



SIGNIFICANT ACHIEVEMENTS (2014-23)

Aspiring for a Developed India in the *Amrit Kaal*



Indian Council of Agricultural Research (ICAR)
Department of Agricultural Research & Education (DARE)
Ministry of Agriculture & Farmers Welfare
Krishi Bhawan, New Delhi 110001
www.icar.org.in



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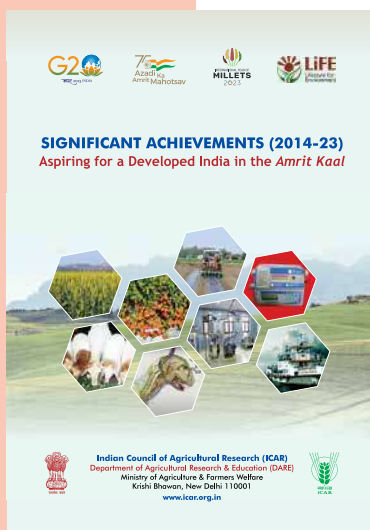
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July 2023

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MESSAGE

Shri Narendra Singh Tomar

Union Minister of Agriculture and Farmers Welfare &
President of the ICAR Society

The country is passing through a more demanding phase by aspiring to be a developed nation during Amrit Kaal. A strong agriculture sector is the intrinsic fuel that propels the overall economy and food security of a nation. Thus, the Indian Council of Agricultural Research (ICAR), New Delhi is obligated to innovate efficient and effective technologies in agriculture sector, demonstrate frontline technologies, and backstop the procreation of human resources and capacities in the country. In past, ICAR spearheaded the innovation in agriculture to get the country out from hunger and malnutrition to bountiful and healthy agriculture output. However, the national aspirations demand increased and targeted efforts to get country ranked among developed nation within short span of *Amrit Kaal*.

It is a matter of great satisfaction that the Council is already on track to achieve the set targets of Amrit Kaal. I am also happy to know that the Council is publishing a document, "Significant Achievements (2014–23): Aspiring for a Developed India in the *Amrit Kaal*". This document contains significant innovations, discoveries, breakthroughs, and milestones achieved during 2014–15 to 2022–23 those are expected to lay foundation for accelerated growth of agriculture during *Amrit Kaal*. Substantially higher achievement during the period than immediate prior period (2005–06 to 2013–14) demonstrate the synergistic impact of clear vision, positive political will, responsive administration and revitalized research environment.

I congratulate the Council for preparing and publishing this document and hope it will serve the needs of policy planners and other stakeholders in identifying decision alternatives.

Best wishes,


(Narendra Singh Tomar)



MESSAGE

Shri Kailash Choudhary

Minister of State

Ministry of Agriculture & Farmers Welfare

I am happy to know that the Indian Council of Agricultural Research (ICAR), New Delhi is publishing a document entitled, "Significant Achievements (2014-23): Aspiring for a Developed India in the *Amrit Kaal*". This publication contains significant innovations, breakthroughs, and milestones achieved during past nine years in its domain areas. The objective achievements of the period are also compared to the previous nine-year period. Overall, exponential growth in output demonstrates the potential of perfect alignment among the vision, political will, policy support, and healthy platform for research, education and extension in agriculture sector.

I congratulate the council for bringing out this informative publication for the benefit of stakeholders including policy planners for timely dissemination, capacity building, and adoption of latest technologies in augmenting farm income.

(Kailash Choudhary)



MESSAGE

Km. Shobha Karandlaje

Minister of State

Ministry of Agriculture & Farmers Welfare

It is a matter of great satisfaction that the Indian Council of Agricultural Research, New Delhi compiled the major achievements made during last nine-years (2014-15 to 2022-23) in the field of research, education, and extension on agriculture and allied sectors. The publication also compares the achievements made during the period with earlier period of 2005-06 to 2013-14. I am sure that the information will help the policy makers and development agencies in faster dissemination and skill development of farmers on new technologies.

I congratulate ICAR team for compilation and successful publication of the document entitled, "Significant Achievements (2014-23): Aspiring for a Developed India in the *Amrit Kaal*".

Best wishes,

(Shobha Karandlaje)



FOREWORD

Indian Council of Agricultural Research (ICAR) has been devoted to plan, co-ordinate and supervise agricultural research, education and extension in the country since its establishment in 1929. It developed and disseminated agricultural technologies for Indian agriculture and fulfilled the human resource development needs. These activities and achievements have made the country self-sufficient and now a major global exporter of agricultural produce.

The most important achievements of ICAR during 2014–23 are: release of 2764 varieties of field and horticultural crops including 123 bio-fortified varieties; enhanced export oriented production of horticultural crops; gene modifications to explore improved resistance to biotic/abiotic stresses; development of 28 eco-friendly pest management modules; development of 53 multi-enterprise integrated farming systems (IFS), organic package of practices for 58 cropping systems involving 44 crops; identification of 104 crop varieties suitable for organic farming; improving the cattle breeds producing more than 3220 liters milk/lactation; perfecting the cloning technology in buffalo for better yield; development of 61 new vaccines and diagnostic kits against animal and poultry diseases; development of new aquaculture, marine fisheries and prawn production technologies and practices towards blue revolution; production of high value compounds/value added products and nutraceuticals; improving standards of agricultural education in line with National Education Policy 2020 (NEP 2020) and strengthening capacities of farming communities and launch of digital platform for two-way multi-lingual communication between farmers and the technology experts. These achievements need a greater flip to meet aspirations of the country in *Amrit Kaal* till 2047.

The present document "Significant Achievements (2014–23): Aspiring for a Developed India in the *Amrit Kaal*" is a compilation of the most significant



achievements of ICAR made during 2014-23 *vis-a-vis* 2005-14. It provides an insight into ICAR's preparedness to enter the '*Amrit Kaal*' with an aim to achieve the goals of 'Developed Nation-India'.

I congratulate the entire team for bringing out this important publication. I hope that the document would be useful to the students, researchers, teachers, policy makers, planners, administrators and farmers of agriculture. The suggestions for improvement are welcome towards better outcome in future.

A handwritten signature in blue ink, appearing to read 'H. Pathak', is positioned above the printed name.

(H. Pathak)

Date: 12 July, 2023

Place: New Delhi

Secretary, DARE and Director General, ICAR



PREFACE

The ICAR mandated activities on agricultural research, extension, education, and capacity building have consistently contributed to food, nutrition and livelihood security of the country. The innovations, growth and sustainability in Indian agriculture sector are the outcomes of these activities. The synergistic congregation, positive policy decisions, administrative actions, persistent financial support and determined efforts at field and laboratory level during last nine years have exponentially accelerated the agricultural outputs and outcomes in India. The major achievements of ICAR during 2014–2023 are precisely presented in this document "Significant Achievements (2014–23): Aspiring for a Developed India in the *Amrit Kaal*". The achievements are grouped into 16 themes. To document the net progress, the achievements during two periods (2014–23 and 2005–2014) were compared.

In crop husbandry, the progress highlighted an increase in number of varieties released in field crops (2279) and horticultural crops (485). These varieties were tailored to improve crop quality and yield through bio-fortification and addressing emerging biotic and abiotic stresses. The crop varieties were equally supplemented for efficient farm outputs with location and crop specific production practices, 28 eco-friendly pest management modules, contingency practices, soil-crop-water management strategies, bio-fertilizers, bio-formulations, farm machineries, integrated organic farming practices and integrated farming system modules. ICAR also supported the establishment of model agro-processing centres for enhancing value addition and storage and reducing post-harvest losses.

In animal husbandry, 68 new breeds were registered. Improved cattle breed '*Freiswal*' and '*Vrindavan*' produced 3220 litres of milk per lactation. The mutton sheep strain '*Avishaan*' produced litter size of 2–4 and gain average live weight



of 22 kg in 6-month period. ICAR also developed 61 new vaccines and diagnostic kits against animal and poultry diseases. The new aquaculture, marine fisheries and prawn production technologies and practices are set to bring blue revolution in the country.

The frontier research during the period resulted in genome sequencing of more than 43 species of plants and animals, and identification of trait-specific genes in crops, livestock and fish. The genome-editing has enhanced the productivity and stress tolerance in rice cultivar MUT1010. Gene modification experiments highlighted the potential for improved resistance to biotic stresses especially in pigeon pea, potato and banana. The cloning technology in *Murrah* buffalo was perfected and cloned calves '*Shakti*' and '*Karnika*' were born.

The ICAR innovations resulted in signing of 3308 agreements and commercialization of 1273 technologies during the period 2014–23. Further, innovation on nano-celluloses from cotton linters and wastes; high value compounds and nutraceuticals from aquatic organisms including seaweeds; vaccines and health products and value-added products are ready for commercialization.

Quality agriculture education is key to backstop frontier research, innovations and accelerating technology driven modern agriculture in the country. In this endeavor, ICAR helped to improve standards of education in agricultural universities, restructure course curriculum to harness regional specialties as per National Education Policy 2020 (NEP2020) and introduce new courses in many emerging fields like genomics, nano-technology, artificial intelligence, data analytics etc.

The objectives of research and education are not truly realized unless their benefits have reached the unreached stakeholders. The 731 Krishi Vigyan Kendras (KVKs) across the country and ICAR institutes have played vital role by issuing 69.71 crore mobile agro-advisories, providing capacity building trainings to 1.36 crores farmers, and conducting more than 18.41 lakh demonstrations on crops and livestock. Besides, an ICT based platform "*Kishan Sarathi*" was launched to strengthen two-way multi-lingual communication between farmers and the technology experts.

The document is an effort to provide a glimpse of ICAR's achievements specifically during last nine years (2014–23) and, in general, during the last 18 years (2005–2023). It would form the base document of ICAR's preparedness for planning and



implementation of activities during the '*Amrit Kaal*' to achieve the set targets by 2047.

The authors are sincerely thankful for the guidance, supervision, and support of Dr. Himanshu Pathak, Secretary, DARE and DG, ICAR in bringing out the document. The contributions of Dr. S. Ayyappan and Dr. T. Mohapatra, former Secretaries, DARE & DGs, ICAR are deeply acknowledged. The inputs provided by all the SMDs/Units are duly acknowledged with thanks to all the DDGs/ADGs and concerned personnel of ICAR.

Date: 12 July, 2023

Place: New Delhi

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M.K. Tripathi

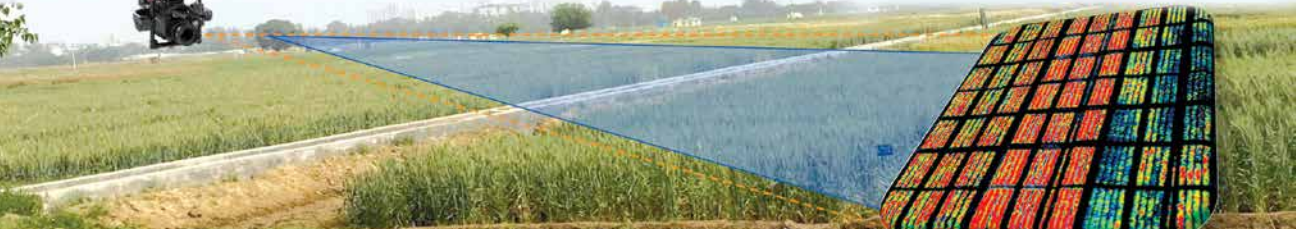
P.K. Katiha

S. Khurana

A.R. Rao

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SIGNIFICANT ACHIEVEMENTS (2014-23)

The collaborated efforts of farmers, researchers, policy planners and developmental agencies have gradually transformed the country from a begging bowl to a bountiful harvest. The agriculture sector continues to play a critical role in economic growth and development of the country. Presently, despite declining availability of land and water for farming and increasing climate vulnerability, the food grain production has reached 330.53 million tons (3rd Advanced estimates 2022-23-DA&FW) for field crops and 342.33 million tons for horticultural commodities (3rd Advance Estimates 2021-22-DA&FW). Similar increase has been recorded in milk, meat, egg, and fish as well as in the non-food crops. The technological advancements through improved varieties, production and protection technologies, health, nutrition and breed improvement in livestock, poultry and fisheries along with innovative frontline extension through KVKs have been vital in increasing the productivity and output. In comparison to 2005-14, the continued technology-backstopping from ICAR improved the average productivity in the country during 2014-23 by 20.2% in cereals including coarse-cum-nutri-cereals, 21.6% in pulses, 13.6% in oilseeds, 13.5% in sugarcane, 29.2% in fruits, 7.1% in vegetables, and 30.4% in spices. Similarly, the technology upscaling in livestock sector increased the 9-years average total milk production in the country by 55.62%, egg production by 69.63%, and meat production by 78.60% over average value of immediate past 9-years period. In addition, innovations and capacity building in fisheries sector supported increase in total fish production during the period by 62.81% over comparable previous period. The adoption of effective aquaculture practices augmented the share of Inland fisheries to almost three-fourths of total fish production. Despite these significant achievements in the past, agriculture in the country has many complexities and challenges that need to be addressed through research, education and extension.



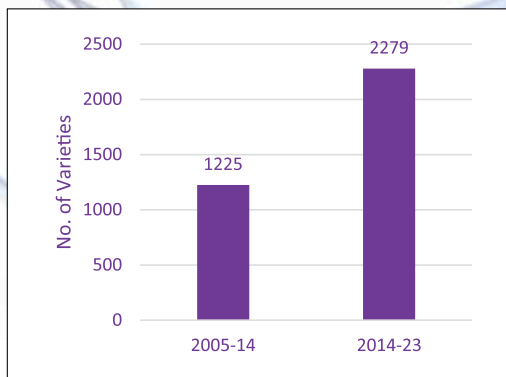
ICAR continued to play a critical role in developing technologies for the growth of agriculture and allied sectors. Some of the most significant and critical technologies which grossly impacted farmers' income, food and nutritional security and agricultural exports during last eight years (2014-2023) in the areas of field crops, horticultural crops, crop genomics, genome editing, indigenous livestock, poultry, fishery technologies, natural resources, climate resilience, farm mechanization, post-harvest operations, lab to land & farmers outreach programme, technology commercialization, agri-entrepreneurship, agri-education, infrastructure, human resource management, international relations and policy planning are given in the document. Through development of technologies, ICAR is poised to continue "Atmanirbharata" (self-reliance) in food, nutrition and livelihood security to achieve the aspirations of a developed India by 2047.



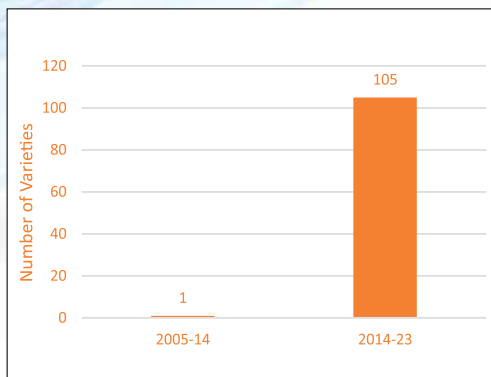
1. Crop sciences

High yielding varieties and hybrids for improved outputs

Varietal improvement, one of the major mandates of ICAR has not only increased the productivity but also remained as a carrier of other farm technologies. Farmers' access to improved quality seeds of superior varieties has consistently increased the productivity and quality of farm produce. During 2014–23, a total of 2279 high yielding varieties of field crops were released against 1225 during 2005–14. All these varieties were gazette notified for income augmentation of the farmers. In field crops, 1888 out of 2279 varieties are climate resilient. Specific traits like drought and sub-mergence tolerance, disease resistance and improved nutrition quality have also been introgressed in 87 varieties of field crops using genomic tools like marker assisted selection (MAS) in comparison to only eight before 2014.



