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STANDING COMMITTEE ON AGRICULTURE, ANIMAL HUSBANDRY AND FOOD PROCESSING (2025-26)

EIGHTEENTH LOK SABHA

MINISTRY OF AGRICULTURE AND FARMERS WELFARE (DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION)

RESEARCH FOR DEVELOPING WATER EFFICIENT VARIETY OF SEEDS TO SAVE GROUND WATER

THIRTY-FOURTH REPORT

सत्यमेव जयते

LOK SABHA SECRETARIAT
NEW DELHI

March, 2026 / Chaitra, 1948 (Saka)

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(DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION)

Research for Developing Water Efficient Variety of Seeds to Save Ground Water

Presented to Lok Sabha on	***27.03.2026***
Laid on the Table of Rajya Sabha on	***27.03.2026***

LOK SABHA SECRETARIAT
NEW DELHI
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31. Shri Randeep Singh Surjewala

Shri Krishan Lal Panwar, Member resigned from Rajya Sabha on 14.10.2024.

**Shri Masthan Rao Yadav Beedha, Member, Rajya Sabha has been nominated to the Standing Committee on Agriculture, Animal Husbandry and Food Processing w.e.f on 8th August 2025, vide Lok Sabha Bulletin Part-II, Para No. 3117 dated 13.08.2025.*

COMPOSITION OF THE STANDING COMMITTEE ON AGRICULTURE, ANIMAL HUSBANDRY AND FOOD PROCESSING
(2025-26)

PRESENT

CHARANJIT SINGH CHANNI - CHAIRPERSON

MEMBERS

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3. Smt. Harsimrat Kaur Badal
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27. Shri Madan Rathore
28. Shri S.R. Sivalingam
29. Shri Ramji Lal Suman
30. Shri P. P. Suneer
31. Shri Randeep Singh Surjewala

SECRETARIAT

1.	Shri Dhiraj Kumar	-	Joint Secretary
2.	Shri Maheshwar	-	Director
3.	Shri Prem Ranjan	-	Deputy Secretary

INTRODUCTION

I, the Chairperson, Standing Committee on Agriculture, Animal Husbandry and Food Processing (2025-26), having been authorized by the Committee to submit the Report on their behalf, present this Thirty-Fourth Report on the Subject *'Research for Developing Water Efficient Variety of Seeds to Save Ground Water'* pertaining to the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education).

2. The Standing Committee on Agriculture, Animal Husbandry and Food Processing had selected the Subject for examination during 2024-25. The Committee took evidence of the representatives of the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) on the Subject at their Sitting held on 20th June, 2025. As the examination of the Subject could not be completed during 2024-25, the Subject was again selected for examination by the Committee during 2025-26.

3. The Report was considered and adopted by the Committee at their Sitting held on 23rd March, 2026.

4. For facility of reference and convenience, the Observations/Recommendations of the Committee have been printed in bold at Part-II of the Report.

5. The Committee wish to express their thanks to the representatives of the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) for appearing before the Committee and furnishing requisite information in connection with the examination of the Subject.

6. The Committee would also like to place on record their deep sense of appreciation for the invaluable assistance rendered to them by the officials of Lok Sabha Secretariat attached to the Committee.

NEW DELHI;
24th March, 2026
03 Chaitra, 1948 (Saka)

CHARANJIT SINGH CHANNI
Chairperson
Standing Committee on Agriculture
Animal Husbandry and Food Processing

ABBREVIATIONS

AGGRi Alliance	Accelerated Genetic Gain in Rice Alliance
AICRP	All India Coordinated Research Projects
AICRPDA	All India Coordinated Research Project for Dryland Agriculture
AINP	All India Network Projects
AMAAS	Application of Micro-organisms in Agriculture and Allied Sectors
AWD	Alternate Wetting and Drying
BCM	Billion Cubic Metres
BSPCs	Breeder Seed Production Centres
CAU/SAUs	Central and State Agricultural Universities
CFLDs	Cluster Front Line Demonstrations
CRIDA	Central Research Institute for Dryland Agriculture
CRPs	Consortium Research Projects
CRTs	Climate Resilient Technologies
CRURRS	Central Rainfed Upland Rice Research Station
CRV	Climate Resilient Village
DA&FW	Department of Agriculture and Farmers Welfare
DSR	Direct Seeded Rice
EU	European Union
FLDs	Front-Line Demonstrations
FPOs	Farmer Producer Organization
FSSI	Federation of Seed Industry of India
GEAC	Genetic Engineering Appraisal Committee
GM	Genetically Modified
GMOs	Genetically Modified Organisms
IBKP	Indian Biosafety Knowledge Portal
IBSC	Institutional Biosafety Committee
ICAR	Indian Council of Agricultural Research
ICARDA	International Centre for Agricultural Research in Dry Areas
ICRISAT	International Crop Research Institute for Semi Arid Tropics
IIFSR	Indian Institute of Farming Systems Research
IISWC	Indian Institute of Soil and Water Conservation
IoT	Internet of Things
IRRI	International Rice Research institute
KBLP	Ken-Betwa Link Project
KVKs	Krishi Vigyan Kendras
LMOs	Non-Living Modified Organisms
MoA&FW	Ministry of Agriculture and Farmers Welfare
MP	Madhya Pradesh
NARS	National Agricultural Research System
NBPGR	National Bureau of Plant Genetic Resources
NFSM	National Food Security Mission
NGOs	Non-Governmental Organizations
NIASM	National Institute for Abiotic Stress Management
NIC	National Informatics Centre
NICRA	National Innovations in Climate Resilient Agriculture
NPP	National Perspective Plan
NRCIPM	National Research Centre for Integrated Pest Management
NSAI	National Seed Association of India
NSCL	National Seed Corporation Ltd.
NSG	National Seed Grid
NTIWRDM	National Taskforce on Integrated Water Resource Development and Management

NUE	Nitrogen Use Efficiency
NWDA	National Water Development Agency
NGTs	New Genomic Techniques
NGOs	Non-Governmental Organizations
PDMC	Per Drop More Crop
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PSUs	Public Sector Undertakings
RCGM	Review Committee on Genetic Manipulation
RTCP	Real-Time Contingency Planning
SATHI	Seed Authenticity Traceability & Holistic Inventory
SMSP	Sub-Mission on Seeds and Planting Material
SSAP-W	State Specific Action Plans on Water
SSCAs	State Seed Certification Agencies
SMSP	Sub-Mission on Seeds and Planting Material
TDC	Technology Demonstration Component
TGCP	Translational Genomics in Crop Plants
UP	Uttar Pradesh
VCRMCs	Village Climate Risk Management Committees
WUE	Water Use Efficiency
YMD	Yellow Mosaic Disease

REPORT

PART - I

Chapter – I

A. Introductory

1.1 Agriculture sector has been the backbone of the Indian economy, playing a vital role in national income and employment. This sector contributes approximately 16 per cent of the country's GDP for FY 24 at current prices and supports about 46.1 per cent of the population. Not only does its performance directly impact food security, but it also influences other sectors, sustaining livelihoods and supporting economic growth. The food grain production of 50.8 million tonnes in 1950-51 has now touched 332.23 million tonnes during 2023-24. The bumper food grain production is primarily attributed to cultivation of high yielding crop varieties developed by the National Agricultural Research System (NARS) led by Indian Council of Agricultural Research (ICAR). Despite the increase in crop production, further enhancements in productivity across various crops and regions are vital for boosting performance and positively influencing farmers' incomes. To meet the projected demand of 1.68 billion population during 2047, we need to develop highly water efficient varieties with higher grain yield.

1.2 In India, while the volatility in agricultural growth has notably diminished over time due to targeted interventions, the sector is not without its challenges. Issues like climate change and water scarcity present significant obstacles that require focused and targeted interventions. Major adverse impacts of climate change on agriculture are owing to increase in temperature; change in rainfall pattern; weather hazards, decline in soil and water quality; shifting dynamics of insects, diseases, soil flora and fauna; intrusion of sea water on land and biotic and abiotic stresses arising due to climatic extremes. Amongst these challenges, availability of water for agriculture is one of the serious issues. In India, the agriculture sector also remains highly vulnerable to weather variability. Nearly 51 per cent of the 139.9 million hectares (m ha) net cropped area of the country falls under rainfed situation which supports 40 per cent of its human and 60 per cent of livestock population. Rainfed agriculture is complex, highly diverse and risk prone. It is characterized by low levels of productivity and input usage coupled with vagaries of monsoon emanating from climate change; resulting in wide variation and instability in crop yields. One of the most viable solutions to overcome this serious issue is the development of varieties which are amenable to low water requirement conditions and can perform well even under drought like conditions. Moreover, as per reports, ground water is depleting at an alarming rate in several parts of the country and availability of water for Agriculture is one of the serious issues as maximum instability in yield is generally due to less or non-availability of water. So, to maintain the sustainability of crop production and attain the target of ensuring food, nutrition, environment and livelihood security, development of water efficient crop varieties and production of their seeds are quite essential. In addition, promoting agricultural production patterns and practices that align with the specific agro-climatic conditions and natural resource available in the different regions across the country is vital. Investment in research and development, especially on climate-resistant varieties, improved agriculture practices, diversification to high-yield and climate-resilient crops and micro-irrigation, can yield to sustainable long-term benefits.

B. ONGOING PROGRAMMES TO DEVELOP WATER EFFICIENT VARIETIES

1.3 Crop Science Division of the ICAR is working on 85 field crops under an Umbrella Scheme titled "Crop Science for Food and Nutritional Security" through its six sub-schemes viz., (i) Basic and Strategic Research and Education, (ii) Plant Genetic Resource Management, Seed and Hill Agriculture, (iii) Genetic Improvement for Food and Fodder Crops, (iv) Pulse and Oilseed Crop Improvement, (v) Improvement of Commercial Crops for Genetic Gains and (vi) Insects and Microbes Resources, Plant Protection and Pollinators Research; is focusing on undertaking research and capacity building activities by harnessing conventional and modern scientific knowledge and modern tools for developing location specific improved crop varieties/ hybrids and matching protection and production technologies; refinement of seed production chain; conserve the genetic resources including plants, insects and microorganisms; and providing advisory services and capacity building in the domain area besides promoting the basic, strategic and anticipatory crop science research. The six sub-schemes have total 63 components including 28 Institutes, 20 All India Coordinated Research Projects (AICRP), six All India Network Projects (AINP), four Consortium Research project (CRPs), Incentivizing Research in Agriculture, Translational Genomics in Crop Plants, Genome Editing, Millet Global Hub and Application of Microorganisms in Agriculture and Allied Sectors (AMAAS). All the scheme components have one or more activities related to development of crop varieties needing less water requirement or technologies which can help in mitigating the effect of scarcity of water. Sub-scheme-wise details along with budget outlay for the period 2021-22 to 2025-26 are presented as under:

S.No.	Name of Sub-scheme/ Components	Budget (Rs. crores)
I	**Basic and Strategic Research and Education**	
1	Indian Agriculture Research Institute, New Delhi	838.510
2	Indian Agriculture Research Institute, Jharkhand	117.740
3	Indian Agriculture Research Institute, Assam	129.260
4	CRP on Hybrid Technology, New Delhi	32.900
5	CRP on Molecular Breeding, New Delhi	26.060
6	National Institute for Plant Biotechnology, New Delhi	58.280
7	Translational Genomics in Crop Plants (TGCP), NIPB, New Delhi	9.760
8	AINP on Biotech Crops	24.750
9	Indian Institute of Agricultural Biotechnology, Ranchi	132.800
10	Enhancing climate resilience and ensuring food security with genome editing tool	310.00
	Total of sub-scheme (I)	**1680.060**
II	**Plant Genetic Resource Management, Seed and Hill Agriculture**	
1	National Bureau of Plant Genetic Resources, New Delhi	133.640
2	All India Network Project (AINP) on Potential Crops, New Delhi	9.910
3	Consortium Research Project (CRP) on Agrobiodiversity, NBPGR, New Delhi	32.990
4	Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora	64.760
5	Indian Institute of Seed Science, Mau	41.260
6	AICRP on Seed (Crops), Mau including ICAR Seed Projects	68.960
	Total of sub-scheme (II)	**351.520**
III	**Genetic Improvement for Food and Fodder Crops**	
1	National Rice Research Institute, Cuttack	82.825
2	Incentivising Research in Agriculture, Cuttack	65.190
3	Indian Institute of Rice Research, Hyderabad	69.800
4	AICRP on Rice, Hyderabad	41.261
5	CRP on Biofortification, Hyderabad	39.000
6	Indian Institute of Wheat and Barley Research, Karnal	56.881
7	AICRP on Wheat & Barley, Karnal	14.380
8	Indian Institute of Maize Research, Ludhiana	79.000
9	AICRP on Maize, Ludhiana	24.751
10	Indian Institute of Millets Research, Hyderabad	37.572
11	AICRP Sorghum and small millet, IIMR Hyderabad	28.515
12	AICRP on Pearl millet, IIMR Hyderabad	11.320

13	Indian Grassland and Fodder Research Institute, Jhansi	50.830
14	AICRP on Forage Crops and Utilization, Jhansi	14.760
15	Global R&D Hub for millets in India	250.000
	Total of sub-scheme (III)	**866.085**
IV	**Pulse and Oilseed Crop Improvement**	
1	Indian Institute of Pulses Research, Kanpur	99.200
2	AICRP on Rabi Pulses (chickpea, lentil, fieldpea), IIPR Kanpur	19.320
3	AICRP on Khrarif Pulses (Pigeonpea, mubgbean, urdbean, lathyrus, rajmash, cowpea arid legumes)	24.750
4	Directorate of Groundnut Research, Junagarh	52.730
5	AICRP on Groundnut, Junagarh	14.860
6	Indian Institute of Soybean Research, Indore	36.960
7	AICRP on Soybean, Indore	12.320
8	Directorate of Rapeseed Mustard Research, Bharatpur	36.980
9	AICRP on Rapeseed & Mustard, Bharatpur	17.060
10	Indian Institute of Oilseeds Research, Hyderabad	49.990
11	AICRP on Oilseeds, IIOR, Hyderabad (sunflower, safflower, castor, linseed)	21.470
12	AICRP on Sesame and Niger, Jabalpur	7.690
	Total of sub-scheme (IV)	**393.330**
V	**Improvement of Commercial Crops for Genetic Gains**	
1	Indian Institute of Sugarcane Research, Lucknow	115.030
2	AICRP on Sugarcane, Lucknow	12.910
3	Sugarcane Breeding Institute, Coimbatore	68.850
4	Central Tobacco Research Institute, Rajamundry	32.440
5	AINP on Tobacco, Rajamundry	5.482
6	Central Institute of Cotton Research, Nagpur	71.385
7	AICRP on Cotton, Coimbatore	11.444
8	Central Research Institute for Jute and Allied Fibres, Barrackpore	54.209
9	AINP on Natural Fibres, CRIJAF, Barrackpore	7.110
	Total of sub-scheme (V)	**378.860**
VI	**Insects and Microbes Resources, Plant Protection and Pollinators Research**	
1	National Institute of Biotic Stress Management, Raipur	79.290
2	National Bureau of Agricultural Insect Resources, Bengaluru	32.990
3	AICRP on Biocontrol of Crop Pests, Bengaluru	24.010
4	National Bureau of Agriculturally Important Microorganisms, Mau	45.450
5	Application of Micro-organisms in Agriculture and Allied Sectors (AMAAS)	21.360
6	National Research Centre for Integrated Pest Management (NRCIPM), New Delhi	27.505
7	AICRP on Nematodes in Cropping System, New Delhi	11.000
8	AICRP - Honeybees and Pollinators, New Delhi	13.210
9	AINP on Pesticides Residues& Contaminants, New Delhi	11.560
10	AICRP on Crop Pest Management (Soil arthropod, Agri Agrology, Vertebrate Pest mgmt)	30.260

11	AINP on Emerging Pests (UG 99, wheat blast, Sclerotinia stem rot, red rot, Locust, Fall Army Worm)	12.860
	Total of sub-scheme (VI)	**309.495**
	GRAND TOTAL	**3979.35**

(Background Note Page: 2-4)

1.4 The development and evaluation of varieties under the AICRPs is done based on the five major agro-climatic zones. Based on their suitability, these varieties are recommended for the whole zone or for a particular state. Development of water efficient varieties in all mandated crops is one of the objectives under AICRPs across all Agro-climatic zones and state-specific conditions.

(Reply to LOP No. 2 dt. 9.7.2025)

1.5 The Department also informed that in addition to the planned projects, a good number of externally funded projects are also working on the objective of breeding for low water requiring varieties in different field crops.

The externally funded projects operating in the Council with the objective for development of low water requiring genotypes are listed as under:

Rice

- Molecular tagging of genes related to early seedling vigour using landraces and wild introgression lines to develop climate smart rice varieties *(Funded by SERB, DST)*
- Evaluating IoT enabled AWD system for reducing GHG emissions and enhancing sustainability of rice production *(Funded by CULTVATE)*
- Identification and characterization of superior haplotypes for agronomically important traits in rice (*Oryza sativa*. L.) *(Funded by SERB, DST)*
- Accelerated genetic gain in rice - Irrigated rainfed (Drought, salinity & submergence) and DSR ecologies (AGGRI- Alliance)

Maize

- Improving rainfed (Kharif) maize productivity *(Funded by CIMMYT)*

- Deployment and scaling high-yielding, climate-resilient and water-efficient maize hybrids to enhance productivity of low yielding districts in Kharif *season (Funded by CIMMYT)*

Oilseeds

- Exploiting genetic diversity for improvement of safflower through genomics-assisted discovery of QTLs/genes associated with agronomic traits (DBT-Safflower)
- Exploitation of genetic & genomic resources for improvement of niger (*Guizotia abyssinica* L.F. Cass) through breeding and biotechnological tools (DBT-Niger).

