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**1. Atal Jai Anusandhan Biotech UNaTI (Undertaking Nationally relevant Technology Innovation) Mission:**

**(a) GARBH-Ini (Inter-disciplinary Group for Advanced Research on Birth outcomes)**

A Mission to promote Maternal and Child Health, and develop prediction tools for pre-term birth

Globally, preterm birth is a major public health problem and a major cause (approx 30%) of under 5 mortalities in India. With an aim of acquiring deep fundamental knowledge about preterm birth and to use this knowledge to find efficient and sustainable solutions towards reducing the associated mortality and morbidity, an inter-institutional and interdisciplinary programme was established in 2015.

Under this program coordinated by an interdisciplinary research group christened as GARBH-Ini (Inter-disciplinary Group for Advanced Research on Birth outcomes), a unique pregnancy cohort is being established in which women are enrolled within 20 weeks of gestation, followed until delivery and once at postpartum. Multidimensional correlates of preterm birth namely clinical, epidemiological, statistical, genetic, proteomic and imaging are being studied so as to elucidate biological and non-biological risks of preterm birth.

The ultimate aim of the cohort study is to develop an algorithm for early stratification of women at risk of delivering preterm so that timely healthcare interventions can be made; to identify candidate molecular biomarkers using the integrative omics approach which can be taken up for validation studies; to categorise the PTB phenotype based on pathological factors in addition to gestation age.

In the GARBH-Ini cohort more than 8000 women have been enrolled so far. The bio-repository in the GARBH-Ini platform comprises of well characterized clinical phenotypes with about 800,000 bio-specimens and 450,000 ultrasound images collected over the entire duration of pregnancy. The study has provided some interesting leads. The proportion of preterm birth enrolled (13.4%) is higher than those reported from economically developed (8.6%) or the low-income countries in Northern (7.3%) or Sub-Saharan Africa (12.3%). In the cohort, the still birth rate has been found to be 2%; prevalence of low birth weight is nearly 27%; fetal growth restriction as identified in the last trimester of pregnancy is 38%. Women with either history of prior preterm birth, short interpregnancy interval, short cervix, antenatal vaginal bleeding or multiple gestation had a higher significant risk of PTB. The documented use of biomass fuel for cooking and exposure to passive smoking also appears to increase the risk of preterm birth. A multi-omics approach is being used to evolve biomarkers for early identification and risk stratification of preterm birth.

GARBH-Ini has been recognized as one of the five Atal Jai Anusandhan Biotech Missions of Department of Biotechnology. The cohort database and the repository created are envisaged to become global resources to answer critical questions on preterm birth and other birth outcomes.



- (b) **Mission Antimicrobial Resistance (AMR):** Considering Antimicrobial Resistance as global threat, during 2018-2019 FY, the Department has launched an ambitious “Mission program on Antimicrobial Resistance” with the vision to develop indigenous and cost-effective therapies against AMR; categorization of AMR-specific pathogen priority list of India; establishment of Bio-repository for AMR-specific pathogens; and development of rapid and cost-effective diagnostic kits to identify AMR-specific pathogens.



- Considering AMR as the top most national priority, the Department has notified **National Centre for Microbial Resource (NCMR)**, National Centre of Cell Sciences, Pune (an Autonomous Institute of DBT) to function as a Bio-repository for resistant microbes/infective agents (Bacteria and Fungi)” and to carry out collection, storage, maintenance, preservation and characterization of these microbes across the country. After deliberating several consultations meeting with various pertinent stakeholders, NCMR has developed uniform SOPs for deposition, storages and transport of AMR samples.
- Recently, NCMR has been selected as State reference laboratory under Maharashtra State Antimicrobial Resistance (**MAHASAR**) surveillance network program of Maharashtra in collaboration with WHO. Food Safety and Standards Authority of India (FSSAI) has notified it’s all 163 laboratories and 19 referral food testing laboratories across the country to deposit their AMR-specific samples to NCMR Bio-repository, Pune. Further, DRDO and NCDC have also notified their laboratories to deposit their samples at NCMR, Pune.
- Further, the Department is working with WHO, Country Office, New Delhi to share the information regarding National AMR-specific Pathogen priority list which will be available very soon.

- The Department in collaboration with BIRAC, New Delhi is preparing a landscaping report on existing rapid and cost-effective diagnostic kits to identify AMR-specific pathogens, which will be useful to focus on supporting R&D efforts in developing AMR specific rapid and cost effective diagnostic kits.
- In a process to fulfil the ambition of this program, Department of Biotechnology (DBT) in collaboration with Biotechnology Industry Research Assistance Council (BIRAC) has announced support for Projects in the area of development of new antibiotics and alternatives to antibiotics to counter AMR. Under this Call, 378 LoIs have been received by the Department. After two rounds of screening, total 10 projects have been recommended for financial support.
- Further in this direction in order to address the rising threat of antimicrobial resistance (AMR) with a holistic and multi-sectoral (One Health) approach, “India’s One Health Initiative” to combat problems associated with AMR was launched on 18th February, 2019 in Delhi.
- Recently, India has partnered with **Global AMR R&D Hub** as a member of Board of Members through Department of Biotechnology, Ministry of Science & Technology, Government of India. This expands the global partnership working to address challenges and improve coordination and collaboration in global AMR R&D to 16 countries, the European Commission, two philanthropic foundations and four international organisations (WHO, FAO, OIE and OECD) as observers. By partnering, with the Global AMR R&D Hub, the Department will work with all partners to leverage their existing capabilities, resources and collectively focus on new R&D intervention to address drug resistant infections.



## **(C) Ind-CEPI MISSION**

### **BACKGROUND:**

CEPI (*Coalition for Epidemic Preparedness Innovations*) has already conducted a prioritization exercise in the past based on which it issued RFPs for Lassa, Nipah, MERS, RFV and Chikungunya vaccine candidates. The Ind-CEPI Mission will facilitate the studies through the provision of clearly defined criteria and pathways for vaccine assessment, which will be developed in consultation with CEPI. The Mission aims to strengthen the development of vaccines for the diseases of epidemic potential in India as well as build coordinated preparedness in the Indian public health system and vaccine industry to address existing and emergent infectious threats in India.

### **MISSION IMPLEMENTATION:**

The Department of Biotechnology, Ministry of Science and Technology, Government of India is supporting the implementation of the Ind-CEPIs mission “Epidemic preparedness through rapid vaccine development: Support of Indian vaccine development aligned with the global initiative of the Coalition for Epidemic Preparedness Innovations (CEPI)”, as part of the Atal JaiAnusandhan Biotech Mission - Undertaking Nationally Relevant Technology Innovation (UNaTI).

The mission is being implemented through a dedicated Program Management Unit (PMU) at Biotechnology Industry Research Assistance Council (BIRAC). The Ind-CEPI Mission was approved on 27<sup>th</sup> March 2019 with a total cost INR 312.92 crore.