High yielding field crop varieties



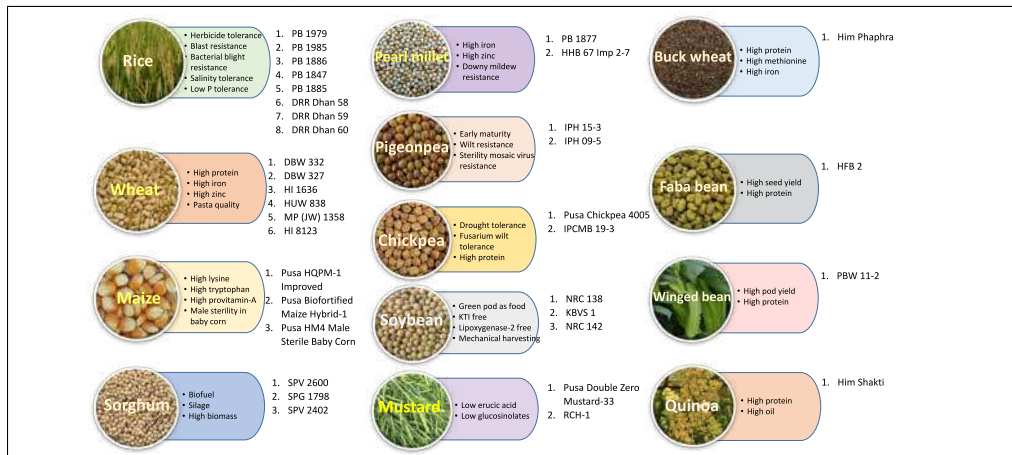
Biofortified field crop varieties



The varietal improvement in field crops led new normals in crop production

Bio-fortified field crop varieties for nutritional security

During 2014–23, ICAR released 105 bio-fortified field crop varieties with higher levels of Fe, Zn, protein, pro-vitamin A, etc. in the edible parts besides reduced level of anti-nutritional factors, while only one such variety was released during 2005–14. A total of 25360 quintals of breeder seed of 51 such varieties have been produced during 2016–17 to 2022–23 against the indent from different public and private seed production agencies.



35 Special trait crop varieties dedicated to the nation by Hon'ble Prime Minister on September 28, 2021.

Promotion of millets

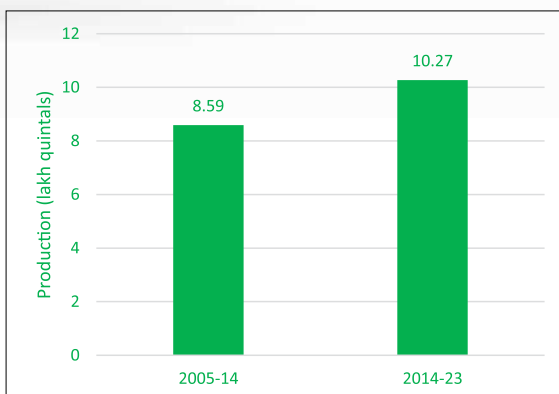
Establishment of more than 170 startups, 400 entrepreneurs and training to large number of stakeholders is leading to revival of the millets. In context to International Year of Millets 2023, organized a convention of Nutri-cereals stakeholders besides initiative of nutri-gardens and tree plantation at Hyderabad during September 17–18, 2021. ICAR is geared up to implement budget announcement 2023–24 on "Supporting IIMR, Hyderabad as Centre of Excellence for sharing best practices, research and technologies at the international level" to make India a Global Hub for "Shree Anna".

Spearheading the public sector seed-chain of field crops for improving Seed Replacement Rate (SRR)

ICAR is the nodal agency to supply Breeder Seed of field crops in the country for their downstream multiplication into foundation and certified seed for use by the farmers. In the period of nine years ending



in 2013–14, the ICAR cumulatively supplied 8.59 lakh quintals breeder seed of varieties/hybrids of field crops to the both public and private sector seed multiplication and distribution agencies. Cumulative supply of breeder seed by the ICAR enhanced by 20% and reached 10.27 lakh quintals during the period ending in 2022–23. ICAR also produced 41.54 lakh quintals quality seeds of field crops during 2014–23 in comparison to 34.89 lakh quintals during 2005–14. Consequently, not only the SRR in pulses, oilseeds and cereals increased substantially during 2014–23, the Varietal Replacement Rate (VRR) has also increased significantly leading to enhanced production. The VRR for varieties (less than 10 years of release) has touched 96% in lentil and mungbean, 85% in Chickpea, 79% in urdbean, 75% in pigeon pea, 68% in soybean, 65% in mustard, 57% in groundnut, 93% in wheat, and 65% in rice.



Breeder seed production

Enhancement of pulse production

DARE/ICAR released 343 improved and climate resilient pulse varieties, produced 1.75 lakh q breeder seed for different agro-climatic zones, produced 6.16 lakh q seeds through 150 seed hubs and conducted 5.97 lakh frontline demonstrations (FLD) through KVKs covering area of 2.3 lakh ha during last 9 years against 1.35 lakh FLDs and 0.42 lakh ha area during 2005–14. These contributed to higher productivity and increased cropped area resulting in record pulse production. The pulse production increased by 62.15 percent from 17.15 million tons in 2014–15 to 27.81 million tons during 2022–23 (second advanced estimate). The pulse revolution in India is expected to make the country self-sufficient in pulses very soon.

Sugar revolution

The country has witnessed sugar revolution during past 6–7 years through ICAR developed sugarcane variety Co-0238 that provides 20 t ha⁻¹ higher cane yield and about 2% more sugar recovery, resulting



in additional production of 5–7 million tons of sugar. Mostly grown in Uttar Pradesh due to large scale popularization and adoption of this variety. The acreage of Co-0238 has exponentially increased from 3.09% in 2013–14 to 72.87% in 2022–23 and influenced the livelihood of more than 20 million people in the state of Uttar Pradesh.



Sugarcane var. Co-0238

Export enhancement

Agriculture contributes almost 12.6% to total exports of India. The key agricultural commodities for export enhancements are: High yielding Basmati rice varieties such as Pusa Basmati 1121, Pusa Basmati 1509, Pusa Basmati 1718, Pusa Basmati 1637, etc. These varieties have annual exports of worth almost Rs 30000/- crore. The wheat varieties HD 2967, HD 3086, HD 3226, DBW 187 earned approx. Rs 6000/- crore annually from exports. The annual sugar exports worth Rs. 11,297 crore were mainly because of sugarcane variety Co-0238.

Eco-friendly modules for pest management

A total of 28 modules of Integrated Pest Management (IPM) for minimizing crop losses and improving productivity with eco-friendly technology were developed during the nine years' period ending in 2022–23 against only 16 IPM modules developed during 2005–14.

Non-transgenic herbicide tolerant Basmati rice varieties

One of the significant achievements is the development of two herbicide tolerant Basmati rice varieties Pusa Basmati 1979 and Pusa Basmati 1985. These varieties will prove as game changer for direct seeded rice (DSR) cultivation in rice growing belts of India.



Effect of herbicide spray on traditional and herbicide tolerant Basmati rice varieties

Development of genomic resources

Genomic resources of four crops, three insects, 21 microbial and eight pathogen species including whole genome sequences were developed. Eight Genes responsible for specific agronomic traits were identified in six crops by allele mining and gene-based association analysis, of which one gene (*rice SHMT3*) was validated by genetic transformation. Developed a quick and reliable qPCR and LAMP-based diagnostic assay to detect Karnal Bunt (*Tilletia indica*) (sensitivity 100 fg) in wheat.

Genome editing

- ◆ Genome editing is a precision mutagenesis tool for genetic improvement of crops. Transgene free genome edited mega rice cultivar MUT1010 with enhanced yield and stress tolerance was developed by editing four different genes.
- ◆ Rice *Teosinte Branched1 (TB1)* gene, a negative regulator tillering, was edited to create a loss of function mutant of *TB1* gene with 38 bp deletion in rice cv. MTU1010. The transgene free SDN1 type *TB1* mutant produced about 35 tillers as compared with 15 tillers in WT MTU1010 plants, and produced 66- 70% higher grain yield per plant as compared with MTU1010.



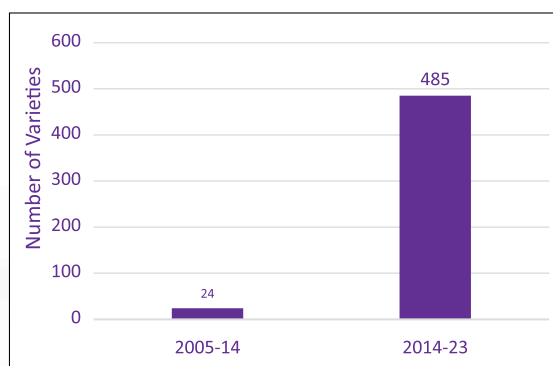
Genome edited mutant of mega rice cv. MTU1010 with enhanced salt & drought tolerance and grain yield



2. Horticulture sciences

Recent advances in planting materials

- A total of 485 varieties of Horticultural crops including 18 biofortified varieties were developed during 2014–23 against only 24 varieties developed during 2005–14. The production of quality planting materials was enhanced by 226% from 251.8 lakh during 2005–14 to 822.0 lakh during 2014–23. The production of breeder and truthfully labeled seed was 1978.50 quintal during 2005–2014 and 5983.27 quintal during 2014–2023.
- Grafting of commercial varieties of grapes in Dogridge rootstock made cultivation possible in saline and alkaline soil conditions in Maharashtra and Karnataka. The technology use improved the quality besides 5–10% increase in



Horticultural crop varieties



yield at 10–15% lower cost of cultivation and reduced irrigation water requirement. The Dogridge rootstock is now being used in almost 90% grape area in the region.



Grape var. 'Thompson seedless' vineyard raised on Dogridge rootstock

- Emphasis was laid on breeding multiple disease resistant varieties in few crops such as tomato. Tomato hybrid 'Arka Abhed' is resistant to four diseases (bacterial wilt, early blight, late blight and leaf curl virus) with productivity at par to any commercial variety including those from private sector. Similarly, 'Arka Rakshak' is a triple disease (tomato leaf curl virus, bacterial wilt and early blight) resistance variety developed with higher productivity. French bean variety 'Arka Arjun' has resistance to bean yellow mosaic virus with almost 18 t ha⁻¹ productivity potential in 70 days and thus the variety fits well in crop diversification strategies. In medicinal plants, two varieties (Arka Dhanvantari and Arka Shubhra) of velvet bean (*Mucuna*) with almost double *L-Dopa* content were identified.



Arka Abhed



Arka Rakshak



French bean var. Arka Arjun

- Pomegranate variety 'Phule Bhagwa' released in 2003–04 has been adopted in more than 86.1% area under the crop in Maharashtra, Karnataka, Gujarat, Andhra Pradesh and Madhya Pradesh. It was due to higher yield, less susceptibility to fruit

spots and thrips, better desirable fruit characters (aril, colour and size), and better keeping quality (15–25 days at ambient conditions). Since the release of the variety, unprecedented increases in area (123%), production (280%), productivity (70%) and export (380%) were observed. The direct total annual economic benefit/surplus from variety '*Phule Bhagwa*' has been estimated at Rs.9,617 crores for 2021–22 (at 2018 prices).



Phule Bhagwa

- Developed five scab resistance apple hybrids for specific traits. It includes Ammol, Ambrit, Priame, Pride, and Pritor.



Ammol-
(Early maturity)



Ambrit-
(Ambri flavour)



Priame-
(Scab resistance)



Pride-
(Scab resistance)



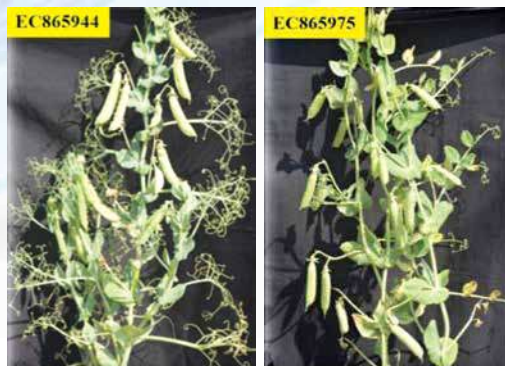
Pritor-
(Scab resistance)

- Handholding of farmers has resulted in promotion and protection of farmers varieties '*Sidhu*' and '*Shankara*' in jackfruit and Lakshmana in tamarind. As a result, farmers earned a record income of Rs. 22 lakh by selling the grafted plants of jackfruit in a period of two years which was shared between ICAR and farmers on 75:25 proportion.

Jackfruit '*Sidhu*'Jackfruit '*Shankara*'



- Large-scale propagation and popularization of 'Kamalam' fruit (dragon fruit) has resulted in multiplication of approximately 9.5 lakh plants under this exotic fruit. A total of 15 trainings for 3,600 farmers of seven states were conducted for popularizing 'Kamalam' fruit in India.



- Two exotic genotypes of late maturing vegetable peas, EC 865944 and EC 865975, were identified resistant to powdery mildew.

Powdery mildew resistant vegetable pea genotypes 'EC 865944' and 'EC 865975'

- Artificial 'Guchchhi' mushroom production technology: For the first time, successfully produced 'Guchchhi' mushroom (Morchella) under semi natural conditions in green house. As a result, India has entered the list of few countries like USA, China and France culturing 'Guchchhi' mushroom.



Morchella cultivation under artificial conditions

- Eight biofortified high yielding varieties of five horticultural crops namely 'Bhu Krishna' and 'Bhu Sona' of sweet potato; 'Kufri Neelkanth' and 'Kufri Manik' of potato; 'Sree Neelima' and 'Da 340' of greater yam; 'Kashi Lalima'



Potato var. Kufri Manik



Potato var. Kufri Neel Kanth



Sweet potato var. Bhu Krishna



Sweet Potato var. Bhu Sona



Sweet potato var. Bhu Ja



Greater yam var.
Sree Neelima



Greater yam var.
Da 340



Sweet Potato var. Bhu
Sona (at Farmer's Field)



Potato var.
Kufri Pukhraj

of okra; and 'Manjari Medika' of grapes were identified and released for cultivation and augment nutritional security of large masses.

- Potato variety 'Kufri Pukhraj' is one of the most popular short-duration varieties in North Indian Plains and presently covering more than 80% of total potato area in Uttar Pradesh, West Bengal, Bihar, Punjab, Haryana, Gujarat, Jharkhand, Chhattisgarh, Assam, and Orissa which is about 33% of the total potato area in the country. This variety is realizing 15 % higher yield and ~15% less cost of cultivation due to savings on disease management over the check variety 'Kufri Jyoti'. The annual economic surplus during the year 2021-22 has been estimated to the tune of Rs 4,729.0 crores (at 2018 prices).
- High density planting systems in apples were standardized and successfully demonstrated with significant increase (8-9 t ha⁻¹ to 30-35 t ha⁻¹) in productivity.
- Digitization of two online seed portals by integrating with YONO Krishi app of SBI was achieved. It has benefitted the farmers and other stakeholders of 28 states and 6 union territories. The sales proceeds worth of Rs 1.0 crore were received within six months period.
- An improved onion cold storage structure with state-of the art technology intervention has been designed and test validated for minimizing post-harvest losses and augmenting price volatility of onion in the market.



High Density Planting of Apple in Kashmir



Launched integration of ICAR-IIHR seed portal with SBI-YONO



Support to oil palm development programme

- During last 5 years, almost 58% of the total domestic edible oil demand of the country was met by imports. Palm oil has constituted bulk of these imports. Oil palm is known to be the highest edible oil yielding perennial horticultural plants that satisfies 30% of the world's edible oil requirements. In India, almost 28.00 lakh ha area is considered suitable for oil palm cultivation, but only 3.49 lakh ha area has been covered at present. ICAR is continuously conducting research on the crop since 1975 to support oil palm development programmes in the country. The major achievements during the years are briefly highlighted below:
- Developed new 3rd generation hybrids with targeted high oil yield of 7–8 t ha⁻¹ and dwarf hybrids with oil yield of 7 t ha⁻¹.
- A process and kit for insect facilitated controlled pollination in oil palm (Patent granted IPO No. 387063).
- Developed fertigation technique for oil palm with reported saving of 50% to recommended fertilizer.
- Identified three germplasm of dura oil palms (as female parent), three short stature dura type, and one tenera type oil palm genotypes with more fresh fruit bunch yielding.
- Identified three high yielding oil palm varieties for release and notification for cultivation in Andhra Pradesh 'Godavari Swarna' (NRCOP-4), 'Godavari Ratna' (NRCOP-2) and 'Godavari Gold' (NRCOP-17).



