DARE-ICAR

Research Priorities & Technologies for Farmers' Welfare

SIGNIFICANT ACHIEVEMENTS

2021-22

Indian Council of Agricultural Research
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Ministry of Agriculture & Farmers Welfare
Krishi Bhawan, New Delhi -110001
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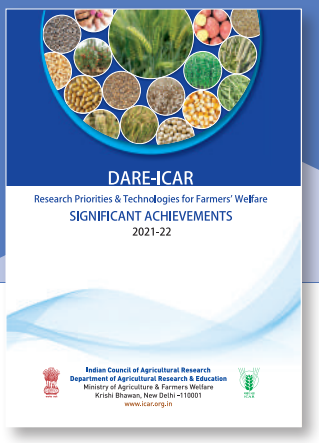

Cover: Efforts towards Enhancement of Food & Nutritional Security

October 2022

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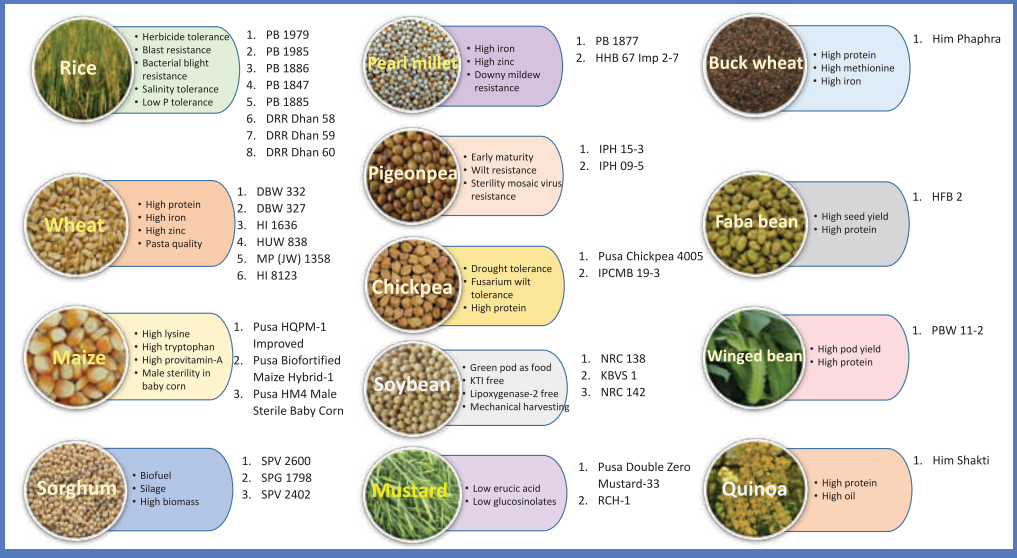
"Over the years, there has been a lot of great work in the country in the research and development of biofortified seeds; and I congratulate all the agricultural universities and agricultural scientists for the same. While only one variety of this type reached farmers before 2014, today 70 Bio-fortified varieties of different crops are available to farmers. I am glad that some of these bio-fortified varieties have been developed with the help of local and traditional crops."

Prime Minister

(On the occasion of the 75th Anniversary of FAO, October 16 2020)

35 Special Trait Crop varieties Dedicated to Nation by Hon'ble Prime Minister on 28-09-2021



Diversity in milletes

FOREWORD

ICAR has commemorated the 75th Year of Nation's independence as *Azadi Ka Amrut Mahotsav* by initiating unique drives including lecture series by eminent persons, massive awareness campaigns to reach the unreached, documentation of 75000 success stories of doubling farmer income, and bringing out a book entitled, "Indian Agriculture: A Saga of Success-Role of ICAR through Different Revolutions".

During 2021-22, ICAR was devoted towards development and dissemination of technologies for self-reliant agriculture, customer-focused activities, and prosperity of agricultural and rural sectors. The new technologies developed have significantly enhanced the production of food grains, fruits, vegetables, milk, meat, egg and fish, and addressed specific needs of the farmers despite limitations of land resources, increasing weather uncertainties, and emerging more virulent pests and pathogens. Further, the strong collaboration of ICAR with government and non-governmental agencies, academic and scientific institutions, industry, and farmers has helped Indian agriculture to sustain natural resources, to improve food supply and dietary nutrition profile, and to make it globally more efficient and competitive.

The present document "Achievements of ICAR during 2021-22" describes the technologies in agriculture and allied sectors for augmentation of farmers income, promoting entrepreneurships, enhancing resource use efficiency, reducing imports and promoting exports. In addition, ICAR also made significant advances in ICT to enhance farmers' access to subject matter specialists for timely and informed decision making.

The Covid pandemic redefined and relocated many established system-denominators. However, the dynamic and resilient framework of ICAR easily adapted to the new system and supported the changing needs of farming community.

The document is a sincere effort to provide a glimpse of ICAR's achievement during 2021-22. I congratulate the entire team for bringing out the publiction. The suggestions for improvement are welcome towards better outputs and outcomes in future.

Date: October 18, 2022

Place: New Delhi

(Himanshu Pathak)
Secretary, DARE and
Director General, ICAR

PREFACE

The strong collaboration of ICAR with other stakeholders at grassroots level continued backstopping towards nation's food and nutritional security despite of challenges such as biotic and abiotic stresses in agriculture and Covid pandemic. The major accomplishments of ICAR during 2021-22 are precisely presented in this document.

The achievements are grouped into different themes. The release of 389 crop varieties, production of quality breeder seed and planting materials and promotion of agricultural exports marked the **impact of ICAR technologies**. While, the release of biofortified crop varieties, strengthening POSHAN Abhiyan, promoting startups and entrepreneurs in food processing especially in millets contributed significantly in **enhancement of nutritional outcome**. The **climate resilience** in agriculture was addressed by releasing resilient varieties, capacity building in new resilient villages, and revalidating agriculture contingency plans of 15 districts. In addition, **chemical free agriculture, water footprint reduction, disruptive innovations for smart/ precision agriculture** summarizes R&D efforts for enhancing respective resource use efficiencies at field level.

The major achievements in **animal productivity and health management** were documentation of indigenous animal breeds, cloning technology in breeding, feed supplement formulations, dairy technology, and Sero-surveillance of animal diseases. The research breakthrough in aquatic sector is summarized in **Blue Revolution.** The innovations in farm and post-harvest equipments, processing protocols, and storage are covered under **mechanization** and **reduction of post-harvest losses.**

During the period, the **agricultural education** was strengthened through revision of UG and PG course curricula, quality assurance in higher agricultural education and enhancement in number and amount of scholarships. Further, approval of road map for the implementation of New Education Policy 2020 and constitution of a committee for developing syllabus and curricula on natural farming were the efforts to **align agricultural education with National Educational Policy.**

The **Lab to Land outreach by KVKs** helped ICAR to reach the unreached through establishment of new KVKs, conduct of FLDs, skill development trainings, extension activities, and supply of large quality of seeds and planting materials. Besides, documented ~71000 success stories of farmers towards **Doubling of farmers' income.** Effective use of ICT in decision making and marketing of farm produce for empowering farmers is summarised under **digital linkage with farmers.**

The document is an effort to provide a glimpse of ICAR's R&D achievements during year 2021-22 under the guidance and supervision of Dr. T. Mohapatra, former Secretary, DARE and DG,ICAR and support of Dr. Himanshu Pathak, Secretary, DARE and DG, ICAR. The inputs from all the SMDs/Units are duly acknowledged with thanks to all the DDGs/ADGs and concerned personnel. The support of Mrs Suman Khurana, Senior Technical Officer of PIM section is highly appreciated.

