

GOVERNMENT OF INDIA  
MINISTRY OF AGRICULTURE AND FARMERS WELFARE  
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION

**LOK SABHA**  
**UNSTARRED QUESTION NO. 5891**  
TO BE ANSWERED ON 03/04/2018

**APPLICATION OF BIOTECHNOLOGY IN AGRICULTURE**

5891. SHRI TEJ PRATAP SINGH YADAV:  
SHRIMATI ANJU BALA:

Will the Minister of AGRICULTURE AND FARMERS WELFARE  
कृषि और किसान कल्याण मंत्री be pleased to state:

- (a) whether there is an urgent need for application of biotechnology in various areas of agriculture for the economic well being of farmers and for food security of the nation;
- (b) if so, whether the Government has formulated any policy/schemes in this regard and if so, the details thereof;
- (c) whether the Government is undertaking any Research & Development (R&D) in biotechnology application in the agriculture sector;
- (d) if so, the details thereof including the funds allocated for the purpose during the last three years and the outcome thereof; and
- (e) whether a number of centres are involved in the biotechnology research in the agriculture sector and if so, the details thereof including the achievements made in development and commercialization of agro-products and other steps taken by the Government in this regard?

**A N S W E R**

MINISTER OF STATE IN THE MINISTRY OF AGRICULTURE AND FARMERS WELFARE  
कृषि और किसान कल्याण मंत्रालय में राज्य मंत्री  
**(SHRI GAJENDRA SINGH SHEKHAWAT)**

**(a) & (b):** Yes, the Department of Biotechnology (DBT) funds R&D in Agriculture and allied areas through its scheme “Biotechnology Research & Development” implemented in R&D institutions, Ministries/Departments; Central/ State/ Private universities; NGO’s and private sector.

In addition, in the Indian Council of Agricultural Research (ICAR), the use of biotechnology has been made as an integral part of the Crop Improvement programme both in field and horticultural crops and also in animal science and fisheries. ICAR established a Biotechnology Centre in 1985 in Indian Agricultural Research Institute which was promoted to “National Research Centre on Plant Biotechnology (ICAR-NRCPB)” as an independent Institute in 1993, with a vision to impart the biotechnology advantage to the National Agricultural Research System (NARS). ICAR also launched a Network Project on Transgenics in Crops (NPTC) in 2005 under the 10<sup>th</sup> Plan for promotion of biotechnology research and development in India. During 12<sup>th</sup> Plan, ICAR has set up the Indian Institute of Agricultural Biotechnology, Ranchi, Jharkhand with wide scope viz., (i) molecular breeding for accelerated improvement of specific traits using genes available in the germplasm of that plant, livestock or fish species; (ii) molecular diagnostics and vaccines for effective control of livestock diseases; (iii) genetically modified organisms incorporating foreign genes of interest into a target organism; and (iv) nano-biotechnology for biosensor and delivery devices for precision farming. Further, there are Biotechnology Department in all the major ICAR institutes and State Agricultural Universities dealing with living commodities, plants, animals, fishes and microbes.

**(c) & (d):** Yes, Madam. DBT has supported 103 individual projects, 23 networks and 8 Centres of Excellence (*Annexure-I*) in Agriculture Biotechnology Research operating under various Institutes and Universities during last three years with budgetary allocation of Rs. 171.0 crores. ICAR has released Rs. 183.0 crores for the various Institutes/projects focussing on Biotechnology research (*Annexure-II*). Continuous efforts have led to number of basic and applied outcome in the form of technology, varieties etc. during last three years (*Annexure-III*).

(e) Yes, most of these projects are multi-institutional involving number of ICAR Institutes, State/Central Agricultural Universities, and other Institutes/Universities with agriculture faculty. Details of number of centres involved and achievements are given at *Annexure-I, II and III*.