High yielding oil palm germplasm

Support for National Mission on Edible Oil (NMEO) -oil palm

- Prepared and submitted Reassessment Report on suitability of oil palm cultivation in India.
- Developed and released Oil Palm site suitability Evaluation mobile application software for farmers' use at micro level.
- Organized 20 capacity building programmes on oil palm cultivation for 215 officers and 1,375 farmers from Telangana, North Eastern Regions and other oil palm growing states.
- Training programmes on oil palm cultivation were organized to 3500 officers and 36000 farmers
- Distributed 55 harvesting chisels to 11 farmers' groups in Goalpara, Assam for facilitated agronomic operations.



Oil palm based mixed farming system

- Distributed 31 aluminum poles for facilitating harvesting of fresh fruit bunches of palms in Andhra Pradesh.
- Imparted on farm demonstration on vermicomposting and distributed vermibeds and harvesting poles useful in easy cultivation and handling practices in oil palm.
- Supported NMEO-OP launching programmes at Guwahati (for North Eastern Regions); Telangana (Other States); and Arunachal Pradesh.
- Sustainability and additional income by growing intercrops: Oil palm based inter-cropping systems in mature plantations with cocoa, red ginger, heliconia, bush pepper, long pepper, mango ginger, banana, ornamental crops improved the sustainability and provided additional income (CB ratio – 1:2.38 to 1:2.86) to farmers.
- Developed oil palm based mixed farming system with fodder crops, dairy & backyard poultry (CB ratio – 1:3.28).
- Training programmes on oil palm cultivation were organized to 3500 officers and 36000 farmers.
- Published Mobile Apps (23) short video films (6) on different aspects of oil palm cultivation.
- Multiplication of quality planting material for enhanced area under oil palm.

Impact of oil palm sprout production on area expansion and revenue during 2017-18 to 2022-23.

S. N.	Variables (units)	Value
1.	Number of germinated seeds (lakhs)	14.93
2.	Area spread (ha)	9331
3.	Revenue generated (Rs. lakhs)	522.5
4.	Saving of foreign exchange (Rs. lakhs)	1239.2



Plant protection research in horticultural crops

- Late blight resistant transgenic potato lines expressing RB gene and virus resistant transgenic potato (RNAi against ToLCV) were advanced to BRL-1 trial stage (applied for trial permission).
- Transgenic banana for fusarium wilt resistance, potato for amelioration of cold induced sweetening and sugarcane for abiotic stress tolerance were advanced to different stages of glass house trials.
- *Arka Mealy melt*- A mealybug exterior body wax dissolving formulation has been developed that makes different species of mealy bugs more vulnerable to pest control measures.



(A) Before and (B) after application of 'Arka Mealy melt'

- To strengthen food safety issues, an herbal formulation '*Arka Herbi Wash*' with potential to eliminate 80–100% pesticides and microbial contaminants from the surface of fruits and vegetables was developed.
- Golden milk: Two turmeric milk preparation '*MILMA Golden Milk*' and '*Golden Milk Mix*'; one as ready to serve sterilized flavoured turmeric milk and the other one as turmeric milk instant mix powder were standardized.



Flavoured turmeric milk preparation, '*MILMA Golden Milk*' and '*Golden Milk Mix*'



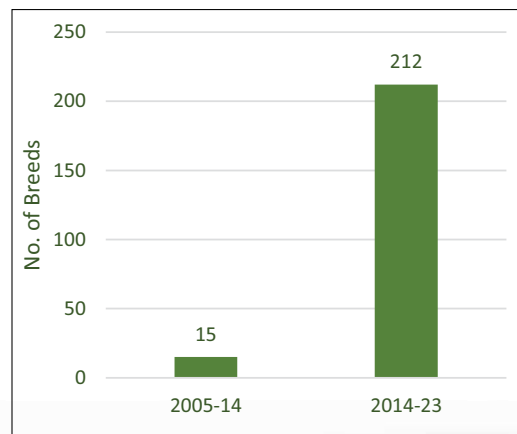
ICAR-Central Institute for Research on Buffaloes
Hisar (Haryana) India
Produced 7 Clones of 'M-29' Murrah Bull
Recloned - Clone Bull 'Hisar-Gaurav'
ICAR-NASF Project "Production of Multiple Copies of Elite Buffalo Bulls using Animal Cloning Technology"



3. Animal sciences

Breed improvement

- During 2014–23, a total of 212 breeds of indigenous livestock and poultry were Gazette notified. It includes 68 newly registered breeds for the protection, improvement and IPR safety to indigenous breeds. In comparison, only 15 breeds of livestock and poultry were registered during 2005–14. The new livestock breed registered during 2022–23 are 'Kathani cattle' (Maharashtra), 'Sanchori cattle' (Rajasthan) and 'Masilum cattle' (Meghalaya), 'Purnathadi buffalo' (Maharashtra), 'Sojat goat' (Rajasthan), 'Karauli goat' (Rajasthan) and 'Gujari goati' (Rajasthan), 'Banda pig' (Jharkhand), 'Manipuri Black pig' (Manipur) and 'Wak Chambil' (Meghalaya).



Animal breed registration



Manda buffalo of Odisha



Monyul Bah of Arunachal



Dharwadi bull



Sanchori cattle of Rajasthan



Purnathadi buffalo of Maharashtra



Combai dog of Tamil Nadu

- Improved breed "*Frieswal*" declared a cattle breed on 3rd November 2019. This new breed has mature lactation yield of 3628 kg milk. In addition, developed cattle breed "*Vrindavani*" having lactation milk yield of 3220 kg.



Frieswal Cow



Frieswal Bull

- Developed a prolific master mutton sheep strain "*Avishaan*" that produces 2-4 off-springs per litter and produces average daily milk yield of 716 g. Offspring attain average live weight of 22 kg at six-month age under farmers' conditions.
- Developed 9 pig varieties with higher body weight at marketable age of 8 months.



- Developed 12 poultry varieties suitable for backyard poultry with higher egg production and body weight at 20 week age.



Himsamridhi



Jharsim



Narmadanidhi

- Produced multiple copies of elite Murrah buffalo bull (No. M-29) and achieved one re-cloning pregnancy of Hisar Gaurav (normal fertility 55%). Buffalo cloned calves Shakti (12.09.21) and Karnika (20.12.21) were born.



Hisar Gaurav

OPU-IVF-Calf (Veer Gaurav)
born on Dec 2022

Murrah bull M-29



Clones of Murrah bull M-29



Cloned bull Rajat



Cloned bull Swarn

- Developed high/ medium density DNA Chips for indigenous cattle, buffalo, backyard poultry, goat and medium density DNA Chip of camel.
- First de novo genome assembly (3Gb) of Indian mithun (*Bos frontalis*) was done with coverage of 91.5% of genome and annotated of 28,044 protein-coding genes.
- Genomic resources of two animal species including whole genome sequences were developed.



- Identified trait-associated genes through transcriptome studies for skeleton muscle in goats, milk in cattle & buffaloes, muscle growth in catla (fish), insecticide resistance in cotton leafhopper and salt stress in *Chromohalobacter*.
- Developed high density SNP chip for goat (>601,000 SNP markers), which was validated on 480 animals of 15 goat breeds from different agro-ecological regions of the country.
- Developed native chicken specific medium density 74K SNP chip "INDICHICK".
- Dairy-based integrated farming system model developed for small farmers.

Animal health

- During 2014–22, stepped up the FMD surveillance by three times and sero-monitoring by 4 times to test a total of 14.86 lakh serum samples in comparison to only 6.16 lakh samples during 2005–14.
- Developed and commercialized Vaccine "Lumpi-ProVac Ind" for Lumpy Skin Disease in cattle and "Inactivated Low Pathogenic Avian Influenza (H9N2) Vaccine" for Chickens.
- Developed 61 new vaccines/vaccine candidates and diagnostic kits during 2014–2023 for animal and poultry diseases of which 9 were commercialized, whereas during 2005–14, only 27 vaccines/vaccine candidates and diagnostic kits were developed.



Lateral flow rapid test kit for avian influenza H5 virus antigen



Peste des Petits ruminants antigen check kit for surveillance in small ruminants



Peste des Petits ruminants antibody check kit for surveillance in small ruminants

- Developed a urinary metabolite-based pregnancy detection kit "Preg-D" in cows and buffaloes.
- Developed an anti-methanogenic supplement (Harit Dhara) which reduces methane emission by 18–20% without any adverse impact.



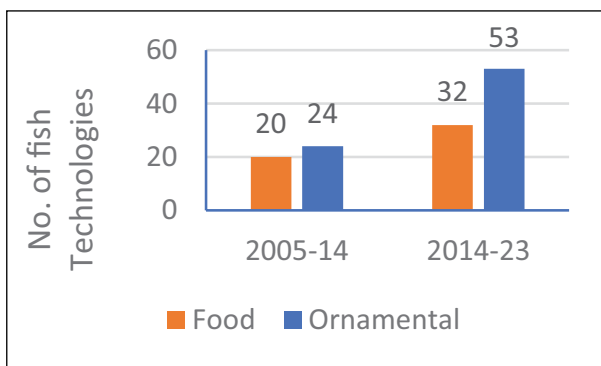
- BUFCOL-A, a patented complete diet formulation for enhanced survivability and growth of neonatal buffalo calves was developed.
- Anionic mineral mixture supplementation- The adoption of the supplement reduced the incidence of milk fever by 71%.
- Developed rapid and cost-effective tests of milk for detergents, antibiotic residues, and pesticides besides mastitis and seven most common adulterants (neutralizers, salt, glucose, maltodextrin, added urea, sucrose and hydrogen peroxide). In addition, a kit was also developed to detect cow milk blending in camel milk and vice versa.



4. Fisheries sciences

Species diversification

- To augment the fish production and raise the income of fish growers in the country, technologies for breeding and seed production for 32 cultivable finfish and shellfish species were developed during 2014-23 against 20 species during 2005-14.



Fish breeding & seed production technologies

- With a focus to promote ornamental fish, breeding technologies were developed for 53 ornamental fishes during 2014-23 against 24 species during 2005-14.

Food fishes



Orange spotted grouper



Indian pompano



Grey mullet



Mangrove snapper



John snapper



Milkfish

Ornamental fishes



Ocellaris clownfish



Pseudanthias marcia



Platinum Percula clownfish



Orange Skunk clownfish



Maroon clownfish



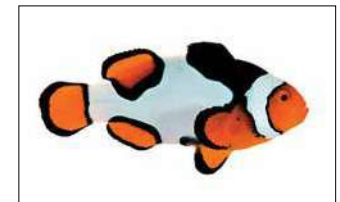
Black clownfish



Camel shrimp



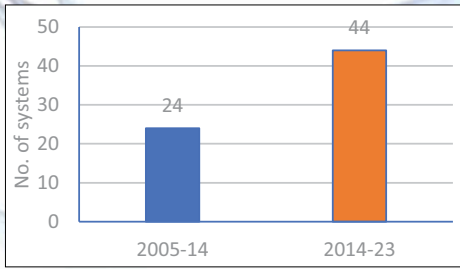
Cloudy damsel fish



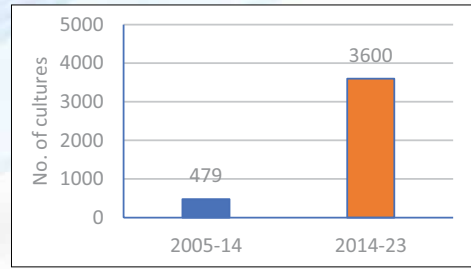
Picasso clownfish

System diversification

- The diversification in aquaculture systems led to designing and development of 44 improved/new aquaculture systems for finfish/shellfish culture during 2014-23 against 24 such systems during 2005-14.



Aquaculture systems



Marine cage culture

- During 2014–23, marine cage culture of cobia, silver pompano and seabass has been expanded all along the coast with about 3600 cages as compared to 479 cages during 2005–14.



Marine cage culture for coastal regions

- Designed and established recirculating aquaculture system (RAS) for rainbow trout culture in high altitudes.
- Developed and demonstrated shrimp farming technology for saline wastelands with production levels of 4–6 t ha⁻¹ in four-month period. Presently, the technology is mainstreamed in over 2500 acres land in the states of Haryana, Punjab, Rajasthan, and Uttar Pradesh.



Recirculating aquaculture system (RAS)



Shrimp Farming in saline wastelands



Genetic improvement programme

- Developed genetically-improved strains of commercially important freshwater fishes/prawn:
 - ♦ Improved freshwater prawn with higher growth of over 50% after 13th generation of selection.
 - ♦ Improved Rohu "Jayanti" with over 50% of growth after 13th generation.
 - ♦ Improved catla with over 30 % of growth after 2nd generation.
 - ♦ Improved Indian magur with higher growth of over 20% after 2nd generation.



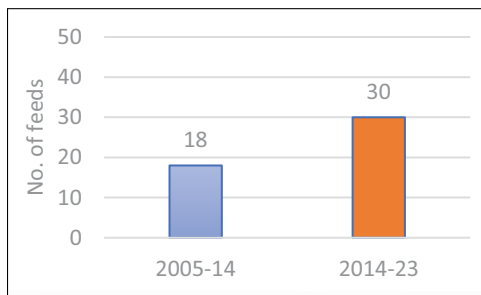
Improved Rohu "Jayanti"



Freshwater prawn

Fish feeds

- The fish feed formulations for various life stages play a critical role in augmenting the fish productivity. During 2014-23 period, in total 30 indigenous fish feed formulations for various life stages of diversified aquaculture species were developed against only 18 such formulations during 2005-14.



Fish feed formulations



Fish feed formulations for life stages of diversified aquaculture species



Fish health management

- Greater emphasis was given to develop fish-based health and value-added products. Overall 31 fish health products and 47 value-added products were developed during 2014–23 as compared to 12 fish health and 20 value added products during 2005–14.
- The health products developed during last nine years include diagnostic kits for White Spot Syndrome Virus, Koi herpes virus (KHV), Spring Viraemia of Carp Virus (SVCV), tilapia lake virus, etc.; vaccines against *Aeromonas hydrophilla*, *Edwardsiella ictaluri*, *Flavobacterium columnare*, Cyprinid Herpes Virus/CyHV2, Viral Nervous Necrosis (VNN), etc. and therapeutic formulations, viz. CIBAMOX, CIBASTIM, ARGUNIL, ARGUCURE, OONIL, etc.



Fish health products

- The National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) was implemented through 31 laboratories across the country, which reported over 3200 disease incidences and discovered nine new fish diseases.
- The National Repository of Fish Cell lines (NRFC) established at ICAR-National Bureau of Fish Genetic Resources (NBFGR) possesses over 65 fish cell lines.

Whole genome sequencing

- The whole genome sequencing of seven fish species, viz. rohu, catla, magur, grey mullet, hilsa, Indian oil sardine and Indian white shrimp have been undertaken.

Exploration of marine fisheries resources

- Designed and developed eight fishing crafts during the 2014–23 as compared to only one fishing craft during previous nine years.
- Developed multipurpose deep-sea fishing vessel "Sagar Harita" and presently with the same design over 130 vessels are in operation in Gujarat, Tamil Nadu, Kerala, Andhra Pradesh and Odisha.



Sagar Harita: multipurpose deep-sea fishing vessel

- Designed and developed 33 m HDPE shrimp trawl with reduced body length, drag reduction and energy efficiency. Further, designed a 3.0 m FRP pedal boat for fishing in backwater and reservoirs and also for recreational uses.

Value addition

- Developed 55 value-added/waste-to-wealth products during 2014–23 while only 20 such products during 2005–14.



High value compounds and value added products from aquatic systems

Nutraceuticals and high value compounds

- Developed 51 nutraceuticals from aquatic organisms including seaweeds during 2014–23 as compared to three in 2005–14. Some of the important nutraceuticals produced from seaweed are used against several human ailments such as joint pain, arthritis, diabetes, obesity, dyslipidemia, fatty liver diseases, hypertension, hemoglobin



Nutraceuticals from sea weeds



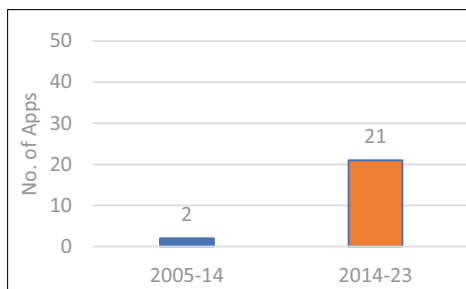
enhancer, hypothyroid disorder, antioxidant, cardio vascular diseases and immunity booster.