Date: October 10, 2022

Place: New Delhi

Editors

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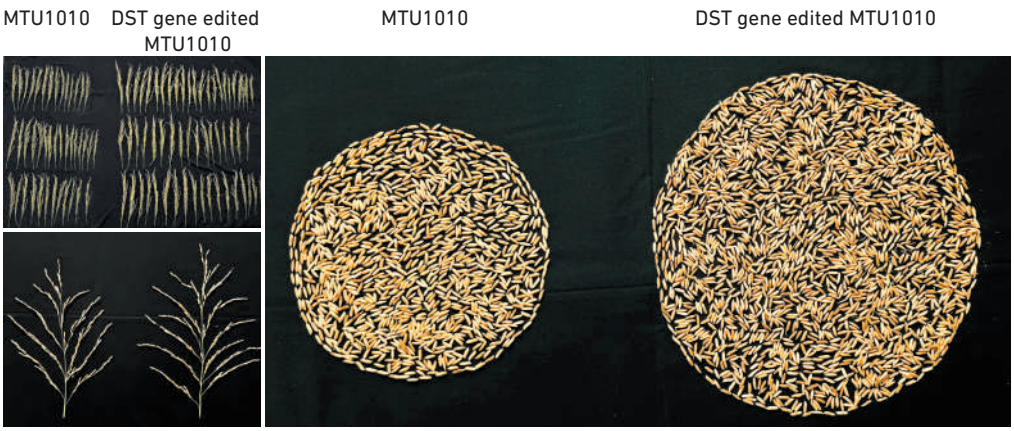
भाकृअनुप
ICAR

DARE-ICAR SIGNIFICANT ACHIIEMENTS 2021-22

1. Impact of ICAR Technologies

Varietal improvement and quality breeder seed production are major mandates of ICAR since independence. It 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 increased the productivity (15-20%) and quality of farm produce. More



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

than 5800 varieties of field and horticultural crops have been developed since independence and that has revolutionized Indian agriculture. In recent times, the traditional breeding methods are being supplemented with modern molecular tools like genome selection and genome editing for accelerated and targeted varietal improvement. Till date, molecular tools are successfully deployed in 74 released varieties of seven crops. The major achievements and impacts of ICAR technologies during the current year are briefly described below:

- **Varietal improvement:** A total of 389 varieties/ hybrids of 45 crops including cereals (156), oilseeds (58), pulses (69), fibre crops (69), forage crops (19), sugarcane (12) and potential crops (6) were released for commercial cultivation. The released varieties included 35 special trait varieties of crops and 14 Marker Assisted Selection derived varieties (Rice-8, Maize-2, Pearl millet-1, Chickpea-2 and Soybean-1).
- **Seed production:** About 106,498 quintal breeder seed of 1,399 varieties (56 crops) was produced against the DA&FW breeder seed indents of 84,678 quintal. In addition, 481,473 quintal quality seed of crops and 239.89 lakh planting materials were produced and supplied under various programmes.
- **Germplasm collection and conservation:** Conserved 8,622 new accessions of orthodox seed species in the National Genebank, cryo-preserved 237 accessions of seeds and pollen genomic resources in Cryo-Genebank, and conserved 272 microbial genetic resources. This made overall collection of 4,56,568 accessions in National Genebank and 12,076 accessions in Cryo-Genebank.
- **Germplasm registered:** Total 215 genetic stocks of 37 crop species were registered for economically important traits, and 13 genes of economic importance were cloned and characterized.
- **Good agriculture practices:** Developed 56 production, protection and post-harvest technologies and good agriculture practices (GAPs).
- **Export promotion:** ICAR Basmati rice varieties accounted 99.5% of total export of Basmati rice (~Rs. 30,000 crore) while wheat varieties (HD 2967, HD 3086, HD 3226, DBW 187) accounted for around 3.0 million ton of export (~Rs. 6,000 crore). Sugarcane variety Co-0238 has contributed towards sugar production of around 1.84 million ton and export worth Rs. 11,297 crore.

Grape veriety 'Thompson seedless' in dogridge rootstock

- Grafting of commercial varieties of grapes in *dogridge* rootstock has enabled grape cultivation in saline and alkaline soil conditions in Maharashtra and Karnataka. It has resulted in better yield (5-10%) and quality berries, but reduction in cost of cultivation (10-15%) and total water requirement have ultimately led to higher profits. At present, nearly 90% of grape area (1.25 lakh ha) is on this rootstock. Since adoption of the technology, the direct total economic surplus/benefits from grape crop has been estimated to the tune of Rs. 1,721.6 crores during 2021-22 (at 2018 prices).
- Pomegranate variety *Phule Bhagwa* released in 2003-04 has been adopted in more than *86.1* per cent area under the crop in Maharashtra, Karnataka, Gujarat, Andhra Pradesh and Madhya Pradesh. It was due to higher yield, lesser susceptibility to fruit spots and thrips, better desirable fruit characters

Pomegranate var. Phule Bhagwa

(aril, colour and size), and better keeping quality (15-25 days at ambient conditions). Since release of the variety, unprecedented increase 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).

- **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 and 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).

Potato variety 'Kufri Pukhraj

- **Tomato hybrids Araka Rakshak and Araka Samrat** are resistant to three most difficult tomato diseases namely *tomato leaf curl virus (ToLCV)*, bacterial wilt (BW) and early blight (EB) with yield potential up to 80 t/

Tomato hybrids Araka Rakshak

ha in 140 days. The field demonstrations showed 35.3% higher yields, more number of harvests (18-21), reduced cost of cultivation, and almost 58.8% higher returns than check varieties. During 2021-22, these hybrids were spread to nearly 14,000 ha area and mostly targeted for bacterial wilt infected areas and for summer cultivation. To meet the higher demand of its seed, a total of 14 licenses were issued resulting in revenue realization of Rs. 42 lakh up to 2021-22. The total economic surplus/benefits accrued since release of triple disease resistant hybrids (2010) is Rs 804.2 crores (2021 prices) with present benefit of Rs. 161.18 crores during 2021-22.

- Developed genetically improved strain of giant freshwater prawn (*Macrobrachium rosenbergii*) through selective breeding, which is registered as *CIFA-GI Scampi*. It has shown 53% higher cumulative growth of after 13th generation. Four multiplier scampi hatcheries in Andhra Pradesh are supported for its greater outreach.

Freshwater prawn CIFA-GI Scampi

2. Enhancement of Nutritional outcome

In India, at least 32.1% of the children below 5 years are underweight and stunted, while 57% of women and 33.9% of men in age group 15-49 years are anaemic. The malnutrition significantly cost India in terms of lower productivity, illness, death and overall poor human development. Crop biofortification is one of the sustainable and cost-effective approach to address the malnutrition particularly among the undernourished population. Only one biofortified crop variety was released till 2013-14 and to fill the void, ICAR with needed policy support accelerated the efforts to develop biofortified varieties of crops. Now, ICAR released 87 nutrition-rich and high yielding cultivars of important crops like rice, wheat, maize, pearl millet, finger millet, small millet, lentil, groundnut, linseed, mustard, soybean, cauliflower, potato, sweet potato, greater yam and pomegranate till date. These cultivars have higher essential nutrients viz., iron, zinc, calcium, protein, lysine, tryptophan, provitamin-A, anthocyanin, vitamin-C, oleic acid and linoleic acid but lower anti-nutritional factors.

- **Biofortified varieties released:** During 2021-22, 15 biofortified varieties of Wheat (5), Rice (1), Maize (3), Pearl millet (1), Mustard (3), and Soybean (2)

have been released taking the tally of biofortified varieties in the country to 87. Hon'ble Prime Minister dedicated 35 special trait crop varieties including the above set of 15 verieties to the nation on September 28, 2021. Around 55 biofortified varieties released during past four years have been included in the seed chain and 15,062 quintals breeder seed of these varieties has been produced for downstream multiplication. In addition, around 300 seed companies have come forward and signed MoA for multiplication and distribution of seed of biofortified varieties. Presently, more than 4.5 m ha area is under biofortified varieties of crops including wheat (4.0 m ha), rice (0.75 lakh ha), pearl millet (2.0 lakh ha), lentil (0.25 lakh ha) and mustard (3.0 lakh ha).

- **Nutri-Smart Village:** Programme was launched in 75 villages in 23 districts (13 states) to strengthen the POSHAN Abhiyan.
- **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 convention of Nutri-cereals stakeholders besides initiative of Nutri-gardens and tree plantation at Hyderabad during September 17-18, 2021. This was attended by 1,04,745 participants including seven union ministers, 38 Members of Parliament, nine state Govt. ministers,

Nutritional garden at KVK DURG

60 MLAs and 2271 VIPs. Total 607027 plants and 77879 vegetable seed packets were distributed among the farmers for awareness about nutrition and establishment of Nutri-gardens.

- Identified two **biofortified greater yam (*Dioscorea alata*)** varieties (Sree Neelima and Da 340). Sree Neelima is high yielding (35 t ha^{-1}) variety with purplish flesh colour, good culinary and nutritive quality (anthocyanin-15 mg/ 100 g^{-1}, protein-15.37% DW, starch- 18.1%FW, potassium-1.14%, Fe-70.80 ppm, Manganese-7.20 ppm, zinc- 49.80 ppm and calcium-820 ppm). While Da 340 is high yielding (80 t ha^{-1}) variety with high protein (14.68% DW) and rich anthocyanin (37.69±2.21 mg/100g FW) and suitable for processing especially for the preparation of bio-fortified pasta.