Tobacco

- Genetic exploration to harness burley germplasm resources and breeding for water stress tolerance in burley tobacco (Funded by Godfrey Phillips India Ltd, Guntur)

Sugarcane

- Genome editing in sugarcane to improve yield, quality, biotic stress tolerance and biomass modification for biofuel production (Under the Central Sector Scheme Crop Science for Food and Nutritional Security, Sub-scheme)
- Enhancing climate resilience and ensuring food security with genome editing tools) (ICAR-EFC) (a) Creating targeted mutation in sugarcane for improving water deficit tolerance
- CRISPR – Crop Network – Targeted improvement of stress tolerance, nutritional quality and yield of crops by using genome editing (NASF)
- Deciphering the genetic basis of root-system architecture developing climate resilient sugarcane (BRNS)
- Identification of climate resilient drought tolerant sugarcane varieties suitable for Haryana state (RKVY Haryana).

Cotton

Technology for upscaling of non-GM Extra Long Staple Cotton Production in Maharashtra and Tamil Nadu.

1.6 Besides, ICAR under its flagship network project ‘National Innovations in Climate Resilient Agriculture (NICRA)’ launched in 2011 is also focussed on climate resilient technological innovations as detailed below:

- Climate resilient technologies *viz.,* resilient intercropping systems, conservation agriculture, crop diversification from paddy to other alternate crops like pulses, oilseeds, agroforestry systems, zero till drill sowing of wheat to escape terminal heat stress, alternate methods of rice cultivation (system of rice intensification, aerobic rice, direct seeded rice), green manuring, integrated farming systems, integrated nutrient management, integrated pest management, organic farming, site specific nutrient management, *in-situ* moisture conservation, protective irrigation from harvested rainwater in farm pond, micro irrigation method (drip and sprinkler) etc. developed and demonstrated to large number of farmers.
- Developed several doable rainfed technologies like rainwater management, efficient and profitable cropping systems, nutrient management, energy management, alternate land use/farming systems which can increase production, decrease cost of cultivation, reduce drudgery and enable farmers to complete farm operations timely. These technologies have been widely adopted by the farmers across the country and imparted stability in productivity and production particularly in the rainfed areas.
- Climate resilient varieties have been developed under NICRA in rice (CR Dhan 201, NICRA Aerobic Dhan 1, CR Dhan 412, CR Dhan 414, NICRA Aerobic Dhan 2, Pusa 1882-12-111-20, NICRA Hill Rice 2022-2, NICRA-Boro Dhan 1), wheat (HD 3411), mungbean (Virat, Varsha, Heera, Kanika), lentil (IPL 534), maize (CMH 08-287) and tomato (Kashi Adbhut, Kashi Tapas) resistant to diseases and extreme weather conditions. These varieties have been introduced in drought and heat wave affected districts, well adopted by farmers resulting in increased crop yields and monetary returns at different locations.
- Simulation modelling studies indicate that adopting improved varieties coupled with improved agronomic management can minimize the yield loss due to extreme weather events in several crops.
- Planting methods such as zero till, raised bed planting, cropping intensification with harvested water were demonstrated in North-Eastern and districts in the Eastern states.

- Location-specific climate resilient technologies have been tested and validated at on-farm sites of 151 climatically vulnerable districts for adoption by the farmers. One village cluster from each of the 151 districts was selected by the respective Krishi Vigyan Kendra (KVK) in the district and the program is implemented through farmer participatory approach which can be upscaled by the respective State Governments.
- Major achievements of Climate Resilient Village (CRV) developed under this programme includes Location specific Climate Resilient Technologies (CRTs) demonstrated in 446 villages covering 2,13,421 households and 2,35,874 ha area and Village climate risk management committees (VCRMC), custom hiring centers, seed and fodder production systems and community nurseries enabled wider adoption of CRTs. NICRA model villages are being upscaled by different State Governments and agencies such as PoCRA in Maharashtra, Drought proofing of watersheds by NABARD, etc.

Department of Agriculture and Farmers Welfare is also promoting the climate resilient varieties particularly less water requiring under the contingency planning when there is delay in monsoon or rainfall is much lower than normal rainfall.

1.7 On being asked about the Institutions of the Department of Agricultural Research and Education engaged in research for developing water efficient variety of seeds to save groundwater, the Department stated:

"The Indian Council of Agricultural Research (ICAR) is actively addressing the challenges of climate change in agriculture through a range of targeted initiatives implemented by its leading institutes. Crop Science Division is the largest division of ICAR carrying the research programmes for developing high yielding crop varieties including research for developing water efficient varieties of seeds through its 28 Institutes, 26 All-India Coordinated Research Projects (AICRPs) and All-India Network Projects (AINPs) and nine other projects through their more than 650 centres located in various ICAR Institutes/Central and State Agricultural Universities (CAU/SAUs) across different agro-ecological regions. The mandate of AICRPs/AINPs is 'Development, multi-location evaluation and dissemination of technologies to enhance the productivity and profitability of field crops on an ecologically and economically sustainable basis for the food and nutritional security of the nation' and these operate on the following objectives:

- Generation and evaluation of new genetic material in multi-location trials to identify genotypes with broad and specific adaptation.
- Development, evaluation and validation of crop management technologies for sustainable production and ensuring protection from biotic and abiotic stresses.
- Pre-breeding and trait discovery for improving crops using diverse germplasm resources
- Varietal maintenance and seed production.
- Share experience, knowledge and genetic material among the stakeholders working in different parts of the country.

In addition to the Crop Science Division Institutes, Institutes and programmes under Natural Resource Management Division are also equally contributing towards development of varieties and management technologies for higher productivity under water deficit/ less water availability conditions and help in saving the ground water. These Institutes include ICAR-National Institute for Abiotic Stress Management (NIASM), Baramati (Maharashtra) and ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad (Telangana). The project entitled "National Innovations for Climate Resilient Agriculture" (NICRA) under ICAR-CRIDA is exclusively involved in development of water efficient varieties and management technologies."

1.8 On being asked about the Institutes/Organizations, other than that of ICAR and DARE, engaged in development of water efficient variety of seeds to save groundwater, the Department stated:

"The institutions other than ICAR and DARE engaged in development of water efficient variety of seeds to save ground water the National Agricultural Research System (NARS) partners like State Agriculture Universities (SAUs) located across agro-climatic zones in India, Central Agricultural Universities (CAUs) which undertake the research under the aegis of ICAR through the All India Coordinated Research Project Centres. Other than the NARS the international organizations viz., International Centre for Agricultural Research in Dry Areas (ICARDA (chickpea, lentil), International Crop Research Institute for Semi Arid Tropics (ICRISAT (pigeonpea), WorldVeg (Mungbean, blackgram), International Rice Research institute (IRRI) under AGGRi Alliance project are engaged in development of rice water efficient varieties. A few private companies also have their independent Research and Development programmes for development of water efficient varieties."

1.9 When the Committee asked whether the Institutions and schemes of the Department for developing water efficient variety of seeds are catering to the requirements of all agro-climatic zones of the country, the Department stated:

"Yes, the varietal testing is done on Zonal and State Basis under the All India Coordinated Research Projects of different crops. The AICRPs help in identification of site specific varieties technologies through its multilocation testing protocol across the zones. ICAR is mandated for the production and supply of breeder of varieties developed through various crop based AICRPs to the different public and private seed production agencies. The AICRP on Seed (Crops) is coordinating the production of breeder seeds of the varieties developed by different Institutes/ SAUs/ CAUs through its 68 breeder seed production centres (BSPCs) located across 27 states and UTs covering diverse agro-climatic zones. The state-wise distribution of BSPCs is given below:

S. No.	State	Centre
1	Assam (1)	AAU, Jorhat
2	Andhra Pradesh (1)	ANGRAU, Guntur
3	Andaman & Nicobar Islands (1)	ICAR-CIARI, Port Blair
4	Bihar (2)	BAU, Sabour; RPCAU, Pusa
5	Chhattisgarh (1)	IGKV, Raipur
6	Delhi (1)	ICAR-IARI, New Delhi
7	Goa (1)	ICAR-CCARI, Goa
8	Gujarat (5)	AAU, Anand; SDAU, SK Nagar; NAU, Navsari; JAU, Junagadh; ICAR-IIGR, Junagadh
9	Haryana (2)	CCSHAU, Hisar; ICAR-IIWBR, Karnal
10	Himachal Pradesh (1)	CSKHPKV, Palampur
11	Jammu & Kashmir (2)	SKUAST, Srinagar; SKUAST, Jammu

12	Jharkhand (2)	BAU, Ranchi; ICAR-IARI, Jharkhand
13	Karnataka (4)	UAS, Bangalore; UAS, Dharwad; UAS, Raichur; UAHS, Shimogga
14	Kerala (1)	KAU, Trissur
15	Madhya Pradesh (3)	JNKVV, Jabalpur; RVSKVV, Gwalior; ICAR-NSRI, Indore
16	Maharashtra (6)	VNMKV, Parbhani; MPKV, Rahuri; PDKV, Akola; KKV, Dapoli; VSI, Pune; ICAR-CICR, Nagpur
17	Manipur (1)	CAU, Imphal
18	Meghalaya (1)	ICAR RC NEH, Barapani
19	Odisha (2)	OUAT, Bhubaneswar; ICAR-CRRI, Cuttack
20	Punjab (2)	PAU, Ludhiana; ICAR-IIMR, Ludhiana
21	Puducherry (1)	PAJANCOA&RI, Karaikal
22	Rajasthan (6)	AU, Kota; SKRAU, Bikaner; SKNAU, Jobner; MPUAT, Udaipur; ICAR-CAZRI, Jodhpur; ICAR-IIRMR, Bharatpur
23	Telangana (4)	PJTSAU, Hyderabad; ICAR-IIRR, Hyderabad; ICAR-IIMR, Hyderabad; ICAR-IIOR, Hyderabad
24	Tamil Nadu (2)	TNAU, Coimbatore; ICAR-SBI, Coimbatore
25	Uttar Pradesh (10)	NDUAT, Faizabad; CSAUAT, Kanpur; SVPUAT, Meerut; BUAT, Banda; BHU, Varanasi; RLBCAU, Jhansi; ICAR-NISST, Mau; ICAR-IGFRI, Jhansi; ICAR-ISRI, Lucknow; ICAR-IIPR, Kanpur
26	Uttarakhand (2)	GBPUAT, Pantnagar; ICAR- VPKAS, Almora
27	West Bengal (3)	BCKV, Nadia; UBKV, Pundibari; ICAR-CRIJAF, Barrackpore”

C. TARGETS AND ACHIEVEMENTS

1.10 Development of varieties is a continuous process and various water efficient varieties have been produced over the years. Keeping the changing climate and scarcity of irrigation water, degrading soils, the focus has been on development of varieties suitable for such conditions. The target was to develop at least 80% varieties having one or more traits for biotic/ abiotic stress tolerance to face the climate change impact. Likewise, out of the total varieties, the focus was to breed 15-20% percent varieties as water efficient/ drought tolerant and at least 7-8% of total varieties were targeted to have tolerance to extreme water deficit conditions. The overall target set have been achieved as out of total 3053 varieties of 85 crops released since 2014, 2813 varieties (92%) are climate resilient, 1064 varieties (35%) are drought tolerant and 328 varieties (10.7%) are extremely drought tolerant. The details of the water efficient varieties developed during the last 10 years (2014 – 2024) and current year (2025) are as follows:

During the last 10 years (2014-2024) and current year (2025) a total of **328 drought tolerant** / less water or rainfall requiring varieties have been released and notified, out of which **195 are of Cereals** comprising 103 of Rice, 30 of Wheat, 22 of Maize, 9 of Sorghum, 13 of Pearl Millet, 3 of Little Millet, 5 of Kodo Millet, 1 each of Barnyard Millet and Foxtail Millet, 8 of Finger Millet; **25 are of Oilseeds** comprising 5 of Soybean, 6 of Groundnut, 2 each of Sesame and Toria, 1 each of Niger, Taramira and Linseed and 7 of Indian Mustard; **43 are of Pulses** comprising 4 of Urd bean, 2 each of Moong bean, Horse gram, Moth bean and Lentil, 3 of Cowpea, 14 of Pigeon pea, 9 of Chickpea, 1 each of Cluster bean, Faba bean, Rajmash, Lathyrus and Winged bean; **14 are of Fibre** comprising 11 of Cotton, 1 of Jute and 2 of Mesta Roselle; **16 are of Forage crops** comprising 3 of Forage Pearl Millet, 2 each of Forage Sorghum and Rice bean, 1 each of Forage Maize, Forage Cowpea, Napier Bajra Hybrid, Fescue grass, Marvel grass, Anjan grass, Forage Sewan grass, Guinea grass and Seteria grass; **33 are of Sugarcane**; **2 are of Other crops** comprising 1 each of Kalingda and Grain Amaranthus.

Further, during the same time, **1064 rainfed** varieties have been released and notified, comprising of **391 of Cereals** which include 128 varieties of Rice, 66 of Maize, 50 of Sorghum, and 41 of Pearl Millet. Among the millets, 14 varieties of Little Millet, 5 each of Proso Millet and Barnyard Millet, 8 of Kodo Millet, 31 of Finger Millet, 11 of Foxtail Millet, 27 of Wheat and 5 of Barley; **162 of Fibres** which includes 61 varieties of Cotton and 70 varieties of Bt Cotton/Hybrids, 13 varieties of Jute, 9 of Mesta (Roselle), 6 of Mesta (Kenaf), 2 of Sunhemp, and 1 variety of Ramie; **69 of Forages** which include 18 varieties of Forage Sorghum, 14 of Forage Pearl Millet, 7 of Forage Cowpea, and 3 each of Forage Maize and Guinea Grass, 4 each of Marvel Grass and Anjan Grass, 2 each of Dhaman Grass, Rice Bean, and Forage Sewan Grass, and one variety each of Setaria Grass, Black Kolukattai Grass, Jawahar Vicia, Bundel Bajra *Squamulatum* hybrid, Aparajita, Dinanath Grass, Oats, Lucerne, Hedge Lucerne (*Desmentus virgatus*), and Berseem; **219 of Oilseeds include 69** varieties of Soybean, 42 of Groundnut, 28 of Linseed, and 18 of Safflower, 14 of Sunflower, 13 of Indian Mustard, 8 each of Sesame and Niger, and 7 each of Castor and Toria. Additionally, 3 varieties of Taramira and one variety each of Yellow Sarson and Brown Sarson; **16 of Potential Crops (Other Crops)** which include 6 varieties of Grain Amaranth, 5 of Tobacco, and 2 of Kalingada. Additionally, one variety each of Buckwheat, Asalio, and Winged Bean; **203 of Pulses** which include 48 varieties of Pigeon Pea/Red Gram, 37 of

Chickpea, 31 of Lentil, and 28 of Field Pea, 17 of Urdbean/Blackgram, 11 of Green Gram/Mungbean, 10 of Cowpea (Grain), and 5 of Horse Gram, 4 varieties of Moth Bean, 3 of Pigeon Pea, 2 each of Cowpea, Cluster Bean (Guar), and Lathyrus, and 1 variety each of Rajmash/French Bean, Faba Bean, and Indian Bean and **4 of Sugarcane.**

1.11 On being asked about steps taken/being taken by the Department to further strengthen/broad base the research for developing water efficient variety of seeds to save ground water, the Department stated:

"In varietal development programme of each crop, emphasis has been made to develop early maturing and moisture stress tolerant varieties. Several steps have been taken to strengthen the research on water efficient crop like import of new germplasm, use of exotic and wild germplasm for development in new varieties, use of molecular markers and precision breeding in development of drought tolerant and early maturing varieties and creation of phenotyping facility for research on water efficient crop varieties. Brief about the efforts made is presented as under:

- **Import of elite germplasm:** Germplasm with desired traits for low moisture tolerance and enhanced water use efficiency have been imported in different crops with special emphasis to oilseeds and pulses which are being used in the breeding programme.
- **Establishment of Phenotyping Faculties for Drought and Heat Screening:** State of art facilities for screening the various genotypes in field crops have been established at ICAR-Indian Agricultural Research Institute, New Delhi and ICAR-National Institute for Abiotic Stress management, Baramati.
- **Establishment of rainout shelters for screening the genotypes for drought tolerance:** Crop-wise rainout shelters for screening the germplasm and advanced breeding lines in different crops have been established. Rainout shelters have been established at ICAR-Indian Agricultural Research Institute, New Delhi for multiple crops and one for pulses; ICAR-Sugarcane Breeding Institute Regional Station, Karnal for sugarcane, ICAR-IIPR, Kanpur for Pulses; ICAR Indian Institute of Groundnut Research, Regional Station at Anantpur.
- **Various drought tolerant advance lines/ varieties developed in different crops:** Two entries of maize viz., IIMR23K-18 and CAH2313 have been identified as drought

and heat tolerant under combined heat and drought stress trial of one year, however needs validation with another year of testing. In case of oilseeds, focused breeding programs have led to development of short-duration, drought- and heat-tolerant oilseed varieties like KBSH-53 (sunflower), PBNS-12 (safflower), JN-105 (niger), Padmini (linseed), DCH-177 (castor), and RT-351 (sesame).