Machinery and App

- Developed 'Fish Waste Management Machine' of capacity 1.5 t/day
- Developed 21 mobile App/database during 2014-23 while only 02 such App/software were developed during 2005-14. 'MatsyaSetu App' is one of these, which is used for subject-wise self-learning online course modules.



Fish waste management machine

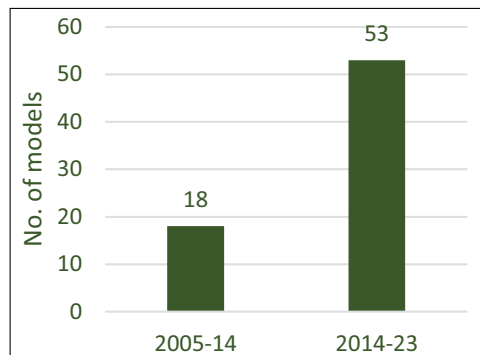


Mobile Apps



5. Natural resource management

- **Integrated farming system (IFS)** models are the potential tools for enhanced farm productivity and income of small and marginal farmers. During 2014-23, total 53 multi- enterprise integrated farming system (IFS) models were developed as compared to 18 such models during 2005-14. Higher income to the tune of Rs. 3.6 lakhs per annum per hectare can be realized with these models.
- **Chemical free agriculture** denotes the cultivation of crops without depending on chemical inputs such as fertilizers, pesticides, weedicides, etc. ICAR is continuously working to develop appropriate technologies. Organic farming has been identified for augmenting income of the farmers and improving soil health. To accomplish this task, organic package of practices



Integrated farming system models

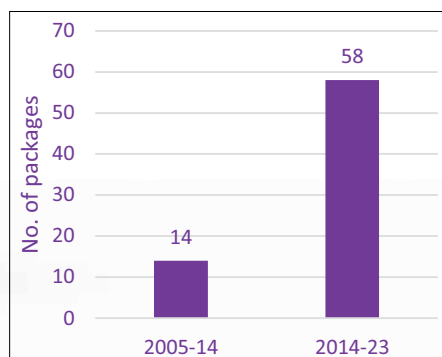


for 58 cropping systems involving 44 crops were developed during 2014-23 against only 14 during 2005-14. In addition, 104 crop varieties suitable for organic farming were identified. Furthermore, the Union Budget 2022 has also emphasized on chemical free farming by promoting it on farmers' lands in 5-km wide corridors along the river Ganga. ICAR has developed ten organic farming packages including cropping systems suitable to Gujarat (Greengram-coriander-vegetable cowpea), Rajasthan (sweetcorn + blackgram-chickpea, Fennel + cabbage -cowpea + maize), Uttarakhand (Finger millet + black soybean -wheat + toria) and Sikkim (Maize+soybean-buckwheat, Maize-blackgram-toria), Kerala (Cassava-vegetable cowpea), and West Bengal (Rice-vegetable pea-sesame) conditions during last two years.



Silvihorticulture (Melia dubia + Curryleaf)

- 88 biocontrol agents, 31 biopesticides and 41 biofertilizers were documented and circulated.
- Standardized drip fertigation schedules for 34 crops & cropping systems during 2014-23, against 20 during 2005-14 for achieving higher nutrient use efficiency.
- The organic farming has been identified for augmenting income of the farmers and improving soil health. To accomplish this task, 58 organic farming packages of practices were developed during 2014-23 against 14 during 2005-14.
- Indian agriculture sector contributes significantly to an increasing carbon footprint as about 80% of the fresh water in India is used for irrigation purposes. This cannot be sustained in long run and thus, urgent paradigm shift is required in the management of water resources. **Water footprints in agriculture** can be reduced through smart irrigation technologies



Organic farming package of practices



including micro irrigation and fertigation in high value crops. Drip irrigation/fertigation schedules have showed promising outcomes with 9–80% higher yield, 11–71% saving in irrigation water and 18–25% saving in fertilizer.

- Developed low-cost bamboo drip irrigation technology for hilly upland conditions of North-East India



Bamboo drip irrigation

- A low-cost portable soil test kit/mini lab (*Mrida Parikshak*) was developed in 2015–16 for rapid analysis, and distribution of soil health cards to farmers. So far, distributed nearly 28 million soil health cards at national-level facilitating soil testing service at farmers' doorstep.



Mrida Parikshak, a portable soil testing kit

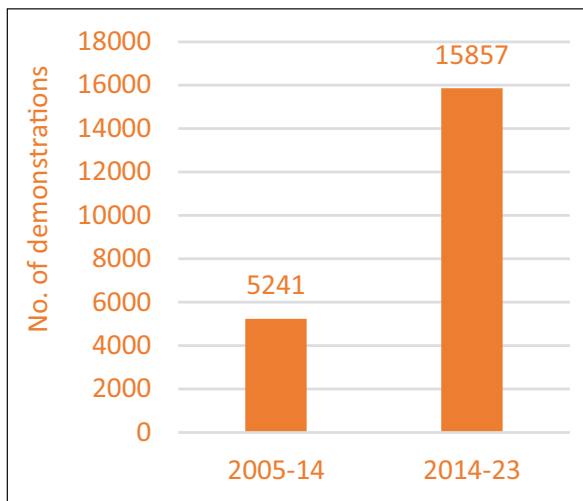


- Developed 31 fertilizer prescription equations with ready reckoner during 2014–23 to provide soil test fertilizer recommendations for cereals, pulses, oilseeds, fibre crops and vegetables for various agro-ecological regions of India.
- The land resource inventories for effective agricultural land use plans were developed for 339 blocks during 2014–23 in comparison to 19 during 2005–14. In addition, inventory also developed for 27 aspirational districts in 8 states besides Bundelkhand region.
- Developed a simple, quick and cost-effective kit based on substrate induced respiration to monitor soil biological health. The kit contains assemblies to incubate soil with a defined substrate along with an indicator "Gel probe" which changes its color based on the amount of CO₂ evolved from soil. The color-change of the gel exhibits positive correlation with actual measure of CO₂ and soil biological quality index.
- Developed a seed treatment machine for coating of seeds with different micro-organisms like *Rhizobium*, *Azotobacter*, *Azospirillum*, Phosphorous solubilizing bacteria (PSB) one after other with a sticking agent through film-coating method. The formulation enhanced the yield of maize, ragi, red gram and groundnut by 17–34%, with a cost benefit factor 1.31–2.97 and prolonged the survival of the microbial inoculants on the seed (about 10³ cfu/seed) up to 90 days of storage.
- ICAR-FUSICONT is a bio-formulation developed using antagonistic fungal isolate CSR-T-3 of *Trichoderma reesei* and a bacterial PGPR isolate CSR-A-11 of *Lysinibacillus fusiformis* in a unique IPR protected media with a dynamic substrate. This bio-formulation is used to control the wilt diseases in banana, vegetables (tomato, potato, capsicum, chilies) and spice (cumin and fenugreek) crops.
- Developed EKCEL-decomposer (capsule) consisting of ligno-cellulolytic microorganism (including Fungi, Bacteria and Actino-bacteria) in specified proportion along with curd, jaggery and urea with fresh cow dung for rapid *in-situ* decomposition of crop residues.
- Designed and developed an Agri-voltaic system through which electricity can be generated, crops can be cultivated at interspace area and rainwater can be harvested from top surface of PV-module. About 49% land area of a solar PV-installation system can be used to cultivate crops, which is otherwise left as fallow.
- Developed granular minerals fertilizers as an alternative to conventional P and K fertilizer using low-grade rock-phosphate and feldspar, respectively



and a matrix of slowly decomposing C compounds prepared by chemically treating mixture of indigenous leonardite and cellulosic waste. These mineral fertilizers gave comparable yield obtained with conventional Di-ammonium phosphate and Muriate of Potash fertilizers with about 50% lower cost and hence could be an effective substitute of DAP and MoP.

- **Climate resilient agriculture:** Indian Agriculture is highly vulnerable to climate change. As per the latest IPCC AR-6 Report, increase in rainfall, high inter-annual variability, intense and frequent heat waves, likely temperature increase by 1.5 to 4.0° C, and rise in sea level by 300 mm could be the major challenges for sustainable agriculture in the coming years.
- Bringing climate resilience by developing and adopting appropriate adaptation techniques is the mechanism to cope with the changing climate. Breeding stress tolerant varieties and supplementing them with proven NRM technologies and contingent preparedness could effectively mitigate the vulnerabilities of crops to weather abnormalities.
- 68 climate resilient technologies were demonstrated in 446 villages on 15857 farmers' fields during 2014-23 against 12 technologies demonstrated in 151 villages on 5241 farmers' fields during 2005-14. During the year 2022-23, five new climate resilient technologies were developed.

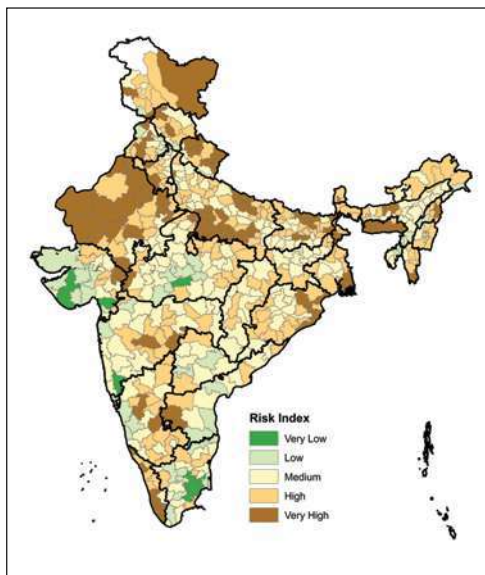


Climate resilient technologies demonstrated at farmers' fields

- 389 varieties released are tolerant to one or more biotic and abiotic stresses. These include 15 climate resilient varieties tolerant to traits like water logging, drought, heat, salinity, etc.



- Developed a new rice variety for coastal saline tracts of Odisha (CR Dhan 412/NICRA Dhan).
- Identified submergence tolerant rice varieties (Swarna Sub1, Ranjith Sub1, Ratnagiri-1, 5, 7, MTU-1061) to minimize the impact of flood on yields by 70% over farmer's practice.
- Developed a mobile app for accessing information on risk and vulnerability at district level for adaptation planning.
- Updated 15 district agriculture contingency plans. Organized seven interface meetings with department of agriculture of state Governments i.e., Maharashtra, Karnataka, Odisha, Telangana, Gujarat, Madhya Pradesh and Rajasthan to enhance the preparedness of state Governments to delayed/deficit/excess rainfall situations.
- Climate change research facilities such as high through-put phenotyping platforms, Free Air Temperature Elevation (FATE), Carbon dioxide and Temperature Gradient Tunnels (CTGC), rainout shelters, animal calorimeter, shipping vessel, flux towers and satellite data receiving station etc. have been established and



INDIA: Risk due to Climate Change (2020-2049) in Agriculture

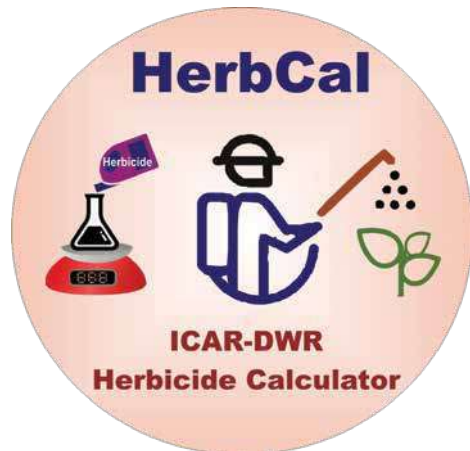


FATE facilities for climate change research



are being used to study the impact of elevated CO₂ and temp on crops, livestock, fisheries, soil, water, pests and diseases.

- Updated 450 District Agriculture Contingency Plans that provide contingency measures and technological solutions for minimizing the impact of weather aberrations. Twenty-four district drought proofing action plans were also developed for Karnataka, Andhra Pradesh and Rajasthan states.
- **Farm Tree:** An Android Mobile App provides a user-friendly, bilingual (Hindi and English) e-platform to have necessary and crisp information on 25 promising agroforestry tree species of India (<https://play.google.com/store/apps/details?id=com.cafri.farmtree>).
- **Fly Cocobot- A drone-based coconut harvester:** Fly Cocobot is a drone-based remotely controlled unmanned gender-friendly coconut harvesting and crown-clearing machine for safe harvesting of coconuts. It flies to the top of the palm, gets attached to the trunk with grabbing arms, cutting arm then opens up for cutting the desired bunch decided through video displayed on screen of the remote module. Pragmatic uniqueness of this device lies in its suitability for using in mixed cropping plantation of coconut and black pepper thereby leading for higher returns. The machine is conceptualized, through Joint efforts by ICAR-CCARI, Old Goa and Goa University, to have operational efficiency of 12-15 palms/ hr.
- **Herb Cal- A new multi-language Mobile app to calculate herbicide dose:** ICAR-Directorate of Weed Research, Jabalpur has developed a user-friendly multi-lingual mobile app named 'Herb Cal' for effective application of herbicides. The App automatically calculates the amount of herbicide and quantity of water to be taken for spray on the basis of inputs on crop, area, dose and herbicide formulation. This app is available on "Google Play Store".

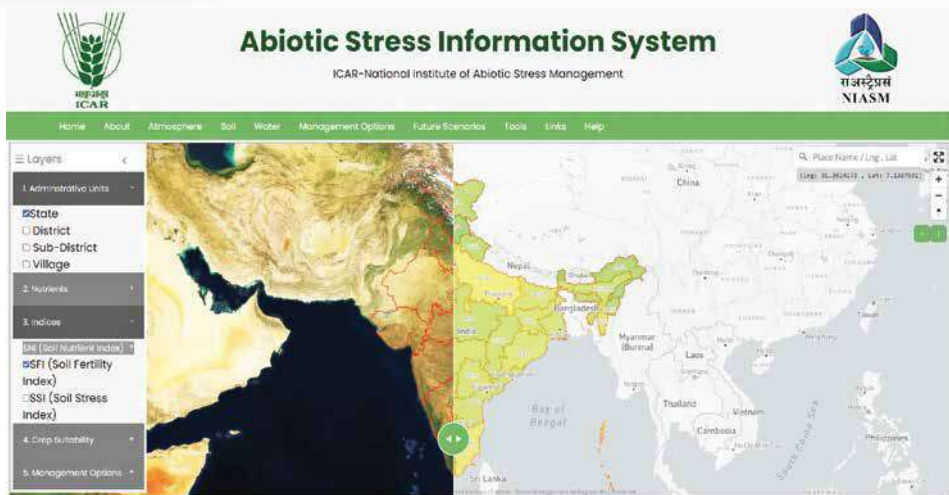


HerbCal: mobile App for dose calculation of herbicides

- **Abiotic Stress Information System (ASIS):** The beta version of the Abiotic Stress Information system (ASIS) has been developed by ICAR-NIASM and is hosted on <http://117.239.43.83/asis/> (<https://niasm.icar.gov.in/asis>). It consists of modules on atmospheric and soil Stress information



for generating query based geo-spatial maps. The Atmospheric stress information module sources data using API services offered by IMD for daily weather warnings, forecast and nowcast. The soil stress information system uses farmer level datasets of Soil health card (SHC) scheme of Government of India curated based on threshold criteria for nutrient specific values, geo-fencing and de-duplication approaches. The nutrient and soil fertility indices have been calculated up to village level using curated datasets.



