes up hunger estimates. The extent of the bias is likely to be substantial as hunger

most likely would be a small part of undernutrition and mortality;

3. It is not possible to theoretically evaluate the bias because of the confounding between indicators and hunger. It may be possible to evaluate the bias empirically only through large data sets;
4. There is a problem of multiple counts with no remedy as individual values are not known;
5. GHI is not available at the micro level (e.g., under 5 mortalities at district and lower levels not known);
6. Strangely, GHI ignores lack of access and anxiety, though this is how hunger is defined.

Following the importance of the work, ICMR constituted an Expert Committee of eminent Statisticians, Pediatricians and Public Health Experts to review the suitability of indicators used in the GHI. The Expert Committee in its unanimous Report observed that GHI does not measure hunger per se and ranking countries using GHI is not appropriate. A White Paper also appeared in ICMR Journal highlighting these results. The findings were presented on request in different organizations like DWCD, NAAS, NITI Aayog and PMO and were approved.

Alternatives to GHI: 'Zero' hunger is one of the very important goals of sustainable development goals. Good quality survey-based data are required which would capture access and anxiety through indicators with a direct bearing on hunger. Presently, available options are as follows:

Survey based behavioral responses on access and anxiety:

FAO's Food Insecurity Experience Scale (FIES); USAID's Food and Nutrition Technical Assistance (FANTA) based Food Access Survey Tool (FAST) and its modified version (MFAST) by the IASDS. Both FAST and MFAST seek answers to 9 questions on behavioral responses from individuals/ households experiencing food insecurity. MFAST study is based on the following questions:

1. The family ate few meals per day on a regular basis;
2. Obligated to eat non-preferred food;
3. Sometimes food stored in the house ran out and have no cash to buy;
4. Worried frequently about where the next meal would come from;
5. Needed to purchase food frequently (because own production or purchased food ran out);
6. Took food on credit from local store;
7. Needed to borrow food from relatives/ neighbors to make a meal;
8. Needed to borrow food to meet social obligations;
9. Members of the household who had to skip the meal due to lack of food are i. working adults, ii. House-wife, iii. Both, iv elderly persons and v. children.

Questions 3-9 together gives data for food insecure households. Question 9 gives individual level hunger. It reflects severe form of hunger. Questions 3-4 give anxiety.

Indicators having a direct bearing on hunger

These may include dietary intakes of important food stuffs like cereals, pulses and fats & oils and other major sources of energy, protein and micro-nutrients.

Recently, Ministry of Statistics and Programme Implementation (MoSPI) and FAO, jointly organized a virtual workshop on FIES to discuss various methodological issues at facilitating the design of pilot surveys that will be undertaken in selected States and districts to ascertain the applicability of this tool in the Indian context. As this is not yet completed, we may not discuss it any further.

FANTA was validated using FAST in Bangladesh, 2001. MFAST was also validated by IASDS in Banda district, 2011. FAST had 600; and MFAST had 8953 comparable households. The analysis indicated that both Access and anxiety are measurable. Overall, results of the two are not much different.

Both FAST and MFAST had 9 questions seeking behavioral responses for individuals/households experiencing food insecurity.

A close look into 9 questions points out that these can be remodeled into following 3 questions module:

(i) The family ate means per day on a regular basis for last 15 days;

(ii) Worried frequently (at least once in the last 15 days) about where the next meal would come from as the food stored in the house ran out and no cash to buy more;

(iii) Had to take food on credit from a local store/ relatives or neighbors (at least once in the 15 days) to make a meal for the family or to serve a meal to guests or relatives;

This type of MFAST can be easily canvassed by agencies like National Statistical Office (NSO) in India and by similar survey agencies across countries. It has the potential to be part of the consumption survey of NSO. To improve hunger estimation, more information can be added from secondary data on public distribution system (PDS) supply, natural disasters and related variables to assess the access component. Such data can be available from studies like food insecurity and food nutrition atlases that provide data on availability, access and absorption.

Dietary and consumption surveys should be conducted every 3 years. This would allow evaluation of hunger status at a low cost without much difficulty. Similarly, hunger status should also be computed every third year.

Key takeaways

- The current GHI ranking for countries is not the most appropriate methodology.
- Dietary and consumption surveys should be conducted in every three years.
- To improve hunger estimate FAST and MFAST indices need to be substantiated with information on PDS, natural disasters and related variables.