\*\*\*\*\*

**Agriculture Biotechnology projects funded by DBT during last 3 years****A. List of Individual projects**

<b>S. No.</b>	<b>Project Title</b>	<b>Institution Name</b>
1	Generation of mapping populations and identification of QTL(s) for Downy Mildew Resistance in Pearl Millet ( <i>Pennisetum glaucum</i> (L.) Br.)	Indian Agricultural Research Institute, New Delhi
2	Genetic modification of starch biosynthetic pathway in indica rice cultivar in favor of resistant starch production"	Indian Institute Of Technology, Kharagpur
3	Molecular and functional characterization of yield enhancing quantitative trait loci from wild rice	CCMB, Hyderabad
4	Phenotyping of mapping populations at hot spots and tagging of major QTLS associated with spot blotch resistance in wheat"	Directorate of Wheat Research, Karnal - Haryana
5	Mapping of Mungbean yellow Mosaic Virus resistance loci in soybean	National Institute of Plant Genome Research, Delhi
6	Characterization of protease inhibitor and isolation of gene encoding protease inhibitors from rice bean ( <i>Vigna umbellata</i> )	CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur
7	Characterization of <i>Xanthomonas oryzae</i> strains from North – West and eastern regions for screening for Xop like effectors to investigate its role as virulence determinants to induce blight in rice	Indian Agricultural Research Institute, Delhi
8	Metabolic engineering of oil biosynthetic pathway in safflower [ <i>Carthamus tinctorius</i> ] for fortification with Omega 3 FA	Vittal Mallya Scientific Research Foundation, Bangalore
9	Identification of suitable varieties and strains for saline sodic soils having more nutritional quality and less anti-nutritional factors of <i>sawan</i> and <i>kodo</i> millets using biochemical traits	N.D. University of Agriculture & Technology, Faizabad
10	Molecular mapping and introgression of stigma exertion trait in hybrid rice parental lines	Directorate of Rice Research Rajendranagar, Hyderabad
11	Identification and Mapping of QTLs Linked to Jassid ( <i>Amrascadvastans</i> ) Tolerance in Cotton ( <i>Gossypium</i> spp.)",	Tamil Nadu Agricultural University, Tamilnadu
12	Development of Saturated genetic linkage map for <i>Gossypium hirsutum</i> L. using SSR and SNP markers.	National Botanical Research Institute, Lucknow
13	Development of Vitamin E biofortified Indica rice	Bharathiyar University, Coimbatore
14	Metabolic engineering of <i>Catharanthus roseus</i> for improved accumulation of terpene indole alkaloids	CSIR-Central Institute of Medicinal and Aromatic Plants, Allalasanra, Bangalore
15	Spatiotemporal Manipulation of Profilin Gene Family in cotton Fiber cells for Increased yield and quality	Gautam Buddha University, Greater Noida-201 308.
16	Studies on The Role of Antioxidative Defense Mechanisms In Deciphering Drought Stress Tolerance In Soybean ( <i>Glycine max</i> (L) Merr.)	GITAM Institute of Technology, Gandhi Nagar Campus, Vilakapatnam
17	Antioxidative Modulation and Stress Related Genes & sRNA Expression Profiling of Maize ( <i>Zea mays</i> L.) in Response to Arsenic Exposure.	University of Kalyani, Nadia, West Bengal
18	Introduction of very-long-chain polyunsaturated fatty acids biosynthesis pathway in Indian mustard ( <i>Brassica juncea</i> )	University of Delhi, New Delhi.
19	Isolation and Characterization of Genes involved in the Santalol Biosynthesis in Indian Sandalwood, <i>Santalum album</i>	National Chemical Laboratory, Pune
20	Evaluation of Transgenic Groundnut with resistance to bud and stem necrosis viruses.	ICAR-Directorate of Groundnut Research, Junagadh, Gujarat