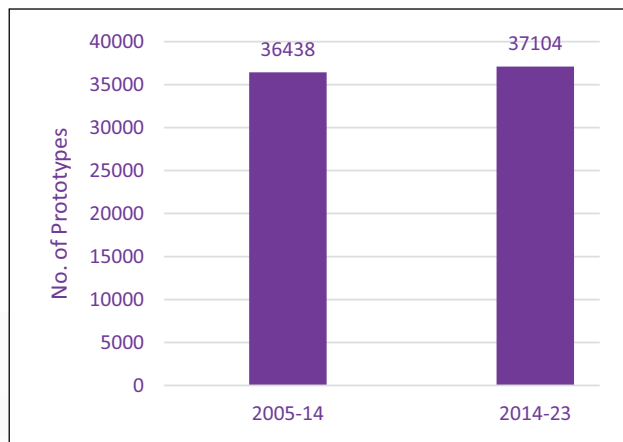
Abiotic stress information system hosted at <https://niasm.icar.gov.in/asis>



6. Agricultural engineering

Farm mechanization

- Overall 272 machines were developed during 2014-23 against 258 machines during 2005-14 to promote farm mechanization. The farm machines prototypes development increased to 37104 during 2014-23 against 36438 during 2005-14. This has helped availability of new farm machines to farmers for higher efficiency in farm operations with better comfort.



Farm machinery prototypes



Drip lateral and plastic mulch layer-cum-planter



Tractor operated Paper-tape Vegetable Transplanter



Trencher-cum-FYM applicator for grape orchards



Self-propelled onion weeder



Multi-row rotary weeder attachment to rice transplanter



Solar assisted e-prime mover for field operations



Micro-controller based precision planter for maize and cotton



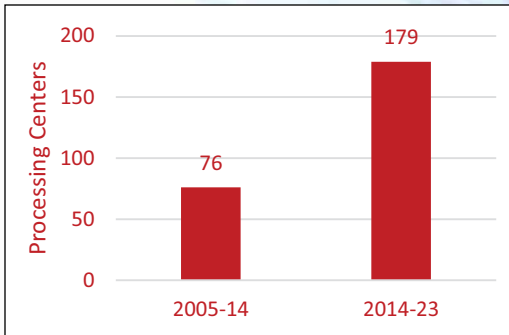
Self-propelled small maize harvester



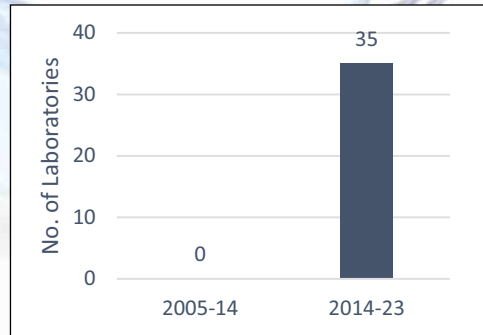
Paddy straw based biogas plant

Post-harvest operations

- ICAR supported the establishment of agro-processing centers for capacity development of the entrepreneurs in the food processing and post-harvest management. During, 2014–23, ICAR established and technically backstopped 179 agro-processing centers against only 76 during 2005–14.



Agro-processing centres established



Food testing laboratories established



CIPHET evaporative cooled storage



Modular onion storage structure



Post-harvest treatment machine for fruits and vegetables



Small millets dehuller (Abrasive type)



Peeling machine for medicinal root crops



Refractance Window (RW) drying based fruit bar manufacturing system

- ICAR backstopped establishment of 35 food testing labs during 2014-23 for the very first time.
- Sugarcane bud chip settling transplanter has been developed and licensed to three farm machinery manufacturers. The machine has been included under subsidy programme of Tamil Nadu state and more than 52 units of machinery sold in India and abroad during last one year.



- The *Makhana* popping machine developed in 2013-14 by ICAR has become very popular and eliminated drudgery to negligible level in the popping of *Makhana* besides adding more value to the finished products. Three private licensees are manufacturing this machine and 5 value-added products have been made. The *Makhana* and its value-added products grew by about 40% in past 3 years.



Rotating orifice feeding system for makhana popping machine



Popped makhana grading machine

- Designed a Buckwheat Dehuller of 40 kg/hr capacity with power consumption of 1.25 kWh. The machine has 67% dehulling efficiency at low seed moisture ($\leq 6\%$ wb) in a single pass with less than 6% broken. The machine separates unhulled and dehulled grains in different channels. The approximate cost of the machine is Rs. 40,000/-.
- Developed technology for accelerated retting of jute. This technology saves 50% water and 10-day time in retting of jute. In addition, the fibre quality is improved by 1-2 grade enabling additional income of Rs. 4500/t of jute fibre. It is commercialized as NINFET-Sathi through signing MoA with M/s Quality Export and Jute Corporation of India. It has become popular in West Bengal among jute growers.
- Developed Digital Ginning Percentage Indicator (DGPI) for portable cotton gin to empower farmers with premium rate for their cotton over and above 34% ginning percentage (GP).
- The mechanization solutions were provided to combat burning of crop residues in the northern Indian states. Designed Happy Seeder, Super Straw Management System, Paddy Straw Chopper, Zero till drill and other machines. In total, 242460 machines were distributed



Digital ginning percentage indicator (DGPI) for portable cotton gins



through a Central Sector Scheme to the farmers. As a result, the straw burning events during 2022 were reduced by 54% over year 2016.

- Established unique Nano cellulose Pilot Plant in 2015 which can produce nanocellulose (10 kg per 8-hour shift) from cotton linters, cotton wastes and bagasse. It is the first of its kind in India and fifth in the world. The pilot plant is poised to bring more synergy in convergence of Agri-business Incubation and its Industrial applications.
- Technical inputs were provided for branding Indian Cotton as "Kasturi Cotton India" to enhance the international perception and valuation for Indian cotton thereby improving export opportunities and foreign exchange earnings. Developed technology for commercial utilization of the cotton stalks, as source of renewable energy as briquettes and pellets.



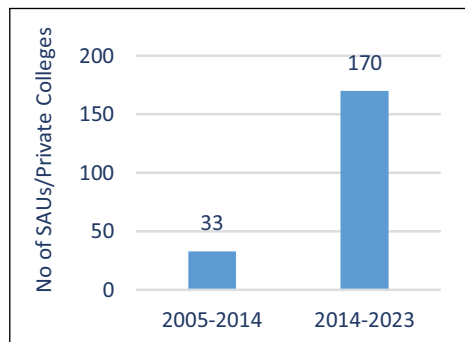
Process protocol for branding Indian cotton as "Kasturi Cotton India" for export



7. Agricultural education

Quality higher agri-education

- The accreditation of SAUs helped enhancing the quality standards of education in the Agricultural Universities. 33 SAUs were accredited during 2005–14 whereas 170 SAUs/ Private colleges accredited during 2014–23.
- A new program "Emeritus Professor" was initiated in 2016–17 to tap brains and skills of outstanding superannuated professionals of National Agricultural Research and Education System (NARES) by utilizing their talent in teaching courses and other related activities, student research guidance and developing instructional material/text books including e-learning resources for use in national agricultural education programme and distance education in the fields of agriculture, veterinary science &



Accreditation of SAUs/private colleges



animal husbandry, fisheries, community science, dairy technology and allied sciences.

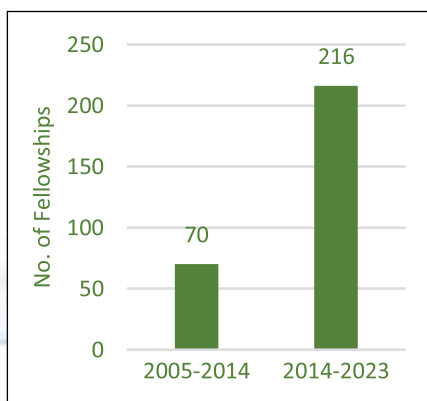
- Student-READY programme was launched in 2015 and implemented across agricultural universities since 2016-17 exposing more than 119306 undergraduate students to various facets of agri- entrepreneurship.
- More than 294 pilot course-curricula/certificate courses on emerging areas of agriculture and allied sector were developed under NAHEP. Till date 3116 trainings were conducted and benefitted more than 30,000 students across the country.
- Towards digital agriculture, more than 111 mobile and web-based applications were developed by partner AUs under NAHEP. These applications will not only support students, faculties, entrepreneurs but also act as an advisory source to farmers.
- Developed Agricultural Education portal-(EKTA) as a single window platform for unified solution linking Education Division with AUs (2017-18). This was an initiative under digital India programme.
- Launched Gender Knowledge System Portal (<http://icar-ciwa.org.in/gks>) to share Gender related information with stakeholders.
- Developed National Agricultural Biocomputing Portal as a single point access to High Performance Computing (HPC) resources for all NARES users.
- a-IDEA (Association for Innovation Development of Entrepreneurship in Agriculture) was recognized as an incubator for supporting agriculture startups under "GoI Startup India initiative 2015"
- Learning outcomes such as Waste to Wealth and Clean and Green Campus Awards were initiated under NAHEP. Hon'ble Prime Minister of India felicitated the winners of Clean and Green Campus Awards on 28th September 2021 to IGKV Raipur for "linen from linseed stalks", PJTSAU Hyderabad for "Black soldier mediated bioconversion of organic waste to black gold", and UAS Bangalore for "Establishment of pilot scale demonstration plant for production of microbial inoculants using corn cob as carrier". The Prime Minister also asked the institutes for initiations in redefining its environmental culture and develop new paradigms by creating sustainable solutions to environmental, social and economic needs of the inhabitants.
- The Krishi Megh (Cloud Infrastructure and Services) was established with (i) ICAR Data Centre (DC) having HCl infrastructure & GPU Server with Artificial Intelligence (AI) capabilities and (ii) ICAR Disaster Recovery Centre (DRC) established at ICAR-NAARM



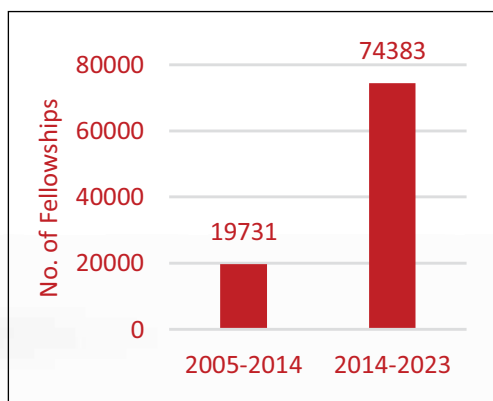
- Virtual Classrooms in 18 Agricultural Universities have been established. The Agri-DIKSHA Web Education Channel initiated for online learning in Agricultural Universities.
- Developed sampling methodologies for estimation of harvest, post-harvest losses of horticultural crops, livestock, and fisheries which have been accepted by FAO and field tested in Nepal, Zambia, Mexico and Thailand. Integrated sampling methodology for crop yield estimation for Crop Insurance were developed using field surveys and latest technologies under Pradhan Mantri Fasal Bima Yojana (PMFBY).
- **KRISHI Portal** (Agricultural Knowledge Resources and Information System Hub for Innovations Empowering Knowledge Management): An online portal for ICAR Research Data Repository of ICAR. The portal received Gold Icon Award in Open Data Champion category from MEITY, Govt. of India on December 30, 2020.
- **eLISS Web Portal and App**: This is an Integrated Sample Survey (ISS) Solution for Major Livestock Products (Milk, Meat, Egg and Wool) with modules on sample selection, data entry and analysis, and GIS map (<https://iss.icar.gov.in/Home>, mobile app e-LISS).

Incentivization for higher education

- ICAR-International Fellowship programme initiated in 2010-11 was revised as Netaji Subhas-ICAR International Fellowships (NS-ICARIFs) program in 2014 for pursuing doctoral degree in agriculture and allied sciences, in the identified priority areas, to the (i) Indian candidates for study abroad in the identified overseas Universities/Institutions having strong research and teaching capabilities and (ii) to overseas candidates for study in the



International fellowships



National fellowships



Indian Agricultural Universities (AUs) in the ICAR-AUs system. The number of fellowships increased from 15 during 2010–11 to 30 from 2014–15 onwards with duration of fellowship being three years.

- ICAR granted 74383 national student fellowships and 216 international fellowships during 2014–23, whereas only 19731 national student fellowships and 70 international fellowship were awarded during 2005–2014.
- Under National Agriculture Higher Education Project (NAHEP), about 500 students visited around 110 international Higher Educational Institutes (HEIs) across the globe and around 170 faculty members undergone training in more than 50 International Universities in cutting edge technologies and emerging areas of agricultural sciences.

Steps towards National Education Policy – 2020

- Road map for the implementation of New Education Policy (NEP)-2020 in Agriculture Universities was developed, finalized, approved and released by the Honorable Minister, Ministry of Agriculture & Farmers Welfare on 28th September 2021.
- Revised the Course curriculum for UG and PG as per National Education Policy 2020 (NEP2020). The new restructured courses harness regional specialties and meet region-specific needs, e.g., Coastal Agriculture, Hill Agriculture, Tribal Agriculture etc.
- Inter-disciplinary approach in selection of courses has been adopted to compliance with the NEP 2020. The courses have been categorized as major, minor, supporting, and compulsory courses. The optional courses may be from any discipline/department enabling the inter-disciplinary approach.
- New BSMA syllabus implemented from 2021-2022 academic session in 79 disciplines for MSc and PhD programmes. New common academic regulations for PG and PhD programmes implemented considering NEP 2020 recommendations.
- Sixth Deans committee has been constituted by ICAR for necessary revision, alteration and modification in course content and curriculum in UG programme, so that certificate diploma and degree courses could be introduced as per requirement and provisions of NEP2020. The report is awaited.
- New degree programmes and courses were recommended in emerging fields like genomics (biotechnology), nanotechnology, GIS, precision farming, conservation agriculture, secondary agriculture, hi-tech cultivation, specialty agriculture, renewable energy, artificial intelligence, big data



analytics, mechatronics, plastics in agriculture, dryland horticulture, agrometeorology and climate change, waste disposal and pollution abatement, food plant regulations and licensing, food quality, safety standards and certification, food storage engineering, food plant sanitation and environmental control, emerging food processing technologies, sericulture, community science, and food nutrition and dietetic.

- ICAR has constituted a committee for developing syllabus & curricula of natural farming in undergraduate programmes and asked to develop the syllabus by April 2022. This syllabus shall be integrated into the existing Undergraduate courses at State Agricultural Universities, Deemed Universities, Central Agricultural Universities and Central Universities with Agricultural Colleges and shall be implemented from 2023–24 in the agricultural universities.
- ICAR has joined CUET (UG) from Academic Year 2023–24 for admission to 11 Undergraduate Courses/Programmes in Agriculture and Allied Sciences, for its 20% All India Quota seats. A total of 5,27,114 candidates have registered for ICAR (UG) CUET 2023–24 for admission to UG Programmes offered by the ICAR.

Central Agricultural Universities (CAUs)

1. Central Agricultural University, Imphal, Manipur

- During the last 9 years of its establishment, 75 students cracked Agriculture Research Service examination, 1251 students placed in Grade I officers in Government organizations, 115 students become successful entrepreneurs and 230 got national fellowships.
- The research accomplishments of the university during 2014–23 included release of 4 crop and 2 horticulture high yielding varieties; production of 0.15 lakh tons breeder seed; development of 3 organic farming package of practices, 9 integrated farming system models, 2 vaccines / diagnostic kits, 3 fish breeding and production technologies, 27 farm machinery prototypes, 3 animal breed registration, demonstration of 22 climate resilient technologies, designing of 10 aquaculture systems and establishment of 2 food testing laboratories and 6 processing units.
- The frontline demonstrations conducted by the university benefitted 0.36 lakh farmers, while it trained 0.86 lakh farmers and extension workers. Produced and distributed 10.3 seed and 9.6 lakh planting materials to farmers. Over one lakh farmers were registered for mobile advisories.