- **Special programmes for breeding water efficient varieties:** In case of wheat and barley, varietal testing trials for restricted irrigation conditions are conducted in each zone. After multi-year multilocation testing new water use efficient wheat and barley varieties are identified and recommended for cultivation. In case of sugarcane, fifteen pre-breeding materials have been developed under an institute project entitled "Development of Multiparent Advanced Generation Inter- Cross (MAGIC) population for drought tolerance in sugarcane". These pre-breeding materials are used as parents for developing drought tolerant varieties. Groundnut genotypes that exhibit superior performance under drought conditions and possess high WUE are being routinely screened under a rainout shelter at the Institute's regional station in Anantapur. Regular crossing programs are conducted to develop HYVs of groundnut with enhanced WUE. As a result, advanced breeding lines viz. PBSA 11061 and PBSA 11010 are under coordinated trial/ ready for state release.

- **Registration of drought tolerant/ water efficient donors with Committee for Plant Germplasm Registration Committee:** Donors with high drought tolerance viz. NRCG 10666, NRCG 14082, NRCG 15363, NRCG 16508, NRCG 14963, NRCG 13036, NRCG 13383, NRCG 13516 are identified following screening of 2000 germplasm accessions for over 3 seasons. Registration of these with National Bureau of Plant Genetic Resources (NBPGR) as genetic stocks is in progress. In cotton, a cotton drought tolerant genetic stock IC0587405 has been registered with ICAR-NBPGR. In case of pulses, the projects with the objective of developing pulses varieties suitable for rainfed cultivation are already operating and majority of the varieties are having traits for water use efficiency. Under multilocation trials for evaluation of candidate entries of Spring and Summer mungbean, urdbean, and rainfed trials of chickpea have been taken up to develop specific varieties which can grow well in these ecologies.

- **Special efforts for development of water efficient varieties in rice:** Varietal development programmes in rice now give priority to traits such as drought tolerance, early maturity, aerobic adaptation, and suitability to Direct Seeded Rice (DSR). In All India Coordinated Research Project (AICRP) on Rice strengthened multi-location testing for breeding lines under rainfed system for identification of water-efficient rice varieties in drought-prone and upland ecologies have been taken-up. Support for the Development of Suitable Agronomic Packages for Direct Seeded Rice (DSR) to reduce water and labour, Alternate Wetting and Drying (AWD) to reduce irrigation frequency. The Department is fostering partnerships with national and international agencies, including IRRI, AGGRi Alliance (Accelerated Genetic Gain in Rice Alliance), and projects funded by other international agencies. Further, a dedicated research center under the ICAR-Central Rice Research Institute, Cuttack viz., Central Rainfed Upland Rice Research Station (CRURRS), Hazaribag, specifically focusing on rainfed and water-limited ecosystems."

D. Water Efficient Seed Mission

1.12 When the Committee categorically asked whether the Department agree with the view that there is a need to have a long term 'Water Efficient Seeds Mission' for development of water efficient varieties of seeds of various field crops, the Department stated:

"Under the recently announced National Mission of High Yielding Seeds development of water efficient varieties and their further upscaling will be one objective. However, a long-term 'Water Efficient Seeds Mission' with special emphasis on crops with high water use efficiency (WUE) or rainfed crops will be more impactful which should have focus on Precision Farming practices to enhance water use efficiency.

Such Mission aligned with other national priorities would provide a focused framework to address the challenges of rainfed agriculture, promote the conservation of groundwater resources, and support scientific innovations in breeding drought-resilient and water-efficient groundnut genotypes. Further, by mobilizing targeted manpower, sustained funding, and institutional support, the Mission will play a transformative role in ensuring sustainable crop production under water-deficit conditions specifically in case of oilseeds and pulses.”

E. Genetic Improvement by Integrating Modern Tools

1.13 Keeping the gravity of the problem in view, the programmes of breeding climate resilient varieties have been reorganized. As maximum unstability in yield is generally due to less or non-availability of water, hence breeding the less water requirement crop varieties and production of their seed is the focus of the Crop Improvement programmes. Among the 63 programmes operating under Crop Improvement the project entitled, “Enhancing climate resilience and ensuring food security with genome editing tool” with a total budget of Rs. 310 crores during 2023-24 to 2025-26 is based on the cutting edge latest biotechnological tools where 24 crops have been included for improvement in this programme.”

1.14 The details of the program on **“Enhancing climate resilience and ensuring food security with genome editing tool”**, as submitted by the Department, are as under:

“In the 2023-24 budget, the Government of India allocated ₹500 crores for genome editing in agriculture. The 500 crores was allocated to Crop Science (300) and Natural Resource management (10 crores), Horticulture (120 crores), Agricultural Engineering (10 crores), Fisheries (20 Crores), and Animal Sciences (40 crores) SMDs. With the 310 crores allocated to Crop Science and Natural Resource management SMDs, a Sub-Scheme on **“Enhancing climate resilience and ensuring food security with genome editing tools”** with a budget of Rupees 310.00 Crores under the EFC Scheme on **“Crop Science for Food and Nutritional Security”** was approved in 2023. This sub-scheme is being coordinated by ICAR-Indian Agricultural Research Institute, New Delhi as Lead Centre, 23 ICAR Institutes as partner Institutes. Under this project genome editing of 24 crops is being carried out. These include 7 cereals, 6 pulses, 6 oilseeds, 3 fibre crops, sugarcane and tobacco. In addition, genome editing of four insect pests namely pink bollworm (*Pectinophora gossypiella*), fall armyworm (*Spodoptera frugiperda*), cotton leafworm (*Spodoptera litura*), Fruit fly (*Bactrocera zonata*) is being carried out. The details of crops and traits improved through genome editing are given below:

Crop	Traits
Rice	Drought and salt tolerance, Herbicide Tolerance, dwarfing, Ideal Plant Type, lodging resistance, shattering resistance, grain number, early flowering, Nitrogen Use Efficiency (NUE), WUE, Bacterial Blight Resistance, Blast resistance, Southern rice black-streaked dwarf virus, Nematode resistance, Fe Biofortification, Low Phytate, male sterility (for 2 line hybrid system), Clonal rice seeds production, yield
Wheat	NUE, Phosphorus Use Efficiency, Heat stress tolerance, Salt tolerance, Resistant starch, Biofortification of Fe and Zn
Maize	Haploid induction, High planting density, BLSB resistance, low-glycemic maize, Kernel number per cob
Sorghum	Herbicide tolerance
Pearl millet	Shelf life, Grain yield
Finger millet	Drought stress tolerance, Grain yield
Foxtail millet	Grain yield
Mustard	Early flowering, Improved plant architecture, shattering resistance, tolerance to Sclerotinia rot, Aphid resistance, Orobanche resistance, Low erucic acid, High oleic acid, Improved oil yield, Seed number per siliqua, seed yield
Soybean	Photoperiod insensitivity, photosynthesis, Insect resistance, Yellow Mosaic Disease (YMD) resistance, resistance to pod shattering, Drought tolerance, Water logging tolerance, Salinity stress tolerance, oil yield, seed yield
Groundnut	Seed RFOs, High oleic acid, low phytic acid
Sesame	Determinate habit, Seed no. per capsule, Non-shattering, High oleic acid content, oil content, seed yield

Sunflower	High oleic acid content, Powdery Mildew Resistance
Castor	Low ricin content
Linseed	Early flowering, 1000 seed weight
Chickpea	Drought, Fusarium wilt
Chickpea	Nodulation, Productivity
Pigeonpea	High yield
Urd bean	Tolerance to MVYV and UCLV, High yield
Grasspea	Low Lathyrus toxin, specifically β-N-oxalyl-L-α,β-diaminopropionic acid (β-ODAP)
Lentil	High yield
Cowpea	High biomass
Sugarcane	Drought tolerance, high sucrose content, flowering resistance, tillering, red rot resistance, Virus resistance, reduced lignin, high biomass yield
Cotton	Compact architecture, determinate sympodial shoots, Fibre quality, Seed oil quality, Tolerant to premature Square and boll shedding, Resistance to short-day flowering, Improve fibre quality (reduced lignin & pectin in bast fibre), Boll yield
Jute	Herbicide Tolerance,
Flax	Haploid Induction, Heat Tolerance
Tobacco	Low Nicotine content”

1.15 On being asked, the Department furnished a detailed note on various aspects of genome editing details of which are as under:

- **“Mutations are the source of evolution, crop domestication and crop improvement:**

Mutation is a small change in the nucleotide sequence of a genome (DNA). Mutations can be grouped in to 1) point mutation where one nucleotide is replaced with another or insertion or deletion of one or a few nucleotides; and 2) Chromosomal Mutations. Point mutations can be i) silent due to the redundancy of the genetic code, ii) mis-sense leading to a single amino acid in the protein, iii) Nonsense Mutations which create a premature stop codon causing a truncated or longer non-functional protein, and iv) Frameshift Mutations due to insertion or deletion of nucleotides that changes the reading frame of the gene leading to significant changes in the amino acid sequence of the protein. Chromosomal mutations can be i) deletion of a segment of a chromosome, ii) duplication of a segment of a chromosome, iii) inversion of a segment of a chromosome, and iv) translocations of a segment of a chromosome to a non-homologous chromosome.

Mutations occur naturally which are called as spontaneous mutations. Mutations can be induced by chemical or physical or biological mutagenic agents. Spontaneous mutations occur naturally due to errors during DNA replication or spontaneous DNA damage. The spontaneous mutations are the primary source of genetic variation within populations. The frequency of spontaneous mutation is very low (10^{-6}). The spontaneous mutations led to evolution and domestication of crops plants, and are used in breeding of modern crop varieties. Two major examples of use of spontaneous mutations in crop breeding are the semi-dwarf 1 (sd1) mutation, and reduced height 1 (rht1) mutation in rice and wheat, respectively, which brought green revolution and food security to the world.

Since the frequency of spontaneous mutations are very low, scientists have discovered method of using x-rays as mutagenic agent to artificially induced mutations about 100 years ago. Later chemical and physical mutagenic agents have been discovered, and are being used over the past 75 years to develop and release crops varieties. The limitations/demerits of physical and chemical mutagenic agents include rare with reference to specific target locus of a gene, and rare desirable mutations, and creation of large number of non-targeted mutations. Thus, getting a desirable mutant is a rare chance. Hence, scientists were continuously making efforts to develop methods for precision mutagenesis.

Genome editing is a precision mutagenesis method to create mutation at a target locus of a gene with very high frequency. Instead of non-targeted mutation created by physical or chemical mutagenic agents, genome editing uses biological mutagenic agents (gRNA and Cas enzyme) to create targeted mutation in a gene.

Induced mutagenic agents such as physical or chemical agents create DNA damage at several locations on the genome, while genome editing agents create mutations on the location which is complementary to the gRNA and thus at one or few locations. The DNA damage created by physical, chemical and genome editing reagents are repaired by native cellular mechanisms, which often lead to creation of mutation at DNA locus where the DNA damage was caused by the mutagenic agent. Therefore, similar to conventional physical or chemical mutation methods, mutations are created by genome editing in the native gene in the native location on the genome.

Globally, over 3400 crop varieties have been released through mutation breeding using physical or chemical mutagenic agents, and about 346 varieties have been released in India since 1948 (https://nucleus.iaea.org/sites/mvd/SitePages/Home.aspx). Starting from the domestication, selection, and recombination breeding, all the crops that we cultivate today are the results of either spontaneous or induced mutations, and there is no biosafety and environmental safety concern.

- **Method of creation of mutations using Genome Editing:**

In genome editing method, for creating mutation (editing) in the target gene, an exogenous DNA coding for gRNA and Cas enzyme are used. Similar to the method of development of transgenic GM crop, recombinant DNA technology and genetic transformation are used in genome editing to create mutation. A DNA vector (exogenous DNA) consisting of exogenous DNA coding for gRNA and Cas enzyme, and a gene coding for as selection marker such as hygromycin resistance (*NPTII*) is used for genetic transformation of crop plant. In the transformed plant, the "introduced exogenous DNA (vector)" is integrated in to the host plant genome. In the first generation of transformed plants, the gRNA and Cas enzyme express from the introduced exogenous DNA. The gRNA-Cas enzyme complex specifically binds to target locus on the host plant genome, and Cas enzyme makes a precise cut (DNA double strand break) on the host plant genome DNA at the targeted location in the gene.

Depending upon the method by which the DNA damage caused by the mutagenic agent is repaired, the mutations are classified as Site Directed Nuclease 1 (SDN 1), SDN2 and SDN3.

a) Site-Directed Nuclease-1(SDN1) mutation: Involves the unguided repair of a targeted double-strand DNA break (DSB) by natural endogenous DNA repair mechanism of the host organism such as nonhomologous end joining. The spontaneous repair of this break can lead to a mutation causing gene silencing, gene knock-out or a change in the activity of a gene. The plant produced will be free from foreign DNA. These mutations can be base substitution/indels/deletions including large deletions or structural changes. These resultant mutations are comparable to those occurring in nature, obtained through conventional mutagenic treatments or natural variation found in primary/secondary gene pool.

b) Site-Directed Nuclease-2 (SDN2) Mutation: Involves a template-guided repair of a targeted DSB using an externally supplied donor sequence. The donor carries one or several small mutations flanked by two sequences matching both ends of the DSB, and is thus recognised as a repair template, allowing the introduction of the mutation(s) at the target site. The resultant mutant carries modified sequence, leading to altered expression profile of the gene and/or altered activity of the encoded protein/RNA. Thus, the edited version could be regarded as allelic form comparable to those available in primary/secondary gene pool.

c) Site-Directed Nuclease-3 (SDN3) Mutation: A foreign DNA is provided as repair template, foreign genes can be precisely inserted in the safe harbor loci in the genome. The SDN3 mutants will contain foreign DNA. Hence these are considered as GMOs.

In the first generation of mutants created by genome editing, the plant will have the introduced exogenous DNA (gRNA, Cas9 and selection marker gene), and the desirable mutation. In the subsequent generations, plants with the desired mutant is segregated from the plants containing introduced exogenous DNA. Plant containing introduced exogenous DNA are discarded and destroyed, and plants containing only desired mutations with no introduced exogenous DNA are carried forward. Thus, the mutants developed by SDN1 and SDN2 methods of genome editing are indistinguishable from natural/induced mutants, free from transgene (introduced exogenous DNA), and thus are not Genetically Modified Organisms (GMOs) or LMOs (Non-Living modified organisms). Hence, the final varieties obtained from genome editing do not elicit any biosafety and environmental safety concerns. Spontaneous mutations, and induced mutations developed by conventional physical/chemical mutation techniques and those developed by genome editing techniques have the same effect on the genes, and organisms. Only native gene is mutated by genome editing as in case of the conventional mutation breeding method. Hence, there is no biosafety risk, environmental risk and ecological risk is associated with varieties developed by genome editing.

- **Regulation of genome edited crops in India:**

Several countries such as USA, Japan, UK, Philippines, Australia, Brazil, Argentina, Kenya, Nigeria, Indonesia, Canada, Columbia, etc., have already exempted gene edited plants developed by SDN1 and SDN2, and they are considered as plant varieties developed by any other breeding tools. On March 14, 2025, European Union (EU) Member States agreed in the European Council on a common position to move forward with development of new rules plants generated using modern precision breeding methods that, in the EU, are collectively termed "new genomic techniques" (NGTs). The European Union is also working constructively to develop rational regulation for genome edited crops. Already genome edited soybean crop in USA, tomato and fishes in Japan are commercially cultivated and consumed.

In India, the biosafety and environmental safety of GMOs/LMOs are regulated under Rules 1989 of Environment (Protection) Act of 1986 of Government of India. Since, in the first step of development of genome edited plants, recombinant DNA technology is used, development of genome edited mutant, till the exogenous introduced DNA is removed, is regulated under Rules 1989 of Environment (Protection) Act of 1986 of Government of India.

"Draft Genome Edited Organisms: Regulatory Framework and Guidelines for Risk Assessment" in January 2020 was published by DBT for different ministries, stake holders and public consultation. Based on the inputs received from various stakeholders, ministries and national science academies, Ministry of Environment, forest and Climate Change, Government of India published OM on 30th March 2022, exempting genome edited crop free from exogenous introduced DNA from GM regulation rules (Rules 7-11 of Rules 1989). Further, RCGM, DBT, GoI published “Guidelines for safety assessment of genome edited plants 2022” and “SOPs for regulatory review of genome edited plants” in 2022 following the International standard practice followed in other countries.

For conduction of research and development using genome editing, approval of Institutional Biosafety Committee (IBSC) needs to be obtained by the developer scientist. The details of gene, vector, crop, scientists involved etc., are uploaded in Indian Biosafety Knowledge Portal (IBKP), and the IBSC discusses all the details and gives approval. The proceedings of IBSC is submitted to Review Committee on Genetic Manipulation (RCGM) for noting of the proceedings.

The work on development of genome editing mutants is carried out under biosafety Lab, transgenic greenhouse and nethouse contained conditions. Once the mutation is confirmed in the transformant plant, the exogenous introduced DNA is segregated out from the mutation in the subsequent generation by selfing or backcrossing. Developer select the desirable mutant plant with no undesirable phenotype. Then the developer confirms the absence of exogenous introduced DNA in the genome edited mutant by using the protocols given in the “SOPs for regulatory review of genome edited plants 2022”.