21	Identification and characterization of zinc responsive genes in maize ( <i>Zea mays</i> ) by RNAseq	National Bureau of Plant Genetic Resources,, New Delhi.
22	Development of Single Nucleotide Polymorphisms (SNPs) for Brassica juncea	Sher-e-Kashmir University of Agricultural Sciences & Technology Chatha, Jammu
23	In vitro culture of Capsicum chinense Jacq. cv. 'Umorok' for capsaicin production	Manipur University, Imphal, Imphal
24	Genetics and molecular tagging of drought tolerance gene(s) in lentil	Indian Agricultural Research Institute, Pusa Campus, New Delhi
25	Molecular marker -assisted introgression of two major blast resistant genes and a large effect QTL for grain yield under drought stress in rice	ANGRAU Campus, Hyderabad, Andhra Pradesh
26	Identification and Mapping of QTLs associated with Zinc deficiency tolerance in Rice	Tamilnadu Agricultural University, Coimbatore
27	Metabolic engineering for production of terpenoids in tobacco plants	ICGEB, New Delhi-110067
28	Secondary metabolism and pathogenesis in rice blast fungus	National Institute of Technology, Durgapur, West Bengal
29	Development of bi-parental population for mapping of leaf rust resistance gene and QTLs for 1000- kernel weight in wheat.	Indian Agricultural Research Institute, New Delhi
30	Development of molecular markers in rice associated with genes responsible for salinity tolerance, exploring new genetic variations, and development of rice cultivars with strong tolerance to salinity through molecular breeding.	Kerala Agricultural University, Kerala
31	Developing rust resistant genotypes in JL 24 and TMV 2 varieties of groundnut by marker assisted transfer of QTL	University of Agricultural Sciences, Dharwad
32	Marker-assisted introgression of Pup1 into elite rice varieties	ICAR-Indian Institute of Rice Research, Hyderabad
33	Engineering Broad Spectrum Resistance against Gemini viruses	Jawaharlal Nehru University, New Delhi
34	Development of low sinapine mustard ( <i>Brassica juncea</i> ) lines through antisense and RNAi technology	University of Delhi South Campus New Delhi
35	Metabolic Engineering of Phytic Acid Pathway for Improving Iron Bioavailability in Wheat	National Agri-Food Biotechnology Institute (NABI), S.A.S.Nagar, Mohali
36	Marker Assisted breeding for development of gynocious Indian cucumber line	IARI, New Delhi
37	Diversification of canola quality traits to some important Indian cultivars of Brassica juncea through marker-assisted backcross breeding	University of Delhi South Campus, New Delhi
38	Marker-assisted introgression of Pup1 into elite rice varieties	ICAR-Indian Institute of Rice Research, Hyderabad
39	Genetic engineering of sugarcane for water deficit stress tolerance	Sugarcane Breeding Institute, Coimbatore, Tamilnadu
40	Development of haploid-inducer lines of Brassica juncea through genetic engineering of centromere histone protein	National Research Centre on Plant Biotechnology, New Delhi
41	Symmetric somatic hybridization for late blight resistance in potato ( <i>Solanum tuberosum</i> L.)	Central Potato Research Institute, Shimla
42	Developing rust resistant genotypes in JL 24 and TMV 2 varieties of groundnut by marker assisted transfer of QTL	University of Agricultural Sciences, Dharwad
43	Marker assisted improvement of popular maintainer and restorer lines of rice for tolerance to abiotic stresses	Indian Institute of Rice Research, Hyderabad
44	Identification of host factors conferring natural resistance in paprika, red chillies and green chillies against chilli leaf curl virus	Jawaharlal Nehru University, New Delhi
45	Erucic acid profiling and Introgression of low erucic acid trait in desirable cultivars of <i>Brassica juncea</i> L.	Sher-E-Kashmir University of Agricultural Sciences & Technology of Jammu