Special Lecture

SAVE SOIL-THE WORLD'S LARGEST PEOPLE'S MOVEMENT

Sadhguru

Yogi, mystic and visionary, Sadhguru is one of the most influential people of our times. An Enlightened Master, he has undertaken some enormous challenges – work that has been as sweeping as it has been varied. All his efforts, however, have always been towards just one goal: Raising Human Consciousness.

Soil is the habitat upon which trillion of lives thrive. Once there is no richness in soil you have forsaken planet in many ways. We are addressing climate change, carbon emissions, air pollution and water scarcity, but are not focusing on soil, which is the basis of life. For millennia, life on earth has been sustained by a thin layer of fertile soil on the earth's crust. Deforestation and other factors have degraded and eroded topsoil at alarming rates. Globally, 52 per cent of agricultural land is already degraded. We are only remaining with 80-100; harvests that meant 45-50 years of agriculture are left. If current rates of soil degradation continue, this would be the end of life.

In the next 25 years there will be food shortage. In the last 100 years, 50 per cent of the top soil has been lost which is reducing the nutrient content of the food. What we are facing now is 'soil extinction'. The top soil i.e. 12-15 inches of soil contains 80 per cent of life. Open soils leads to rapid degeneration. To avoid soil degradation, we should provide shade to soil with the help of soil covers. It reduces soil erosion and protects the fertile topsoil by reducing the amount of precious rainwater that runs off. Soil is not just soil but the legacy which we will have to pass on to the future generations. Therefore, we have to take the actions in such a way that is implementable. India has predominantly been an agricultural

country and with the Green Revolution, India become self-reliant in food production. However, the sustainability of soil over time has deteriorated and the time has come when we have to think to "Save Soil".

Sadhguru has started a "Save Soil" campaign at global scale. This is an effort to address this degeneration of soil, by inspiring at least 3.5 billion people, which is 60% of the world's population, to support long-term government policies to revitalize soil. Presently, over 3.9 billion people have been reached out with this campaign. Sadhguru has covered 26 nations physically, besides many more through online mode during 100 days of journey. As an immediate outcome, 80 nations and 11 states of India have already joined this global movement of "Save Soil".

The desertification and soil degradation cannot be separated, and the global warming and climate change cannot be addressed without considering the soil. Almost everything comes from soil and the precious top soil need to be saved. Chemical fertilizers and agricultural inputs have promoted food production and made India surplus in food grains, but on the other hand, soil has degraded; as per FAO, 27,000 species of microbes are lost every year. People are giving overwhelming support to "Save Soil" movement. Under a 'Grassroot Movement Cauvery calling' at Cauvery basin, wherein 62 million trees have been planted. This movement is being supported by UN and government of India has also pledged support in 13 other river basins of India.

'Save Soil Policy Book' of Isha Foundation, focuses on positive effect of application of organics and use of cover crops. Well managed soil with adequate application of organics and practice of cover crops can moderate the effect of changing climate and act as shield against the occurrence of droughts. The degradation of soil carbon is an ecological problem in the present context and soil organic carbon should be enhanced to offset the climate change.

Sadhguru voiced his apprehensions on socioeconomic consequences where, children of farmers are not practicing farming and migrating to other enterprises as farming has become less lucrative business. We have to bring agriculture income to that level where it is profitable. In this respect, Farmer Producer Organizations needs to be strengthened with suitable economic policies to support the initiative.

Key takeaways

- Soil is the only magical material that turns death into life and everything essential like food, fodder and clothes etc. comes from soil.
- There is a need to maintain a balance between organic and chemical fertilizers, and the ICAR scientific community should take lead on sustaining soil health.