Under this protocol, the developer generate data to confirm that

1) Stability of the mutation across generations. DNA sequence data of mutant across generation are obtained for the mutant locus to confirm stable inheritance of the mutation.

2) Absence of selection marker such as antibiotic resistance gene: Phenotypic analysis of parent genotype (Wild Type, WT), primary transformant containing introduced exogenous DNA, and the mutant free from exogenous introduced DNA are grown on the antibiotic medium, and the sensitivity equivalence of WT and mutant is established.

3) Overlapping PCR analysis to show the absence of introduced exogenous DNA: As per the overlapping PCR method given in the “SOPs for regulatory review of genome edited plants 2022”, PCR primers are designed to detect any vector fragment that may be integrated in to the host genome, and PCR was carried out to demonstrate the absence of any vector fragment in the mutant genomic DNA.

Based on these data, the IBSC exempts the SDN1 and SDN2 mutants free of introduced exogenous DNA from Rules 7-11 (inclusive of 7 and 11) of Rules 1989. The detailed dossier is submitted to RCGM along with the proceedings of IBSC. Then the RCGM deliberate on the dossier and ascertain that all procedures given in the SoPs for exemption of genome edited mutant free of introduced exogenous DNA is followed, and the mutant is free from introduced exogenous DNA. Then the RCGM confirms the exemption given by IBSC. Then the genome edited mutant is treated equivalent to that of mutant obtained by conventional method, and tested in field trials of AICRPs for identification as variety for cultivation by farmers."

1.16 On being asked by the Committee whether the crops developed through 'genome editing' tool can be considered as Conventional Variety of crops or Genetically Modified (GM) crops, the Department stated:

"Genome editing is a precision mutagenesis tool. Mutation is a small change in the nucleotide sequence of a genome (DNA). Mutations occur naturally which are called as spontaneous mutations. Mutations can be induced by chemical or physical or biological mutagenic agents. Spontaneous mutations occur naturally due to errors during DNA replication or spontaneous DNA damage. The spontaneous mutations led to evolution and domestication of crops plants, and are used in breeding of modern crop varieties. Two major examples of use of spontaneous mutations in crop breeding are the semi-dwarf 1 (sd1) mutation, and reduced height 1 (rht1) mutation in rice and wheat, respectively, which brought green revolution and food security to the world. In 1927, induced mutations with X-rays was discovered. Later chemical and physical mutagenic agents have been discovered, and are being used over the past 75 years to develop and release about crops varieties.

Developing a desirable mutant with physical and chemical mutagenic agents is a rare chance. Hence, scientists developed Genome editing, a precision mutagenesis method to create mutation at a target locus of a gene with very high frequency. Instead of non-targeted mutation created by physical or chemical mutagenic agents, genome editing uses biological mutagenic agents (gRNA and Cas enzyme) to create targeted mutation in a gene.

In both GM Crops and Genome editing, a DNA vector (exogenous introduced DNA) is used for genetic transformation. In GM crop, the vector (exogenous introduced DNA) has a gene for desirable trait (for example, *Cry1Ac* gene conferring insect resistance) and a gene for selection of transgenic plant (for example, *NPTII* gene conferring hygromycin antibiotic resistance). Thus, in GM crops, exogenous introduced DNA is stably integrated in to plant genome and confers trait of economic importance.

In case of genome editing, a DNA vector (exogenous introduced DNA) consisting of gene cassette for the gRNAs, Cas enzyme and selection marker is introduced in to the parent variety through genetic transformation. After mutagenesis in the first or second generation of the transgenic plant, the exogenous introduced DNA is segregated out, and only the plants with a desirable mutation in the target locus is carried forward to develop a variety. Thus, genome edited variety does not contain any foreign gene, and has only desirable mutation. The difference between GM crop and genome edited mutant are given in the following Table:

Difference between GM crop and Genome edited mutant crop

	GM Crops	**Genome Editing**
1. Vector DNA or Foreign DNA (introduced Exogenous DNA) contains	Gene that confers trait of interest (for examples, *Cry1Ac* gene conferring insect resistance) and selection marker gene	Genes coding mutagen (for sgRNA, Cas9 enzyme) and selection marker
2. Integration of introduced Exogenous DNA	Stably integrated at random in the host plant genome	Stably integrated at random in the host plant genome
3. Function of the introduced Exogenous DNA	Integrated transgene is transcribed and the transcribed RNA or translated protein confers the trait of interest.	The transcribed sgRNA and Cas9 protein act at the desired specific locus/loci to create the mutation.
4. Trait of economic	The introduced Exogenous DNA	The mutation in the native gene of the host plant

importance is conferred by		
5. Presence of introduced Exogenous DNA in the commercial variety	The commercial variety developed will have the stably integrated transgene.	Transgene and desired mutant loci are segregated, plants with introduced Exogenous DNA are destroyed, and the mutant is free from introduced Exogenous DNA
6. Molecular detection	By using molecular techniques, GM crops can be identified and distinguished from parent variety	By using molecular technique, the mutant cannot be distinguished from same mutant that can arise from spontaneous or induced mutation breeding.

The mutant plant developed through 'genome editing' tools is considered as a conventional variety of crops as genome editing creates mutation in the native gene similar to that of spontaneous or induced mutagenic agent."

1.17 When the Committee asked whether development of seeds through 'genome-editing' is permissible in India as Genetically Modified (GM) crops are banned, the Department stated:

"Yes. Development of seeds through 'genome-editing' is permissible in India. Ministry of Environment, Forest and Climate Change issued an Office Memorandum on 30th March 2022 for exemption of SDN-1 and SDN-2 categories of Genome Edited Plants which are free of exogenous introduced DNA from the provisions of Rules 7 to 11 (both inclusive) of the Rules 1989 of EPA, 1986.

GM Crops are not banned in India. Bt cotton is a GM crop approved for cultivation in 2002 by the Genetic Engineering Appraisal Committee (GEAC) of Ministry of Environment, Forest and Climate Change, Government of India. Since then, it is commercially cultivated in the Country. In 2022-23, the GM Bt cotton was cultivated in about 12.9 million ha in India."

1.18 To the pointed query of the Committee whether the use of scientific tools like genome editing etc. for developing seeds of various crops is a way to bypass the ban on Genetically Modified crops, the Department stated:

"No. The use of scientific tools like genome editing etc. for developing seeds of various crops is not a way to bypass the ban on Genetically Modified crops. The Genetically Modified crops essentially carry a gene from foreign source, while genome edited crops do not have any such foreign genes. Genome edited crops are similar to conventional bred varieties and hence they are not considered as genetically modified crops.

In first step of genome editing, recombinant DNA technology is used and exogenous DNA (sgRNA and Cas9 gene) is introduced in to the host plant. The genes for sgRNA and Cas9 integrate in to the host plant and these genes express, and sgRNA-Cas9 complex create DNA damage at target locus of the gene in the host plant, and when the damaged DNA is repaired by native cellular enzymes, mutations in the target gene are induced. In the subsequent generation, the exogenous introduced DNA containing locus and mutant locus segregate in to different plants. Plants carrying exogenous introduced DNA are discarded. Plants with only desirable mutant but no exogenous introduced DNA is selected.

As per the Ministry of Environment, forest and Climate Change, Government of India OM on 30th March 2022, on exempting genome edited crops free from exogenous introduced DNA from GM regulation rules (Rules 7-11 of Rules 1989), RCGM, DBT, GoI "Guidelines for safety assessment of genome edited plants 2022" and "SOPs for regulatory review of genome edited plants 2022", the developer of the genome edited crops conducts experiments to obtain phenotypic and molecular evidences for the absence of exogenous introduced DNA. These data are submitted to the Institutional Biosafety Committee (IBSC) which examine the application and gives exemption to the genome edited mutants (SDN1 or SDN2 type) free from exogenous introduced DNA. Then the proceedings of IBSC is submitted to Review Committee on Genetic Manipulation (RCGM) for noting of the proceedings. Till this stage the genome edited plants is grown and handled under confined lab/greenhouse/transgenic net house conditions as per the provisions of Rules 1989 of Environment (Protection) Act 1986. Once the proceedings of IBSC on exemption of genome edited mutant is noted by RCGM, IBSC exempts the genome edited mutant, and once exempted, genome edited mutant is considered as variety developed by conventional breeding method. Since genome edited plants do not contain any foreign gene, and mutation is created in the native gene similar to spontaneous/induced mutation, the genome edited crops are non-GM, and is not bypass of GM crops. "

1.19 When the Committee asked whether the Department has analyzed the side effects of the use of tools like genome editing, speed breeding etc. for development of various crops on the health of the consumers, natural resources, biodiversity and environment, the Department stated:

"As the genome editing is induced mutagenesis tools with the use of biological mutagenic agents namely gRNA and Cas enzyme instead of conventional physical (radiation) or chemical mutagenic agents. While conventional mutation breeding is random, probability based, imprecise and uncontrolled, the genome editing process is very precise and targeted. Genome edited varieties are very similar to conventional bred varieties developed through mutation breeding tools. The foreign DNA (introduced exogenous DNA) is removed from the genome edited plants by genetic segregation, and only introduced exogenous DNA free SDN1 and SDN2 mutants developed through CRISPR-Cas genome editing are exempted by IBSC and RCGM.

Since similar to conventional physical or chemical mutation methods, mutations are created by genome editing in the native gene in the native location on the genome, and only introduced exogenous DNA free mutants are permitted for field testing and further release, there is no environmental biosafety or food safety concerns. *Globally, over 3400 crop varieties have been released through mutation breeding using physical or chemical mutagenic agents, and about 346 varieties have been released in India* since 1948 (https://nucleus.iaea.org/sites/mvd/SitePages/Home.aspx). Starting from the domestication, selection, and recombination breeding, all the crops that we cultivate today are the results of either spontaneous or induced mutations, and there is no biosafety and environmental safety concern.

Speed breeding is a method of accelerating the breeding cycle of crops to breed varieties faster. It is done through adjustment of lights, temperature, and other factors affecting crop growth and development. It does not have any side effects on the health of the consumers, natural resources, biodiversity and environment."

1.20 On being asked to provide a detailed note on the potential ill effects and concerns including bio-safety and environmental safety concern related to crops developed through genome editing etc., the Department submitted:

"There are two concerns raised by some people who are against GM crops.

1) Foreign DNA in the mutagenesis process of genome editing

2) Off-target mutations

The use of foreign DNA in the mutagenesis process of genome editing is addressed under Rules 1989 of EPA 1986 in India following the global standards. After thorough analysis and understanding, it has been established that all crop breeding lines developed by the process of genome editing are very much similar to conventional bred varieties developed through mutation breeding tools. Several countries such as USA, Japan, UK, Philippines, Australia, Brazil, Argentina, Kenya, Nigeria, Indonesia, Canada, Columbia, etc., have already exempted gene edited plants developed by SDN1 and SDN2, and they are considered as plant varieties developed by any other breeding tools. Already genome edited soybean crop in USA (from 2019), tomato and fishes in Japan (from 2021) are commercially cultivated and consumed. A "Draft Genome Edited Organisms: Regulatory Framework and Guidelines for Risk Assessment" in January 2020 was published by DBT, Government of India for open consultation from different ministries, stake holders and public. Based on the inputs received from various stakeholders, ministries and national science academies, and a thorough analysis and following the global standards, Ministry of Environment, Forest and Climate Change, Government of India issued an Office Memorandum on 30th March 2022 for the exemption of SDN-1 and SDN-2 categories of Genome Edited Plants which are free of exogenous introduced DNA from the provisions of Rules 7 to 11 (both inclusive) of the Rules 1989 of Environment (Protection) Act, 1986.

The biosafety concern of genome edited plants during the initial phases of development are addressed through existing GM regulation rules (Rules 1989). For conduction of research and development using genome editing, approval of Institutional Biosafety Committee (IBSC) needs to be obtained by the developer scientist. The details of gene, vector, crop, scientists involved etc., are uploaded in Indian Biosafety Knowledge Portal (IBKP), and the

IBSC discusses all the details and gives approval. The proceedings of IBSC is submitted to Review Committee on Genetic Manipulation (RCGM) for noting of the proceedings. The research on development of genome edited plants is carried out in the lab, transgenic greenhouses and net houses with biosafety protection.

Once the mutation is confirmed in the transformant plant, the exogenous introduced DNA is segregated out from the mutation in the subsequent generation by selfing or backcrossing. Developer select the desirable mutant plant with no undesirable phenotype. Then the developer confirms the absence of exogenous introduced DNA in the genome edited mutant by using the protocols given in the “SOPs for regulatory review of genome edited plants 2022” (RCGM, DBT, GoI).

Under this protocol, the developer generate data to confirm that

1) Stability of the mutation across generations. DNA sequence data of mutant across generation are obtained for the mutant locus to confirm stable inheritance of the mutation.

2) Absence of selection marker such as antibiotic resistance gene: Phenotypic analysis of parent genotype (Wild Type, WT), primary transformant containing introduced exogenous DNA, and the mutant free from exogenous introduced DNA are grown on the antibiotic medium, and the sensitivity equivalence of WT and mutant is established.

3) Overlapping PCR analysis to show the absence of introduced exogenous DNA: As per the overlapping PCR method given in the “SOPs for regulatory review of genome edited plants 2022”, PCR primers are designed to detect any vector fragment that may be integrated in to the host genome, and PCR was carried out to demonstrate the absence of any vector fragment in the mutant genomic DNA.

Based on these data, the IBSC exempts the SDN1 and SDN2 mutants free of introduced exogenous DNA from Rules 7-11 (inclusive of 7 and 11) of Rules 1989. The detailed dossier is submitted to RCGM along with the proceedings of IBSC. Then the RCGM deliberate on the dossier and ascertain that all procedures given in the SoPs for exemption of genome edited mutant free of introduced exogenous DNA is followed, and the mutant is free from introduced exogenous DNA. Then the RCGM confirms the exemption given by IBSC. Then the genome edited mutant is treated equivalent to that of mutant obtained by conventional method, and tested in field trials of AICRPs for identification as variety for cultivation by farmers. Therefore, all biosafety procedures are followed till the developer shows that genome edited mutant is equivalent to conventional mutant variety developed by conventional mutagenesis.

The off-target mutation in genome editing are far less as compared with uncontrolled conventional mutagenesis method with physical and chemical mutagenic agents. Any plant with undesirable phenotype are discarded, only plants with desirable phenotypes are selected. This is the procedure followed in conventional mutation breeding, and the same is followed in genome editing. Therefore, no concern of off-target mutation mediated environmental safety and biosafety.

The mutations created through genome editing have the same effect as that of mutation created through conventional mutation breeding. Mutant with desirable traits are being used in agriculture since domestication of crops."

F. Review Mechanism for Assessment

1.21 When the Committee asked whether the present review mechanism for assessment of newly developed seeds of various crops in terms of yield, quality, nutritional value, taste, shelf life, etc. vis-à-vis conventional varieties is adequate or needs further strengthening, the Department stated:

"The current AICRP system of coordinated multilocation trials encompasses various ecologies of different growing regions of the country and it is a robust system of review mechanism of newly developed varieties. It is a unique system in the entire globe and must be continued. The present review mechanism for the assessment of newly developed seed varieties, as implemented through ICAR's coordinated network trials and institutional protocols, has been broadly effective in evaluating key parameters such as yield potential, disease and pest resistance, grain quality, and adaptability across agro-climatic zones. The system ensures that new varieties are rigorously compared with conventional checks under diverse environments, thereby maintaining scientific rigor and transparency in varietal release.

However, with the evolving priorities of agriculture—such as nutritional security, consumer preferences, climate resilience, and sustainability, there is a growing recognition that certain dimensions like nutritional profiling, sensory evaluation, shelf life, and water-use efficiency (in case of drought tolerant varieties) may be supplemented for further strengthening within the existing framework. Besides, the shelf-life parameter of crop commodities should be categorized for various time duration. Therefore, while the current mechanism is robust, there is scope for its continuous refinement to keep pace with future challenges and expectations."

G. Constraints and Problems

1.22 On being asked about the problems in respect of infrastructure, human resources/manpower, finance etc. being faced by the Department in undertaking research for developing water efficient variety of seeds to save ground water, the Department stated:

"The Department is getting regular funds for development of crop varieties under above-described schemes. Three budget announcements have also been made by the Govt. of India during 2025-26 viz., National Mission on High Yielding Seeds, Mission for Cotton Productivity and establishment of 2nd Gene Bank as safety copy, which will also expedite the research for climate resilience as well as water efficient varieties. However, for strengthening more than 65-year-old Institutes, establishing state of art infrastructure including genotyping platforms, inhouse and field phenotyping facilities for precision phenotyping, Tissue culture labs, Speed breeding for rapid generation advancement etc., additional funds will help in faster development of water efficient and climate resilient varieties."

1.23 On being categorically asked whether the funds allocated for research for developing water efficient variety of seeds to save ground water in the last five years were sufficient, the Department stated:

"Yes, the funds provided during past years were sufficient to develop water efficient varieties. Apart from the funds allocated by GoI for the schemes and AICRPs as described above, researchers are also generating grants from various national and internationally funded projects. Moreover, every year funds are increased rationally for taking up the research works."