Greater Yam Sree Neelima

Plant, tubers and value added products of greater yam accession Da-340

- **Popularization of biofortified sweet potato varieties:** Biofortified sweet potato varieties (Bhu Sona, Bhu Krishna, Shree Kanak, Bhu Kanti and Bhu Ja) were demonstrated in the fields of 569 farmers covering 140.1 ha area in three districts of Orissa. The cultivation of biofortified sweet potato varieties resulted in average yield of 12.2 t/ha with net return of Rs 77,900/ha and B:C ratio 2.77. The demonstrations were supported with 16 trainings of farmers on Bio-fortified sweet potato production and value addition besides developing market links with seven firms/ companies to procure the tubers at farm gate for further processing, packaging and marketing.
- Developed carotenoid 'Fucoxanthin' from brown seaweed (*Sargassum sp.*) having wide health benefits as antioxidant. It could potentially be used as human food supplement.
- Developed eco-friendly edible packaging film using green seaweed for reducing polythene footprints.

3. Oil Palm Development Programme

During last 5 years, almost 58% of the total domestic edible oil demand of the country was met by imports and palm oil constituted bulk of these imports. Oil palm is known to be the highest edible oil yielding perennial crop that satisfies 30% of the world's edible oil requirements. In India, almost 19.33 lakh ha area is considered suitable for oil palm cultivation but presently only 3.49 lakh ha area has been covered. The crop urgently needs promotion for expansion of area and commercialization in the country. ICAR is continuously conducting research on the crop since 1975 to support oil palm development programmes in the country. The major achievements during the year are briefly highlighted here:


High yielding oil palm germplasm

- Developed new 3rd generation hybrids with targeted high oil yield of 7-8 tones/ha and dwarf hybrids with oil yield of 7 tonnes/ha.
- A process and a kit were developed to facilitate controlled pollination in Oil Palm through Insects (Patent granted IPO No. 387063).
- Developed fertigation technique for oil palm- Reported saving of 50 % of recommended fertilizer.
- Identified more fresh fruit bunch yielding three germplasm of *Dura* oil palms (as female parent), three short stature dura type, and one *Tenera* type oil palm genotypes.
- Identified three high yielding oil palm varieties for release and notification for cultivation in Andhra Pradesh (Godavari Swarna), Maharashtra and Goa (Godavari Ratna) and Tamil Nadu (Godavari Gold).
- 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.
  - Conducted Twenty capacity building programmes on oil palm cultivation to 215 officers and 1,375 farmers of Telangana, North Eastern Regions and other oil palm growing states.

- Distributed 55 harvesting chisels to 11 farmers' groups in Goalpara, Assam for facilitating agronomic operations.
- Distributed 31 aluminium 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.
- Reported 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 enhanced CB ratio from 1:2.38 to 1:2.86.
- Developed oil palm based mixed farming system with fodder crops, dairy & back yard poultry (CB ratio - 1:3.28).



- Training programmes on oil palm cultivation were organized for 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:

Production of oil palm sprouts by ICAR for area coverage	2021-22	2017-18 to 2021-22
Number of germinated seeds (lakhs)	2.56	13.35
Area spread (ha)	1423	7896
Revenue generated (Rs. lakhs)	76.86	454.51
Saving of foreign exchange (Rs. lakhs)	204.8	1068.0

4. Climate Resilience

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. The major achievement of ICAR during 2021-22 towards bringing climate resilience to farm sector are highlighted below:

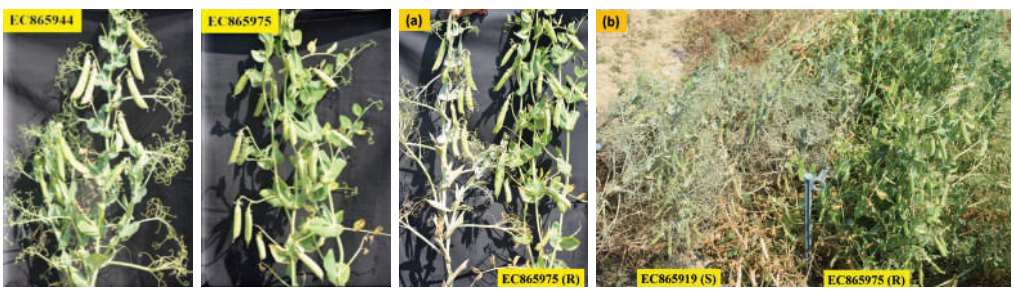
Genome edited Pusa Chickpea 4005

- 322 of total 389 varieties released during 2021-22 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.* A total of 14 such varieties released and notified during 2021-22.
- 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.
- Undertaken 829 demonstrations, 613 capacity building programmes and 110 extension activities on various climate resilient technologies.
- Developed a mobile app for accessing information on risk and vulnerability at district level for adaptation planning.
- Climate resilient villages established in 151 vulnerable districts involving one lakh farm families; 45 new villages added.
- 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.
- Developed 30 new resilient technologies and demonstrated 68 climate resilient NRM technologies in 446 villages.
- Four New IFS models were developed.

5. Chemical Free Agriculture

Chemical free agriculture denotes the cultivation of crops without depending on chemical inputs such as fertilizers, pesticides, weedicides *etc.* Although fertilizer and pesticide consumption in India is much lower compared to the developed countries, the imbalance use in fertilizer usage and indiscriminate and unscientific application of pesticides are causing soil, water and environmental pollution. This necessitates to gradually convert the conventional agriculture towards organic or chemical free agriculture. In India, some of the agro-ecologies are organic by default. Targeting the areas, ICAR is continuously working to develop appropriate technologies and till now identified 104 crop varieties suitable for organic conditions and developed organic package of practices for 68 cropping systems involving 39 crops. Further, the Union Budget 2022 is also emphasized on chemical free farming by promoting it on farmers' lands in 5-km wide corridors along the river Ganga. Some of the major achievements of ICAR during the year on chemical free agriculture are described below:

- Six organic farming packages were developed, out of which four cropping systems were suitable to Gujarat (Greengram-coriander-vegetable cowpea), Rajasthan (sweetcorn + blackgram – chickpea), Uttarakhand (Finger millet + black soybean -wheat + toria) and Sikkim (Maize-soybean-buckwheat) conditions.
- Developed EKCEL-decomposer (capsule) consisting of ligno-cellulolytic microorganism (including Fungi, Bacteria and Actinobacteria) in specified proportion along with curd, jaggery and urea with fresh cow dung for *in situ* decomposition.
- Identified two exotic collections of late maturing vegetable peas (EC 865944 and EC 865975) immune to powdery mildew under controlled



(a) Resistant genotypes 'EC 865944' and 'EC 865975'

(b) Grown with susceptible genotype under huge disease pressure in natural field conditions

as well as natural field conditions over three years with zero percent disease index score.

- Technologies of 88 Biocontrol agents, 31 Biopesticides and 41 Biofertilizers were documented and circulated.

6. Water Footprint Reduction

Indian agriculture sector contributes significantly to an increasing carbon footprint, 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 footprint in agriculture can be reduced through smart irrigation technologies 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 fertilizers. Major achievements of ICAR during the period to develop technologies for reducing water footprint are briefly indicated below:

- Developed Surface irrigation schedules for 26 crops and 8 cropping systems in 12 agro-ecological regions.
- Drip fertigation schedules save 30-40% irrigation water, 25-30% energy and 20-25% nitrogen over surface irrigation besides 10-15% higher yield; Fertigation schedule of three crops (Tomato, Brocolli and Onion) added during 2021-22.
- Designed and standardized mini pan evaporimeter for on-farm irrigation scheduling in Eastern India by the farmers.
- Standardized a sub-surface drip irrigation (SDI) system to increase irrigation water and nutrient use efficiency.
- Developed a sub - surface drip fertigation schedule for *suru* sugarcane variety CoM 0265 in the Deccan canal tract having medium deep black soil in western Maharashtra.
- Realtime Contingency Plans developed for managing Water and Weather Cycles.
- Developed Re-circulatory Aquaculture System (RAS) based hatchery and culture system for rainbow trout farming for reducing water and land footprints.
- Developed low-cost bamboo drip irrigation technology for hilly upland conditions of North-East India.