### **Ind-CEPI OBJECTIVES:**

1. Supporting the development of at least 2-3 new vaccines for potential outbreak threats up to phase 2 testing in five years.
2. Strengthening of infrastructure to support the needs of the vaccine development through an academia-industry interface.
3. Supporting capacity building and skill development.
4. Strengthening internal inter-ministerial co-ordination for rapid vaccine development and testing to address known and unknown infectious disease threats.
5. Strengthening of development frameworks, surveillance and logistics for use of new vaccines, where appropriate

### **SUPPORTING VACCINE DEVELOPMENT EFFORTS:**

In the wake of the global COVID-19 pandemic, Ind-CEPI provided financial support to Genovra Biopharmaceuticals Limited, Pune for developing the “Next-generation mRNA vaccine against COVID-19 to provide long-term protection to the population

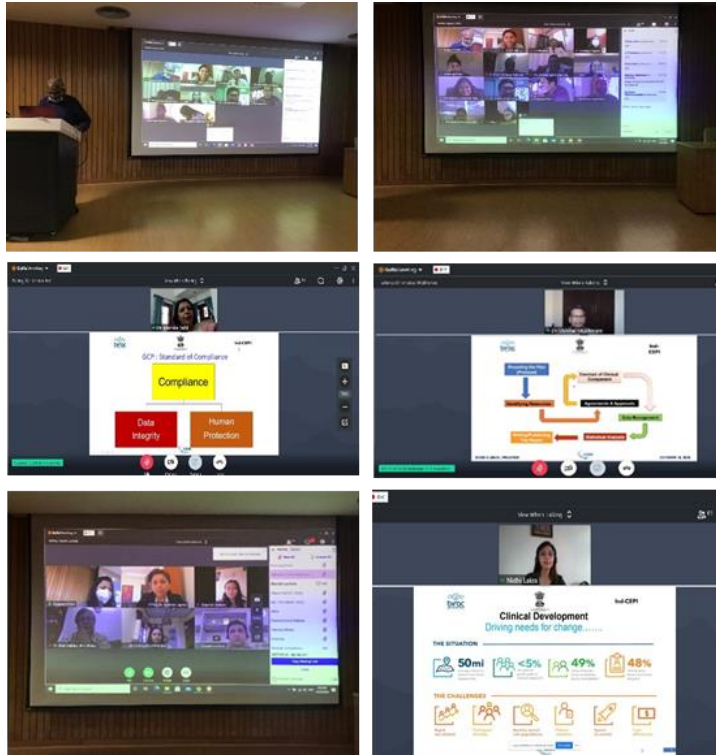
within its national/ international territories” under strategic funding for COVID-19 Consortium. The project is supported for duration of 18 months, for manufacturing of vaccine candidate, and safety and immunogenicity in Phase I/II clinical trial.

Also, Translational Health Science and Technology Institute (THSTI), an autonomous institute of the DBT, is being supported under the Ind-CEPI mission for establishment of BSL-3 facility, a translational laboratory for platform technologies and development of assays to support vaccine development. The mandate of the bioassay laboratory at THSTI is to provide validated assays for vaccine development on par with global standards. The Department of Biotechnology- Translational Health Science and Technology Institute (DBT-THSTI) Bioassay laboratory has been recognised by CEPI, for support under the global network of Laboratories for centralized assessment of COVID 19 vaccines.

Ind-CEPI has also provided financial support to the “Global Chikungunya Vaccine Clinical Development program” (GCCDP) a collaboration between Bharat Biotech International Ltd (BBIL) and the International Vaccine Institute (IVI) to advance the development of a novel candidate Chikungunya virus (CHIK) vaccine, BBV87. The proposal has been supported for GMP manufacturing of the vaccine in India and subsequent manufacture of clinical trial materials.

### **SKILL DEVELOPMENT AND SURVEILLANCE NETWORKS:**

Aimed towards skill development, capacity building and development of surveillance frameworks, Ind-CEPI initiated the eCourse Series “Strengthening Clinical Trial Research Capacity in Neighbouring Countries” in collaboration with CDSA, Faridabad. An orientation session to this training program was conducted on 22<sup>nd</sup> Sep 2020 through online platform. This training envisages an in-depth coverage of Good Clinical Practice, Ethical considerations in clinical research, Good Clinical Laboratory Practice and Large vaccine field trials. The ongoing eCourse on GCP had very encouraging response and wide participation from Afghanistan, Bangladesh, Bhutan, Maldives, Mauritius, Nepal and Srilanka.



Glimpses from the Sessions 1-3 on Good Clinical Practice

(d) **Mission Innovation: Accelerating the Clean Energy Innovation**

**Mission Innovation (MI)** is a global initiative of **24 countries** and the European Commission (on behalf of the European Union) working to reinvigorate and accelerate global clean energy innovation to make clean energy widely affordable. MI was announced at COP21 on November 30, 2015, as world leaders came together in Paris to commit to ambitious efforts to combat climate change. The programme aims at coordinating the activities of Mission Innovation (MI) clean energy RD&D initiatives worldwide to help deliver the following objectives:

- Substantial boost in Public Sector Investment
- Increased Private sector engagement and Investment
- Increasing international collaborations
- Raising awareness of Transformational potential of Energy Innovation.

India as a member participates in the **Mission Innovation Steering Committee, Business and Investor Engagement Sub-Group** and **Co-leads the Analysis and Joint Research Sub-Group** of Mission Innovation. India is an active member of all eight global calls (MI Challenges), to action aimed at accelerating Research, Development, and Demonstration (RD&D) for Clean Energy Development and is a co-lead in three challenges (Smart Grids, Off-Grid access to Electricity and Sustainable Biofuels).