1.24 On being asked about the expectations of the Department from this Committee in achieving the desired result or to strengthen the research ecosystem for developing water efficient variety of seeds to save ground water, the Department stated:

"The Department expects this Committee to provide strategic guidance and actionable recommendations to strengthen and expand research efforts focused on developing water-efficient crop varieties. The committee may recommend additional funds for strengthening infrastructure of more than 50 years old Institutes for facilitating cutting edge research for developing less water consuming/ drought tolerant varieties of different crops for targeted regions of the country.

AICRPs centres are generally facing difficulty of infrastructure and human resource. Some of the states are supporting the AICRPs properly, however in many states, support is not upto mark. For breeding the water use efficient varieties, good phenotyping facilities along with state of art laboratories are required at some selected AICRP centres across the country, which should be supported by the concerned states for water efficient varieties.

States should be advised to develop State Seed Rolling Plans for ensuring regular supply of certified seeds of high yielding climate resilient varieties within minimum time of their release. It will help in increasing share of seed from the public sector agencies and facilitate the farmers with good quality seed at reasonable cost. Currently truthfully labelled seed of research varieties/ hybrids are marketed openly by private seed producers, where hardly any regulation is applied, which lead to deceiving the farmers. The States and Department of Agriculture and Farmers Welfare may also be involved in such examination."

1.25 The Department further suggested the Committee:

"The alternate crops suggested under the crop diversification plan should be selected from among major crops that have demonstrated success in terms of establishment, productivity, and market returns in the respective block, district, state, or agro-climatic zone. It is essential to strengthen agricultural research in a network mode across diverse agro-climatic regions, with an emphasis on technology development and dissemination tailored to local needs. Further, there is a strong need to enhance research funding through collaborative models, involving multiple stakeholders including research institutions, extension agencies, and farmers. Additionally, evaluation of government water-related schemes should be conducted on scientific and impact-based parameters, ensuring they are farmer-centric and integrated, rather than assessed in isolation."

H. Seed Systems and Accessibility

1.26 Varieties of different field and horticultural crops are developed under the All India Coordinated Research Projects (AICRP). Once a variety is identified during Annual Group Meeting of respective AICRP, some quantity of basic seed is given to National Seed Corporation Ltd. (NSCL) for stock seed production. After release of the variety and its notification in Gazette of India, some quantity of stock seed is used as breeder seed by the NSCL and rest is informed to DAFW for its distribution under mini kits and other demonstrations under National Food Security Mission (NFSM) through State Deptt. of Agriculture at farmers' fields. After notification, the Department of Agriculture of States, NSCL, Public Sector Undertakings (PSUs), Non-Governmental Organizations (NGOs), Farmer Producer Organization (FPOs) and Private Seed Companies (Through Seed Associations) give the indent for breeder seed of variety to Seed Division of Department of Agriculture and Farmers Welfare (DA&FW), Ministry of Agriculture and Farmers Welfare (MoA&FW), Govt. of India. Indents thus received from various public and private seed producing agencies for different varieties from different agro-climatic conditions are compiled in DAFW Seed Division and a meeting of all the indenting agencies and Project Coordinators/Directors of ICAR Institutes is convened by Seed Divisions of DA&W and ICAR. Based on the availability of nucleus stage (seed from which breeder seed will be produced), the variety-wise indents of various agencies are finalized and communicated to the respective Crop Director/ Project Coordinator of ICAR Institutes/AICRPs for further allotment to the producing Units i.e. ICAR Institutes or State/Central Agricultural Universities. AICRP on Seed (Crops) at ICAR-National Institute of Seed Science and Technology, Mau

(Uttar Pradesh) coordinates all the activities of breeder seed production at its 65 centres across the SAUs/CAUs and ICAR Institutes located in different agro-climatic conditions.

The same system is catering the need of varietal development as well as seed supply of different categories of 85 field crop varieties for the different agro-climatic conditions of the country."

1.27 When the Committee asked the Department to provide information (year-wise and crop-wise) about quantum of breeder seed of drought tolerant varieties produced and made available to the various seed producing agencies for downstream multiplication of foundation and certified seeds in last ten years and whether the Department has faced any shortage during these years, the Department stated:

"ICAR is mandated to produce breeder seeds as per the indent of DA&FW, which in turn are converted into foundation, certified and TL seeds in the next generations respectively by seed producing agencies and finally distributed among the farmers. The department has not faced any shortage of breeder seed. However, in few years due to adverse weather conditions like untimely rains, extreme drought, the varietal mismatches have been observed, but indented quantity has been provided with alternative suitable varieties."

1.28 On being asked to provide information about the amount of water efficient seeds of various crops distributed in the last ten years, the Department stated:

"During past 10 years 3,96,217.9 quintals of quality seed of water efficient varieties produced and distributed under AICRP on Seed (Crops) through its centres."

1.29 When the Committee categorically asked whether the production of breeder and certified seeds of water efficient varieties of various crops in the country is sufficient to meet the requirements, the Department stated:

"Over the past 10 years, a total of 1,45,266.2 quintals of breeder seed of water-efficient varieties was produced against an indent of 93,147.8 quintals. The breeder seed production is aligned with the annual demand (indents) placed by various state governments as per their Seed Rolling Plan and also by other public and private seed producing agencies. The quantity produced has remained adequate to support the production of the required quantum of quality seed, as envisaged under the Seed Rolling Plans of the respective states.

To ensure the smooth and timely availability of breeder seed, the Department of Agriculture and Farmers Welfare, in coordination with ICAR, State Agricultural Universities (SAUs), and seed corporations, has initiated several measures. These include district- and agro-climatic zone-wise seed planning, and support through Seed Village programs to ensure quality seed at farmers level. Efforts are also being made to strengthen the seed supply chain through public-private partnerships, enhance seed testing and certification infrastructure, and promote farmer awareness and adoption of improved varieties through training and demonstrations. These steps aim to bridge the gap arising between demand and supply, particularly for water-efficient varieties, and ensure timely and region-specific seed availability to support sustainable and climate-resilient agriculture."

1.30 About the share of Private vs. Non-Private sector in the Seed Chain, the Department stated:

"The share of the private and public sectors in quality seed availability is 71% and 29%, respectively during 2024 (DAC&FW). In India's seed supply chain, the private sector is dominating for high-value crops like cotton, maize, and vegetables. During 2024-25, against the estimated quality seed requirement of 482.00 lakh quintal, 531.50 lakh quintal seed was available across the country out of which 155.20 lakh quintal was supplied by public sector and 376.30 lakh quintal was from private sector agencies. The public sector focusses on staples such as cereals, pulses, and oilseeds. Due to declining indents from the states, the share of public sector National and State level corporation is declining and private sector is supplying the seeds to the states under various schemes. The private sector is indenting the breeder seed of public sector varieties but now a days private sector share in breeder seed indents is also declining.

However, it is observed that the share of varieties and hybrids notified since 2014, the contribution from the public sector is significant. State Agricultural Universities (SAUs) accounted for 60% of the total notifications, followed by ICAR with a 25% share. The private sector contributed the remaining 15%."

1.31 On being asked about the advantages and disadvantages of mandatory use of water efficient varieties of seeds in cultivation of various crops in the country, the Department stated:

"The idea of mandating the use of water-efficient seed varieties carries both advantages and disadvantages, particularly when applied across diverse agro-ecological zones and farming systems. Among the key advantages, these varieties help reduce water demand, making them especially suitable for water-stressed and drought-prone regions. They enhance climate resilience by minimizing the risk of crop failure during dry spells in rainfed areas and generally ensure better yields compared to conventional varieties under limited moisture conditions. Additionally, they support sustainable agricultural intensification by enabling higher productivity without increasing water usage.

However, there are notable challenges associated with mandatory use. Imposing such a mandate may restrict farmers' autonomy in choosing crop varieties best suited to their local conditions or traditional preferences. Ensuring the timely availability of quality seeds at the right time and place would be a major operational challenge, especially for small and marginal farmers who often face affordability and access barriers. Furthermore, widespread adoption of a few select varieties could lead to homogenization of cropping systems, and threatening the survival of locally adapted landraces that have cultural and ecological significance. Enforcing such a mandate could limit farmers' freedom to select varieties tailored to their local agro-climatic conditions, market needs, or traditional preferences. Our existing seed distribution systems needs to be equipped to meet the increased and rapid demand, avoiding seed shortages, ensuring quality, and easy availability.

Therefore, while water-efficient varieties play a vital role in climate adaptation and resource conservation, a policy-driven approach must carefully balance ecological sustainability, farmer autonomy, seed system readiness, and socio-economic realities."

1.32 When the Committee asked about the view of the Department on the issue of making use of water efficient varieties of seeds mandatory in cultivation, the Department stated:

"Acknowledging that varietal adoption is shaped by diverse agro-climatic conditions, cropping patterns, market preferences, and socio-economic factors influence varietal adoption, government always advocated farmers choice and autonomy in selection of crop varieties. However, there is a critical need to create awareness among farmers about the importance of adopting water-efficient varieties as a strategy for climate adaptation and water conservation, which needs to be supported by robust evidence of agronomic and economic benefits derived from such varieties. To facilitate wider adoption, a policy-driven approach should be emphasized comprising targeted awareness campaigns, front-line demonstrations (FLDs), and incentivization mechanisms under schemes like National Food Security Mission (NFSM). Improving seed access in arid and resource-poor regions remains a significant challenge, with many farmers relying heavily on the informal seed sector to meet their seed requirements. In this context, greater emphasis must be placed on supporting research and development, participatory varietal evaluation at farmers' fields, and region-specific extension initiatives. State governments must take proactive steps to promote adoption of climate-resilient, water-efficient varieties by ensuring timely availability and affordability of quality seeds, ultimately empowering farmers to make informed varietal choices. For the favourable environmental conditions also the water efficient seeds with the same level of production as under irrigated conditions are required, which will encourage the adoption of water efficient varieties in all type of ecologies."

1.33 When the Committee asked what percentage of the gross and net cropped areas of the country are under cultivation of water efficient variety of seeds of various crops at present, the Department stated:

"Due to the structural limitations in India's agricultural data systems (Ministry of Agriculture & Farmers' Welfare, Directorate of Economics & Statistics, and State Agriculture Departments), particularly the absence of seed variety-level cropping area statistics, the lack of a standardized definition for water-efficient varieties, and the patchy nature of adoption tracking, it is currently not possible to accurately estimate the percentage of gross and net cropped area under water-efficient varieties of seeds at the national or state level. Water efficient, drought tolerance, and salinity tolerance are desirable traits in seeds, however these are not yet institutionalized as formal statistical categories in seed systems. This makes it difficult get the required data from the agriculture data system. However, with the establishment of Seed Registry (in final stage of implementation) and full implementation of SATHI portal (public system already onboarded), the traceability of water efficient varieties will also be captured, enabling the actual area coverage under such varieties."

1.34 On the issue of Seed Traceability, the Department stated:

"Seed Authenticity Traceability & Holistic Inventory (SATHI) is a national platform implemented by the collaborative efforts of the Ministry of Agriculture and Farmers' Welfare, Government of India with the Technical support of ICAR, and the National Informatics Centre (NIC). It proposes to provide a digital platform that streamlines the holistic management of seed production, quality certification, distribution, and traceability pan-India. This endeavor establishes a National Seed Grid (NSG), integrating all seed stakeholders within a unified national digital platform.

SATHI distinguishes itself as a multi-tenant application capable of accommodating all states within a single project instance, providing an unmatched level of agility to state specific needs while ensuring the core principles remain consistent across the board. This level of adaptability empowers each state to configure the platform according to their unique requirements, offering a tailored experience that creates a perception that SATHI was individually crafted for them. States have the freedom to configure regional specific workflows, terminologies, payment collection mechanisms, as well as specialized data capture and validation strategies, all without compromising the fundamental principle of quality seed production. It is proposed that Standardized QR coded traceable tags on each bag made mandatory for all states which upon scanning will link to SATHI to disseminate information about the seed bag.

The development of the platform has been taken up in 2 phases.

Phase I of the project has been launched which covers onboarding the stakeholders involved in Nucleus to Breeder Seed Production, Breeder to Foundation and Foundation to Certified Seed Production processes to SATHI platform and capture their transactions at the granular level. All the State Governments, Agricultural Universities, National Level Institutions submitting their breeder seed requirement on the portal itself triggering the breeder seed production program. All stakeholders like Seed producer both Private & Governments, Seed Processing Plants, Seed Certification Bodies, State Level Seed Testing Labs & Labs of BSPC, Central Seed Testing Lab, Seed Dealers & Retailers, Seed Hubs, Various Breeder Seed Production Centers are on-boarded on SATHI. The process like Seed Grower Registration, Producer Registration, Plant Registration, direct collection of various fees at bank accounts of respective State Government, Geo-Tagged Field Inspection/Re-Inspection/Supervisory Inspection, Transport Certification issue, Raw Seed Intake by Plant & Processed Stock Entry, Coded Sample Slip Generation, Central Coding Centers, Sample Collection Centers, Test result entry by the labs and release order issue but not limited to this are all done online on SATHI portal.

Being an ambitious project, SATHI was officially launched by the Honorable Minister of Agriculture, Shri. Narendra Singh Tomar, on April 19, 2023.

States on-boarded: Out of 26 State Seed Certification Agencies (SSCAs) in the country all the SSCAs except that of Telangana and Gujarat are on boarded on SATHI. As far as Breeder Seed Production is concerned all the 23 Project Directors of Agricultural and Horticultural Crops concerned are onboarded on SATHI. There are 350 Breeder Seed Production Centers (BSPCs) of ICAR that are also on aborded on SATHI.

Phase II of the project will cover seed Supply chain and Inventory management. The movement of seed bag in supply chain will be recorded in real time to provide end to end traceability and Seed Inventory from Micro to Macro level (Retailer to State and National level). Pilot run of Phase II (supply chain management) has been successfully carried out in two states Maharashtra and Uttarakhand. The other states that are onboarded on Phase-I of SATHI have also started the process of onboarding on SATHI.

Implication and Features of SATHI

- End to end visibility and traceability of seeds throughout their lifecycle.
- Identification of a seed source, variety and quality by backward linkage (traceability) till its origin.
- Automation of manual processes of indent submission, allocation, allotment, lifting etc. for breeder seeds.
- Real time monitoring of demand, allocation and supply of breeder seeds.
- Automation of seed certification system involving registration, inspection, testing, certificate issuance.
- Reduced paper work, easy and effective inspection by use of Mobile/Tablet app for inspection.
- Automated registration of seed dealers, application renewal and license issuance.
- Dashboard based monitoring and MIS for complete track of all activities in seed lifecycle.
- Monitoring of seed inventory and sale to farmers.
- Inspection Mobile App.
- With full implementation, Information on Seed availability at Micro to Macro level (Retailer, state and National level) will be easily available.

OTHER PERIPHERAL MODULEs OF SATHI

- Central Seed Testing Lab (5% Sample Sending and Testing Module).
- Dashboard Development for National Level Seed Producing Agencies.
- Seed Hubs Integration and Monitoring Dashboard.
- Integration With Krishi Mapper and Other Portals.

- Integration of Seednet on Sathi.
- TL Seed Module for Notified Seed.
- CVRC variety proposal submission module.

For onboarding private seed companies on SATHI, the Seeds Division has initiated the work in association of NIC. The Seeds Associations like National Seed Association of India (NSAI) and Federation of Seed Industry of India (FSSI) were involved in the work. The Private Companies and Seed Associations have some apprehensions on which the Seed Division is working."

I. Capacity Building and Awareness Creation

1.35 After release of the variety, it's seed availability to the farmers is one of the important activities. The mechanism adopted/followed by the Department for dissemination/popularization of the water efficient variety of seeds of various crops and water-use-efficient technologies developed – among farmers and other intended beneficiaries so as to minimize consumption/utilization of ground water is as under:

"Availability of breeder seed is the primary step for taking any variety to farmers through the various central and state seed production and extension agencies. Varieties of different field crops are developed under the AICRPs. Once a variety is identified during Annual Group Meeting of respective AICRP, some quantity of basic seed is given to National Seed Corporation Ltd. (NSCL) for stock seed production. Once the variety is released and notified in Gazette of GOI, 25% of this stock seed is used as breeder seed by the NSCL and rest is informed to Department of Agriculture and Farmers Welfare (DA&FW) for its distribution under mini-kits and other demonstrations under National Food Security Mission (NFSM) though State Deptt. of Agriculture at farmers fields. After notification, the Department of Agriculture of States, NSCL, Public Sector Undertakings (PSUs), Non-Governmental Organizations (NGOs), Farmers Producer Organization (FPOs) and Private Seed Companies (Through Seed Associations) give the indents for breeder seed of a variety to Seed Division of DA&FW, MoA&FW, GoI. Indents, thus received from various public and private seed producing agencies for different varieties are compiled in DA&FW Seed Division and a meeting of all the indenting agencies and Project Coordinators/ Directors of ICAR Institutes is convened by Seed Division of DA&FW and Seed Section of ICAR. Based on the availability of nucleus seed (seed from which breeder seed will be produced), the variety-wise indents of various agencies are finalized (Seed Rolling Plan) and communicated to the respective Crop Director/ Project Coordinator of ICAR Institutes/ AICRPs for further allotment to the producing Units i.e. ICAR Institutes or State/Central Agricultural Universities.