Bamboo drip irrigation

7. Disruptive Innovations for Smart/Precision Agriculture

Systematic applications of disruptive ICT technologies have potential to transform traditional Indian agriculture into smart agriculture system by using informatics on variability, vulnerability and dynamism of agricultural system. These technologies have been found effective in quality monitoring, grading and reducing post-harvest losses of agri-produces. Keeping in view the socio-economic condition of Indian farmers, ICAR recently developed a Network Program on Precision Agriculture to identify and promote location specific precision agriculture technologies. The achievements for the year 2021-22 on precision agriculture are summarised below:

- Developed Land Resource Inventory of Bundelkhand region for sustainable land use planning.
- Developed simple, quick and cost effective soil biological health kit to monitor soil biological health without involvement of much scientific skill and equipment.

- Developed 25 fertilizer prescription equations as ready reckoner under STCR and STCR-IPNS for cereals, pulses, oilseeds, fibre crops and vegetables for various agro-ecological regions of India.
- Developed granular mineral fertilizers as an alternative to conventional phosphorous and potassium fertilizers using low-grade rock-phosphate and feldspar, respectively and a matrix of slowly decomposing carbon compounds. The efficacy of these mineral fertilizers was tested on crops and gave comparable yield with conventional P (Di-ammonium phosphate) and K (Muriate of Potash) fertilizers.
- Quantification of impact of CA on soil health, weed & pest dynamics, input use efficiency, carbon sequestration and greenhouse gas emissions has been completed.
- Standardized a Horti–silviculture system of Dragon fruit + Melia dubia along with in situ soil moisture conservation measures for semi-arid region of Gujarat affected by soil erosion caused by Mahi River.

8. Animal Productivity and Health

India has one of the largest livestock populations in the world and, therefore, animal sector has enormous potential to contribute on food, nutrition and livelihood security. At ICAR, research activities on animal science are mainly oriented towards conserving indigenous livestock germplasm, faster multiplication of superior germplasm, increasing overall livestock productivity by using tools from frontier sciences, and enhancement of nutrient bioavailability of crop residues and other feed/fodder sources. Major achievements towards improving animal productivity and health are briefly described below:

- Registered 2 buffalo breeds - Dharwadi of Karnatka and Manda of Odisha and characterized 8 native populations of Cattle, Buffalo and Dog.

Dharwadi bull

Manda bull

- Cryopreserved 21180 semen doses and 970 vials of somatic cells of 7 native breeds.
- Launched Country-wide "Mission towards Zero Non-descript Animal Genetic Resources" and organized 10 State Interface meetings.
- 132812 doses of frozen semen of cattle- Gir, Sahiwal, Kankrej and Frieswal cattle were produced.

Cloning of Elite Male Germplasm : Hope for Future Sustainable Milk Production

Cloned Bull Produced from Somatic Cell Isolated from Fresh Seminal Plasma

Clone of a High-Ranking Progeny-Tested Buffalo Bull

Calves Produced from Semen of Cloned Bulls namely Swarn and Rajat (August-December 2021

- Produced Calves from semen of cloned bulls: Swarn and Rajat.
- Four DNA Chips developed & patents filed: MD Chip of camel, LD chip of riverine buffalo, HD chip of swamp buffalo, LD chip of Indigenous cattle.
- A total of 12,19,423 unit germplasm of livestock and poultry species were supplied.
- Developed feed supplement (Harit Dhara) that reduces enteric methane (per day) up to 17-20 % in ruminants.
- Developed technology for CARI-multigrain egg biscuits, CARI-low sugar egg Biscuit, Egg Kulfi and Egg-rabri malai.
- Developed a technology of reduced–fat milk paneer.
- Established Portable Meat Production and Retailing Facility for sheep and goats.

- Developed strip test for mastitis detection in milk samples, kits for detection of antibiotic residues in aqua-products.
- One herbal antimicrobial disinfectant for food applications was developed and a patent application filed.
- Developed a novel herbal "Formulation for the treatment of dermal mycoses in camel" (Patent No. 347971).
- 314 microbes deposited in NCVTC, Hisar repository.
- Technology of CSF cell culture vaccine and live attenuated sheeppox vaccine (Srin 38/00) were transferred to two firms.
- During the year, 5 patents were granted.
- Vaccine candidates for Covid, Lumpy Skin Disease and Japanese Encepalitis have been developed.
- Developed diagnostic Lateral Flow Rapid Test kit for Avian Influenza H5 Virus Antigen and PPR Surveillance ELISA kits (PPR Ab Chek kit and PPR Ag Chek Kit) for small ruminants.
- Disease monitoring and surveillance of exotic and emerging diseases:
  - FMD: 82063 samples tested in Sero-surveillance from 23 states and Sero-monitoring was conducted in 74878 samples.
  - Avian Influenza (AI): 34, 721 samples from 18 States tested for H5N1.
  - Lumpy Skin Disease (LSD): 493 bovine samples (cattle & buffalo) from 43 districts in eight states were tested.
  - African Swine Fever (ASF): 104 tissue/blood samples from NE states were tested for disease outbreaks in pigs.
  - Tested 10813 samples for EIA and 11433 for Glanders from different states of India.
- Commercialised a chemical formulation 'Argcure' against ectoparasite, *Argulus.* The product eradicates over 85% infection after second dose of application.
- Developed formulation 'OoNIL' for controlling Epizootic Ulcerative Syndrome (EUS), which is one of the most destructive diseases of freshwater and brackish water fish in the Asia- Pacific region.
- Developed vaccine against Viral Nervous Necrosis (VNN) in brackishwater fishes. VNN is a serious viral disease affecting many marine, brackishwater and freshwater fishes resulting in 100% mortality in larval and early juvenile stages.

9. Blue Revolution

India is second largest fish producing and largest shrimp exporting country in the world. However, foreseeing the untapped potential to increase productivity and production from aquaculture and fisheries resources, Hon'ble Prime Minister called for a revolution and has named it as "Blue Revolution". ICAR is technically backstopping the revolution through eight dedicated fisheries research institutes engaged in developing, refining and disseminating need-based technologies. The contribution made during the year is briefly presented below:

- Developed breeding and seed production technologies for two cultivable marine species viz. Picnic bream (*Acanthopagrus berda*) and Banded grunter (*Pomadasys furcatus*) and one freshwater species; Peninsular carp (*Labeo kontius*).
- Developed breeding and seed production technologies of three marine ornamental fish species, viz., Azure damsel (*Chrysiptera hemicyanea*), Sea Goldie (*Pseudanthias squamipinnis*) and Cloudy damsel (*Dascyllus carnieus*), and one freshwater species, i.e. Indian spiny eel (*Macrognathus pancalus*).

Azure Demsel

Banded Grunter

Sea goldie

- Extended technical support for expansion of Pacific White Shrimp (*L. vannamei*) farming in inland saline water, which is now, spread over 2500 hectare area in Haryana, Punjab, Rajasthan and Uttar Pradesh.
- Discovered two new fish species, viz., blind eel (*Rakthamichthys mumba*) from Mumbai Coast and congrid eel (*Ariosoma melanospilos*) from Colachel, Kanyakumari, Tamil Nadu.
- Designed and developed 33m HDPE shrimp trawl with reduced body length, drag reduction and high energy efficiency. Further, designed a 3.0 m FRP pedal boat for fishing in backwater and reservoirs and also for recreational uses.

HDPE shrimp trawl

10. Enhancement of Mechanization

Farm mechanization saves time and labour, increases comfort, cut down production cost in the long run, and boosts crop output and farm income. Over the period, total farm power availability, a measure of farm mechanization, from all sources increased from 0.3 $kWha^{-1}$ during 1960 to 2.54 $kWha^{-1}$ during 2019-20. However, the overall farm mechanization level of the country is 47% which is lower than China (59.5%) and Brazil (75%). ICAR is continuously working to design, refine and promote farm machineries and equipment to transform Indian agriculture to smart farming. The achievements made towards the target are briefly presented below:

- Developed 27 farm equipment, machines and technologies to enhance farm efficiency. The important farm implements/machines include 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, Self-propelled small maize harvester, Solar assisted e-prime mover for field operations, Low cost solar insect light trap, Remote Control Sensor based Site Specific Chemical Applicator for Field Crops, Micro-controller based Precision Planter for

Maize and Cotton, Paddy Straw based Biogas Plant, and Cotton Stalk Briquette based Crematorium.