Calendar of Lectures held under ICAR 75 Lecture Series

S. No.	Name	Designation *	Title of lecture	Date
1.	Dr Suresh Kumar Chaudhari	Deputy Director General (NRM)	Valuing Water for Agriculture	17 March, 2021
2.	Dr K. Alagusundaram	Deputy Director General (Agricultural Engineering), ICAR	Precision Mechanization	25 March, 2021
3.	Prof. Virendra Kumar Tiwari	Director, IIT Kharagpur, WB	Agricultural Mechanization for India in the 21st Centaury	31March, 2021
4.	Dr Anand Kumar Singh	Deputy Director General (Horticulture), ICAR	Containing Malnutrition through Horticulture	5 April, 2021
5.	Dr Joy Krushna Jena	Deputy Director General (Fisheries Science), ICAR	Aquaculture As Avenue for Assuring FISH (Food Security, Income Growth, Social Upliftment & Healthy Life)	16 April, 2021
6.	Dr Erach Bharucha	Director, Institute of Environment Education and Research, Bharati Vidyapeeth	Environmental Education in India	22 April, 2021
7.	Dr Anil Prakash Joshi	Green Activist, Social Worker	Prakriti aur Paryavaran	25 May, 2021
8.	Dr S.K. Sharma	Former Advisor, Ayurveda in Ministry of AYUSH	Food & Dietary Concepts of Ayurveda-Indian traditional Wisdom of Food for Better Nutrition & Health	1 June, 2021
9.	Dr Steve Goss	Independent Consultant for World Bank and FAO	PPP for Sustainable Irrigation: Roles of Government, Users & the Private Sector	7 June, 2021
10.	Dr Farbod Youssefi	Senior Agriculture Specialist, South Asia, World Bank	Fostering Enabling Environment for Agribusiness	9 June, 2021
11.	Prof. A.K. Srivasatava	Member ASRB	Know Your Dairy Food	17 June, 2021
12.	Shri Pratap Chandra Sarangi	Hon'ble Minister of State	Rishi Krishi	24 June, 2021

* As on date of lecture delivered

S. No.	Name	Designation *	Title of lecture	Date
13.	Gurudev Sri Sri Ravi Shankar	Spiritual Leader	How to Overcome Stress	28 June, 2021
14.	Dr Rajeev K. Varshney	Research Programme Director, ICRISAT	Genomics and Breeding Innovations in Agriculture	6 July, 2021
15.	Ms Kakoli Ghosh	Chief Technical Advisor, Sustainable Rural Agriculture Development Programme, FAO, Riyadh, Saudi Arabia	Shaping Agri-Food Systems and Sustainable Development Goals for Smallholders: Where are the Solutions?	9 July, 2021
16.	Dr B.N. Tripathi	Deputy Director General (Animal Sciences), ICAR	Corona Viruses: Burgeoning and Enduring Threats	14 July, 2021
17.	Dr Pramod Kumar Joshi	Former Senior Advisor to DG, IFPRI	Building Resilience Against Climate Change: Role of Technologies, Policies and Institutions	20 July, 2021
18.	Prof. Umesh K. Reddy	Professor of Biology, West Virginia State University, USA	Translational Genomics for Improvement of Horticultural Crops	28 July, 2021
19.	Prof. Paul Gepts	Distinguished Professor, University of California, Davis	Challenges to the Utilization of Genebanks	2 August, 2021
20.	Dr Jagdish Chander Suri	Director & Head of Department, Pulmonology, Critical Care & Sleep Medicine, Fortis, ND	The Covid-19 Pandemic: What Lies Ahead	3 August, 2021
21.	Prof. P.V. Vara Prasad	Distinguished Prodessor and Director, Kansas State University, USA and President Crop Science Society of America	Sustainable Agricultural Intensification for Improving Food Security and Climate Resilience	13 August, 2021
22.	Shri P.P. Adrushya Kadsiddheshwar Swamiji	Mathadhipati, Shri Siddhegiri Math, Kaneri, Kolhapur, Maharashtra & Chairmen KVK, Kolhapur	Indigenous Cow Based Organic Farming for Aatmnirbhar Bharat	16 August, 2021