The Department of Biotechnology is the nodal agency supporting & coordinating clean energy national efforts in collaboration with DST and other line ministries in India. The Mission Innovation initiative is making a concerted effort to enhance the pace of innovation and scale of transformation in support of a clean energy revolution to meet the requirements and goals for India's economic and energy security promptly. **This is being achieved by:**

**Increasing International RD&D Collaborations:** To encourage and facilitate the leveraging of knowledge, capabilities, and resources among Mission Innovation members and other stakeholders, DBT (via Mission Innovation) via a **“Collaborative” approach**, launched the Funding Opportunity Announcement for Carbon Capture (IC3), Sustainable Biofuels (IC4) and Converting Sunlight (IC5) and **49** collaborative R&D projects have been recommended for financial support. By pooling financial resources and technical expertise from members, this **collaborative approach** has resulted in filling gaps in the international clean energy ecosystem, convene the international clean energy RD&D community (>3000), exchange of academics and researchers (>1000), identify gaps and opportunities for innovation and facilitate Information sharing. For details please visit: <http://mission-innovation-india.net/foa/>

**Raising awareness of the transformational potential of Energy Innovation:** A wide range of workshops and events were organized to bring together key

stakeholders to agree on priorities, promote innovation, opportunities for innovators & investors and explore opportunities for further collaboration. In 2019-20 DBT has organized the **MI- Face to Face meeting of all Innovation Challenges under Analysis and Joint Research (AJR)** and the Mission Innovation Beyond 2020 Regional workshop: 6th November 2019 and **Nine national/international consultative meetings**. This initiative has helped to highlight the importance of clean energy innovation, **address the key gap areas** and at **strengthening the international platform** for collaboration and stepping up the pace of innovation via ambitious research, development and demonstration activities that can help members to unlock clean energy transition pathways measurably and successful transition to MI2.0 via Mission-oriented approach (**Stakeholder engagement >2000 stakeholders**). The details can be accessed at <http://mission-innovation-india.net/mi-india/>

**Increased Private sector Engagement and Investment: CEIIC: DBT-BIRAC-TATA trusts:**

DBT and its Public Sector Undertaking, BIRAC has joined hands with Tata Trusts in successfully setting up the Clean Energy International Incubation Centre (CEIIC) to provide end-to-end support to startups, ranging from infrastructure, technology, angel funding, access to venture capitalists, mentorship, exposure to national and international organisations, experts. Under Mission Innovation mandate, the Incubation Centre launched a two **National Product Energy Challenge** which resulted in **25 winning solutions** covering different areas of Clean energy.

**Clean Energy Investment and Technology Innovations:** IEA and the Ministry of Science and Technology, Govt. of India is currently focusing on assessment of R&D investments in clean energy in the country. The Joint partnership is helping to address the Clean Energy Transition in Indian landscape and highlighting the need for exchange of good practices, suggesting a way forward for policy and decision-makers.

**Avoided Emissions Framework: India-Sweden Collaboration:** India through Clean energy International Incubation Centre (CEIIC) (a joint initiative of DBT and Tata Trusts) and Sweden through RISE has collaborated under Avoided Emissions Framework (AEF) to accelerate the Clean energy initiatives for a Sustainable Future. This collaboration has been instrumental in identifying and supporting a new generation of solution providers in clean energy. Under this partnership, **Eight companies** have been selected to demonstrate an initial 100 million tons of potential CO<sub>2</sub> emission reduction by 2030. Details can be accessed at <https://misolutionframework.net/>

**Delivering the Mission Innovation Breakthroughs: MI Solutions:** The Mission Innovation Breakthrough Solutions has resulted in Four Clean Energy Success

stories in India exemplifying the determination of scientists and engineers in universities and industry across India, to continue to drive the phenomenal progress made to date, and to succeed in delivering a clean growth revolution. The details can be accessed at <http://mission-innovation.net/resources/publications/>

**Mission Innovations Champions: Scaling the Potential of Clean Energy Innovation: Turning Awareness into Action:** Mission Innovation Champions is a recognition programme to celebrate and support innovative researchers who are accelerating the clean energy revolution. The MI Champions Program 2019 & 2020 has resulted in recognizing exceptional clean energy innovators in India on key innovative clean energy research and technology developments. Besides this the program has helped in supporting cross-border exchanges of ideas and talent and building a community of visionaries committed to the promise of clean energy research and development, activating and engaging a new generation of researchers, inventors, and leaders. MI Initiative has resulted in 2 Global MI Champions and Four National MI Champions scaling up innovations in Clean energy. The details can be accessed at <http://mission-innovation-india.net/mi-champions/>

**Information Sharing:** The preparation of reports and related documents highlighting the key gap areas, challenges, success stories and winning solutions in Clean energy has helped in enabling a better and faster understanding of the knowledge and good practices, generating new ideas, team cementing, getting top talent access (nationally and globally) about Clean energy sector. The reports/publications can be accessed at <http://mission-innovation-india.net/reports/>

**Outreach Activity:** The Mission Innovation India Unit with support from Department of Biotechnology has launched a dedicated website for Mission Innovation and related activities. Full details about recent workshops, Meetings, Country reports and Press releases can be found at [www.mission-innovation-india.net](http://www.mission-innovation-india.net).

#### **Engagement with MI Community:**

a. India has been actively participating in the Mission Innovation Ministerial held every year. DBT has successfully engaged >1000 Clean Energy stakeholders including Public-Private partners, Academia, Industry, Investors, Small and Medium Enterprises (SMEs) and Innovators via the successfully organized stakeholders meeting on Public-Private cooperation for Clean energy transition to scale-up innovations.

b. India has been actively participating in **MI Ministerial(s) and at the 5th Mission Innovation Ministerial (MI-5) held virtually on 23rd September 2020**

hosted by Kingdom of Saudi Arabia was attended by a high-level delegation led by **Hon'ble MoS&T, H&FW and ES Dr Harsh Vardhan, Secretary DBT Dr Renu Swarup** and Senior officials from DBT and DST. Hon'ble Minister of S&T, ES and H&FW led the Indian delegation and presented India's commitment for MI 2.0 activities. MI Impact was presented by SBT highlighting the key impact of the clean energy innovation activities at the national and international level. The meeting reaffirmed India's commitment via **Joint member Statement** to accelerate the pace of innovation and facilitate clean energy transitions by advancing the solutions and technologies needed to support national goals. Details can be accessed at <http://mission-innovation-india.net/mi-5/>



(e) **Development of Biofortified and Protein-Rich wheat: contributing to POSHAN Abhiyan**

**Background:**

Micronutrient malnutrition is a major problem in India and other developing countries. It causes many micronutrient malnutrition induced morbidity and mortality in the developing countries. More than half of the world's population suffers from iron and zinc deficiency popularly called as hidden hunger. Over 25 million more children will suffer from malnourishment and India will be one of the worst affected in the Asian region suggests, a report by the International Food Policy Research Institute.

There are many national and international biofortification research and breeding programs to develop biofortified crops with increased bioavailable concentration of essential micronutrients. Biofortification of staple foods is the most promising strategy for alleviation of micronutrient deficiency. There are several approaches to biofortify crops including agronomic biofortification, genetic engineering, and conventional and molecular breeding. Biofortification using advance biotechnology techniques and molecular breeding approach are the most promising approach as it is cost-effective, non-recurrent expenditure, sustainable, and shows higher public acceptability than the more expensive industrial biofortification. The current discussion focused on the enhancement of micronutrient content (iron and folate) and their bioavailability in wheat and rice.