- Developed Mobile app "Machinery Package for Horticultural Crops".
- Released 229 test reports of commercial farm machinery and post-harvest equipment.
- Manufacture 3569 research prototypes of farm machineries and supplied to various stakeholders.
- Commercialized 29 technologies and license agreements signed with various firms.
- Demonstrated 24 improved farm equipment under Front Line Demonstrations (FLDs).
- Trained 129 participants on establishing Custom Hiring Centres for farm implements/ machines.
- More than 50,000 farmers participated in Technology and Machinery Demonstration Mela organized at AICRP centres.
- Developed 18 process protocols, value added products, and software.
- Established 39 Agro-Processing Centres across the country.
- Organised 38 entrepreneurship/skill development trainings.

KASTURI COTTON INDIA

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

Cotton based high performance face mask with replaceable nanofibre filter cartridge

11. Reduction of Post-Harvest Losses

Prevention of post-harvest losses is an important challenge in almost every country. In India, post-harvest losses from harvest to retail levels account for 4-16% of total farm produces. Development of appropriate infrastructure, equipment for processing and handling, setting up of agro-processing centres, and training of farmers and other stakeholders are important areas for reduction in post-harvest losses. The important processing equipment designed and demonstrated by ICAR during the period are briefly described below:

- Developed 10 storage and post harvesting machinery/models. They are Modular Onion Storage Structure, CIPHET Evaporative cooled storage, Small Millets Dehuller (Abrasive type), Post-harvest treatment machine for fruits and vegetables, Peeling machine for medicinal root crops,

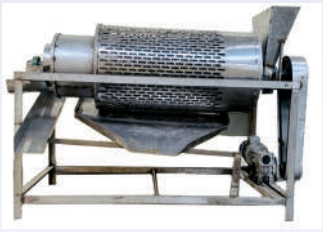
Modular Onion Storage Structure

Small Millets Dehuller (Abrasive type)

Rotating Orifice Feeding System for Makhana popping machine

Post-harvest treatment machine for fruits and vegetables

Peeling machine for medicinal root crops



Popped Makhana Grading Machine

Rotating Orifice Feeding System for Makhana popping machine, Popped Makhana Grading Machine, Refractance window (RW) drying based fruit bar manufacturing System, Modern Jaggery Plant, and Digital Ginning Percentage Indicator (DGPI) for Portable Cotton Gins.

- Developed Fish Waste Management Machine with capacity of 1.5 tonnes per day was commissioned at Fishermen Cooperative Society, Kavaratti, UT of Lakshadweep by Shri Rajnath Singh Hon'ble Union Defence Minister (Govt of India).

12. Strengthening Quality Agricultural Education

The human resources developed by ICAR play a pivotal role in transforming agricultural scenario and achieving self-sufficiency in food grain production besides strengthening higher agricultural education in the country. In this endeavour, ICAR has taken several new initiatives in the agricultural digital sector and introduced numerous digital initiatives across National Agricultural Research and Education System in line with the Goal 4 of SDG by 2030. The achievements made during the year are presented below:

- 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*.
  - 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, agro-meteorology 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 dietetics.

- The Student READY (Rural Entrepreneurship Awareness Development Yojana) programme aims at developing young agripreneurs for emerging knowledge intensive agriculture and integrates activities for skilling the youth in project development and execution, decision-making, individual and team coordination, accounting, quality control, marketing and conflict resolutions, *etc*. with end-to-end approach. During the year, 19557 students awarded READY stipend.
- Post- NEP2020, the 6th Deans' Committee has been constituted to suggest alignments in the Course Curricula. Quality assurance in higher agricultural education, pursued by ICAR/DARE/SAUs, involves accreditation, framing of minimum standards for higher education, norms for establishing new colleges, academic regulations, personnel policies, review of course curricula and delivery systems, support for creating/ strengthening infrastructure and facilities, improvement of faculty competence and admission of students through All India Examination.
- The syllabi of PG courses revised by Broad Subject Matter Area (BSMA) Committees were released for implementation across AUs. Total 19 BSMA Committees were constituted for finalization of 79 courses for assisting the Core Group.
- Interdisciplinary approach in selection of courses has been adopted for 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.
- The 26th Undergraduate Examination for admission to 15% seats of degree programmes in agriculture and allied subjects other than Veterinary Sciences including the award of National Talent Scholarship (NTS) was held during Sept. 7-9, 2021 in online mode (CBT). The examination attracted 1,44,848 applications, out of which 1,22,993 candidates (85 %) appeared.

- All-India entrance examination for admission to 25% seats in PG programmes and award of ICAR-PG scholarship was conducted on Sept. 17, 2021. A total of 20,811 candidates appeared in the examination (91%), out of which 10,215 were female candidates. Among the categories, OBC (NCL) candidates were highest (7,970) followed by General (5,786), SC (3,604), ST (2,026) and Gen. EWS (1,425).
- All-India competitive examination for admission to 25% Ph.D. seats and award of Junior/Senior Research Fellowship was held on Sept. 17, 2021. A total of 8,919 candidates appeared (89%) in the examination. Of these, the number of female candidates (4,703) was higher than that of males (4,215). Among the categories, OBC (NCL) candidates were highest (3,027) followed by General (2,906), SC (1,555), ST (748) and Gen. EWS (683).
- National level Kritagya Hackthon 2.0 on "Precision and Economical Animal Husbandry" was initiated during September 2021. The applicants showcased their innovative approaches and technological solutions to promote precision and economical animal farming in India. Total 32 of 269 teams were shortlisted for National evaluation on 17-19 January, 2022 and four winner teams were felicitated by Hon'ble Minister of Agriculture and Farmers Welfare of Government of India, Shri, Narendra Singh Tomar on 13th April 2022.
- During the year, 11939 students awarded various scholarships, viz. National Talent Scholarship (NTS), Senior Research Fellowship (SRF)/ Junior Research Fellowship (JRF) *etc.* including 89 international fellowships under ICAR- Netaji Subhas International Fellowship.
- About 500 students have received international trainings/ internships under the 3 sub-components of NAHEP on more than 330 emerging areas of agriculture and allied sector and visited ~110 international higher educational institutes across the globe.
- Partner AUs have also developed more than 200 pilot course-curricula/ certificate courses on emerging areas of agriculture and allied sectors under NAHEP. During the period, over 2,000 trainngs were conducted and benefitted more than 20,000 students across the country.

13. Aligning with National Educational Policy

The National Education Policy 2020 aims to address India's growing developmental imperatives. The Policy proposes to revise/revamp the

education structure, including its regulation and governance system that is aligned with the aspirational goals of 21st century education. It is based on the principle that education must not only develop cognitive capacities-both 'foundational capacities' and 'higher-order' cognitive capacities, such as critical thinking and problem solving – but also social, ethical, and emotional capacities and dispositions. As per the policy, ICAR activities during the year were:

- Developed, finalised and got approved the road map for the implementation of New Education Policy 2020 in Agriculture Universities. It was released by the Honourable AM on 28th September 2021. Subsequently, constituted Sixth Deans' committee for necessary revision, alternation 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.
- Constituted a committee for developing syllabus and curriculum on natural farming in undergraduate programmes. The committee has been asked to develop the syllabus by April 2022 and shall be implementing from the next academic session in the agricultural universities.

14. Lab to Land Outreach by KVKs

KVK, is an integral part of the National Agricultural Research System (NARS), aims at assessing location specific technology modules in agriculture and allied enterprises, through technology assessment, refinement and demonstrations. KVKs have also been functioning as knowledge and resource centre of agricultural technologies to support the initiatives of public, private and voluntary sectors for improving the agricultural economy of the district and are linking the NARS with extension system and farmers especially through lab to land outreach activities. The contribution made in these endeavours during the year are briefly described here.

- Established 7 new KVKs at Raebareli (Uttar Pradesh), Kistwar and Ramban (Jammu & Kashmir), Jalore, Pali and Sikar (Rajasthan), and Thane (Maharashtra).
- Conducted more than 2.94 lakh Frontline Demonstrations (FLDs) with the participation of farmers to demonstrate the production potential of technologies in agriculture and allied sectors.
- To harness the productivity, conducted 62868 FLDs on pulse crops and 89667 FLDs on oilseed crops. In addition, produced 34728.25 quintals

Field day on Green gram in Kaimur Bihar

IFS Demo at KVK Jalandhar

seed of pulse crops through 95 seed hubs setup at KVKs and the seed was made available to the farmers.