AICRP on Seed (Crops) at ICAR-National Institute of Seed Science and Technology (NISST), Mau coordinates all the activities of breeder seed production. Breeder Seed is monitored by a Monitoring Committee consisting of Breeder of the variety, representatives from NSCL, State Seed Certification Agency and the In-charge/ Nodal Officer of Station/ Farms/ Seed Production unit. The breeder seed is thus supplied to the indenting agencies as per the indents of the various agencies. Further downstream multiplication of breeder seed to foundation and certified seed is taken up by the various central and state public sector agencies as well as private sector seed agencies."

1.36 The Department uses a multi-channel strategy to promote water-efficient seed varieties among farmers. These varieties are distributed through national programs like the Sub-Mission on Seeds and Planting Material (SMSP) and NFSM, ensuring their availability via certified agencies and cooperatives. Krishi Vigyan Kendras (KVKs), ICAR institutes, and State Agricultural Universities conduct on-farm demonstrations, training, and awareness campaigns to showcase the yield benefits. Initiatives like NICRA and Biotech-KISAN involve farmers in selecting and adopting drought-tolerant seeds. Additionally, mobile advisories, field days, and public-private partnerships support widespread adoption, helping reduce groundwater use in agriculture.

In addition, ICAR-AICRPs centres and Krishi Vigyan Kendras are conducting the Front Line Demonstrations (FLDs) and Cluster Front Line Demonstrations (CFLDs) sponsored by NFNSM, respectively of newly released varieties across the country for their popularization.

1.37 When the Committee asked about the reasons for low adoption of water efficient variety of seeds developed by the ICAR by the farmers and what can be done to enhance their adoption by the farmers, the Department stated:

"Major reasons of low adoption of water efficient variety of seeds developed by the ICAR by the Farmers are (i) poor awareness about the water efficient varieties, (ii) lesser demonstrations, (iii) poor breeder seed indents leading to seed availability, (iv) yield gaps between water efficient variety and normal bred variety during normal season. Their adoption by the farmers can be enhanced by (i) special package of practice, and (ii) incentivizing farmers through government schemes like NFNSM."

1.38 On being asked about the impact of the campaigns of the Department for popularization/adoption of water use efficient variety of seeds and water use efficient technologies on consumption of ground water in Agriculture sector, the Department stated:

"Impact assessment and adoption studies of Water Use Efficient (WUE) varieties have shown positive results in enhancing productivity under limited water conditions. These varieties have improved yield stability, reduced irrigation needs, and promoted sustainable water management. After release all the varieties are evaluated at farmers' fields through Front Line Demonstrations and Cluster Front Line Demonstrations and indents of such varieties are raised only when the cultivars are performing better than the existing varieties of that area. Overall impact of high yielding varieties combined with other improved technologies is judged by the overall production and productivity of a particular crop.

Country has made a consistent progress in food grain production primarily through increase in productivity and has achieved a record production of 332.23 million tonnes during 2023-24. The deployment of suitable varieties coupled with crop production and protection technologies has led to increased food grain production (6.54 times), pulses (2.88 times), oilseeds (7.69 times), cotton (10.63 times) and sugarcane (7.94 times) since 1950. Besides, an increasing trend of crop production during four consecutive years (2021-22 – 315.62 mt, 2022-23 – 329.69 mt, 2023-24 – 332.23 mt, 2024-2025 – 353.96 mt) was observed even under bad weather conditions due to drought, untimely rains and high temperatures in many parts of the country.

The ever highest food grains production with a total estimated production 353.96 million tons (2024-25) which is 44% higher over 2014-15 (252.02 million tons) is estimated during 3rd Advance Estimates 2024-25. Likewise, Rice has touched the ever highest record production of 149.07 mt with 41% increase over the rice production during 2014-15 (105.48 mt). Wheat has also touched the ever highest record production of 117.50 mt with more than 35% increase over the wheat production during 2014-15 (86.53 mt). The same trend has been followed in maize, where production has also touched the ever highest level of 42.28 mt production with around 75% record increase over 2014-15 (24.17 mt). Ever highest production of oilseeds with a total estimated production 42.60 million tons (2024-25) which is more than 55% higher over 2014-15 (27.51 million tons). This is a major milestone towards Atmanirbharta in oilseeds. Major oilseeds like soybean (15.18 mt ever highest), followed by mustard (12.60 mt) and groundnut (11.90 mt ever highest) have registered the records."

1.39 Further, on being asked about the steps the Department has taken or contemplating to take for capacity building in terms of training to breeders, scientists and farmers for popularizing water-use-efficient seeds and technologies in the country, the Department stated:

"All the ICAR Institutes, State and Central Agricultural Universities and Krishi Vigyan Kendras are conducting need-based training programs to build the capacity of breeders, scientists, and farmers. Additionally, field demonstrations, farmer field schools, and KVK-led outreach programs have been instrumental in transferring these technologies to end-users. However, to further strengthen scientific competencies and remain aligned with cutting-edge technology for water-use efficiency, it is imperative to provide opportunities for scientists and breeders to visit reputed institutes that possess advanced expertise in these areas. Such exposure will enrich the knowledge, skill enhancement, and the adoption of proven global best practices relevant to the Indian context."

Chapter-II

A. Water Budget Based Cropping System

2.1 During the sitting of the Committee, the representatives of the Department stated:

"महोदय, मैं आपके संज्ञान में लाना चाहता हूं कि पानी बचाने के लिए वेराइटी सीड्स एक महत्वपूर्ण आस्पेक्ट है लेकिन उससे ज्यादा आगे जाने की जरूरत है। उसी कड़ी में हमें यह देखना पड़ेगा कि तेलहन, दलहन, मक्का, धान, कपास, गेहूं, कुछ भी हो, इस देश को वाटर बजट बेस्ड क्रॉपिंग सिस्टम डिजाइन करने की जरूरत है। हमें इसके लिए लंबी दूरी तक के लिए सोचना पड़ेगा, क्योंकि जब तक हम बजटिंग नहीं करेंगे, बारिश का कितना पानी आता है, कितना रेप्लेनिश होता है, हम कितना पानी निकालते हैं, और वह फरदर नीचे ना जाए, जितना पानी बचता है उसमें क्या फसल और क्या फसल प्रणाली हो सकती है, लंबे समय तक इसको टिकाऊपन बनाए रखने के लिए एक कार्य योजना बनाई जानी चाहिए।"

2.2 The Department, in a written submission, stated as under:

"Water being a critical input for crop production, the enhanced water resources for irrigation contributed immensely towards spurt in food grain production. Out of 141 Million ha of net sown area in the country, net irrigated area accounts about 78 Million ha (55%) and remaining 63 million ha (45%) is under rainfed condition. The gross irrigated area in India at present is 112.2 M ha. According to Vision 2050 document of ICAR (2015), the available supply is only 1121 billion cubic metres (BCM) compared to the projected total water demand of 1498 (BCM). The attention needs to be paid to integrated water management action plan in the backdrop of diminishing water availability to agriculture due to glacier melting. The additional water demand in domestic, industrial and energy sectors will need additional 222 BCM water by 2050. As a result, the water used in irrigation sector in agriculture in India is expected to decline from 80% at present to 74% by 2050.

In view of the emerging scenarios, the challenge is now to produce more crop per unit volume of water. According to the study made by ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, the availability of resources for agriculture will increase but at a slower rate as compared to the growth in food demand by the year 2050, and in order to strike a balance between the future demand and supply of agricultural products, we need to achieve two-fold increase in water productivity by 2050. Under the scenario of producing 550 million tonnes food grain from shrinking water resources towards the fulfilling the objective of Viksit Bharat by 2047, we have to execute sustainable and climate resilient water management action plan to substantially improve our irrigation efficiency in agriculture from present level of 38% to 65% by Amrit Kaal (2047). In this context, one major factor which needs to be considered is water budgeting and sustainable utilization of water resources. Here is a need to analyze the national water policies addressing the components of water budgeting in agriculture and other sectors.

Ministry of Jal Shakti (Formerly Ministry of Water Resources), Government of India formulates national water policies from time to time with an objective of aiding in planning and governance of water resources for their optimal utilization. In this direction, National Water Policy (1987), National Water Policy (2002) and National Water Policy (2012) were formulated. The first National Water Policy, 1987 aimed at increasing the area under irrigation, food output from 150 million tons in 1987 to 240 million tons in 2000, meet the drinking water needs of 100 percent of the population, and meet the sanitation needs of 80 percent of urban and 20 percent of rural populations. National Water Policy 2002 has given emphasis on commitment to Integrated Water Resources Management and Development, importance to environment related concerns and importance to innovative techniques and strategies based on science and technology. National Water Policy 2012 considers water as economic good to promote its conservation and efficient use. These national policy documents clearly provide the base for initiatives on water budgeting in different sectors of India. In addition, as water is a state subject, several states formulate their policies on water resource planning, development and utilization for agriculture and other sectors.

National Commission on Integrated Water Resource Development (Hashim Committee, 1996-1999) of Ministry of Jal Shakti, Government of India assessed the budget of surface and groundwater resources which was further refined later. It has assessed the total water resources of the country as 4000 BCM based on annual rainfall and other forms of precipitation and utilizable water resources as 1123 BCM (Surface water resources: 690

BCM and Groundwater resources: 433 BCM). Similarly, National Water Mission has taken initiative for assessment and management of water resources in the form of state specific action plans on water (SSAP-W) which will be of immense use in understanding the supply and demand of water resources of Indian States. National Taskforce on Integrated Water Resource Development and Management (NTIWRDM) has been constituted by Ministry of Jal Shakthi under the chairmanship of Dr. Ramesh Chand, Hon'ble Member, NITI Aayog in January 2025 to reassess the water resources of India and to provide integrated plan and action plan for sustainable utilization of surface and groundwater resources. This committee has constituted eight working groups on different components including water budgeting and water use efficiency. Similarly, the National Government schemes like Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Jal Jeevan Mission, Atal Bhujal Yojana play vital role in water resource assessment, budgeting and enhancing water use efficiency.

The national and state water policies stress on various measures for enhancing water use efficiency. Per Drop More Crop (PDMC) component of PMKSY plays vital role in this context. The area under Micro irrigation in India has been enhanced from 3.1 M ha in 1992 to 16.7 M ha in 2023. However, the concentration of micro irrigation is in few states and we need to promote it in several other states where potential exists. Five states of India i.e. Karnataka (2.42 M ha), Rajasthan (2.09M ha), Maharashtra (2.03 M ha), Andhra Pradesh (1.92 M ha) and Gujarat (1.70 M ha) contribute about 70% (10.16 M ha) of total area under micro irrigation in India. For achieving the optimum area under micro irrigation by Amrit Kaal (2047), the efforts must be made to expand the irrigation infrastructure in all the potential states as suggested by various committees. Government of India recently constituted Bureau of Water Use Efficiency for strengthening our efforts to enhance the water use efficiency.

On supply side management, Amrit Sarovar Yojana, played significant role in enhancing the storage capacity of India. Owing to the initiatives taken by Government of India in the form of extensive dam-building activities, the total number of dams in India has attained more than 5264 large dams. The total live storage capacity of 123 important reservoirs located throughout the country is 171.1 BCM which is about 66.36% of the live storage capacity of all the reservoirs in the country i.e. 257.8 BCM. However, India's per capita storage needs to be improved from present level of 190 m^3/person. The major concern is sedimentation in reservoirs which reduces the storage capacity drastically. For enhancing the storage capacity, the reservoir control system must be strengthened while considering needs of both upstream and downstream areas. The creation of water storage infrastructure through rain water harvesting structures is vital and Amrit Sarovar Mission of Government of India which was launched in the year 2022 played significant role by creating or renovating more than 68000 water bodies.

The National Perspective Plan (NPP) was prepared by Ministry of Jal Shakti (Formerly Ministry of Irrigation) in 1980 for water resources development through inter basin transfer of water, for transferring water from water surplus basins to water-deficit basins. Under the NPP, the National Water Development Agency (NWDA) has identified 30 links (16 under Peninsular Component & 14 under Himalayan Component) for preparation of Feasibility Reports. It is heartening to note that the Foundation stone for the Ken-Betwa Link Project (KBLP) was laid down by our hon'ble Prime Minister in December 2024. This project aims to transfer surplus water from the Ken River in Madhya Pradesh (MP) to Betwa in Uttar Pradesh (UP) to irrigate the drought-prone Bundelkhand region."

2.3 On being asked about the merits and limitations of the Water Budget based Cropping Pattern/system, the Department stated:

"Water Budget-Based Cropping Pattern/System refers to designing and managing cropping systems based on the availability of water resources in a particular region, with the aim of optimizing water use for sustainable agriculture. The merits of water budget based cropping pattern / system include optimal utilization of available water resources in the country, ensuring sustainability of access to water for future generations and efficient tackling of climate change induced natural disasters. The demerits include threat of less orientation of food security crops like rice, non-suitability of this approach in challenge ecosystem like waterlogged areas. Merits and demerits are summarized below:

Merits:

- Efficient Water Management: Aligns crop selection with water availability, ensuring optimal use of water resources.

- Reduces Crop Failure Risk: Prevents planting of water-intensive crops during water-scarce periods.
- Saves Costs: Lowers irrigation and energy expenses by promoting suitable crops.
- Promotes Sustainability: Helps conserve groundwater and maintain ecological balance.
- Supports Climate Resilience: Helps farmers adapt to rainfall variability and drought conditions.
- Encourages Crop Diversification/Intensification: Promotes cultivation of less water-demanding and climate-smart crops.

Limitations:

- Knowledge & Data Requirement: Requires accurate local data on rainfall, soil moisture, and crop water needs.
- Resistance to Change: Farmers may be hesitant to shift from traditional cropping patterns.
- Initial Planning Effort: Needs proper institutional support and planning for effective implementation.
- Market Risks: Water-efficient crops may not always fetch good market prices.

Water Budget Based Cropping is a pragmatic and sustainable approach, especially vital in drought-prone and water-deficit areas. While it promotes ecological balance and water efficiency, successful implementation requires institutional support, market alignment, and farmer training."

2.4 When the Committee categorically asked is there a need for implementation of Water Budget Based Cropping System/Pattern in the country, the Department stated:

"Yes, the Department agrees that there is a strong need for implementing a Water Budget Based Cropping System/Pattern across the country. This approach is crucial in view of the increasing frequency of droughts, depleting groundwater levels, and uneven distribution of rainfall across different agro-climatic zones. A water budget-based cropping strategy can significantly contribute to sustainable water management, enhanced resource-use efficiency, and climate-resilient agriculture.

Further, water budget-based cropping is essential as water scarcity and declining groundwater levels have become major constraints, particularly in arid and semi-arid regions. Existing cropping patterns often do not align with local water availability, causing over-extraction and environmental stress. A systematic, scientific approach is needed to match crop water requirements with region-specific water resources to ensure sustainable and efficient agricultural practices. The key aspects of implementation are:

- **Scientific Water Budgeting at Agro-climatic Zone Level:** Surface and groundwater availability must be assessed at district or agro-ecological levels, with water demand estimated for crops, livestock, and domestic use. Tools like remote sensing, GIS, hydrological models, and rainfall data should be used to create dynamic, real-time water budgets for informed planning.
- **Cropping System Planning Based on Water Availability:** Crops and cropping systems should be selected based on local water availability, promoting low water-requiring crops like pulses, oilseeds, and millets in scarce regions while discouraging water-intensive crops such as paddy and sugarcane. Seasonal water budgeting should guide the realignment of cropping patterns with irrigation potential.
- **Policy and Institutional Support:** Water budgeting principles need to be embedded into National and State Water Policies, supported by measures such as water pricing, crop insurance incentives, and participatory irrigation management. Community-based water governance mechanisms must also be promoted for localized decision-making.
- **Capacity Building and Extension:** Capacity building should focus on training farmers, extension personnel, and planners on water budgeting practices, supported by mobile apps and digital platforms that provide real-time water availability data and crop advisories for timely decision-making.
- **Research and Technological Innovations:** ICAR and SAUs should lead the development of location-specific cropping systems aligned with water budgeting,

while advancing climate-smart practices like micro-irrigation, rainwater harvesting, and deficit irrigation to ensure sustainability and efficiency.

The implementation of a **Water Budget Based Cropping System** is vital for long-term sustainability and food security. It not only helps in conserving scarce water resources but also ensures equitable distribution and efficient utilization, especially under changing climatic conditions. The Department fully supports the development and implementation of such a system with appropriate policy backing, institutional mechanisms, and on-ground interventions."

2.5 On being asked whether the Department has prepared any proposal for implementation of Water Budget Based Cropping Pattern in the country, the Department stated:

"The Indian Council of Agricultural Research (ICAR), through the All India Coordinated Research Project on Integrated Farming Systems, has identified alternative efficient cropping systems with higher water use efficiency compared to the existing predominant systems across various agro-climatic regions. In addition, a detailed crop plan analysis was conducted for 14 major crops—rice, wheat, maize, sorghum, pearl millet, redgram, chickpea, soybean, mustard, groundnut, sugarcane, cotton, onion, and potato. Based on indicators such as the Relative Spread Index, Relative Yield Index, Sustainable Yield Index, and Soil Climate Suitability Index, the areas were categorized into 'highly potential', 'moderately potential', 'marginally potential', and 'not suitable'. Utilizing this analysis, the Department of Agriculture & Farmers Welfare (DA&FW) has initiated a crop diversification program from 2023–24 in 75 districts across 17 states, with the objective of replacing marginally suitable and unsuitable rice areas with pulses, oilseeds, millets, vegetables, and other suitable crops. However, a mission mode programme (inter departmental/inter-ministerial) with dedicated funding is required."