**Identified gaps:**

- 1) Gap for identifying QTLs for multiple traits including micronutrient (Fe, Zn and folate) combined with starch quality, vitamin content, etc.
- 2) Bio-accessibility and bioavailability of micronutrients (Fe and Folate) in wheat and rice

**Thrust Areas:** The following thrust areas could be developed for the micronutrient enhancement in wheat and rice.

- 1) Identification of diverse lines and/or pre-breeding lines for micronutrient content (iron, zinc. and folate) for gene discovery through molecular breeding (high resolution QTL mapping).
- 2) Bio-accessibility and bioavailability of micronutrients (Fe, Zn, and Folate) in wheat and rice

## 2. National Biopharma Mission

The Industry-Academia Collaborative Mission of Department of Biotechnology (DBT), Govt of India for accelerating discovery research to early development for Biopharmaceuticals was approved by the Cabinet for a total cost of INR 1500 Cr and 50% co-funded by the World Bank. The program referred to as National Biopharma Mission (NBM), is being implemented by Biotechnology Research Assistance Council (BIRAC) and this program is aligned with the national mission of Make-in India.

This pan-India program is focused on making India a hub for development of novel, affordable and effective vaccines, biotherapeutics and medical devices for combating public health concerns.

This program is encouraging collaborations and development of product platform technologies; creating a global network of experts/mentors/advisors; consolidating resources for building centers of excellence; strengthen existing infrastructure, capacities and technical know-how to enable development of specific products and aid in development of a pipeline for products.

**Vision:** *To enable and nurture an ecosystem for preparing India's technological and product development capabilities in biopharmaceuticals to a level that will be globally competitive over the next decade, and transform the health standards of India's population through*

### **Key Components:**

- Development of product leads that are at advanced stages of the product development lifecycle and relevant to the public health need in vaccine, biosimilar and medical devices & diagnostics.
- Establishing and strengthening shared infrastructure facilities for product development and validation.
- Developing human capital by providing specific trainings to address the critical skills gap across the product development value chain.
- Creating and enhancing technology transfer and intellectual property management capacities and capabilities

## Current Portfolio- Major Highlights

**Vaccines:** The vaccine component is focused on accelerating vaccine development for complex, **emerging and high-priority infections in India**. Currently 11 vaccine candidates for Flu, Cholera, Dengue, Pneumonia, and COVID, under different stages of development are being supported under the Mission.

**Biotherapeutics:** The Mission supports therapeutic proteins and **monoclonal antibodies (mAbs)** that are currently under development by the industry with an aim to bring them closer to market. About 12 mAbs which are not presently existing in Indian market and 03 clones for diseases like cancer, diabetes, psoriatic arthritis, wet macular degeneration and lung infections caused by RSV are being supported

**Medical devices & diagnostics:** With a view to reduce import dependency, improve affordability and increase the innovation quotient, the Mission is supporting development of products in the areas of hospital-use equipment, diagnostic imaging, implants, wound-care products etc. Many diagnostic devices and reagents used for diagnostic kits are also supported including Molecular diagnostics, ELISA, LFT, sample transport reagents etc. Currently 17 devices and 13 diagnostics are being supported.

**National facilities:** Creating an enabling ecosystem for affordable product development in the country viz-a-viz creation of GLP, GMP, GCLP facilities besides cell line repositories and facilities for medical device testing and prototyping. The Mission is currently supporting establishment of 19 national facilities, out of which 04 are already operational.

**Clinical Trial Network (CTN):** CTN for hospital-based trials in patients for testing biologicals in different specialties of oncology, diabetology, rheumatology and ophthalmology. Currently, 05 consortia including 35 hospitals are being supported. Strengthening the capacity of vaccine clinical trials via epidemiology studies for dengue and chikungunya, in already existing Demographic Surveillance sites and establishing new sites is another major focus area. Ten (10) Field Sites have been prepared for the same.

**Strengthening Technology Transfer Capabilities:** Five (05) TTO's have been established with a view to strengthen the technology transfer capacity of the country. These are located at:

- a. IKP Knowledge Park, Hyderabad
- b. Centre for Cellular and Molecular Platforms (C-CAMP)
- c. KIIT Technology Business incubator, Bhubaneswar
- d. Biotechnology Business Incubation Facility (BBIF), Foundation for Innovation and Technology Transfer (FITT), New Delhi
- e. Entrepreneurship Development Center (EDC), Pune

Skill Development: The Mission supports trainings and workshops as per its mandate. Workshops in the areas of clinical research, regulatory compliances, technology transfer, biopharmaceuticals and medical devices have been majorly supported. 1406 candidates have been trained under Mission supported trainings with about 37.12% female participation.

### 3. Phytopharmaceutical Mission

**Phytopharmaceutical Mission for North East Region:** The Department has launched a 'Phytopharmaceutical Mission for North East Region of India' with a view to promote development of phytopharmaceuticals in North East Region. Through this mission, it is expected to enable farmers from NE states and phytopharmaceutical industry to become global leaders in production and export of some quality botanical drugs for unmet medical needs. The proposed Phytopharmaceutical Mission aims to achieve following outcomes: (i) Captive cultivation of selected medicinal plants of NER, which have great demand to ensure supply of authentic and quality botanical raw material to the user industries in the country; (ii) Development of technology packages for production of GMP grade medicinal plant extracts for export markets and (iii) Production of safe and efficacious phytopharmaceuticals from medicinal plants of NER for unmet medical needs using modern scientific tools and following global standards as per new notification of DCGI guidelines for Phytopharmaceutical drug development, 2015. Under the Phytopharmaceutical Mission for North East Region, a QC and QA facility for medicinal plants has been already established and cGMP facility for pilot-scale extraction for phytopharmaceutical products from the medicinal Plants of NE India is being set up.

**Inter-Ministerial Cooperation program on 'Phytopharmaceutical' drug development:**

The DBT has signed a tripartite agreement with CSIR and ICMR with the aim for mutual collaboration to develop phytopharmaceutical products for therapeutic use following following DCGI- CDSCO protocols. The effort would be to take forward the leads already existing with CSIR, DBT and ICMR and develop specific collaborative projects in the domain aiming at rigorous modern scientific testing and development of standard products to maintain global competitiveness. Under the Inter-Ministerial Cooperation program of CSIR, DBT and ICMR on 'Phytopharmaceutical' drug development, a pipeline of phytopharmaceutical drugs has been developed. This include: developing phytopharmaceutical drug from *Ficus semicordata* for diabetes; developing phytopharmaceutical drug from *Trachyspermum ammi* for Post Kala-azar Dermal Leishmaniasis (PKDL); CBD-THC Enriched phytopharmaceutical drug for cancer pain management; cannabis based phytopharmaceutical drug for management of resistant pediatric epilepsy; development of *Boswellia serrata* based phytopharmaceutical drug for osteoarthritis.