- The KVKs produced 1.51 lakh quintal seeds and 490.97 lakh quality planting materials of field and horticultural crops to distribute among the farmers.
- The KVKs organized 55406 skill development training programmes benefiting 16.90 lakh farmers including farm women and rural youth. In addition, 120 National Skill Qualification Framework aligned courses of more than 200-hours duration were organized for 2915 rural youth.
- To create awareness among farmers on improved agricultural technologies, the KVKs conducted about 9.91 lakh extension activities with the participation of 236.36 lakh farmers.
- Under ARYA (Attracting and Retaining Youth in Agriculture) project, 3387 agro-based enterprise units were established benefitting 5394 rural youth. Further, the KVKs organized 775 training programmes benefiting 16,812 youth under this project.

15. Doubling Farmers' Income

Doubling of farmers' income by 2022 is the most important agenda of the government of India. With this in view, ICAR has intensified efforts towards farmers' participatory research to develop and scale up location specific, cost effective and climate resilient technologies to enhance agricultural production, productivity and profitability in the agriculture sector and increase farmers' income. In this regard, a document on *State Specific Strategies for Doubling Farmers Income – 2022* has been prepared by ICAR. The strategies in the document were focussed with greater emphasis on agri-business through transforming farming into agri-enterprises performing multiple

functions at one point of time. The major efforts/achievements made by ICAR during the year are described below:

- Implemented following programmes i) Attracting and Retaining of Youth in Agriculture (ARYA), ii) Farmer FIRST (Farm, Innovations, Resources, Science and Technology), and iii) Mera Gaon Mera Gaurav (Village adoption by ICAR Scientists) towards enhancing livelihood and incomes of rural mass through location specific comprehensive models for making Agriculture more profitable.

World Bee Day celebration at KVK Vizianagaram Andhra Pradesh

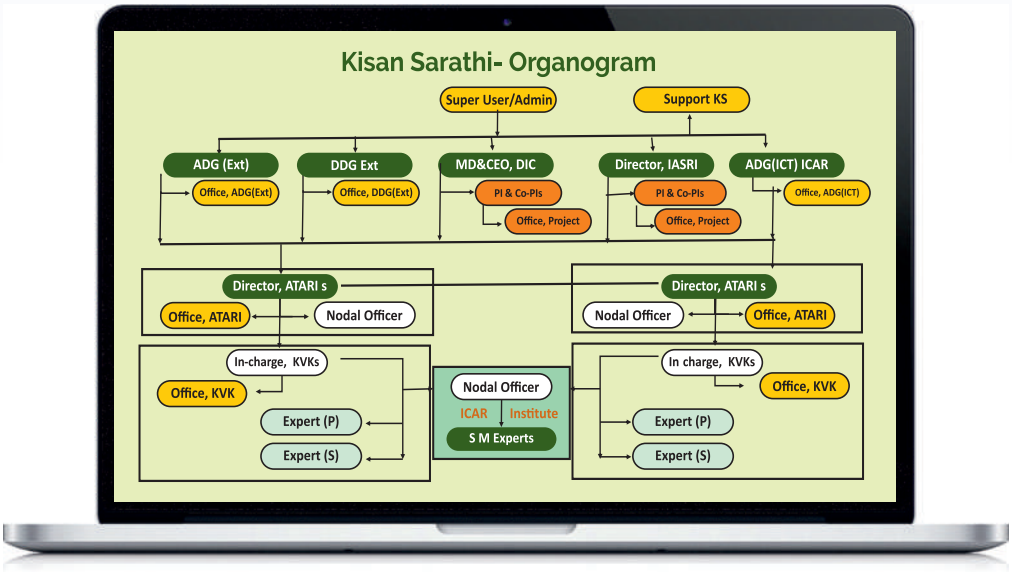
- Each KVK adopted two villages for increasing farmers income.
- Documented ~71000 success stories for doubling farmers' income. The target set for August 15, 2022 is documentation of 75000 farmers, whose income is doubled.
- Developed four integrated farming system models suitable for Karnataka, Odisha, Telangana and Maharashtra.
- Developed a bio-enhancer CSR-GROSURE formulation comprised of highly efficient salt tolerant bacteria strains CSR-M-16 (*Bacillus licheniformis*), CSR-A-11 (*Lysnibacillus fusiformis*), and CSR-A-16 (*Lysnibacillus sphaericus*) for sodic soils up to pH 9.0.
- Arranged 369 trainings and 507 demonstrations on improved production practices/ post-harvest management practices and preparation of value-added products on horticultural crops *etc.* for the benefit of stakeholders.
- Produced and distributed 14,30,232 plants of perennial horticultural crops, 275.56q breeders'/truthful label seeds of vegetables, spices *etc.*, 13,78,001 rooted cuttings and 3102.14 MT breeder seed of tuber crops to farmers and other stakeholders for enhanced area coverage under improved varieties.

16. Digital Linkage with Farmers

ICAR has developed strong linkages with farmers through various digital media platforms, mainly involving Krishi Vigyan Kendras (KVKs), ICAR-Institutes and Agricultural Universities (AUs). The KVK portal developed

by ICAR provides information about the infrastructure facilities created for farmers in KVKs, training programmes for the farmers and field demonstrations to be carried out in farmers' fields. The major digital initiatives during the year were:

- 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. Under pilot project, 243 KVKs and 1067 agricultural experts are registered to support 20.14 lakh registered farmers of 50178 villages in six states. Currently 731 KVKs and 3130 agriculture experts have been registered to implement the scheme across the country.



- Developed more than 300 Mobile Apps and integrated them into a single Mobile App i.e., KISSAN 2.0 for dissemination of desired technical knowledge to the farmers.
- Created several digital media platforms to establish real-time linkages between scientists and farmers. The digital linkages strengthened during the year are briefly presented below:

- Developed 'Matsya Setu App' for teaching and demonstrating freshwater fish culture technologies. It was launched by Shri Giriraj Singh, Hon'ble Union Minister for Fisheries, Animal Husbandry & Dairying (Govt. of India), on 6th July, 2021. The App has species-wise and subject-wise self-learning online modules on different aspects of freshwater aquaculture.
- Web based software for business promotion in the area of fruit processing.

17. Promoting Agri-Startups & Intellectual Property Rights

Technology-led innovations are a well-recognized trigger to increase livelihood opportunities. Agri-startups with their innovative ideas are transforming traditional way of Indian agriculture. The development of technology-based entrepreneurship through effective technology transfer has proved efficient in saving both monetary and physical efforts. With an array of agricultural technologies coming from 100 odd research institutions covering the entire supply chain in agriculture is the key driver for ICAR/AgIn in start-up support. The fact is that ICAR/AgIn has created more than 800 successful start-ups through proven technology transfers in the last few years. In these endeavours, the initiative taken during the year are briefly described as follows:

- Established 50 Agri Business Incubators (ABIs) centres by Council that have incubated about 361 entrepreneurs, out of those 193 entrepreneurs/ startups initiated their own business during 2021-22.
- Conducted 127 Entrepreneurship Development Program (EDPs) to encourage the potential entrepreneurs.
- Protected innovative technologies through granting i) 52 patents of 27 ICAR Institutes, ii) registration certificates (through PPV&FRA) to 58 plant varieties.
- Filed 70 new plant varieties applications, 16 design applications and 22 trademarks; and registered 50 copyrights.
- Signed 417 agreements to strengthen the cross learnings for consultancy/ contract research and services with 240 public/private organizations.
- Signed 575 technology licensing agreements with 452 public private organizations and entrepreneurs at the institutes and 242 agri-based technologies/processes were transferred.

18. ICAR's Global Reach

As a part of reaching out to global level, ICAR signs MoUs/work plans for bilateral/ multilateral cooperation with international institutions of repute including CGIAR institutes. Human resource development/capacity building programmes were also implemented through international co-operation. The ICAR initiatives during the year on strengthening its global reach are briefly discussed as follows:

Organized five bilateral/multilateral cooperation programmes and nine meetings with CGIAR institutions.

- Signed work plan for period 2021-2025 with ICAR-BI-CIAT and ICAR-ICRAF and for 2021-2023 with CABI.
- Undertaken collaborative research programmes between ICAR and WorldFish on small-scale Fisheries, sustainable aquaculture and, value chains and nutrition.
- Continued the collaboration between ICAR and Network of Aquaculture Centres in Asia-Pacific (NACA) for aquaculture development in Asia-Pacific region.
- Oragnised APAARI–NBFGR collaborative International Capasity Building Programme on "*Application of Biotechnological Tools for Aquatic Genetic Resource Management and Ex Situ Conservation*" for participants from 14 countries .