46	Understanding molecular mechanism of sheath blight resistance in rice	TERI, New Delhi
47	Enhancement of starch accumulation and grain filling by dual specificity protein phosphatase AtDSP4 in Arabidopsis and OsPP42 in rice	Delhi University, South Campus, Delhi
48	Cross talk between phosphorus and iron in the maintenance of nutrient homeostasis in plants	NRCPB, New Delhi
49	Understanding heat and drought tolerance mechanism in lentil ( <i>Lens culinaris</i> Medik.) and its improvement by over-expression of antioxidant genes.	Bihar Agriculture College, Bihar Agricultural University, Bhagalpur
50	Comparative genome and transcriptome analysis of Magnaporthe (Blast Fungus) isolates from rice and non- rice hosts.	M.S. University of Baroda, Fatehgunj, Baroda
51	Expression Analysis of Galactomannan Biosynthesis Pathway Genes in Cluster Bean ( <i>Cyamopsis tetragonoloba</i> L) through Transcriptome Sequencing	Guru Jambheshwar University of Science & Technology, Hisar
52	Enrichment of Vitamin E in Sesamum oil by transgenic approach	Bharathidasan University, Tiruchirappalli, Tamil Nadu
53	Functional Genomics of Thermal Stress Tolerance in Indian Wheat	University of Delhi South Campus, New Delhi
54	Engineering rice for resistance to major lepidopteran pests using a novel synthetic cry2AX1 gene	Tamil Nadu Agricultural University, Coimbatore
55	Biofortification of long chain polyunsaturated fatty acids in peanut by metabolic engineering of fatty acid biosynthetic pathway	ICRISAT, Hyderabad, Andhra Pradesh
56	Mapping of QTLs for beta carotene in pearl millet ( <i>Pennisetum glaucum</i> (L.) R. Br)	Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
57	Harnessing favorable QTL of wild and exotic germplasm for yield contributing traits in lentil using advanced backcross QTL analysis	Indian Institute of Pulses Research, Kanpur
58	Marker Assisted Breeding for Developing Early Maturing versions of Popular Rice Varieties of Tamil Nadu	TANU, Coimbatore
59	DNA Marker Assisted Mapping of Anthracnose Resistance in Chilli ( <i>Capsicum annum</i> L.).	University of Agricultural Sciences, GKVK, Bangalore
60	Understanding the molecular intricacies of Rice-Rhizoctonia interactions	National Institute of Plant Genome Research, New Delhi
61	Improvement of Biscuit Making Quality of Indian Wheats Utilizing Molecular Approach - Phase II	Directorate Of Wheat Research, Karnal, Haryana
62	Characterization and molecular mapping of aphid ( <i>Rhopalosiphum maidis</i> Fitch.) resistance in barley.	Punjab Agricultural University, Ludhiana, Punjab
63	Development of high yielding gall midge resistant rice varieties through marker assisted pyramiding of multiple gall midge resistance genes	PJTSAU, Hyderabad
64	Marker aided incorporation of major genes conferring resistance to blast disease into genetic background of high altitude temperate rice ( <i>Oryza sativa</i> L.)	Sher-e-Kashmir University of Science and Technology, Khudwani
65	Development of F1-Hybrid Cotton using Novel Reversible Male Sterility System	National Botanical Research Institute, Lucknow, UP
66	Development of sorghum genotypes suitable for lignocellulosic biofuel production through marker-assisted gene pyramiding of brown midrib genes	Directorate of Sorghum Research, Hyderabad
67	Marker Assisted Introgression of QTLs Controlling Heat Tolerance related traits into elite rice genotypes of Tamil Nadu for adaptation to climate change.	Tamil Nadu Agricultural University, Coimbatore
68	Marker assisted improvement of rice variety Pusa 44 for phosphorus use efficiency	<b>Indian Agricultural Research Institute, New Delhi</b>
69	Development of GA-sensitive semi-dwarf high yielding climate resilient wheat utilizing Marker assisted background selection	Punjab Agricultural University, Ludhiana, Punjab