**Turmeric Mission programme:** A Turmeric Mission programme has been launched with an aim to generate high-quality raw material for developing nutraceutical products / dietary supplements from turmeric for global market as well as developing curcuminoids / curcumin-based therapeutics for various disease segments. Two projects focussing on quality enhancement of turmeric for nutritional and quality profiles and efficient post-harvest management practices and integrated development of turmeric sector in north eastern and Bundelkhand regions for improvement of productivity, quality and post-harvest processing technology have been undertaken. Three projects on nanocurcumin-based combinatorial

therapy for tuberculosis, pre-clinical assessment of novel curcumin formulations as drugs for breast cancer therapy and evaluation of safety and efficacy of curcumin (Biocurcumax capsule) as an adjunct drug to standard therapy for treatment of uncomplicated *Plasmodium falciparum* malaria have been undertaken.

#### 4. Biotech-Krishi Innovation Science Application Network (Biotech-KISAN)

The Department of Biotechnology (DBT) has launched a farmers-centric Mission Programme known as Biotech-Krishi Innovation Science Application Network (Biotech-KISAN), which will link India's farmers with Indian and global best in science for India's future. The programme will provide funding to establish the Biotech-KISAN Hub in each of 15 agro-climatic zones of the country under the leadership of a champion, who will act as the Facilitator. Each Hub will create a network by developing strong linkages with top quality scientific institutions / State Agricultural Universities (SAUs) / Krishi Vigyan Kendras (KVKs) / existing state agriculture extension services / system and other Farmers' organizations in the region as well as linkages with leading international institutions / organizations. Biotech-KISAN Hub will also have a tinkering laboratory. The aim of the programme is to work with small and marginal farmers especially the woman farmers for better agriculture productivity through scientific intervention and evolving best farming practices by linking available science and technology to the farm by first understanding the problem of the local farmer and provide solutions to those problems. The proposed core activities of Biotech-KISAN Hub will be as follows:

- a. Understanding the problems of the local farmer;
- b. Scouting for available technologies and solutions to problems of farmers in the region;
- c. Demonstration and scale-up programmes for implementing the solutions to the problems of farmers – addressing water, soil, seed and marketing issues;
- d. Creation of strong Scientists-Farmers Interaction Platform and connectivity; training programmes for the farmer and immersion programmes for scientists;
- e. Communication set up through radio and TV and connectivity through social media;
- f. Individual thematic fellowship programmes for selected farmers in the zone at high-tech science laboratories;
- g. Special solution-driven thematic fellowships to women farmers (*Mahila Kisan Biotech Fellowship*) to develop them as leaders and grass root scientists.

The activities of the collaborating institutions will include: (a) Conduct training programmes for farmers in science laboratories and (b) Training programmes for scientists in farms. It is also planned to develop short-term training programmes by DBT in partnership with international organisations / universities, where farmers will be exposed to best global farm management and practices. Biotech-KISAN is a scientist-farmer partnership scheme for agriculture innovation through participatory research with an objective to connect science laboratories with the farmers to find out innovative solutions and technologies to be developed and applied at farm level.

2. The expansion of activities of already supported Biotech-KISAN Hubs in selected Aspirational Districts as well as establishing new Biotech-KISAN Hubs to carryout activities in Aspirational Districts has been included in the “Transformative Ideas of DBT for 100

days”. A total of 115 Aspirational Districts are proposed to be covered under the activities of Biotech-KISAN Hubs during the next two years (up to 2021-2022).

3. So far, a total number of **31 Biotech-KISAN Hubs** have been established covering all **15 agro-climatic zones** in the country and implemented its activities in total 150 districts including 100 Aspirational Districts. The activities are also proposed to be expanded in remaining Aspirational District. Over 25,000 farmers have been already benefited in improving their agriculture productivity and income. The programme will lead to link the farmers with the latest scientific innovations with a view to enhance agricultural production, increasing farmers’ income along with creating bio-entrepreneurship in rural areas. The Biotech-KISAN platforms are proposed to be used for demonstration and validation of various technology, products and processes already developed in agri-sector through support of DBT/BIRAC along with promoting bio-entrepreneurships in rural areas. The programme is proposed to benefit over 2 lakhs farmers along with demonstration and validation of 25 technologies / products and creating at least 200 bio-entrepreneurships in rural areas in next two years. A list of Biotech-KISAN Hubs established so far by DBT is enclosed at Annexure I.

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**DEPARTMENT OF BIOTECHNOLOGY**  
**List of DBT Biotech-KISAN Hubs with Districts to be covered**

<b>S. No.</b>	<b>Name and address of the Hub Facilitator</b>	<b>Agro-climatic Zone</b>	<b>Districts to be covered</b>	<b>Email ID</b>
1.	Dr. Himani Purohit, HESCO, Dehradun	Western Himalayan Region	Dehradun, Chamoli, Almora, Haridwar and Udham Singh Nagar (Uttarakhand)	<a href="mailto:himanipurohit9@gmail.com">himanipurohit9@gmail.com</a> ;
2.	Prof. T. Srinivas, ANGRAU, Guntur, Andhra Pradesh	East Coast Plains and Hills	Visakhapatnam, Srikakulam, Kurnool, Anantpur, Kadapa and Vizainagaram (Andhra Pradesh)	<a href="mailto:thumati28@gmail.com">thumati28@gmail.com</a> ;
3.	Dr. S. A. Patil, ISAP, Gulbarga (Kalburgi), Karnataka	Southern Plateau and Hills	Kalaburgi, Bidar, Yadgir and Raichur (Karnataka)	<a href="mailto:gaurav@isapindia.org">gaurav@isapindia.org</a> ; <a href="mailto:sudarshan@isapindia.org">sudarshan@isapindia.org</a> ;
4.	Dr Keshab Chandra Dhara, WBUAFS, Kolkata	Lower Gangetic Plains Region	South 24 Parganas, North 24 Parganas, Nadia, Murshidabad, Birbhum, Maldah and Dakshin Dinajpur (West Bengal)	<a href="mailto:adfwbuafs@gmail.com">adfwbuafs@gmail.com</a> ;
5.	Dr. Dhoom Singh, CSAUAT, Kanpur	Central Plateau & Hills Region	Kanpur, Unnao, Sitapur, Lakhimpur Kheri and Hardoi (Uttar Pradesh)	<a href="mailto:directcsau@gmail.com">directcsau@gmail.com</a> ;
6.	Dr. Sarat Saikia, AAU, Jorhat	Eastern Himalayan Region	Kamrup, Goalpara and West Karbi Anglong (Assam)	<a href="mailto:sarat.saikia17@gmail.com">sarat.saikia17@gmail.com</a> ;
7.	Dr. R.K. Sohane, Bihar Agricultural University, Sabour, Bhagalpur, Bihar	Middle Gangatic Plains Region	Lakhisarai, Gaya, Purnia, Katihar, Khagaria, Banka, Araria and Aurangabad (Bihar)	<a href="mailto:deebausabour@gmail.com">deebausabour@gmail.com</a> ;
8.	Dr. Jagpal Singh, FARMER, Ghaziabad	Upper Gangetic Plains Region	Meerut, Hapur, Gautam Buddh Nagar, Ghaziabad, Bulandshahar and Muzaffarnagar (Uttar Pradesh)	<a href="mailto:jps.farmer@gmail.com">jps.farmer@gmail.com</a> ;
9.	Prof. A. Raouf Malik, SKUAST, Srinagar	Western Himalayan Region	Srinagar, Badgam, Baramulla and Kupwara (J&K)	<a href="mailto:roufmalik@gmail.com">roufmalik@gmail.com</a> ; <a href="mailto:deanhorticulture@skuastkashmir.ac.in">deanhorticulture@skuastkashmir.ac.in</a> ;