2. Dr. Rajendra Prasad Central Agricultural University (RPCAU), Samastipur, Bihar

- After conversion of erstwhile Rajendra Agricultural University into RPCAU on 7th October 2016, 52 academic programs have been offered by eight colleges of the university with a total annual intake of 763 students. Since 2016-17, 1884 degrees were awarded to the students which generated quality human resource in agriculture and allied sectors. Also nurtured the inherent talent of students and promoted the holistic development through DIKSHARAMBH, a foundation course (2022-23). Shri Ram Nath Kovind ji, the former Hon'ble President of India and Shri M. Venkaiah Naidu Ji, the former Hon'ble Vice-President of India and Shri Narendra Singh Tomar, Hon'ble Agriculture Minister were the prominent visitors to grace three Convocations of the university.
- The university was granted 6 patents, released 14 high yielding varieties and one bio fortified variety of wheat; developed 15 technologies and commercialized 12 technologies for enhancing agricultural productivity. Developed 03 products under agro-waste monetization program (Herbal gual, Energy food, Ready-to-eat mushroom dishes) and published 1458 research articles in international and national journals and 05 policy papers.
- The extension accomplishments included a) establishment of 05 new KVKs; b) training of 3.1 lakh farmers/rural youth and 0.67 lakh extension personnel; c) demonstration of 15 conservation agriculture technologies resulted in increase in area under Zero tillage technology from 2,050 acres to 10,782 acres, d) use of mobile agro-advisories by 2.47 lakh users; e) production and distribution of 32328.42 q seeds, 9020.29 q Breeder seed and 398.88 q Bio-fortified seed to farmers and planting materials to 10.5 lakh farmers; f) KVK at Piprakothi was awarded Pandit Deendayal Upadhyay Krishi Vigyan Protshahan Puraskar and g) the trained farmers were awarded with Jagjivan Ram Abhinav Kisan Puraskar, the national award.

3. Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh

- Established on 5th March 2014, 159 undergraduate and 59 postgraduate students have completed degrees in Agricultural and allied programs. Prepared course outlines of 225 under-graduate and 100 of post-graduate disciplines and 155 Course manuals of under-graduate courses in Agriculture, Horticulture & Forestry and 55 of post-graduate disciplines for better on-hands training.



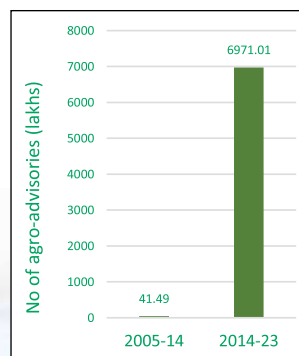
- Constituted Students Centric Platforms: Sensitization for Promotion of Agri-Life Reforms through Science with Human-Touch (SPARSH) for personality development, My Social Responsibility (MSR) for development of sense of sensitivity and social responsibility, Rani Lakshmi Innovation and Incubation Centre (RLIIC) for encouraging aspiring innovation with sparked minds to develop entrepreneurial skills and creation of Agro-industries based enterprises. Published biannually magazines 'Krishi Jeevan' and 'Agri-Life' for dissemination of newer knowledge and published 100 research papers and 210 popular articles.
- Conducted 3000 FLDs on cereals, pulses, oilseeds, fruits, vegetable, flowers, medicinal plants, forestry and agro-forestry crops with the yield advantage in the range of 15-40%. Introduced new crops and cropping system particularly hybrid maize in *kharif* fallows, aerobic rice, dragon-fruit, fig, custard apple, marigold and agroforestry crops and organised 200 training programs on different aspects of agricultural production for capacity building of 10,000 farmers and extension officers of the Bundelkhand region.
- Hon'ble Prime Minister inaugurated the Academic and Administrative buildings of the University. Developed Central Research Facility and 24 need- and purpose- based Post-Graduate Research Laboratories. Established 19 Smart Class rooms, 23 Research laboratories, 44 UG/PG labs, 3 Multipurpose Halls, e-Library, 3 Committee Rooms and Board Room.
- The university has signed 18 bilateral and trilateral MoUs with institutes of India and with Western Sydney University, Australia for in teaching, research and extension activities.



8. Agricultural extension

Lab to Land and farmers outreach

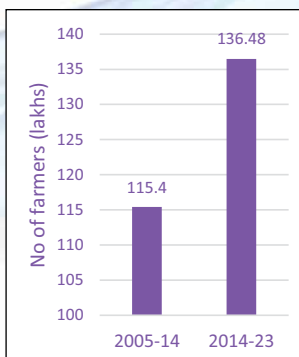
- With the penetration of mobile connectivity deeper in the villages, the KVKs are reaching out to the unreached. This is evident with the soaring agro-advisories provided through mobiles during recent years. The number of mobile agro-advisories provided by KVKs increased to 69.71 crore during 2014-23 against 0.42 crore agro-advisories during 2005-14.
- Training of farmers and capacity development of extension personnel of the States Department of Agriculture and the line departments is the core activity of KVKs. They trained 136.48 lakh farmers and 12.53 lakh extension personnel during 2014-23 as compared to 115.40 lakh farmers and 9.43 lakh extension personnel during 2005-14.
- The number of frontline demonstrations (FLDs) increased by 109.20 % during 2014-23 to 18.41 lakh as compared to 8.80 lakh FLDs during 2005-14. This includes 10.58 lakh exclusive FLDs for pulses



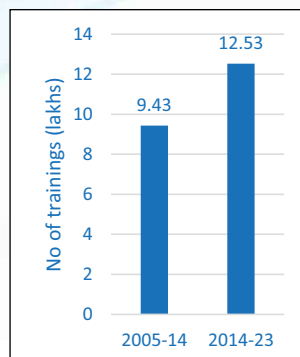
Mobile agro-advisories



and oilseeds. The FLDs have enabled capacity building of 136.48 lakh farmers including farm women and rural youth during 2014-23. In addition, 3.04 lakh Cluster Frontline Demonstrations (CFLDs) on pulses by 549 KVKs estimated average 40% higher yield through adoption of technologies.



Training to farmers



Training to extension personnels

- The outreach to farmers through on-farm trials (OFT) of improved technologies increased by 73% to 3.34 lakh OFTs during 2014-23 in comparison to 1.96 lakh OFTs during 2005-14.
- To catch up with digital revolution, focused efforts by ICAR led to development of 277 mobiles apps on different farm and farmers related services during 2014-23, against ~15 apps during 2005-14. These ICAR apps are being integrated on one common platform called KISAAN.
- For the first time, ICAR provided skill development training aligned with the National Skill Qualification Framework to 40141 rural youth by organizing 1975 training courses.
- The Farmer FIRST (Farm, Innovations, Resources, Science and Technology) initiative was launched during this period by ICAR with enhanced farmers-scientists interface to move beyond production and productivity; the programme is under implementation at 51 centers under ICAR and SAUs spread over 20 states of the country benefitting 50000 farm families of 250 villages. A total of 142791 participatory demonstrations, and 9317 extension programmes have been organized under the project.
- The KVKs organized strategic Information, Education and Communication (IEC) campaign for *in situ* management of crop residues in ~700 villages in the northern India. Almost 2-lakh farmers participated in the campaign. As a result, adoption of good agriculture practices (GAPs) including machinery improved and in comparison, to 2016, a drop of 51.9% in burning incidences was observed during 2019-20.
- Nutri-Smart Village programme was launched in 75 villages in 23 districts (13 states) to strengthen the POSHAN Abhiyan. 60 MLAs and 2271 VIPs attended the programme in KVKs. Total 607027 plants and 77879 vegetable



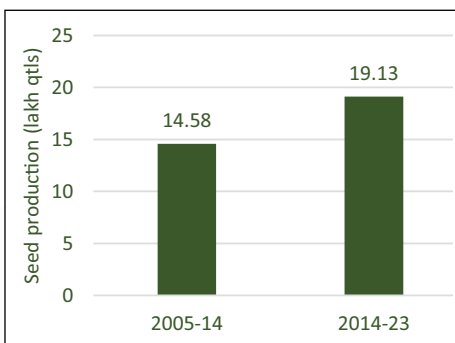
Nutritional garden at KVK DURG

seed packets were also distributed among the farmers for awareness about nutrition and establishment of Nutri-gardens.

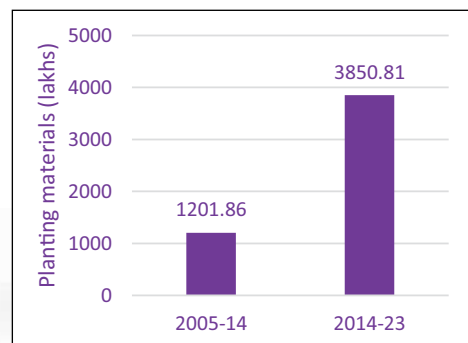
- Under the project "Attracting and Retaining Youth in Agriculture (ARYA)" a total of 14878 agro-based enterprise units were established benefitting 28711 rural youth. The KVKs organized 3059 training programmes benefitting 65661 youth and enhanced their income by 53.86%.
- A programme on "Knowledge Systems and Homestead Agriculture Management in Tribal Areas (KSHAMTA)" is being implemented by channelizing the Tribal Sub Plan fund of ICAR institutes for Development of Tribal Agriculture in 125 tribal districts of the country through KVKs.

Supply of inputs

- The KVKs also produced quality seeds, planting materials, and improved strains of livestock and fish fingerlings. During 2014-23, KVK produced 31.21% more quality seed (19.13 lakh q) and 220 % more planting material (3850.81



Seed production and distribution for Farmers in KVKs



Distribution of Planting materials to farmers



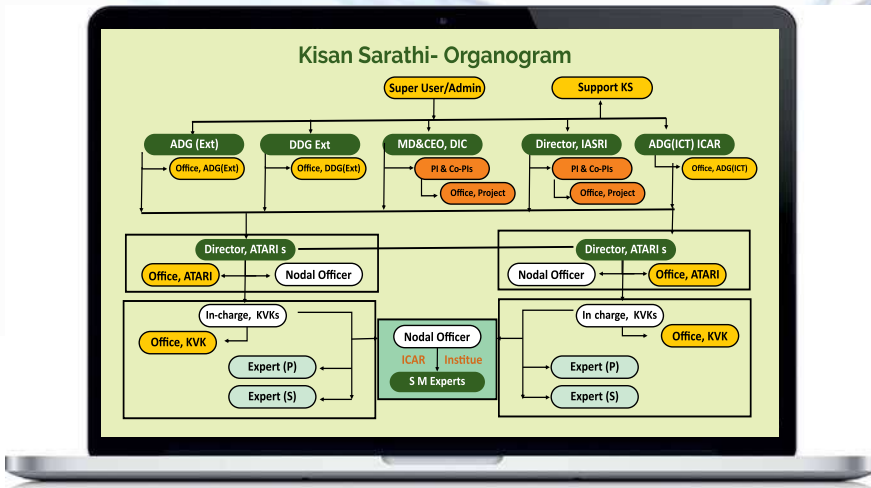
Demonstration and hand holding of farmers

lakh) in comparison to only from 14.58 lakh quintals seed and 1201.86 lakh planting material during 2005–14. Further, about 86800 q quality pulse seed was produced by Pulse Seed Hubs at 95 KVKs.

- During 2014–23, the KVKs produced 1979.45 lakh quality stains of livestock and fish fingerlings against 927.16 lakh strains and fingerlings during 2005–2014.
- To complement the efforts of soil health assessment, KVKs offered their services for the analysis of soil samples of the farmers. The analysis of soil samples of farmers' fields by KVKs increased by 198% from 15.52 lakh samples in 2005–14 to 46.27 lakh samples in 2014–23.
- The technology backstopping and handholding support from KVKs to 117 Farmers Producer Organizations as Cluster Based Business Organizations (CBBOs) raised the total equity of the promoted FPOs by Rs. 6.19 crore.
- Use of Agri-Drones for spraying insecticides and nutrients was demonstrated to 81970 farmers through 15525 FLDs covering 15160 ha area.
- Promotion of Natural Farming was backstopped by 425 KVKs through conducting 3400 demonstrations, training of 17216 farmers and organizing 3365 awareness programmes involving 2.3 lakh farmers.

Digitization

- **Kisan Sarathi** (System of Agri-information Resources Auto-transmission and Technology Hub Interface) is an ICT based platform for two-way multi-lingual communication system between farmers and agricultural experts for transmission of agricultural technology/information and advisory in the form of Text, Images, Audios and Videos. The platform was launched on July 16, 2021 as pilot scheme. Currently, 731 KVKs and 3781 agricultural experts are registered to support 1.05 crore registered farmers of 210117 villages in the country.



Kisan Sarathi: ICT based multi-lingual two-way communication system

- **KCC-CHAKSHU** (Kisan Call Centre- Collated Historically Aggregated Knowledge-based System with Hypertext User-interface): It provides insights and alerts to farmers.
- **KISAAN 2.0** (Krishi Integrated Solution for Agri Apps Navigation): It is an aggregator mobile app and provides information on 270+ agricultural related apps with interface in 11 languages.
- **KVK portal and KVK App**: The systems provide information about facilities and activities of KVKs, and access to District Agricultural Contingency Plans, Package of Practices, Agro-advisory and Agricultural Commodity Market prices to farming community.



9. Commercialization of technologies and agri-startups

- Under commercialization of technologies, the licensing agreements grew from 720 agreements during 2007–2014 to 2970 during 2014–23. The number of licenses during 2014–23 increased to 1725 including government agencies, private industries, MNCs, NGOs, Start-ups and entrepreneurs against 430 during 2007–14. These vigorous efforts increased the commercialization of technologies to 850 technologies during 2014–23 against 307 during 2007–2014.
- Agri-Startup and Entrepreneurship Conclave was organized on 16–17 October, 2018 at NASC Complex, New Delhi for unleashing the potential in agriculture for young agripreneurs (UPAYA). The programme was by Union Minister and MOSs of Agriculture & Farmers Welfare, Ministers of Petroleum and Natural Gas; and Skill Development and Entrepreneurship. The conclave was attended by about 700 participants including 104 startups/ entrepreneurs / licensees nurtured by ABIs of ICAR.
- ICAR established 22 Agri Business Incubators (ABIs) during 2005–14 for providing handholding to entrepreneurs and startups and these were increased to 50 by 2014–23. Consequently, the enrollment of entrepreneurs



and startups became three times to 1832 during 2014–23 against 611 in 2005–2014. A total 584 Entrepreneurs Development Programmes were conducted during 2014–23.

- Agrinnovate India Limited (AgIn), the corporate entity of ICAR was incorporated under the Companies Act, 1956 (No.1 of 1956) since October, 2011 to enhance visibility, bring uniformity of processes and promote centralized transfer of technology. During 2014–15 to 2022–23, AgIn commercialized over 423 technologies, realized Rs.21.40 crore in the from license fee and royalty.
- Bio-pesticide formulation ICAR-FUSICONT controls Panama Wilt (TR4) disease affecting Cavendish bananas globally and helps reduce production loss up to 90%. Agrinnovate granted a non-exclusive local production & global marketing rights to a company in 2021.



10. Infrastructure development

- **Nanaji Deshmukh Plant Phenomics Centre:** Shri Narendra Modi, Hon'ble Prime Minister dedicated the "Nanaji Deshmukh Plant Phenomics Centre" to the nation on October 11, 2017 at ICAR-IARI, New Delhi. This is world's largest plant phenomics facility in terms of analytical capabilities and having state-of-art automated high throughput facility for non-destructive and accurate characterization of a large number of germplasm and recombinant inbred lines under defined environmental conditions. Phenomics will be useful for accurate phenotyping of the germplasm throughout the life cycle in controlled stress conditions to identify superior genes and genotypes for development climate resilient crop varieties. In addition, the image features at the facility will be useful for UAV- and/or remote sensing-aided applications in efficient resource and crop management especially fertilizer and water management, crop health and disease diagnosis.



Nanaji Deshmukh Plant Phenomics Centre, ICAR-IARI, New Delhi



Hon'ble Prime Minister Shri. Narendra Modi dedicated the "Nanaji Deshmukh Plant Phenomics Centre" at ICAR-IARI, New Delhi to the Nation on October 11, 2017



Plant cultivation on moving field conveyor system and various imaging platforms in Nanaji Deshmukh Plant Phenomics Centre at ICAR-IARI, New Delhi

- Commissioned unique Nano Cellulose Plant of capacity 10 kg Nanocellulose/8-hour shift) from cotton linters, cotton wastes, and bagasse in 2015 (First in India and fifth in world).