70	Development of semi-dwarf blast and bacterial blight resistant version of Ranbir Basmati by marker assisted backcross breeding	SKUAS&T, Jammu CSK Himachal Pradesh Agricultural University, Palampur
71	Emergence of Tobacco streak virus infecting Cotton: Investigations on transmission, spread and symptom remission.	Tamil Nadu Agricultural University, Coimbatore
72	Development of high yielding salt - tolerant rice varieties through marker assisted backcross breeding and its dissemination in salt-affected areas of India	Narendra Deva University of Agriculture & Technology, Kumarganj, U.P
73	Development of shoot fly resistant sorghum varieties suitable for Tamil Nadu through marker - assisted selection	Tamil Nadu Agricultural University, Coimbatore
74	Whole genome sequence based SSR markers development in mungbean and their utilization in mapping of Yellow Mosaic Disease resistance in an interspecific cross	Punjab Agricultural University, Ludhiana
75	Fine mapping of Co-Ind gene in common bean land race KRC5 possessing resistance to different races of Colletotrichum lindemuthianum	CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur
76	Programme Support for R&D in agricultural Biotechnology-phase-II Programme at G.B. Pant University of Agriculture and Technology, Pant Nagar	G.B. Pant University of Agric. & Tech., Pantnagar, Uttarakhand
77	Program Support for Research and Development in Agricultural Biotechnology-Phase-II	Tamil Nadu Agricultural University, Coimbatore
78	Pyramiding multiple resistance genes (Ty,Ph and Mi) in high yield varieties of tomato through, h MAS	PAU, Ludhiana
79	Exploitation of resistance gene derived markers (GDMs) for the development of blast and bacterial blight resistant version rice var. HPR2143	CSK Himachal Pradesh Agricultural University, Palampur
80	Integrated MAS to develop groundnut varieties for resistance to foliar fungal diseases and improved and quality	TNAU, Coimbatore
81	Marker assisted introgression of bacterial leaf blight resistance in popular land races of Andaman and Nicobar Islands	Central Agricultural Research Institute, Andaman and Nicobar Islands
82	Mapping of the stem rot resistant gene (s) in groundnut and its transfer to an elite groundnut cultivar	Directorate of Groundnut Research, Junagadh, Gujarat
83	Development of rice varieties for Kerala with pyramided genes for Resistance to BLB by marker assisted selection	Kerala Agricultural University, Trivandrum Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram, Kerala
84	Marker assisted selection for phytophthora and powdery mildew resistance and effective nodulation in soybean (Glycine max L. Merr.)	Tamil Nadu Agricultural University, Coimbatore
85	National containment/Quarantine facility for transgenic planting material	NBPGR, New Delhi
86	Incorporation of biotic stress resistance gene(s) in the genetic background of Pusa Basmati 1509 through marker assisted backcross breeding	Indian Agricultural Research Institute, New Delhi
87	Marker Assisted Introgression of Tomato Spotted Wilt Virus (TSWV) resistance into Indian tomatoes	Sri Konda Laxman Telangana State Horticulture University, Hyderabad
88	Finding Natural Allelic Variants for Yield Related Genes in Rice	Acharya NG Ranga Agricultural University, Tirupati
89	Marker-assisted introgression of yield-enhancing genes to increase yield potential in rice	Directorate of Rice Research, Hyderabad Central Rice Research Institute, Cuttack
90	De Novo Genome Sequencing of Karnal Bunt (TilletiaIndica) Pathogen of Wheat: Characterization of Pathogenicity Genes/Proteins for Development of Diagnostics	G. B. Pant University of Agriculture & Technology, Pantnagar
91	Generation and comparative analysis of salinity responsive miRNAs and miRNA-mediated pathways of halophyte (Oryzacoartata) and a tolerant glycophyte (Oryzasativa cv Nonabokra)	National Research Centre on Plant Biotechnology, New Delhi

92	Engineering the nodulation signaling pathway in rice plant to promote rhizobial infection and nitrogen-fixing symbiosis	The Energy and Resources Institute, New Delhi
93	Coexpression of stress responsive transcription factor genes MuNAC4, MuMyb96 and MuWRKY3 in groundnut ( <i>Arachishypogaea</i> L.) for enhanced drought tolerance.	Sri Krishnadevaraya University Anantapur
94	Understanding genetic control of cold acclimatization in chickpea ( <i>Cicer arietinum</i> L) anthers and devising strategies to minimize losses due to cold stress	CSK HP Agricultural University, Palampur Panjab University, Chandigarh
95	Isolation, functional characterization and evaluation of water deficit stress tolerance responsive genes from high drought tolerant <i>Erianthusarundinaceus</i> by comparative drought transcriptome analysis	Sugarcane Breeding Institute, Coimbatore
96	Development of chromosomal segmental substitution lines for 5U chromosome of <i>Ae. triuncialis</i> for transfer and mapping of multiple disease resistance and grain softness in elite wheat background	Punjab Agricultural University, Ludhiana
97	Genome wide association study in <i>Phaseolus vulgaris</i> – <i>Colletotrichum lindemuthianum</i> pathosystem	SKUSAT, Shalimar, Srinagar
98	Development of genetic stocks for maturity and growth habit genes in soybean ( <i>Glycine max</i> (L.) Merr.)	Indian Institute of Soybean Research, Indore, Madhya Pradesh
99	Understanding the role of TAL effectors of <i>Xanthomonasoryzaepv. oryzae</i> in modulating rice innate immune response to cause bacterial blight.	Indian Agricultural Research Institute, Delhi, New Delhi
100	Improving oil quality and productivity through molecular breeding in groundnut	University of Agricultural Sciences, Dharwad, Karnataka
101	Development of an on-site diagnostic kit for Cardamom mosaic virus	Madurai Kamraj University
102	Or' gene introgression for enhancing-B carotene in Indian cauliflower using marker assisted backcross breeding	Indian Agricultural Research Institute, New Delhi
103	Molecular characterization and development of user friendly on site detection kit (lateral flow device) for Banana top virus (BBTV) infecting banana	Sharda University Uttar Pradesh, Greater Noida