S. No.	Name and address of the Hub Facilitator	Agro-climatic Zone	Districts to be covered	Email ID
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11.	Dr. C. S. Aulakh, PAU, Ludhiana	Trans-Gangetic Plains Region	Patiala, Ferozepur, Sangrur and Moga (Punjab), Chamba (Himachal Pradesh)	<a href="mailto:aulakhcs@pau.edu">aulakhcs@pau.edu</a> ;
12.	Dr. K. V. Dhapke, KVK, Durgapur, Amravati	Western Plateau & Hills Region	Amravati, Hingoli, Akola, Gadchiroli and Washim (Maharashtra)	<a href="mailto:pckvkda2015@gmail.com">pckvkda2015@gmail.com</a> ;
13.	Dr. Ram Gupal Laha, ICAR Research Complex for NEH, Umiam, Meghalaya	Eastern Himalayan Region	Ri Bhoi (Meghalaya), Namsai (Arunachal Pradesh), Hailakandi (Assam), Chandel (Manipur), Kiphire (Nagaland), Dhalai (Tripura), Mamit (Mizoram) and West Sikkim (Sikkim)	<a href="mailto:rglaha@gmail.com">rglaha@gmail.com</a> ;
14.	Prof. C. Babu, TNAU, Coimbatore	Southern Plateau and Hills	Coimbatore, Sivagangai, Niligiris, Virudhunagar and Ramanathapuram (Tamil Nadu)	<a href="mailto:forage@tnau.ac.in">forage@tnau.ac.in</a> ;
15.	Dr. V. Sandhya, Agri Biotech Foundation, Hyderabad	Southern Plateau and Hills	Kadappa, Kurnool and Anantapur (Andhra Pradesh), Khammam, Asifabad and Bhoopalpalli (Telangana)	<a href="mailto:sandhyarao28@gmail.com">sandhyarao28@gmail.com</a> ;
16.	Dr. Milind D. Joshi, KVK, Agricultural Development Trust, Shardanagar, Pune	Western Plateau and Hills Region	Nashik, Pune, Nandurbar and Osmanabad (Maharashtra)	<a href="mailto:milindento15@rediffmail.com">milindento15@rediffmail.com</a> ;
17.	Dr. J. P. Sharma, ICAR-IARI, New Delhi	Central Plateau Region	Chitrakoot, Balrampur, Baharaich and Sravasti (Uttar Pradesh), Karauli, Dholpur and Baran (Rajasthan), Mewat (Haryana)	<a href="mailto:jpscatat@gmail.com">jpscatat@gmail.com</a> ;

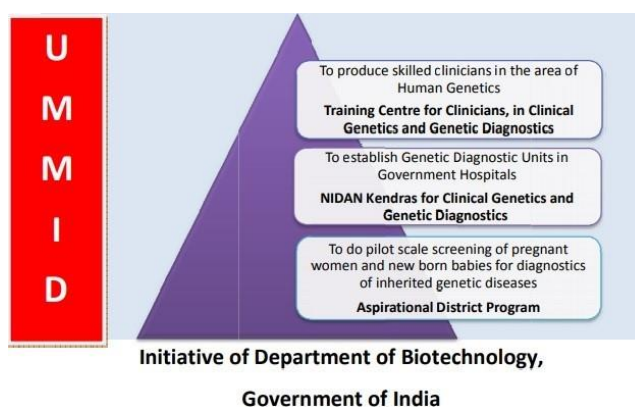
S. No.	Name and address of the Hub Facilitator	Agro-climatic Zone	Districts to be covered	Email ID
18.	Prof. B. M. Musthafa, Integrated Rural Technology Centre, Mundur, Palakkad, Kerala	West Coast Plains and Hills Region	Palakkad (Kerala)	<a href="mailto:musthafachittur@rediffmail.com">musthafachittur@rediffmail.com</a> ;
19.	Dr. Rajat Saxena, Manthan Gramin Evam Samaj Seva Samiti, Bhopal	Central Plateau & Hills Region	Sehore, Hosangabad, Vidisha, Guna, Khandwa, Barwani, Chhatarpur, Damoh and Rajgarh (Madhya Pradesh)	<a href="mailto:ceo@manthangramin.org">ceo@manthangramin.org</a> ;
20.	Dr. Jai Sunder, ICAR-CIARI, Port Blair, Andaman and Nicobar Islands	Islands Region	South Andaman, North and Middle Andaman, Nicobar and Lakshadweep	<a href="mailto:jaisunder@rediffmail.com">jaisunder@rediffmail.com</a> ;
21.	Dr. B. P. Bhatt, ICAR-Research Complex for Eastern Region, Patna, Bihar	Eastern Plateau and Hills region	Ranchi, Hazaribag, Bokaro, Khunti, Ramgarh, East Singhbhum (Jharkhand), Jamui, Nawada and Sheikhpura (Bihar)	<a href="mailto:directoriarrrcer@gmail.com">directoriarrrcer@gmail.com</a> ;
22.	Dr. Ramesh C. Uniyal, ZFHC, Ambach, Valsad, Gujarat	Gujarat Plains and Hills Region	Dohad, Narmada, Anand and Valsad (Gujarat)	<a href="mailto:uniyal68@gmail.com">uniyal68@gmail.com</a> ;
23.	Dr. Dipankar Maiti, ICAR-NRRI, Hazaribag, Jharkhand	Eastern Plateau and Hills region	Hazaribagh, Gumla, Palamu, Chatra and Lohardaga (Jharkhand)	<a href="mailto:dipankar_maiti@live.in">dipankar_maiti@live.in</a> ;
24.	Dr. Mooventhan Palanisamy, ICAR-NIBSM, Raipur, Chhattisgarh	Eastern Plateau and Hills region	Mahasamund, Rajnandgaon and Korba (Chhattisgarh)	<a href="mailto:p.mooventhan@icar.gov.in">p.mooventhan@icar.gov.in</a> ;
25.	Dr. Rupankar Bhagawati, Regional Rainfed Lowland Rice Research Station, ICAR-NRRI, Gerua, Kamrup, Assam	Eastern Himalayan region	Baksa, Barpeta and Darrang (Assam)	<a href="mailto:rbhagawati@rediffmail.com">rbhagawati@rediffmail.com</a> ;
26.	Dr. Santanu Mohanty, College of Agriculture, OUAT, Bhubaneswar	Eastern Plateau and Hills Region	Kalahandi, Bolangir, Kandhamal, Ganapati and Dhenkanal (Odisha)	<a href="mailto:santanu.madhu1960@gmail.com">santanu.madhu1960@gmail.com</a> ; <a href="mailto:santanu.mandu@yahoo.com">santanu.mandu@yahoo.com</a> ;