Nano Cellulose Plant



11. Human resource management

- 612 new specialized programmes have been organized during 2014–2023 in which 9589 employees of various categories participated and out of them 7987 (83%) participants either availed the first-time opportunity to attend any training programme after joining ICAR service or after getting a specific role/charge.
- Developed and implemented online Training Management Information System (TMIS) in ICAR for its employees w.e.f. 1st April, 2019.
- Formulated and implemented "ICAR HRM Policy: Training and Capacity Building" w.e.f. 1st April, 2018 for all categories of ICAR employees.
- There was considerable improvement in average number of Administrative, Technical and Skilled Support Staff (SSS) undergone training, where per cent improvement was 22.8, 110.8 and 1077.5, respectively along with overall improvement of 36.2 per cent in all the categories of employees on the basis of mean data of 8 years (2014–22) over 2013–14.
- The overall Impact of training attended during 2016–20 by various categories of employees was rated as Considerable – Great Extent based on the feedback of 9214 Trainees and their respective Reporting Officers of all ICAR-Institutes.



12. International and national collaborations

- The 11th meeting of BRICS Agriculture Ministers under the theme BRICS Partnership for Strengthening Agro-Biodiversity for Food Security and Nutrition was organized on 27th August 2021 at New Delhi. The Union Minister of Agriculture & Farmers Welfare, Government of India, Shri Narendra Singh Tomar and the Ministers of Agriculture of the Federative Republic of Brazil, the Russian Federation, the People's Republic of China, and the Republic of South Africa participated in the meeting. BRICS-ARP prepared by DARE/ ICAR was operationalized in the BRICS Agri Ministers meeting to intensify cooperation in agricultural research, technology, innovations and capacity building amongst BRICS Nations.
- DARE/ICAR hosted the 4th ASEAN-India Ministerial Meeting on Agriculture and Forestry on 11-12 January, 2018 and organized International Seminar





exclusively for BIMSTEC Countries in December, 2019 on Climate Smart Farming Systems.

- To enhance collaborations with industries and facilitate Corporate Social Responsibility (CSR) funding for agricultural research, ICAR Guidelines for utilization of CSR Funds, 2021 formulated and put in place.

- During 2014–2023, ICAR entered into several MoUs with leading research organizations like CSIR, ICMR, DBT, IIT(D), rural bank-NABARD, Government Departments-MoPFI, MoRD, MSME, NGOs-ICICI Foundation, RCRC, Private organizations – Amazon Kisan, PBRI, and Amity University and Cooperatives such as National Cooperative Development Corporation and Chhattisgarh Minor Forest Produce Cooperative Federation Ltd., etc. for promotion/facilitation of R&D and validation and deployment of agri-technologies and value-added products beneficial to humans, plants and animals. The ICAR- CSIR-Ayush Ministry tripartite MoU signed on 8 March, 2022 for R&D related to medicinal plants and their value-added products.

- Year 2023 is the International Year of Millets and a series of celebrations have been made to promote millets and millet products globally. ICAR-Indian Institute of Millets Research, Hyderabad was declared as Global Centre of Excellence for R&D in Millets (Shree Anna)



International seminar on climate smart farming systems



Signing of MOUs with different organisations



Inauguration of global millet conference



to make India a Global Hub for Shree Anna. Hon'ble Prime Minister inaugurated Global Shree Anna (Millets) Conference on 18 March, 2023, which was attended by Agriculture Ministers of 6 countries and participants from 102 countries, including delegations from 40+ embassies in India and representations from various international organizations including e.. WFP, FAO, ICRISAT, IRRI, ICARDA, UNFCCC, IUCN, AARDO, IUCN, UNICEF etc.

G20 Meeting of Agricultural Chief Scientists (MACS)

- DARE/ICAR successfully organized the 12th G20 Meeting of Agricultural Chief Scientists (MACS) at Varanasi (UP) during 17–19th April 2023, which



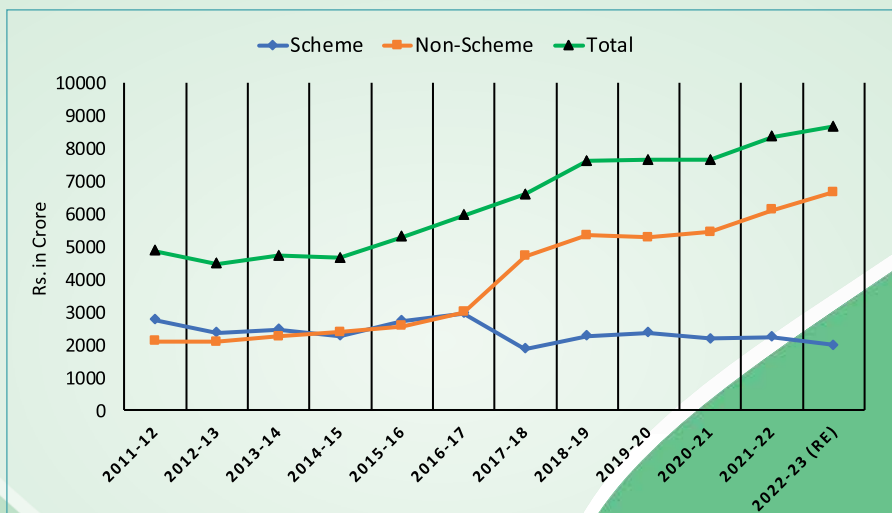
G20 meeting of Agricultural Chief Scientists at Varanasi during 17–19 April 2023

was attended by 80 delegates from G20 Nations, Invited Guest Countries and International Organizations. The Theme of the MACS was "Sustainable Agriculture and Food System for Healthy People and Planet"

- Celebrating the International Years of Millets 2023, MACS unanimously supported the proposal of India for launching of "Millets and other ancient grains international research initiative (MAHARISHI)" initiative to establish mechanisms for connecting researchers and institutions working on identified grain crops at global level.
- Six bilateral meetings were held between India, Argentina, France, Germany, UK, Japan and FAO during MACS. Besides, MACS also supported the India's proposal to organize two technical workshops on "One Health" and "Climate Smart Agriculture".



Bilateral meeting between India and France held during 12th G20 MACS



13. Budgetary allocations

- The financial procedures have been made digital by rolling out PFMS (Public Financial Management System). Hierarchy mapping was executed up to smallest possible unit across ICAR. Successfully implemented Treasury Single Account (TSA) across ICAR since August 1, 2020. This ensured timely drawl of funds and remittance of fund to Institutes.
- In total 4185 internal audit paras and 826 external audit paras have been settled. As on March 31, 2022, replies to remaining 9 internal and 302 external audit paras have already been furnished.

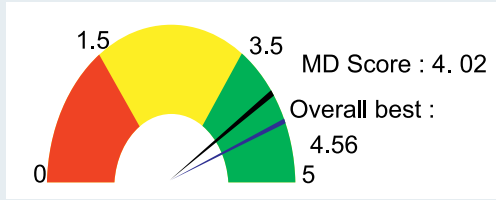


Statement of Expenditure of ICAR and DARE for the last 9 years

(Rs in crores)

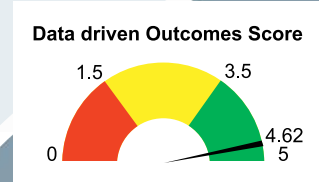
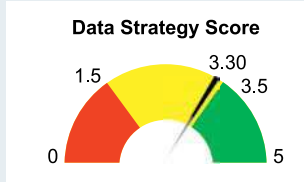
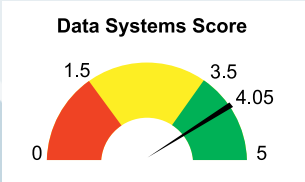
Financial Year	ICAR	DARE	Total
2014-15	4709.41	130.62	4840.03
2015-16	5384.00	188.90	5572.90
2016-17	5782.18	213.03	5995.21
2017-18	6740.55	249.37	6989.92
2018-19	7564.82	378.78	7943.30
2019-20	7357.41	487.59	7845.00
2020-21	7231.92	453.59	7685.51
2021-22	7879.59	560.34	8439.93
2022-23	7911.58	640.83	8552.41

Overall DGQI 2.0 Score=4.02



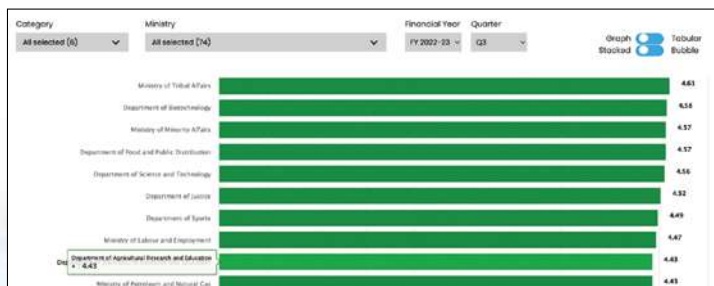
DGQI 1.0 Score
2.19

Pillar Wise Scores



14. ICAR – Data governance quality index (DGQI)

The DGQI is toolkit provides a unique framework for self-assessment of data preparedness levels across the Government of India. DGQI is based on internationally accepted data preparedness assessment models from private and public sectors but appropriately contextualized for India. The intent of the DGQI is to enable Ministries/ Departments and state departments to assess themselves at various levels of data maturity on the basis of a standardized framework, which in turn would facilitate deepening of digitization in the Government of India. The DGQI 2.0 of ICAR for 2021-22 was 4.02 out of 5.0, which has increased to 4.43 for third quarter of 2022-23. DARE-ICAR is placed among top most Departments in Digital Governance.



Improved DGQI score of ICAR for Q3, 2022-23

RULES AND BYE-LAWS

OF THE

INDIAN COUNCIL OF AGRICULTURAL
RESEARCH SOCIETY

(in force w.e.f. April 3, 1975)



INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI

15. Reforms and new policy initiatives

Continued reforms and new policy initiatives are in-built in ICAR setup that keeps it dynamic, progressive, active and relevant to the present and future needs at national and global levels. Some important paradigms are presented here:

1. Governance of ICAR

- Amended the Memberships of ICAR Society and ICAR Governing Body
ICAR Society: The General Body of ICAR Society was expanded by including Union Minister, Minister of state(s), and all the Secretaries in the Union Ministry of Fisheries, Animal Husbandry and Dairying. The Union Minister and Minister of State(s) in the Union Ministry of Fisheries, Animal Husbandry and Dairying shall also be the Senior Vice-President of the Society (Amended vide DARE Notification No.5(1)/2018-Gov.Cell dated 9.07.2021).

Governing Body: The Governing body of ICAR Society was expended by including four representatives of State Governments in rotation basis, one representative of Agro and Agro-Processing Industries, and one representative from a distinguished Non-Governmental Organizations (Amended vide DARE Notification No.5(1)/2014-Gov.Cell



dated 3.04.2014, 5.04.2016 and 20.07.2018).

- **Restructuring of ASRB:** The Government of India vide Notification No. 25/CM/2018(i) dated 06.08.2018 has delinked ASRB from ICAR and attached with the DARE under Ministry of Agriculture & Farmers' Welfare, Government of India. Further, the revamped Board shall have a separate budget head and its own cadre of administrative staff in the secretariat.
- **5-days working week at ICAR Institutes:** The Council implemented 5-days working week in all the ICAR institutes w.e.f. October 1, 2022 with working days from Monday to Friday. (vide OM F.No. 12-10/2018-Cdn. Dated 21.09.2022).
- **Transfer Policy of Scientists:** The online-transfer policy was implemented at ICAR vide letter No. 38(2)/2011-Per-IV(Pt) dated 6.07.2018 and further updated on 1.10.2020 for inter-institutional and intra-institutional transfers of ARS Scientists.

2. Office automation and e-governance

ICAR implemented e-office, e-HRMS, SPARROW software developed by NIC besides software developed at ICAR to bringing more objectivity, accountability, and transparency in office governance and management. Some of the e-governance initiatives are as follows:

- **e-Office:** e-office has been implemented in ICAR-HQs along with 113 ICAR Institutes and their Regional Stations/Sub-Stations in 2019. Implementation of e-Office in ICAR has completely transformed the working of office in ICAR and has empowered officers to work during difficult time of COVID.
- **Smart Performance Appraisal Report Recording Window (SPARROW):** The SPARROW is an online system based on the comprehensive performance appraisal dossier that is maintained for each employee of the Service by the Government. In ICAR, SPARROW is implemented for Administrative, Technical & Supporting Cadres w.e.f. 12.04.2022.
- **Electronic Human Resource Management System (eHRMS):** eHRMS is a work flow based online human resource management solution for proper monitoring, posting, leave, LTC, reimbursement, advances related administrative activities. This has been implemented in ICAR-HQ and will be implemented across all ICAR institutes by May 2023.
- **Land Record Management Information System (LRMS):** ICAR developed and implemented an integrated Land Records Management



System (LRMS) which provides land record information of all institutions along with their Regional Stations.

- **Court Case Management System (CCMS):** This system developed by NIC has been implemented in ICAR for online management of court cases included its monitoring at different courts across country.
- **Personal Information Management System (PIMS):** This system has been developed by ICAR and used for management, transfer and posting of scientific staff at different ICAR institutes.
- **Agricultural Research Management System (ARMS)** (<https://arms.icar.gov.in>): The Agricultural Research Management System (ICAR-ARMS) has been developed by ICAR for evaluation, monitoring and management of scientific output for policy planning of the Council. Version 1.0 of this system was released on 19th March 2021 to input scientific achievements of each scientist from April 2021 onwards. This system will help in real time research assessment and its prioritization at different management levels i.e. institute, SMD and Council.
- Implementation of PFMS-MIS system in all the official activities.
- Biometric Attendance System for monitoring the attendance of the staff.
- Established independent audit of implementation of citizen's charter and public grievance redressal system.

3. ICAR DARPAN dashboard (<http://icar.dashboard.nic.in>)

ICAR Darpan Dashboard is customized using DARPAN portal developed by NIC to transform complex government data into compelling visuals. It enhances the analytical capabilities through data collection by consolidating multiple data sources into one centralized, easy-to-access platform. All ICAR Schemes/Projects are classified into 12 projects consists of 25 Key Performance Indicators (KPIs) and in public domain.

4. Research targeting

- **Rationalization of ICAR Schemes:** Seventy-five Central Sector Schemes of DARE/ICAR during 12th FYP were initially rationalized to 35 Schemes during 14th Financial Cycle and further rationalized to nine Schemes during 15th Financial Cycle.
- Redefined the domains and mandates of research institutes for wider research perspectives.
- Enhanced support for frontier areas of research including genome editing, bio-informatics, climate change, nano-technology etc.
- Consortia Research Platforms (CRPs) were formed to address multi-



disciplinary cutting-edge research challenges in agriculture and allied sectors.

- The National Agricultural Science Fund (NASF) was implemented to promote and support basic research, build strength in frontier research areas and reduce redundancy in research.
- **Aligning the activities of various disciplines under subject matter divisions:** Agricultural research, education and extension follow multidisciplinary approach, hence, scientists with specialization in the domain of the lead SMD quite often carry out activities in the institutes of other Subject Matter Divisions (SMDs). Therefore, the Council has decided to align such activities with the existing operational arrangement for planning, reviewing and reporting. These include a) connecting the institutes and scientists of various SMDs working in the same area to the lead SMD, b) reviewing and prioritizing activities of research/education/extension/ training/ others by the lead SMD for all the related institutes of other SMDs and c) collating and reporting the salient achievements of the related SMDs along with the lead SMD. The alignment of activities was finalized and circulated for implementation.
- **ICAR- Network program on precision agriculture (NePPA):** The ICAR-Network Program on Precision Agriculture was initiated by the council initially with 16 ICAR Research Institutes with IARI as Lead. The program is focused on exploring potential applications of recent developments on technologies related to sensor, IoTs, Drone and ICTs for precision smart agriculture. The major objectives span its scope over soil fertility, crop health, livestock, post-harvest operations, aquaculture and upscaling these using advanced technologies like drones, variable rate technologies (VRT's) to enhance input use efficiency and optimal production system.
- **ICAR-HRM policy-training and capacity building:** The policy was implemented in 2017 for transforming the ICAR employees of all cadres as a vital resource to be valued, motivated, developed and enabled to achieve the organization's mission and objectives.
- **Agri-business incubation centres (ABI):** The ABI Centres are established at ICAR institutes for augmented commercialization of technologies and innovations and also incubate the creativity/wisdom among local people.
- **Certifying innovations and technologies:** The certification of innovations and technologies developed at ICAR institutes since 2020 have been made mandatory for effective dissemination and adoption, and recognition of intellectual assets of the scientists.