S. No.	Name	Designation *	Title of lecture	Date
23	Dr Krishnamurthy V. Subramanian	Chief Economic Adviser, Government of India	Post Covid Reforms	19 August, 2021
24.	Dr Rishi Kumar Tyagi	Coordinator, Asia-pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB) APAARI, Bangkok, Thailand	Harnessing the Benefits of Modern Agricultural Biotechnology in the Asia-Pacific Region-Challenges and Way Forward	24 August, 2021
25.	H. H. Shree Shivkrupanand Swami	Swamiji an Enlightened Yogi	Himalayan Meditation	31 August, 2021
26	Dr Krishna Ella	Founder Chairman and Managing Director of Bharat Biotech	Innovations for Transformation	01 September, 2021
27	Prof. Kadambot Siddique	The Hackett Professor of Agriculture Chair and Director of the UWA Institute of Agriculture, The University of Western Australia	Improving Phosphorus Use Efficiency Using Large Set of Chickpea Germplasm	05 September, 2021
28	Dr Renu Swarup	Secretary, Department of Biotechnology, Ministry of Science & Technology Government of India	Agricultural, Food and Nutritional Security: the Changing Technology Landscape	14 September, 2021
29	Prof. Ramesh Chand	Member NITI Aayog	Agriculture In Post-Independent India: Looking Back and Forward	24 September, 2021
30	Dr Jacqueline d'Arros Hughes	Director General of the International Crops Research Institute for the Semi-Arid tropics (ICRISAT), Hyderabad	Future Proofing the Drylands	05 October, 2021
31	Prof. R.B. Singh	Former Chancellor, Central Agricultural University, Past President, NAAS	Science, Technology and Innovation for Transforming Agriculture in India	12 October, 2021
32	Dr Rajkumar Ranjan Singh	Hon'ble Minister of State for Education and External Affairs	Issues on Land Degradation in North East India	22 October, 2021

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33.	Dr Juan Lucas Restrepo	Director General, Alliance of Biodiversity International and CIAT Global Director of Partnerships and Advocacy, CGIAR	CGIAR's Engagement in the Post-UN Food Systems Summit	25 October, 2021
34.	Dr Mangala Rai	Former Secretary, DARE and Director General, ICAR	Indian Agriculture in Perspective	01 November, 2021
35.	Dr C.D. Mayee	Former Chairman, ASRB New Delhi, Agri. Commissioner, GOI	Talent Search for Manning Agriculture Tree	11 November, 2021
36	Dr Chandrima Shaha	President-Indian National Science Academy, New Delhi	Emerging Diseases and Our Immunity	23 November, 2021
37.	Dr K.V. Prabhu	Chairperson, Protection of Plant Varieties and Farmers' Right Authority, Govt. of India	Protection of Plant Varieties, the Key to Improved Agricultural Commerce & Growth	01 December, 2021
38.	Dr A.K. Singh	Deputy Director General (Agricultural Extension), ICAR	Gender and Nutri-sensitive Agriculture	23 December, 2021
39.	Dr T.R. Sharma	Deputy Director General (Crop Science), ICAR	Indian Crop Improvement Programme: New Vistas	07 January, 2022
40.	Dr W. Selvamurthy	President ASTIF , Amity University	Yoga for Health: Scientific Perspectives	12 January, 2022
41.	Mr Vilas Shinde	Chairman & Managing Director, Sahydari Farmers Producer Company	FPC Movement-Challenges and Way Forward	17 January, 2022
42.	Prof. Bina Agarwal	Professor, Development Economics and Environment, University of Manchester, UK	Rethinking the Way, We Farm in India	24 January, 2022
43.	Prof. K.K. Aggarwal	Chairman, National Board of Accreditation	Enhancing Quality and Relevance in Agriculture Education	4 February, 2022

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44.	Dr Jimmy W Smith	Director General, ILRI	Insights from the Transformation of Dairy India	17 February, 2022
45.	Mr Khurshed Batliwala	Art of Living Teacher	The Secrets of Sleep	21 February, 2022
46.	Prof. A.K. Nigam	Former Professor, IASRI	If not Global Hunger Index Then What?	3 March, 2022
47.	Dr Ajay Kohli	Deputy Director General, IRRI Philppines	Restructuring Agricultural Research to Fast Track Impact: an Integrative System Perspective	10 March, 2022
48.	Justice Navaniti Prasad Singh	Former Chief Justice, Kerala High Court	Land Reforms in Agriculture-Way Forward	14 March, 2022
49.	Shri Atul Jain	General Secretary, Deendyal Research Institute	Traditional Wisdom vis-à-vis Nutrition	21 March, 2022
50.	Prof. Kadambot Siddique	Hackett Professor of Agriculture Chair and Director, The University of western Australia	Innovations in Adaptation to Climate Change in Dryland Agriculture	29 March, 2022
51.	Dr Prabhu L. Pingali	Professor of Applied Economics & Director Cornell University	The Quest for a Zero-Hunger India-Lessons from the Green Revolution	04 April, 2022
52.	Dr S. Chandrasekhar	Secretary, Department of Science & Technology, Govt. of India	Saga of Science	11 April, 2022
53.	Dr R.S. Paroda	Chairman, TAAS and Former Sec, DARE and DG, ICAR	Role of Youth for a Secure and Sustainable Agriculture	21 April, 2022
54.	Dr Radha Shankar Narayanan	CEO, Smart Series	Basics of Goal Setting	27 April, 2022
55.	Dr Johan Swinnen	Director General of the International Food Policy Research Institute (IFPRI)	Transforming Global Food Systems after COVID-19	2 May, 2022