<b>S. No.</b>	<b>Name and address of the Hub Facilitator</b>	<b>Agro-climatic Zone</b>	<b>Districts to be covered</b>	<b>Email ID</b>
27.	Prof. Panjab Singh Singh, FAARD Foundation, Varanasi	Middle Gangetic Plain Region	Chandauli and Sonbhadra (Uttar Pradesh)	<a href="mailto:panjabsingh03@yahoo.com">panjabsingh03@yahoo.com</a> ; <a href="mailto:faardvaranasi@gmail.com">faardvaranasi@gmail.com</a> ;
28.	Shri Bhagirath Choudhary, South Asia Biotechnology Centre (SABC), Jodhpur	Western Dryland Region	Sirohi and Jaisalmer (Rajasthan)	<a href="mailto:bhagirath@sabc.asia">bhagirath@sabc.asia</a> ;
29.	Dr. Nitish Singh, ISHARA, Deoria	Middle Gangetic Plain Region	Siddharth Nagar (Uttar Pradesh)	<a href="mailto:nitishsingh1000@gmail.com">nitishsingh1000@gmail.com</a> ;
30.	Dr. Girish Chandel, IGKV, Raipur, Chhattisgarh	Eastern Plateau and Hills Region	Bastar, Bijapur, Dantewara, Kanker, Kondagaon, Narayanpur and Sukma (Chhattisgarh)	<a href="mailto:ghchandel@gmail.com">ghchandel@gmail.com</a> ;
31.	Dr. N. Anil Kumar, MSSRF, Chennai	Eastern Plateau and Hills Region	Koraput, Malkangiri, Rayagada (Odisha) and Waynad (Kerala)	<a href="mailto:anilmaruthur@gmail.com">anilmaruthur@gmail.com</a> ; <a href="mailto:prabavathyvr@mssrf.res.in">prabavathyvr@mssrf.res.in</a> ;

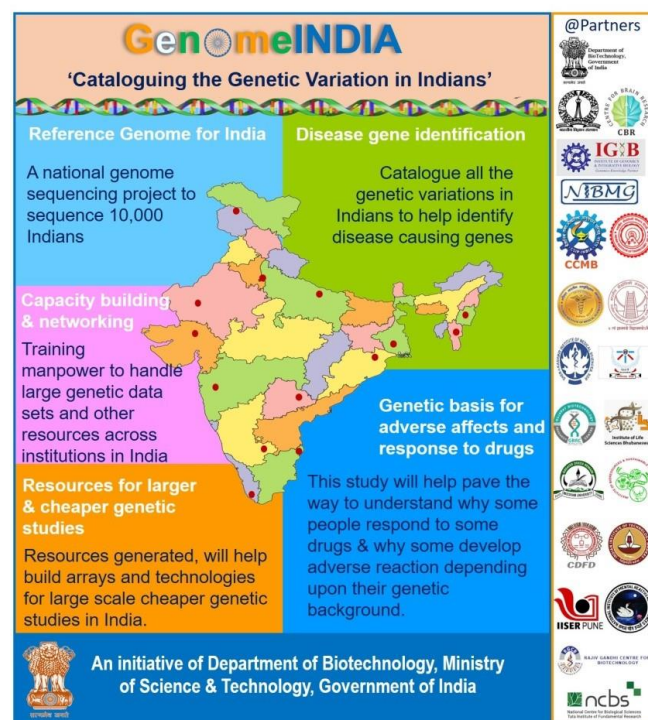
## 5. DBT- Unique Methods of Management of Inherited Disorders (UMMID) initiative

With an aim to address the burden of inherited disorders, the Department launched the DBT- Unique Methods of Management of Inherited Disorders (UMMID) initiative. In the first phase of the UMMID initiative, the Department has supported:

- NIDAN Kendras (National Inherited Disorders Administration Kendras) for providing comprehensive clinical care including diagnosis, management, multidisciplinary care, counseling, prenatal testing at five Government hospitals spread across four states of the country
- Training Centres for providing training to the clinicians working in Government hospitals in Biochemical Genetics, Cytogenetics, Molecular Genetics, Clinical Genetics and Comprehensive clinical care
- Screening of 10,000 pregnant women and 5,000 neonates per year for diagnosis of inherited genetic diseases in each of the following seven aspirational districts: Mewat (Haryana); Yadgir (Karnataka); Haridwar (Uttarakhand); Washim & Nandurbar (Maharashtra); Ranchi (Jharkhand); and Shrawasti (Uttar Pradesh)



**6. Genome India: Cataloguing the Genetic Variation in Indians** is a pan-India initiative focused on Whole Genome Sequencing of representative populations across India. The goal of the initiative is to carry out whole genome sequencing and subsequent data analysis of 10,000 individuals representing the country's diverse population. This would help build an exhaustive catalogue of genetic variations for the Indian population, and aid in the designing of genome-wide association chips for the Indian population which will facilitate further large-scale genetic studies in a cost-effective manner. Furthermore, it would also open new vistas for advancing personalized medicine regimen in the country paving the way for predicting health and disease outcomes and modulating treatment protocols on the basis of the genome sequences. Besides, it would help in identifying the population groups which are more susceptible to various risk factors for certain diseases and would thus be instrumental in designing appropriate intervention strategies for such population groups.