The Council has decided to certify these Products/ Technologies/ Process/ Methodology/Model/Protocol/Policy, etc. with purpose of a) identifying, verifying and compiling the products/technologies for sharing with the stakeholders for better dissemination and adoption. b) Assessing intellectual assets of the scientists more objectively leading to greater professional recognition. A designated committee under DDG of the SMD will evaluate the candidate innovations and technologies. The approved innovations will be assigned a unique identification number and will also be uploaded in the central Technology Repository of ICAR.

5. Agriculture education

The course curricula at agricultural universities have been reformed as per the guidelines of National Education Policy 2020.

- The new curricula are aligned and fine-tuned with the tradition, technology, local needs and the future prospects as per the recommendation of the 5th Deans Committee.
- Recognition of Agriculture Education as a Professional degree.
- Accreditation of Agricultural Universities is made mandatory to assure availability of quality human resource in agriculture (Amended vide DARE Notification No. edn.5/1/2008-EQR(Part-II), dated 10.04.2017).
- **Central Agriculture Universities:** Rani Lakshmi Bai Central Agricultural University, Jhansi was established in 2014 to cater the agriculture specific needs of Bundelkhand. Similarly, Rajendra Agriculture University, Bihar was upgraded to Dr. Rajendra Prasad Central Agriculture University.

6. Agriculture extension

- **KISAN SARATHI-System of agri-information resources auto-transmission and technology hub interface:** An ICT based interface solution "Kisan Sarathi" has been developed to support emerging need of multi ways and multilingual communication among various agricultural stakeholders. More than 3600 agricultural scientists and subject matter experts are registered with Kisan-Sarathi. The services of Kisan-Sarathi for the farmers is available through an IVR based calling system via toll free numbers 1800-123-2175 and a short number 14426. More than 65 Lacs farmers are already registered on this portal.
- **ARYA (Attracting and retaining youth in agriculture):** The ARYA project was initiated to attract and empower rural youth for sustained income and gainful employment in agriculture and allied sector, efficient use of local resource through networking, and convergence of opportunities for sustainable growth. The project is running in 100 KVKs.



16. Major events



Inauguration of Global Millets (Shree Anna) Conference by Shri. Narendra Modi, Hon'ble Prime Minister, Govt of India on March 18, 2023 at Bharat Ratna Dr. C. Subramaniam Hall, NASC Complex



Foundation Stone Laying of Indian White Shrimp Breeding and Improvement Facility at ICAR-CIBA, Chennai by Shri Parshottam Rupala, Hon'ble Union Minister for Fisheries, Animal Husbandry and Dairying, Govt of India on February 27, 2023



Hon'ble Vice President graced as the Chief Guest at 61st Convocation of ICAR-IARI on February 24, 2023



Hon'ble President inaugurated 2nd Indian Rice Congress at ICAR-NRRI, Cuttack on February 11, 2023



ICAR Tableaus in Republic Day Parades of years (a) 2023, (b) 2019 and (c) 2018. ICAR bagged best tableau award in 2019



Hon'ble Union Minister of Agriculture and Farmers Welfare, GoI Shri Narendra Singh Tomar inaugurates North East Krishi Kumbha – 2023 & 49th Foundation Day Celebration of ICAR-RC-NEH on January 4-6, 2023



Farmers Empowerment: PM Kisan Samman Sammelen October 17, 2022 at ICAR-IARI Mela Ground



National Nutri-Cereal Convention 4.0 held on September 23-24, 2022



Inauguration of the 9th GB of ITPGRFA by the Hon'ble Sh. Narendra Singh Tomar, MoA&FW on September 19-24, 2022



Hon'ble Ministers graced 94th ICAR Foundation Day on July 16, 2022



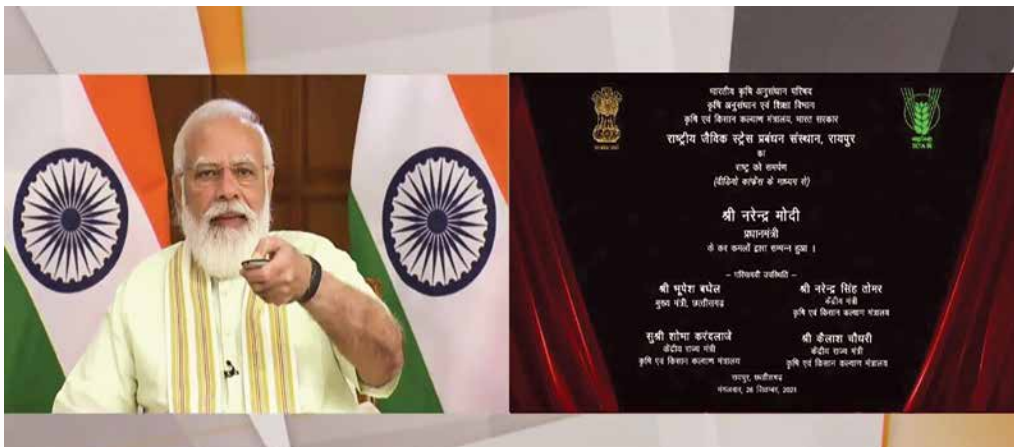
Hon'ble Union Minister for Agriculture and Farmers Welfare Shri Narendra Singh Tomar Ji inaugurated year-long programmes of the ICAR-NDRI on the celebrations of 100 years of the premier dairy Institute of the country on July 1, 2022



Hon'ble MoS laid the Foundation stone of Farmer's hostel & Staff quarters at ICAR- KVK, Belgavi-II on June 19, 2022



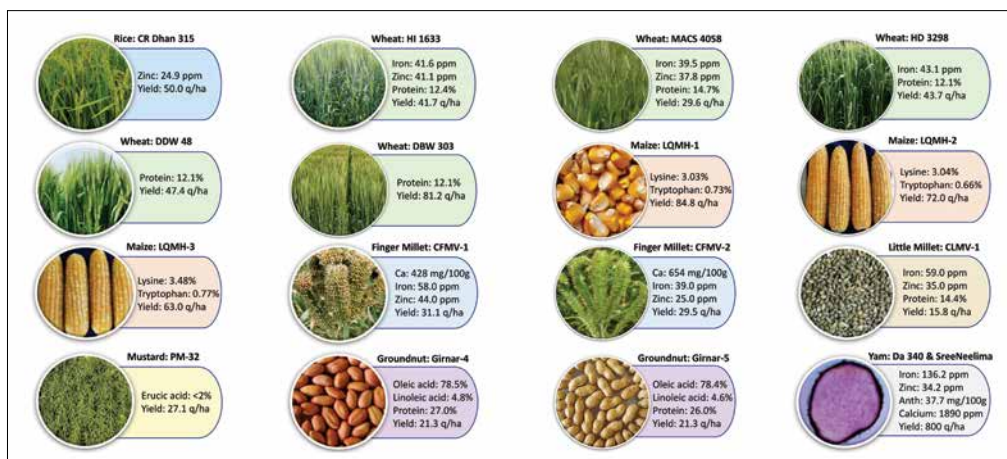
Hon'ble Union MoS for Agriculture and Farmers' Welfare, GoI Smti. Shobha Karandlaje Visited ICAR NEH, Manipur Centre on October 27, 2021



ICAR-National Institute of Biotic Stress Management, Raipur – Dedication to the Nation by Hon'ble PM on September 28, 2021



Shri Parshottam Khodabhai Rupala, Hon'ble Minister of State, Agriculture and Farmers' Welfare inaugurated the administrative building of ICAR-National Institute of Abiotic Stress Management (NIASM), Baramati, Maharashtra through virtual platform on December 16, 2020.



17 Biofortified crop varieties dedicated to the nation by Hon'ble Prime Minister October 10, 2020.



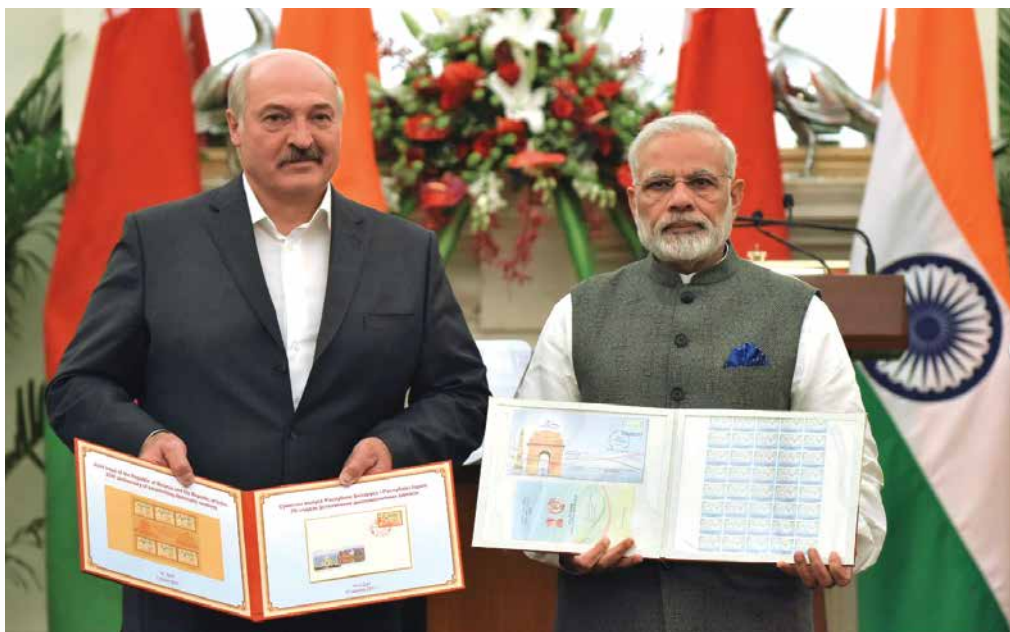
Administrative-cum-Laboratory Building of Mahatma Gandhi Integrated Farming Research Institute (Erstwhile NRC on Integrated Farming) was inaugurated on 8 March, 2019



11th Indian Fisheries and Aquaculture Forum (November 21, 2017; ICAR-CIFT, Kochi).



Nanaji Deshmukh Plant Phenomics facility: World largest in terms of analytical capabilities, inaugurated by Hon'ble Prime Minister on October 11, 2017.



MoU between ICAR and Belarus State Agricultural Academy (BSAA), Belarus, September 11, 2017.



Hon'ble Prime Minister laid the foundation stone of IARI-Assam at Gogamukh, Assam May 26, 2017.



Inauguration of Sagar Harita: A multipurpose fishing vessel, ICAR-CIFT, Kochi by Dr Trilochan Mohapatra, Director General (ICAR) on April 19, 2016.



54th Convocation of IARI February 5, 2016.



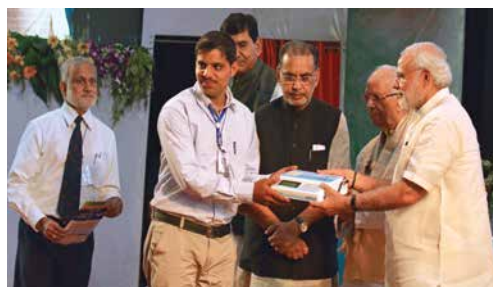
World Soil Day (December 5, 2015).



Foundation stone laying ceremony of NRC on Integrated Farming (NRC-IF) was held at Piprakothi, Motihari East Champaran on 21 August, 2015



Inauguration of new IARI type Institute at Barhi, Jharkhand on June 28, 2015 and completed Shayama Prasad Mukherjee Bhavan at IARI-Jharkhand



Release of Mridaparishak by Hon'ble Prime Minister, Govt. of India in 2015



Laying of Foundation Stone of IIAB, Ranchi by Hon'ble Union Minister of Agriculture 25th August, 2014 at Garhkhatanga, Ranchi (Jharkhand)



86th Foundation Day & Award Ceremony (29 July, 2014), New Delhi.



INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Institutes, Bureaux, Directorates and National Research Centres

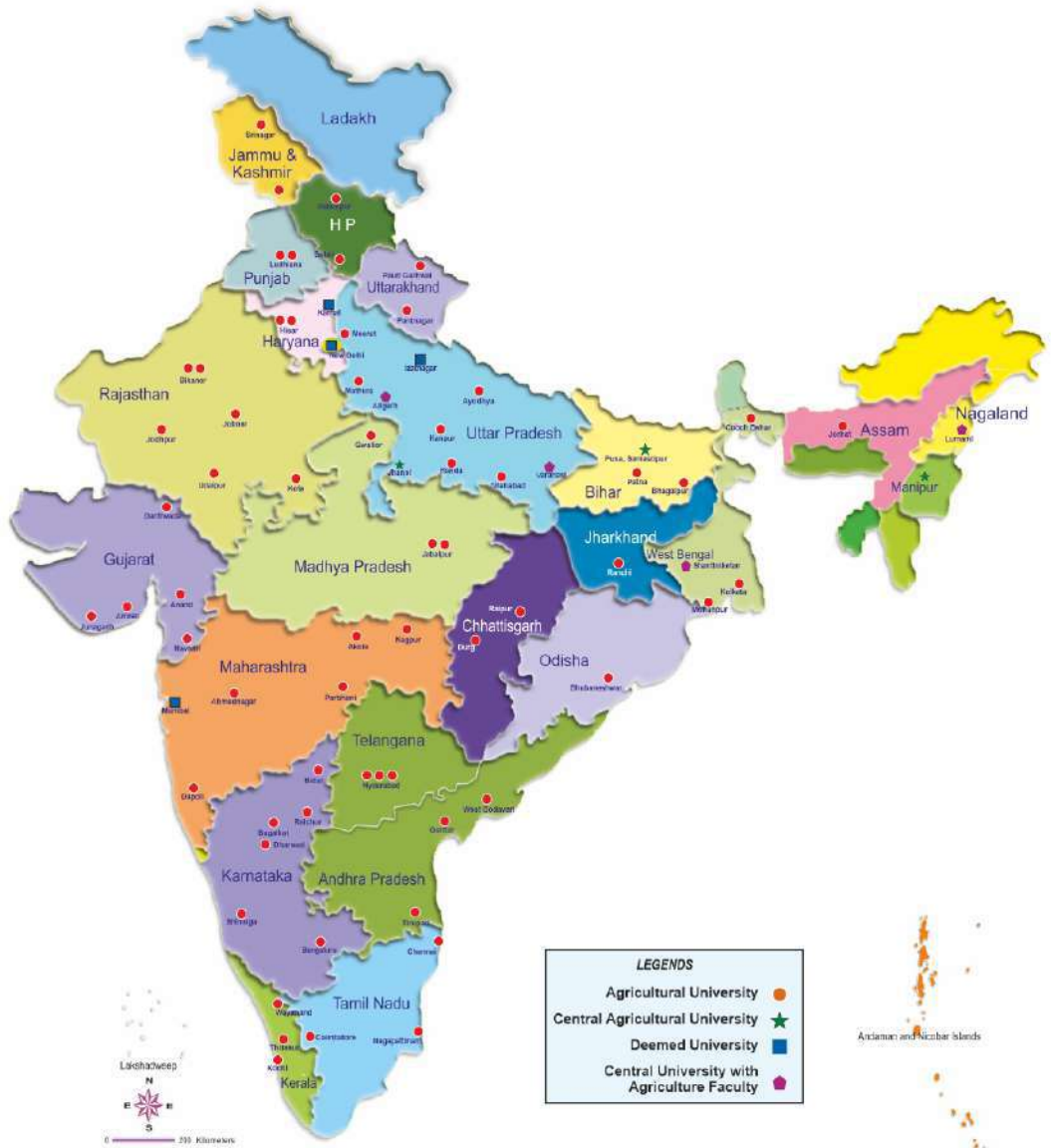


● 72 Research Institutes ● 6 Bureaux ● 12 Directorates ● 12 National Research Centres



INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Agricultural Universities



LEGENDS

- Agricultural University ●
- Central Agricultural University ★
- Deemed University ■
- Central University with Agriculture Faculty ■



* Map not to the scale

● 63 State Agricultural Universities (SAUs) ● 3 Central Agricultural Universities ● 4 Deemed Universities
● 4 Central Universities having Faculty of Agriculture