19. Progress in pulse and oilseed production and Import reduction

During 2015-16 to 2020-21, agri-exports from India were increased by nearly 1.43 times and agri-imports by nearly 1.06 times. Indian agricultural produce that includes dairy, cereals, spices, fruits & vegetables, rice, wheat, cotton, and others are exported to more than 100 countries while India majorly imports vegetable oils, fresh fruits, pulses, and spices. Vegetable oil accounts for more than half of the agri-imports while fresh fruits and pulses accounts for almost 10 and 8 per cent respectively. Government has initiated several initiatives to reduce the imports and ICAR is supporting it through continuous efforts in research and development on the targeted commodities, particularly pulses and oilseeds. Major achievements and efforts made by ICAR in reducing imports are briefly described below:

Increase in Area, Production and Yield of Pulses

Years	Area (m ha)	Production (m t)	Yield (kg/ha)
2015-16	24.91	16.32	655
2020-21	28.83	25.72	892
% Increase	15.73	57.60	36.18

- The increase in pulse production during last six years (2015-16 to 2020-21) was about 57.6% with increase in area by ~15.7% and yield by ~36.2%.
- Release of 237 improved varieties, including the climate resilience varieties of pulses with breeder seed production of 1,12,656 q for different agro-climatic zones has realized higher productivity and increased cropped area.

Decline in Imports of Pulses

Years	Quantity (mt)	Value (Rs crore)
2015-16	5.80	25619.06
2020-21	2.466	11938.00
% Decrease	57.48	53.40

- During the period of last six years (2015-16 to 2020-21), the dependency on import has reduced by 57.48% in quantity and over 53.4% in value terms.
- The Pulse Revolution in India is expected to make the country self-sufficient in Pulses very soon.

Increase in Area, Production and Yield of edible oils

Years	Area (m ha)	Production (m t)	Yield (kg/ha)
2015-16	26.10	25.25	968
2020-21	28.79	36.10	1254
% Increase	10.30	42.97	29.54

- The increase in edible oil production during last six years (2015-16 to 2020-21) was about ~ 43% with increase in area by ~10.3% and yield by 29.5%.
- The release of 239 high yielding varieties and production of 1,75,417 q breeder seed for commercial cultivation can enhance the edible oil productivity (~500 kg/ha) at the farmers' fields.

Status of edible oil Imports

Years	Quantity (m t)
2015-16	14.85
2020-21	13.45
% Decrease	9.43

- During period of last six years (2015-16 to 2020-21), the dependency on edible oil import has reduced by ~9.43% in quantity.
- The continuous efforts in research and development are targeted to reduce import of edible oil significantly.

20. *Azadi Ka Amrut Mahotsav* Celebrations

The country is celebrating 75th Year of Nation's independence as *Azadi Ka Amrut Mahotsav* for 75 weeks preceding 15th August 2022. ICAR also planned various activities for the celebration. This include National/Sectoral Campaigns, Lecture series, Book on Agriculture: A Saga of Success-Role of ICAR through different revolutions, Success Stories on Doubling Farmers' Income and Mega Scientist-Farmers interface on 94th ICAR Foundation Day. These activities will help in reaching out to maximum stakeholders particularly farmers on new developments in different sectors of agriculture. This journey will culminate with congregation of farmers who have been successful in doubling their income, release of the compendium on farmer's success stories, *etc*. The activities consummated during 2021-22 are briefly presented below:

- Organised 14 national campaigns including those on a) Food and Nutrition for Farmers, b) PoshanVatika and Tree Plantation, c) Waste to Wealth, d) Agriculture and Environment: the Citizen Face, e) farm mechanization, *etc*.
- One hundred ten sectoral campaigns were organised on various aspects of agriculture and allied enterprises.
- Out of 75 guest lectures planned, 49 lectures were delivered by eminent personalities from the Government, Development agencies, Ministers, Progressive Farmers, Spiritual influencers on variety of topics.
- Documented ~71000 success stories of doubling farmers' income out of 75000 success stories planned till August 15, 2022.

- Celebrated the iconic week on 'Poshan Abhiyaan' during 12 to 17 September, 2021. Distributed seed packets, planting materials, millet products amongst farmers and the consumers to create awareness about millets as health food. More than 14 lakh people directly participated in the national campaign.
- Different activities *e.g.* national conferences/webinars/days were successfully organized on following aspects:

National conferences/webinars/days/sectoral campaigns

S. No.	Particulars	Date/Duration
1	Sectoral compaign on Ecosystem Management for Sustainable Fisheries	03-10 July, 2021
2	National Conference on "कोविड–जनित 19 परिस्थितियों में देश के आर्थिक विकास एवं आत्मनिर्भरता में कृषि अभियांत्रिकी की भूमिका"	28-29 July 2021
3	Sectoral compaign on "System Diversification in Aquaculture	08 August to September 01, 2021
4	A nationwide programme on "Parthenium Awareness Week"	16-22 August, 2021
5	Webinar on Utilization and Value Addition to Mustard Processing By-products	27 August, 2021
6	Webinar on a sustainable option for agricultural crop residues management through mushroom production	31 August, 2021
7	National Webinar on "Eat Smart Right from Start"	1-7 September, 2021
8	National webinar on "Roadmap on Agricultural Mechanization in state of Madhya Pradesh"	21 September, 2021
9	Webinar on *Makhana* Production and its Mechanized Processing	28 September, 2021
10	Mahila Kisan Diwas	15 October, 2021
11	World Food Day	16 October, 2021
12	Webinar talk on Entrepreneurship in Livestock and Poultry Sector: Opportunities and Approach	18 October, 2021
13	Webinar on "Early diagnosis of crop issues using drone based hyper-spectral imaging"	25 October, 2021

S. No.	Particulars	Date/Duration
14	Webinar on Protected Agriculture - The Next Generation Agriculture	26 October, 2021
15	Webinar on "Post-Harvest Quality Control and Value Chain in Horticulture"	1 November, 2021
16	Webinar talk on Development of Sensors for Quality Analysis of Livestock Products	17 November, 2021
17	Webinar talk on Recent Development in Rapid Point-of-Care Devices for Quality Evaluation of Meat Products	17 November, 2021
18	Antimicrobial Resistance in Fish	18-24 November, 2021
19	Webinar on Plant Based Dairy Analogues: A Healthy Choice	29 November, 2021
20	Soil Health Awareness Week and World Soil Day	1-7 December, 2021.
21	Webinar talk on Status & Scope of Non-Thermal Technology in India	10 December, 2021
22	Webinar talk on Non-Thermal Technologies for Quality Improvement of Livestock & Fish Products	10 December, 2021
23	Webinar on Entrepreneurship through Mechanized *Wadi* Making	23 December, 2021
24	Webinar on Issues of Crop Residue Burning and Management	5 January, 2022
25	Webinar talk on Smart Grain Management Technology for Long-Term Safe Storage	24 January, 2022
26	Sectoral compaign on Diversification in Aquaculture	10 March, 2022
27	World Water Day 2022	22 March, 2022

21. Initiatives on *Atma Nirbhar Bharat*

Atmanirbhar Bharat Abhiyaan or Self-reliant India campaign is the vision of the government for new India. It is aimed to make the country and its citizens independent and self-reliant in all senses. Government announced many bold reforms and enablers including administrative reforms to realize the targets. DARE/ICAR is orienting its research, education and extension activities to align with government recommendations under "*Atmanirbhar Bharat Yojana*" through: i) development of supply chain and management

in all agriculture and allied products, ii) to facilitate Micro Food Enterprises, with focus on 'Vocal for Local with Global Outreach' iii) to facilitate private investments in the dairy processing and cattle feed industry and iv) to promote herbal farming and bee keeping.