## 7. Mission programme on Genetic Enhancement of Pulses

Improvement of legumes is one of the priority areas of Department. Department has initiated a mission program on “Genetic Enhancement on Pulses”. Department through this programme is targeting complex biological system of pulses which has been neglected. Programme envisages providing farmers with improved and productive varieties, disease and climate resilience. A major network project entitled **“Genetic Enhancement on minor pulses: Characterization, Evaluation, Genetic Enhancement and generation of Genomic Resources for Accelerated utilization and improvement of minor pulses”** under the Mission programme on Genetic Enhancement of Pulses has been funded with ILS, Bhubaneswar as the coordinating center. The network project has 13 participating institutes. Under the project, targeted pulses are black gram (*Vigna mungo*, urad bean), green gram (*Vigna radiata*, mung bean), moth bean (*Vigna aconitifolia*), cowpea (*Vigna unguiculata*), rice bean (*Vigna umbellata*), and horse gram (*Macrotyloma uniflorum*, Kulthi). The major focus of the network project is to improve yield, nutritional enhancement, productivity and stress resistance of pulses. Under the project, whole genome sequence of selected under-utilized pulses



Mungbean (*Vigna radiata*): Field View, ARS Badnapur



Urdbean/Blackgram (*V. mungo*): WVC, Hyderabad



Mothbean (*Vigna aconitifolia*): ICAR-CAZRI Jodhpur



Glimpse of variation in floral traits in cowpea



Variation in seed size and color in mungbean accessions

## 8. Mission Programme on Minor Oilseeds

The department has initiated a major mission mode programme on “**Minor Oilseeds of India Origin**” in various crops. The mission mode programme is aimed at sequencing/re-sequencing and phenotypic characterization of available germplasm resources of Minor Oilseeds (Sesame, Linseed, Safflower and Niger) in the country along with exotic lines from diverse agro climatic regions & elite lines of International Institutes. Under the mission programme, 4 major all India network projects were approved which will provide information on new genes to combat biotic, abiotic stresses and nutrition. The detail of network projects is as following:

### **(a) Mainstreaming sesame germplasm for productivity enhancement and sustainability through genomics assisted core development and trait discovery**

Under the network project, **9840 accessions** of sesame will be used for phenotyping of agro-morphological traits and genotyping/re-sequencing followed by GWAS in core set for identification of genes/QTLs conferring resistance against selected biotic (phyllody & dryroot rot) and abiotic stresses (water logging and drought). The project will also target development of pre-breeding material for agronomically important traits through intraspecific and inter-specific crosses.



**Sesame Germplasm Purification at RRS, Vriddhachalam**

### **(b) Leveraging genetic resources for accelerated genetic improvement of Linseed using comprehensive genomics and phenotyping approaches**

Under the network project, phenotyping and genotyping of linseed germplasm (**2748 accessions**) to develop core set and trait specific reference sets for major biotic (*Alternaria* blight, Bud fly) and abiotic (drought, salt) stresses. The project

will also undertake whole genome sequencing of the dominant linseed variety (T-397) and identification of trait specific germplasm accessions/genetic stocks for key agronomic (earliness, no. of capsules/plant, oil content, yield) and nutritional traits (omega-3 FA, lignan, protein), as well as for biotic and abiotic stress resistance.



**Wild Linseed Germplasm**

**(c) Exploiting Genetic Diversity for Improvement of Safflower through Genomics-Assisted Discovery of QTLs/Genes Associated with Agronomic Traits**

Under the project, molecular core set of safflower germplasm (**7000 accessions**) will be developed to discover genomic regions associated with seed yield, oil content, oil quality, resistance to Fusarium wilt, charcoal rot and aphid through genome wide association studies (GWAS). Under this project draft genome sequences of safflower (*C. tinctorius* L.) and its wild relatives, *C. oxyacantha* and *C. palaestinus*, will also be generated. The project will also focus on developing pre-breeding material using the wild species, *C. oxyacantha* and *C. palaestinus* for exploring novel QTLs for yield.

**(d) Exploitation of genomic resources for improvement of niger (*Guizotia abyssinica* L.F. Cass) through breeding and biotechnological tools.**

Under the project, **2100 accessions** of niger will be used for phenotyping for major agronomic traits including autogamy, non-shattering, high harvest index

traits, oil content and oil quality in different agro-climatic conditions. During the course of this project, attempt will be made to broaden the genetic base of niger through pre-breeding and interspecific hybridization and to develop homozygous lines using double haploid technology. Reference genome sequence will be generated for popular Indian variety (IGPN-2004-1) to carry comparative genomics with Ethiopian genotypes, wild *Guizotia* species and other important members of Asteraceae family



**Evaluation and Maintenance of niger germplasm at NRS, varanasi**

## 9 Mission Programme on Characterization of Genetic Resources

The department has initiated a major mission mode programme on “**Characterization of Genetic Resources**” in twenty six crops. The mission mode programme is aimed at sequencing/re-sequencing and phenotypic characterization of available germplasm resources of Cereals (Rice and Wheat) and Pulses (Chickpea) in country along with exotic lines from diverse agro climatic regions & elite lines of International Institutes. Under the mission programme, 2 major all India network projects were approved and one is under approval. These projects will provide information on new genes to combat biotic, abiotic stresses and nutrition. The detail of network projects is as following:

### (a) **Mainstreaming rice landraces diversity in varietal development through genome-wide association studies: A model for large-scale utilization of gene bank collections of rice.**

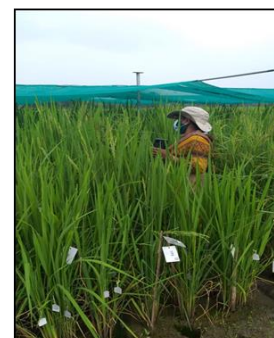
Under this network project, a total of 15251 accessions of rice will be used for genetic characterization and development of core set followed by multi-location evaluation of core set for yield components, tolerance to abiotic, biotic stresses, resource use efficiency, grain & nutritional traits. The project will also facilitate development of elite donors for yield components, tolerance to abiotic, biotic stresses and nutritionally important traits.



Rice accessions grown at IARI, New Delhi



Uniform blast nursery (UBN) screening at MCRC, Khudwani, SKUAST(K)



Screening for false smut at IIRR, Hyderabad

**(b) Germplasm Characterization and Trait Discovery in Wheat using Genomics Approaches and its Integration for Improving Climate Resilience, Productivity and Nutritional quality**

Under this network project, a total of 7000 **accessions of wheat** including landraces and indigenous germplasm available with Indian researchers and National Genebank will be used for agro-morphological characterization and genotyping/re-sequencing to facilitate gene discovery for biotic stresses (including rusts, powdery mildews, Fusarium head blight and spot blotch) and abiotic stresses (including drought, heat and salt tolerance). The project will accelerate genetic gain and speedy development of high yielding wheat varieties.



Off-season wheat nursery at Wellington, Tamil Nadu

**(c) Characterization of Chickpea Germplasm Resource to Accelerate Genomics-assisted Crop Improvement. (Under consideration for approval)**

Under this project, constitution of Iterative Core by large-scale genotypic and phenotypic characterization of **14651 chickpea germplasm accessions** (Pan Genebank Core) conserved at Genebank will be done followed by genome-wide association study (GWAS) for traits of agricultural importance. The project will also entail development of a user-friendly web-interface (database) for access of entire genetic, phenotypic and genomic characterization data and resource information of chickpea for accelerating genomics-assisted crop improvement.