2.6 To the query of the Committee whether the Water Budget Based Cropping Pattern can be conveniently implemented in the country, the Department stated:

"Yes, the Department believes that a Water Budget Based Cropping Pattern can be effectively implemented in the country, provided it is done in a phased and region-specific manner. This requires a science-based approach, guided by thorough analysis of key indicators such as soil type, rainfall patterns, water availability and gap, crop diversification index, productivity, and the comparative economics of existing versus alternate crops. However, for successful implementation, several critical challenges must be addressed. These include:

- **Data gaps** related to accurate and real-time water availability, crop-wise water demand, and yield performance;
- **Policy incoherence**, where water, agriculture, and pricing policies are not aligned to promote water-efficient crops;
- **Limited market access** and procurement support for alternative crops like pulses, millets, and oilseeds;
- **Farmer resistance** to shift from traditional high water-use crops due to risk perception and income concerns;
- **Lack of institutional coordination** between agriculture, water resources, and rural development departments.

Addressing these hurdles through policy integration, technology support, market linkages, and targeted capacity building will be crucial for the scalable and sustainable implementation of water budget based cropping systems."

2.7 During the sitting of the Committee, the need for having a regulatory mechanism/provision detailing crops to be grown and farming methods/practices to be followed for areas where water resources have been severely depleted was raised as under:

"….एक मैकेनिज्म होना चाहिए कि जहां ड्राई एरिया हो गया है, वहां कौन-कौन सी फसलें आप उगा सकते हैं और कौन सी नहीं उगा सकते हैं? यह तय होना चाहिए। जो हम कर रहे हैं, वह सस्टेनेबल डेवलपमेंट नहीं है। आने वाले भविष्य को लेकर, आने वाली नस्लों को लेकर कि वे कैसे जीएंगी, उनके लिए नैचुरल रिसोर्सेज़

का यूज हो। इस तरह से हो कि पानी उनके लिए बच जाए, यह सस्टेनेबल विकास है। अब यह नहीं हो रहा है। अब बर्बादी हो रही है। उसको देखने के लिए क्या कानून हैं....”

2.8 When the Committee asked whether the Department agree with the view that there is a need of legal mechanism/provision detailing which crops are to be grown and which farming methods are to be followed for places where water has been completely dried out, the Department, in a written reply, submitted:

“Yes, there is a clear need for a legal or regulatory mechanism, particularly in critical and over-exploited water zones, to guide farmers on suitable crop choices and farming practices when water resources are severely depleted. However, such a mechanism must be science-based, flexible, and incentive-driven, rather than restrictive. It should consider local agro-ecological conditions, water availability, and socio-economic factors. To ensure farmer acceptance and compliance, the Government must provide adequate support systems, including assured procurement, minimum support prices, and market linkages for alternate, low water-requiring crops, thereby safeguarding livelihoods while promoting sustainable water use.”

B. Climate-Smart Agronomy

2.9 Issues like climate change and water scarcity present significant obstacles and challenges for Indian Agriculture that require focused and targeted interventions. Promoting agricultural production patterns and practices that align with the specific agro-climatic conditions and natural resource availabilities of different regions across the country is vital. Investment in research and development, especially on climate-resistant varieties, improved agriculture practices, diversification to high-yield and climate-resilient crops and micro-irrigation, can yield sustainable long-term benefits. The widespread adoption of digital technologies in agriculture will unlock further possibilities for enhancing productivity.

2.10 On being asked by the Committee to provide details of the Water Smart Strategies implemented by the ICAR in the last 10 years to address ground-water depletion and improve irrigation efficiency, the Department stated:

"Indian Council of Agricultural Research (ICAR) has developed different water smart, cost effective, location specific scientific technologies *viz*., rainwater harvesting and recycling, multiple use of water, conjunctive use of rain, surface and groundwater resources, smart and precision technologies for irrigation and farming practices, optimum irrigation scheduling including micro-irrigation, development of land drainage and reclamation of saline soils to enhance irrigation water efficiency and water productivity in Indian agriculture. Further, Indian Institute of Soil and Water Conservation (IISWC), Dehradun has standardized several location specific bio-engineering water conservation measures for facilitating infiltration and *in-situ* moisture conservation and *ex-situ* storage of run-off water to provide supplementary irrigation to minimize the risk of farming. All these measures improve ground water recharge and minimize depletion of ground water. Some of the strategies and salient achievements are as under:

- Developed ICAR flexi check dam (Rubber Dam) for watershed to reduce soil erosion, create water storage facility, enhance ground water recharge and quick & safe disposal of sediments, and successfully installed at 40 locations in 9 states (Odisha, Maharashtra, Gujarat, Tamil Nadu, West Bengal, Kerala, Uttarakhand, Meghalaya, and Himachal Pradesh) of India. The adoption of the technology enhanced crop productivity (12-36%), cropping intensity (20-31%) and net return by 44,000/ha.

- Developed surface irrigation schedules for 53 crops and micro-irrigation schedules for 54 crops for various agro-ecological regions with improved water saving by 10 to 40% with increased water use efficiency by 17 -130%.

- Fertigation schedule through drip irrigation has been standardized for 20 crops which could save 50–60% water, 25–30% fertilizers besides improving yield, fertilizer use efficiency under different agro-ecological regions of India.

- Automated alternate wetting and drying (AWD) irrigation scheduler for transplanted rice has been developed and being promoted at farmers field through collaborating centres, SAU's and convergence with government schemes which can save 17% irrigation water.

- Sensor-based drip irrigation system and IoT-enabled capacitance-based soil moisture sensing system for irrigation scheduling were developed.

The Council has imparted training to more than 10,000 farmers and other stakeholders on water smart strategies and provide technical backstopping to various developmental schemes as and when required."

2.11 When the Committee asked to provide details about Climate Smart Agronomy promoted by the Department in the last 10 years, the Department submitted:

"The Indian Council of Agricultural Research (ICAR) has been actively promoting climate smart agronomy through its flagship initiative NICRA and the All India Coordinated Research Project for Dryland Agriculture (AICRPDA). These programs focus on developing and disseminating location-specific, climate-resilient agronomic practices.

The Technology Demonstration Components (TDC) of NICRA was demonstrated across 448 villages in 151 climate-vulnerable districts involving KVK's, these practices are supported by custom hiring centres, seed and fodder banks, and farmer-led institutions like Village Climate Risk Management Committees. NICRA conducted 25,716 capacity-building programs using a farmer participatory approach through Krishi Vigyan Kendras (KVKs), focusing on hands-on training, demonstrations, and weather-based agro-advisories. Technologies suited to local agro-climatic conditions—such as zero tillage, crop diversification, and alternate rice establishment methods—were documented and disseminated across 23 States and 3 UTs. Seed and fodder banks, along with Village Climate Risk Management Committees (VCRMCs), were established to ensure timely access to inputs and coordinated community-level responses to climate risks.

AICRP-DA through 28 centres in rainfed areas, developed and field-tested location-specific practices like in-situ moisture conservation (ridge-furrow, compartment bunding), supplemental irrigation using harvested rainwater, and soil test-based nutrient management. These were integrated with Real-Time Contingency Planning (RTCP), involving drought-tolerant short-duration crops and foliar nutrient sprays to tackle delayed monsoons or early-season droughts. Additionally, over 1,229 trainings, 608 field days, and 49 exposure visits helped transfer these methods to 6.7 lakh farmers for large-scale adoption.

Apart from this, ICAR-Indian Institute of Farming Systems Research (IIFSR) has developed and promotes more than 64 integrated farming system models tailored to climatic risks. The Indian Institute of Soil and Water Conservation (IISWC) focuses on landscape-level soil and water conservation strategies, while institutes like ICAR-IARI, ICAR-IISS and ICAR-CRRI work on climate-resilient crop varieties, smart nutrient and water management practices. These programs emphasize region-specific solutions, advanced modeling, weather-based advisories, and sustainable intensification to strengthen resilience against climate variability across diverse agro-ecological zones."

C. Apex Body for Coordination

2.12 During the sitting of the Committee, the Department was asked that:

"…वर्ष 1980 में लगभग सारे खेती से संबंधित डिपार्टमेंट्स एक ही मिनिस्ट्री के अंदर थे, लेकिन अब सात डिपार्टमेंट्स बन गए हैं। इन सभी डिपार्टमेंट्स में कॉर्डिनेशन का कोई सिस्टम है? ऐसी कोई कमेटी है, जो कॉर्डिनेशन करे?"

2.13 The representatives of the Department replied as under:

"सर, यह सही बात है कि वर्ष 1980 तक एक मंत्रालय था, उसके शायद आठ-नौ मंत्रालय हो गए हैं। वे धीरे-धीरे निकलते गए हैं। वे सारे मंत्रालय डायरैक्टली-इनडायरैक्टली खेती से जुड़े हुए हैं। मेरे संज्ञान में कोई कॉर्डिनेशन कमेटी एज सच नहीं है, लेकिन आपस में कॉर्डिनेशन की जरूरत है। सारे विभाग-मंत्रालय खेती से ही लिंक्ड हैं।"

2.14 Further, the Department, in a written submission, stated:

“The Ministries of Agriculture and Farmers Welfare, Chemicals and Fertilizers, Jal Shakti, Environment, Forest and Climate Change, Rural Development, Consumer Affairs, Food and Public Distribution and Commerce and Industry have diverse mandates and activities. However, on need based issues, the discussions and collaborations are held at appropriate level. The suggestion will be presented to Hon’ble Minister of Agriculture and Farmers Welfare.”

2.15 When the Committee categorically asked whether the Department agree with the view that there is a need for establishing an Apex Body to coordinate among various Ministries/Departments/Agencies on Agriculture related issues or the present arrangements are sufficient to cater the requirement of Agriculture sector, the Department stated:

“Yes, a Committee for coordination among various Ministries, Departments, and Agencies on agriculture-related issues needs to be constituted for institutional convergence, policy coherence, and integrated implementation of agricultural strategies, especially in the context of complex and cross-cutting interventions like the Water Budget Based Cropping System.”

PART- II

RECOMMENDATIONS/OBSERVATIONS

Strengthening of R&D Ecosystem for Development of Water Use Efficient Varieties

1. Agricultural sector is the backbone of the Indian economy, playing a vital role in the generation of national income and employment. In India, while the volatility in agricultural growth has notably diminished over time due to targeted interventions, the sector is not without its challenges. Availability of water for agriculture is one of the serious challenges as maximum instability in yield is generally due to less or non-availability of water. So, to maintain the sustainability of crop production and attain the target of ensuring food, nutrition, environment and livelihood security, development of water efficient varieties of crops and production of their seeds are quite essential.

The Committee have been informed that Crop Science Division of the ICAR is working on 85 field crops under an Umbrella Scheme entitled 'Crop Science for Food and Nutritional Security' through its six sub-schemes. The six sub-schemes have total 63 components including 28 Institutes, 20 All India Coordinated Research Projects (AICRPs), six All India Network Projects (AINPs) and four Consortium Research Projects (CRPs). All the scheme components have one or more activities related to development of varieties for less water requirement or technologies which can help in mitigating the effect of less water. In addition, Institutes and Programmes under Natural Resource management Division are also contributing towards development of varieties and management technologies for higher productivity under water deficit/less water availability condition and help in saving the ground water. Besides, ICAR under its flagship network project 'National Innovations in Climate Resilient Agriculture (NICRA) is also focused on climate resilient technological innovations. Apart from these planned projects, a good number of externally funded projects and the international organizations are also working on the objective of breeding for low water requiring varieties in different field crops. A few private companies also have their independent Research and Development programmes for

development of water efficient varieties. The Committee have also been informed that out of total 3053 varieties of 85 crops released by ICAR since 2014, 2813 varieties (92%) are climate resilient, 1064 varieties (35%) are drought tolerant and 328 varieties (10.7%) are extremely drought tolerant. Despite these developments the Committee are of firm opinion that R&D ecosystem of the ICAR needs to be further strengthened and breeding of location specific drought tolerance and high water-use efficient traits catering to the requirement of all agro-climatic regions of the country to be prioritized. The Committee also desire implementation of a long term 'Water Efficient Seeds Mission' for development of water efficient varieties of seeds of various crops to promote the conservation of groundwater resources and to ensure sustainable crop production even under water-deficit conditions.

Genetic Improvement by Integrating Modern Tools

2. The Committee note that the project or sub-scheme entitled 'Enhancing climate resilience and ensuring food security with genome editing tools' (with a total budget of Rs. 310 crores during 2023-24 to 2025-26), under an Umbrella Scheme entitled 'Crop Science for Food and Nutritional Security' is based on the cutting edge latest biotechnological tools where 24 crops, which include 7 cereals, 6 pulses, 6 oilseeds, 3 fibre crops, sugarcane and tobacco, have been included for improvement. The Committee have been apprised by the Department that Genome editing is a precision mutagenesis tool or method which uses biological mutagenic agents (gRNA and Cas enzyme) to create targeted mutation in a gene. Further, Genome edited crops are not considered as Genetically Modified (GM) Crops and bypass of GM Crops as GM Crops essentially carry a gene from foreign source, while Genome edited crops do not have any such foreign gene. Genome edited crops are similar to conventional bred varieties as genome editing creates mutation in the native gene similar to that of spontaneous or induced mutagenic agent. Hence, there is no biosafety, environmental and ecological risk associated with varieties developed by genome editing. Several countries such as USA, Japan, UK, Philippines, Australia, Brazil, Argentina, Kenya, Nigeria, Indonesia, Canada, Columbia, etc. have already exempted gene edited plants developed by SDN1 and SDN2, and they are considered as plant

varieties developed by any other breeding tools. Already, genome edited soybean crop in USA (from 2019), tomato in Japan (from 2021) are commercially cultivated and consumed. The Committee have also been apprised by the Department that development of seeds through 'genome editing' is permissible in India. The bio-safety and environmental safety of Genetically Modified Organisms (GMOs)/Non-Living Modified Organisms (LMOs) are regulated under Rules 1989 of Environment (Protection) Act of 1986 of Government of India. The Ministry of Environment, Forest and Climate Change, Government of India published OM on 30th March 2022 exempting SDN-1 and SDN-2 categories of genome edited crop free from exogenous introduced DNA from the provision of Rules 7 to 11 (both inclusive) of the Rules 1989 (GM Regulation Rules). Further, Review Committee on Genetic, Manipulation (RCGM), DBT, Government of India published 'Guidelines for safety assessment of genome edited plants 2022' and 'SoPs for regulatory review of genome edited plants 2022' following the International standard practice followed in other countries.

The Committee recommend that while undertaking the genetic improvement by integrating modern tools like genome editing, speed breeding, marker-assisted and genomic selection etc., bio-safety measures must be scrupulously followed to secure human health, biodiversity and environment of the country.

<u>Review Mechanism for Assessment</u>

3. As per the information furnished by the Department, the ICAR has a robust system of review mechanism of newly developed varieties. The present review mechanism for the assessment of newly developed seed varieties, as implemented through ICAR's coordinated network trials and institutional protocols, has been broadly effective in evaluating key parameters such as yield potential, disease and pest resistance, grain quality and adaptability across agro-climatic zones. The Committee are of view that with the evolving priorities of agriculture – such as nutritional security, consumer preferences, climate resilience and sustainability, certain dimensions like nutritional profiling, sensory evaluation, shelf life and water-use efficiency (in case of drought tolerant varieties) may be supplemented for further

strengthening within the existing framework. The Committee, therefore, recommend that the Review Mechanism for assessment of newly developed varieties of various crops should be continuously refined and strengthened to keep pace with future challenges and expectations.

<u>Seed Systems and Accessibility</u>

4. The Committee have been informed that after release of variety and its notification in Gazette of India, the Seed Division of Department of Agriculture and Farmers Welfare receives indents for breeder seed of the variety from the Department of Agriculture of States, National Seeds Corporation Limited (NSCL), Public Sector Undertakings (PSUs), Non-Governmental Organizations (NGOs), Farmer Producer Organizations (FPOs) and Private Seed Companies (through Seed Associations) and subsequently in a meeting with all indenting agencies, the indent is finalized. ICAR produces breeder seed as per the indent, which in turn are converted into Foundation, Certified and Truthfully Labelled (TL) seeds in the next generations respectively by seed producing agencies and finally distributed among the farmers. The Committee have also been informed that the Department has not faced any shortage of breeder seed. Over the past 10 years, a total of 1,45,266.2 quintals of breeder seed of water-efficient varieties was produced against an indent of 93,147.8 quintals. The breeder seed production is aligned with the annual demand (indents) placed by various state governments as per their Seed Rolling Plan and also by other public and private seed producing agencies. The quantity produced has remained adequate to support the production of the required quantum of quality seed, as envisaged under the Seed Rolling Plans (Indents) of the respective states. However, due to declining indents from the states, the share of public sector National and State Level Corporation is declining and private sector is supplying the seeds to the states under various schemes.