The GoI announced measures to provide economic relief package and impetus to diverse sectors were affected by the 2nd wave of COVID-19 pandemic for growth and employment. Accordingly, ICAR increased its research to focus on biofortification of crops besides high yield, climate resilience and resistance to biotic and abiotic stresses. In this direction contribution of DARE/ICAR in the campaign is mentioned below:

- Notified 15 biofortified varieties and 15 climate resilient varieties of rice, peas, millet, maize, soyabean, quinoa, buckwheat, winged bean, pigeon pea and sorghum for cultivation.
- More than 200 varieties tolerant to various stresses have been demonstrated in 446 Climate Resilient Villages (CRVs) at 151 vulnerable districts/clusters.
- Developed three Integrated Farming System (IFS) models and one Integrated Organic Farming System (IOFS) Model during the year taking the tally of prototype IFS models to 64 and IOFS models to 60 suitable for 26 States /UTs. These models have capability to (i) mitigate climate risk, (ii) recycle waste materials generated within the system, and (iii) meet food and nutritional security of farm families.
- Organised 1922 training programmes for 68136 migrated labourers in 6 states.
- Organized 100 entrepreneurship development trainings on Custom Hiring of Agricultural Machinery. It facilitated adoption process through industrial liaison in 17 states.
- Organized 74 specialized farmers' trainings on processing and value addition in different production catchment, trained ~ 4,961 farmers and established 42 Agro processing centres for processing and value addition of agricultural commodities.
- To build the capacity on organic farming, developed 60 integrated farming systems and 51 organic farming practices for different agro-climatic conditions and resource endowments.
- To popularize, the organic farming practices, the cluster demonstrations of 50 ha each on organic farming systems were conducted by 411 KVKs.

- KVKs Organized 60,672 training programmes benefiting 16.82 lakh farmers including organic farmers, farm women and rural youths.
- The nutritional profiling of 50 biofortified varieties is the step towards nutritional and quality improvement of crops for providing the country early mover position.
- The regional crop plans for 5 export potential crops completed and nine processable varieties released (potato -1, tomato -3, onion – 3, grape -1, barley-1) to help import substitution of raw material for food processing industries.
- The high yielding varieties of oilseeds have been developed and notified to increase import substitution of edible oils. So far 24 new HYV of oilseeds (Rapessed & Mustard-8, safflower-2, sunflower-1, soybean-2, Linseed-3, sesame-1, groundnut -6 and castor-1) were released during the year.
- In order to accelerate efforts towards blue economy, installed over 800 rafts for demonstration and trained over 1200 stakeholders for promotion of seaweed farming.

22. Activities during Covid-19 period

Covid-19 pandemic largely disrupted the traditional economic activities, education and trainings, and administrative functions besides causing loss of human lives. The impact on agriculture and allied sector was significant for need of critical inputs and marketing the perishable farm produces. ICAR addressed the challenges through designing alternative modules and contingencies to mitigate the impacts for the stakeholders. The important initiatives taken during the period are as under:

- Hon'ble Prime Minister dedicated 35 special trait varieties of field and horticultural crops.
- Granular mineral fertilizers were developed as an alternative to conventional P and K fertilizers.
- Disseminated National and State-specific advisories in regional languages benefitting large number of farmers through digital platforms.
- Implemented e-office to minimise the physical movement of files and receipts.
- COVID protocols were stringently observed in all research laboratories and farms.

- All the Agricultural Universities & Deemed Universities were shifted to online teaching mode.
- To help all the researchers and students, provided all e-resources of CeRA 24X7.
- Necessary alerts were issued to farmers and stakeholders across the country on the pre-cautions and safety measures while carrying out the time bound field/farm operations.
- Screened more than 5.0 lakh human samples for COVID 19, besides testing of wild animals for Covid 19.
- Trained more than 43487 migratory workers in agriculture returning to rural areas of UP, MP, Bihar, Odisha, Jharkhand and Rajasthan.
- e-Courses for under graduate programmes in seven disciplines namely; Agriculture, Fisheries Science, Dairy Science, Veterinary Science and Animal Husbandry, Horticulture, Community Science and Agricultural Engineering have been created covering 1107 credits and 15820 lessons. These e-courses are available at https://ecourses.icar.gov.in and the same may be made available to all the students.
- Established Consortium for e-Resources in Agriculture (CeRA) to facilitate 24x7 online accesses of selected journals in agricultural and allied sciences to all researchers, teachers and students.
- Developed of e-content development studio, language lab, smart as well as virtual classrooms, conducted exams through virtual mode by AUs has provided students and faculties access to the information and knowledge repositories during as well as post pandemic period.
- Resilient Agricultural Education System (RAES) - the need of digital resilience especially the ICT were strongly felt in teaching and learning ecosystem of ICAR- AU owing to social distancing measures and travel restrictions during Covid pandemic. The Initiative focused on development of digital infrastructure, creation of digital content and facilitation of digital capacity building.
- Prepared and circulated advisories targeting different stakeholder groups including fish farmers of freshwater and coastal aquaculture, hatchery operators/workers, feed plant workers, workers in processing factories, fishermen etc.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

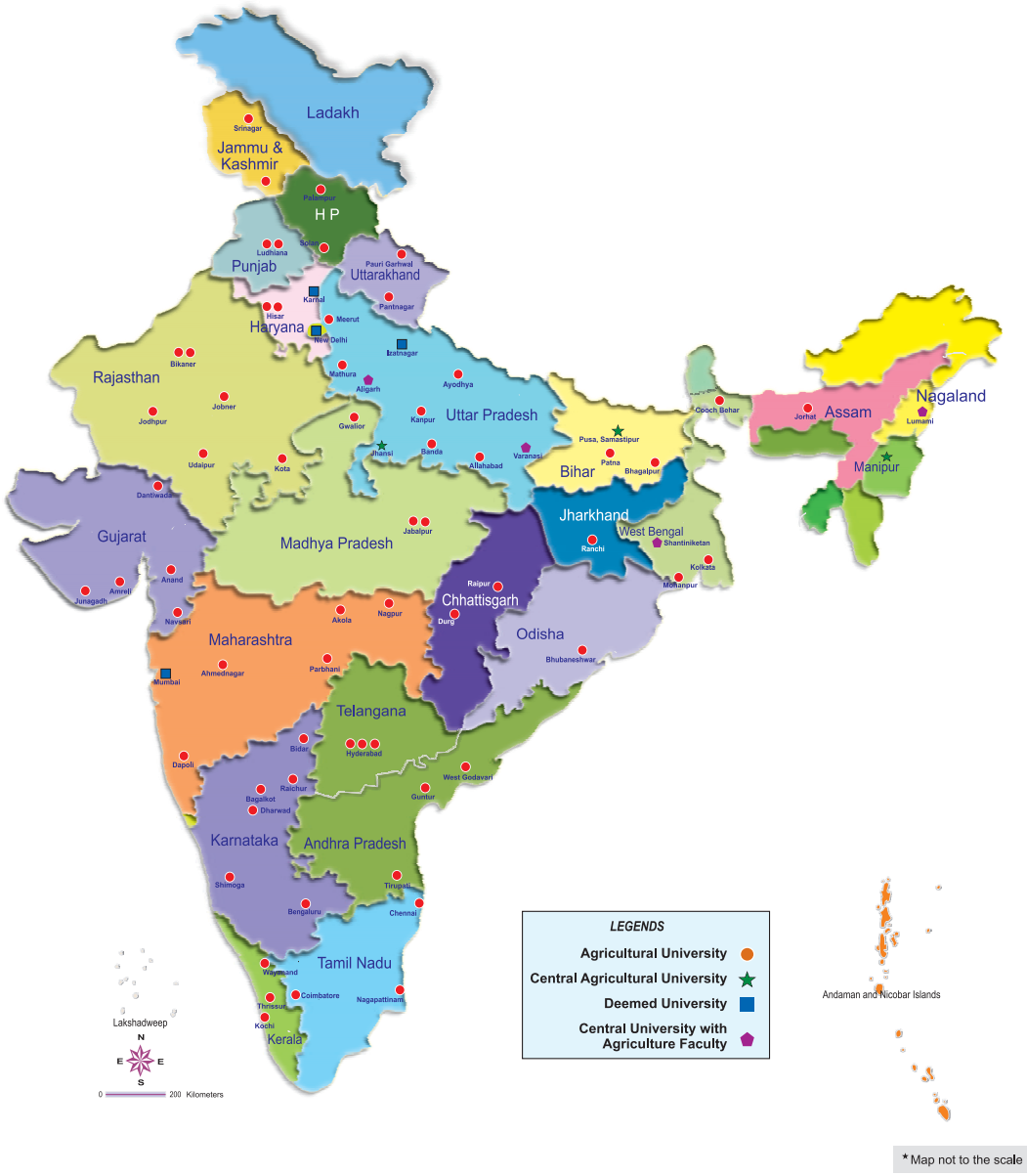
Institutes, Bureaux, National Research Centres and Directorates

*Map not to the scale

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

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Agricultural Universities



*Map not to the scale

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

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