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56.	Prof. Rattan Lal	Director, CFAES, The Ohio State University	Managing Soil for Food and Climate Security and Advance SDGs of the UN	10 May, 2022
57.	Prof. Santanu Chaudhury	Director, IIT Jodhpur	AI and IOT: Enabling Sustainable Digital Agriculture	11 May, 2022
58.	Mr Priyank Kanoongo	Chairperson, National Commission for Protection of Child Rights, Govt. of India, New Delhi	Issue of Child Rights in India-Challenges & Opportunities	19 May, 2022
59.	Prof. Gurdev Singh Khush	Adjunct Professor Emeritus, University of California, Davis	India's Pride in Green Revolution and Way Forward	01 June, 2022
60.	Prof. Uma Lele	President, International Association of Agricultural Economists	Poverty, Hunger, Structural Transformation and Sustainability: India and the Rest of Asia	06 June, 2022
61.	Dr Gotz Hensel	Head of Centre for Plant Genome Engineering at the Institute of Plant Biochemistry of the Heinrich Heine University Dusseldorf	Accelerated Breeding by de Novo Domestication of Crop Plants	13 June, 2022
62.	Dr V.B. Mathur	Chairperson, National Biodiversity Authority, Govt. of India	Biodiversity Governance: Global and National Perspectives	15 June, 2022
63.	Ms Rekha Sharma	Chairperson, National Commission for Women	Women in Leadership Role in India	20 June, 2022
64.	Dr K.M. Bujarbaruah	Former VC, Assam Agricultural University	Assessing Animal Science Technology Contributions to Livestock and Poultry Sector Growth-Need of the Hour	28 June, 2022
65.	Ms Svanhild-Isabelle Batta Torheim	Senior Policy Advisor	Farmers' Rights-a Cornerstone for Food Security and the Management of Seed Diversity	30 June, 2022

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66.	Mr Alok Bansal	Co-founder & Executive Vice Chairman, PB Fintech Limited	The Story Behind Building a Brand Like Policybazar as Motivation for Agri Graduates	05 July, 2022
67.	Shri Kamlesh D Patel	President, Shri Ram Chandra Mission, Spiritual Guide	Krishi Becoming Rishi	08 July, 2022
68.	Mr Gaurav Somwanshi	CEO, Emertech Innovations Pvt. Ltd.	Blockchain Technology: Concept and Use Cases	11 July, 2022
69.	Prof. Sachchida (Sachi) Nand Tripathi	Higher Administrative Grade Professor	Capacity Building and Technology Development by Technical Institutions in National Clean Air Program	13 July, 2022
70.	Dr Kushal Konwar Sarma	Professor of Surgery and Radiology College of Veterinary Science in Assam	Use of Modern Technology in Managing Human-Wildlife Conflict	14 July, 2022
71.	Dr M.L. Madan	Former DDG (AS) ICAR	Designer Technologies for Productivity Increase Among Livestock	20 July, 2022
72.	Mrs M.C. Mary Kom	Boxer, Ex. Member of Parliament, Rajya Sabha	My Journey to Success	02 August, 2022
73.	Dr Jean Balie	Director General International Rice Research Institute	India and IRRI: Collaborating for the Future of Rice-Based Agri-food Systems (RBAFS)	04 August, 2022
74.	Dr Trilochan Mohapatra	Former Secretary DARE and Director General, ICAR	Science for the Society: Agricultural Imperatives	12 August, 2022
75.	Shri Narendra Singh Tomar	Agricultural Minister, Govt. of India	Atmanirbhar Bharat (self-reliant agriculture)	16 August, 2022
	Sadhguru	Founder Isha Foundation	Save Soil - The World's Largest People's Movement	27 August, 2022

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