The Committee are of considered view that seeds are crucial and vital inputs for Agriculture. Ensuring the timely availability of quality seeds at affordable price at the right time and place remains a significant challenge especially for small and

marginal farmers, who face affordability and access barriers, and in arid and resource-poor regions, with many farmers relying heavily on the informal seed sector to meet their seed requirements. The Committee, therefore, recommend the Department to take steps, in coordination with the Department of Agriculture and Farmers Welfare, for strengthening and equipping the existing seed production and distribution system networks to meet the increased and rapid demand, avoiding seed shortage, ensuring quality and affordability and easy availability. Also, State Governments should be impressed upon to take proactive steps to promote adoption of Climate-resilient and water-efficient varieties by ensuring timely availability and affordability of quality seeds to the farmers.

<u>Seed Authenticity and Traceability</u>

5. The Committee note that the Seed Authenticity Traceability & Holistic Inventory (SATHI) is a national platform implemented by the collaborative efforts of the Ministry of Agriculture and Farmers' Welfare, Government of India with the Technical support of ICAR, and the National Informatics Centre (NIC) which proposes to provide a digital platform that streamlines the holistic management of seed production, quality certification, distribution and traceability at pan-India level. This endeavor establishes a National Seed Grid (NSG), integrating all seed stakeholders within a unified national digital platform.

The development of the platform has been taken up in 2 phases. Phase I of the project has been launched which covers onboarding the stakeholders involved in Nucleus to Breeder Seed Production, Breeder to Foundation and Foundation to Certified Seed Production processes to SATHI platform and capture their transactions at the granular level. Phase II of the project will cover seed Supply chain and Inventory management. The movement of seed bag in supply chain will be recorded in real time to provide end to end traceability and Seed Inventory from Micro to Macro level (Retailer to state and National Level). The Committee feel that full operationalization/implementation of SATHI platform would solve seed related issues particularly the menace of spurious and sub-standard seeds for the farmers. The

Committee, therefore, while appreciating the launching of the ambitious SATHI project, desire that the process of onboarding of all the stakeholders including Private Seed Companies on SATHI platform should be expedited in a time bound manner so that the system becomes fully functional and effective at the earliest.

Capacity Building and Awareness Creation

6. The Committee note that Water Use Efficient (WUE) varieties of various crops and water use efficient technologies have bene developed by the Institutes of the ICAR. Impact assessment and adoption studies of WUE varieties have shown positive results in enhancing productivity under limited water conditions. These varieties have improved yield stability, reduced irrigation needs and promoted sustainable water management. However, varietal adoption is shaped by diverse agro-climatic conditions, cropping patterns, market preferences and socio-economic factors. The Committee also note that poor awareness about the water use efficient varieties, lesser demonstrations, poor breeder seed indents leading to seed availability, yield gaps between water efficient variety and normal bred variety during normal season, etc. are the major reasons for low adoption of water efficient variety of seeds by the farmers. The Committee are of the view that there is a critical need to create awareness among farmers about the importance of adopting water-efficient varieties and technologies as a strategy for climate adaptation and water conservation which needs to be supported by robust evidence of agronomic and economic benefits derived from such varieties and technologies. The Committee, therefore, recommend the Department to take prompt and suitable action including awareness creation for addressing the reasons for the low adoption of water use efficient varieties and technologies by the farmers. The Committee also recommend the Department to frequently provide training to breeders, scientists and farmers in water-use-efficient technologies to strengthen their scientific competencies and make them aligned with cutting-edge technologies for water-use efficiency.

Water Budget Based Cropping System

7. The Committee note that the water is a critical input for crop production. Water scarcity and declining groundwater levels have become major constraints, particularly in arid and semi-arid regions. The Committee also note that the total water resources of the country, as per an assessment, is 4000 billion cubic meters (BCM) based on annual rainfall and other forms of precipitation and utilizable water resources is 1123 BCM compared to the projected total water demand of 1498 BCM. There are also competing demands in domestic, industrial and energy sectors which will need additional 222 BCM water by 2050. There are also regional, seasonal and temporal variations in availability of water in the country and the existing cropping patterns often do not align with local water availability, causing over-extraction and environmental stress. In this backdrop, the Committee are of the view that the implementation of Water Budget-Based Cropping Pattern/System i.e. designing and managing cropping systems based on the availability of water resources in a particular region, with the aim of optimizing water use for sustainable agriculture, is a pragmatic and sustainable approach especially vital in drought prone and water-deficit areas as it promotes ecological balance, sustainable water management, enhanced resource-use efficiency and climate-resilient agriculture.

The Committee, therefore, recommend the Department to make sincere efforts, in coordination with the Department of Agriculture and Farmers Welfare and other concerned agencies/organizations, for successful implementation of the Water Budget-Based Cropping System in the Country. The Committee also recommend for establishing a legal or regulatory mechanism, particularly for critical and over-exploited water zones, to guide farmers on suitable crop choices and farming practices taking into consideration local agro-ecological conditions, water availability and socio-economic factors when water resources are severely depleted.

Climate-Smart Agronomy

8. The Committee note that water scarcity and climate change present significant obstacles and challenges for Indian Agriculture. Promoting agricultural production, patterns and practices that align with the specific agro-climatic conditions and natural resource availabilities of different regions across the country is vital. The Committee also not that the Indian Council of Agricultural Research (ICAR) has been actively promoting climate smart agronomy through its flagship initiative 'National Innovations in Climate Resilient Agriculture (NICRA) and the All India Coordinated Research Project for Dryland Agriculture (AICRPDA) by focusing on developing and disseminating location-specific, climate-resilient agronomic practices. The Committee further note that the ICAR has developed and standardized different water smart, cost effective, location specific scientific technologies and practices viz. rainwater harvesting and recycling, bio-engineering water conservation measures for facilitating infiltration and in-situ moisture conservation and ex-situ storage of run-off water to provide supplementary irrigation to improve ground water recharge and minimize depletion of ground water, multiple use of water, conjunctive use of rain, surface and groundwater resources, smart and precision technologies for irrigation and farming practices, optimum irrigation scheduling including micro-irrigation, Fertigation schedule through drip irrigation, sensor-based drop irrigation system and Internet of Things (IoT) -enabled capacitance-based soil moisture sensing system for irrigation scheduling, automated alternate wetting and drying (AWD) irrigation schedule for transplanted rice, development of land drainage and reclamation of saline soils to enhance irrigation water efficiency and water productivity in Indian Agriculture. Besides, technologies and practices such as zero tillage, crop diversification, alternate rice establishment methods, integrated farming system, climate-resilient crop varieties, smart nutrient and water management, weather-based advisories, sustainable intensification etc. strengthen resilience against climate variability across diverse agro-ecological zones. The Committee, while acknowledging the contributions made by the Department and ICAR in promotion of Climate Smart Agronomy, desire that Climate Smart Agronomy should be promoted and encouraged to cover all the agro-climatic regions of the country so as to not only

mitigate the adverse impacts of climate change on the Indian Agriculture but also to reap the sustainable long-term benefits.

<u>Apex Body/Committee for Coordination</u>

9. The Committee note that during 1980s, almost all Agriculture and Allied Sector related Department were under a single Ministry and in course of time several new Ministries have been created, though they are directly or indirectly related to Agriculture. The Committee have been apprised that the discussions and collaborations are held among these Ministries at appropriate level but a permanent coordination Committee or an Apex body for coordination among these Ministries does not exist at present. The Committee, therefore, desire that an Apex Body or a Committee for coordination among various concerned Ministries, Departments and Agencies on Agriculture and Allied Sector-related issues be constituted for institutional convergence, policy coherence and integrated implementation of agricultural strategies especially in the context of complex and cross-cutting interventions.

NEW DELHI;
24th March, 2026
03 Chaitra, 1948 (Saka)

CHARANJIT SINGH CHANNI
Chairperson
Standing Committee on Agriculture
Animal Husbandry and Food Processing

APPENDIX - I

MINUTES OF THE TWENTY NINTH SITTING OF THE STANDING COMMITTEE ON AGRICULTURE, ANIMAL HUSBANDRY AND FOOD PROCESSING (2024-25)

*****

The Committee sat on Friday, the 20th June, 2025, from 1435 hours to 1545 hours in Committee Room `D', Parliament House Annexe, New Delhi.

PRESENT

CHARANJIT SINGH CHANNI - CHAIRPERSON

MEMBERS

LOK SABHA

32. Shri Patel Umeshbhai Babubhai
33. Shri Rajkumar Chahar
34. Smt. Krishna Devi Shivshankar Patel
35. Shri Naresh Chandra Uttam Patel
36. Shri Dharambir Singh
37. Shri Sudhakar Singh
38. Smt. Geniben Nagaji Thakor

RAJYA SABHA

9. Smt. Ramilaben Becharbhai Bara
10. Shri S. Kalyanasundaram
11 Shri Nitin Laxmanrao Jadhav Patil
12. Shri Madan Rathore
13. Shri Ramji Lal Suman

SECRETARIAT

1. Shri Maheshwar - Director
2. Shri Prem Ranjan - Deputy Secretary
3. Shri Anil Kumar Sanwaria - Deputy Secretary

LIST OF WITNESSES

MINISTRY OF AGRICULTURE & FARMERS WELFARE
Department of Agricultural Research & Education

Sl No.	Name	Designation
1	Dr. M.L. Jat	Secretary, (DARE), & Director General (ICAR)
2	Dr. D.K. Yadava	Deputy Director General (Crop Science), ICAR
3	Dr. Sanjay Kumar Singh	Deputy Director General (Horticultural Science), ICAR
4	Dr. Rajbir Singh	Deputy Director General (Agril. Extn.), ICAR

Department of Agriculture & Farmers Welfare

5	Shri Frankin L. Khobung	Joint Secretary, (NRM/RFS),

2. At the outset, the Chairperson welcomed the Members of the Committee to the sitting convened in connection with the examination of the Subject '**Research for Developing Water Efficient Variety of Seeds to Save Ground Water'** pertaining to the Ministry of Agriculture & Farmers Welfare (Department of Agricultural Research and Education). Thereafter, the representatives were called in. The Chairperson welcomed the representatives to the sitting of the Committee and apprised them of the provisions of Directions 55 (1) of the Directions by the Speaker, Lok Sabha, regarding confidentiality of the proceedings.

3. After the introduction by the witnesses, a power-point presentation was made by the representative(s) of the Department of Agricultural Research & Education on the Subject briefing the Committee about the diversity and ecosystems of Indian Agriculture, projected

population and food requirement in Viksit Bharat and other challenges, network of varietal improvement, progress made towards varietal development in field crops, extremely climate resilient varieties developed for stable production, water use efficient varieties developed during 2014-2024, impact of technologies on crop production showing resilience in Indian Agriculture, R&D network and seed system in India, progress made towards seed availability, Breeder & Quality Seeds production of water use efficient varieties and multiple stress tolerant (extreme climate) varieties during last 3 years, new research initiative for climate resilience, announcements in Budget 2025-26 and the way forward.

4. Thereafter, the Chairperson and Members of the Committee raised several issues / points, as briefly mentioned below and sought clarifications / information from the Department thereon:

i. Need for designing Water Budget based Cropping pattern;
ii. Need for establishing an Apex Body to coordinate among various Ministries / Departments / Agencies on Agriculture related issues;
iii. Requirement of having /preparing a Comprehensive Plan/Mission to deal with 'Water';
iv. Mandatory use of water efficient varieties of seeds;
v. Need to have a long term 'Water Efficient Seeds/ Agriculture Mission' for development of water efficient varieties of seeds;
vi. Assessment of difference in nutritional value of natural / original and hybrid variety of crops;
vii. Legal mechanism / provision detailing which crops are to be grown and which farming methods are to be followed for places where water has been completely dried out;

viii. Need for having labelling on seeds packets indicating natural / hybrid / genetically modified / genetically edited seeds;

ix. Issue of availability of genuine /certified seeds to the Farmers;

x. Need of the Seed Law;

xi. Review mechanism for assessment of newly developed seeds of various crops in terms of yield, quality, adoption by Farmers and other parameters;

xii. Issue of Genetically Modified (GM) and Genome Edited (GE) crops;

xiii. Promotion of drip irrigation;

xiv. Promotion of river linking and water harvesting projects for overcoming shortage of water; etc.

5. The representatives of the Department responded to most of the queries raised by the Members. The Chairperson, thereafter, thanked the witnesses for sharing valuable information with the Committee on the Subject and directed them to furnish the requisite information in writing on the points/items, which were not readily available with them to the Secretariat by **30th June, 2025,** positively.

The Committee then adjourned.

APPENDIX - II

MINUTES OF THE THIRD SITTING OF THE STANDING COMMITTEE ON AGRICULTURE, ANIMAL HUSBANDRY AND FOOD PROCESSING (2025-26)

*****

The Committee sat on Thursday, the 20th November, 2025, from 1430 hours to 1445 hours in Committee Room '1', First Floor, Block-A, Extension to Parliament House Annexe (EPHA), New Delhi.

PRESENT

CHARANJIT SINGH CHANNI - CHAIRPERSON

MEMBERS

LOK SABHA

2. Shri Patel Umeshbhai Babubhai
3. Shri Rajpalsinh Mahendrasinh Jadav
4. Shri Sukanta Kumar Panigrahi
5. Smt. Krishna Devi Shivshankar Patel
6. Shri Dharambir Singh
7. Shri Dushyant Singh
8. Shri Sudhakar Singh
9. Shri Kodikunnil Suresh

Rajya Sabha

10. Smt. Ramilaben Becharbhai Bara
11. Shri Banshilal Gurjar
12 Shri Madan Rathore
13. Shri Ramji Lal Suman
14. Shri P. P. Suneer

Secretariat

1.	Shri Maheshwar	-	Director
2.	Shri Prem Ranjan	-	Deputy Secretary
3.	Shri Fauzi Badruddin	-	Deputy Secretary

2. At the outset, the Chairperson welcomed the Members to the sitting of the Committee. The Committee then took up of the draft Reports on the subjects- (i) ‘Production and Availability of Oilseeds and Pulses in the Country’ pertaining to the Ministry of Agriculture and Farmers Welfare (Department of Agriculture and Farmers Welfare); and (ii) ‘Research for Developing Water Efficient Variety of Seeds to Save Ground Water’ pertaining to the Ministry of Agriculture & Farmers Welfare (Department of Agricultural Research and Education) for consideration.

3. A Member of the Committee raised some objections/suggested some modifications to the recommendations contained in the draft Reports. Consequently, the Chairperson decided to keep the adoption of the draft Reports on hold and constitute a Sub-Committee to finalize the draft reports.

The Committee then adjourned.

Appendix-III

MINUTES OF THE TWELFTH SITTING OF THE COMMITTEE ON AGRICULTURE, ANIMAL HUSBANDRY AND FOOD PROCESSING (2025-26)

The Committee sat on Monday, the 23rd March, 2026 from 1035 hrs. to 1118 hrs. in Committee Room No. 2, First Floor, Block-A, Extension to Parliament House Annexe (EPHA), New Delhi.

Present

Shri Charanjit Singh Channi – Chairperson

Members

Lok Sabha

2. Shri Rajkumar Chahar
3. Shri Kuldeep Indora
4. Shri Sukanta Kumar Panigrahi
5. Shri Dushyant Singh
6. Shri Sudhakar Singh

Rajya Sabha

7. Smt. Ramilaben Becharbhai Bara
8. Dr. Anil Sukhdeorao Bonde
9. Shri H. D. Devegowda
10. Shri Madan Rathore

Secretariat

1.	Shri Dhiraj Kumar	–	Joint Secretary
2.	Shri Maheshwar	–	Director
3.	Shri Prem Ranjan	-	Deputy Secretary
4.	Shri Fauzi Badruddin	-	Deputy Secretary

2. At the outset, the Chairperson welcomed the Members to the Sitting of the Committee. Thereafter, the Committee took up for consideration and adoption of the following Draft Subject Reports and Draft Action Taken Reports:

*(i) xxxx xxxx xxxx xxxx;

(ii) Report on the Subject 'Research for Developing Water Efficient Variety of Seeds to Save Ground Water' pertaining to the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education)

*(iii) xxxx xxxx xxxx xxxx;

*(iv) xxxx xxxx xxxx xxxx;

*(v) xxxx xxxx xxxx xxxx;

*(vi) xxxx xxxx xxxx xxxx;

3. The Committee, thereafter adopted the draft Reports mentioned at Para 2 (i) and (ii) with modifications/amendments as listed at Annexure A and B, respectively.

*4. xxxx xxxx xxxx xxxx;

*5. xxxx xxxx xxxx xxxx;

6. The Committee also authorized the Chairperson to finalize the Reports in the light of modifications suggested and present the Reports to Parliament.

The Committee then adjourned.

**Matter not related to this report.*

Annexure-B

Modification/amendment suggested in the Draft Report on the subject 'Research for Developing water efficient variety of Seeds to save Ground Water

S. No.	Recommendation / Observation Para No.	Omitted	Incorporated
1	2	Despite these developments, the Committee are apprehensive about the genome edited crops. The Committee, therefore, recommend the Department to re-assess the Rules, Regulations, Guidelines, SOPs etc. so as to ensure that while undertaking the genetic improvement by integrating modern tools like genome editing, speed breeding, marker-assisted and genomic selection etc., precautionary measures are scrupulously undertaken and provided for so as to avoid any unintended/potential ill effects on human health, biodiversity, environment and bio-safety in the country.	The Committee recommend that while undertaking the genetic improvement by integrating modern tools like genome editing, speed breeding, marker-assisted and genomic selection etc., bio-safety measures must be scrupulously followed to secure human health, biodiversity and environment of the country.