### B. Network Projects

1. Centre for Advanced Research and Innovation on Plant Stress and Developmental Biology	University of Delhi South Campus, New Delhi
2. Marker Assisted Introgression of Different Traits to Develop New Generation Rice Varieties	International Rice Research Institute (IRRI) South Asia Rice Breeding Hub (ICRISAT) Patancheru 502324, Andhra Pradesh, India
	Directorate of Rice Research (DRR), Hyderabad
	Punjab Agricultural University, Ludhiana, Punjab
	Tamil Nadu Agriculture University, Coimbatore
	Indira Gandhi Krishi Vishwavidyalya, Raipur
3. Challenge Programme on Chickpea Functional Genomics	National Institute of Plant Genome Research, Delhi
<b>Sub project 1:</b> Exploring transcriptome dynamics of chickpea development for candidate gene discovery and defining regulatory elements/modules	National Institute of Plant Genome Research, New Delhi
<b>Sub Project 2:</b> <i>Functional genomics of stress tolerance in chickpea</i> <b>Subproject 2A:</b> Functional analysis of candidate abiotic stress responsive genes	National Institute of Plant Genome Research, Delhi
<b>Subproject 2B:</b> Understanding genetic and molecular basis of <i>Ascochyta</i> blight resistance in chickpea	National Institute of Plant Genome Research, Delhi

<b>Sub Project 3: Functional genomics of chickpea seed development and nutrition</b> <b>Subproject 3A: Understanding seed nutrient dynamics by system biology approach</b>	National Institute of Plant Genome Research, Delhi
<b>Subproject 3B: Dissecting molecular mechanisms involved in chickpea seed Development</b>	National Institute of Plant Genome Research, Delhi
4. Screening iron, zinc and carotenoid bioavailability from biofortified staple crops using coupled in vitro digestion/ Caco-2 cell model	National Institute of Nutrition, Hyderabad, Telangana Indian Institute Of Technology, Roorkee, Uttarakhand Eternal University, Nahan, Himachal Pradesh
5. Analysis of diversity in yield component (seed size and weight) transcriptome and epigenome levels for association/genetic mapping of selected loci and chickpea.	NIPGR, New Delhi
6. Enrichment of nutritional quality in maize through molecular breeding	Indian Agricultural Research Institute New Delhi Tamil Nadu Agricultural University, Coimbatore Punjab Agricultural University, Ludhiana, Punjab
7. Improvement of end use quality of 1BL/1RS translocation containing wheat varieties by removing of Sec-1 loci and retaining Glu-B3 using marker assisted back cross breeding (MABB).	Agharkar Research Institute, Pune, Maharashtra Eternal University, Nahan, Himachal Pradesh Punjab Agricultural University, Ludhiana, Punjab
8. Genetic Dissection of Heat Tolerance in Wheat Using Multiple Bi-parental RIL Mapping Populations	G.B. Pant University of Agriculture & Technology, Pantnaga, U.S. Nagar SKUAST-J, Chatha, Jammu Banaras Hindu University, Varanasi
9. Maintenance, Characterization and Use of EMS Mutants of Upland Variety Nagina 22 for Functional Genomics in Rice – Phase II	Indian Agricultural Research Institute, New Delhi NRCPB, Pusa Campus, New Delhi Tamil Nadu Agriculture University, Coimbatore University of Agricultural Sciences (UAS), Bangalore Indian Institute of Rice Research Hyderabad Central Rice Research Institute, Cuttack, Odisha
10. Functional Characterization of Genetic and Epigenetic Regulatory Networks Involved in the Reproductive Development in Rice	University of Delhi South Campus, New Delhi and President, National Academy of Sciences University of Delhi South Campus (UDSC), New Delhi Indian Institute of Science (IISc), Bangalore Osmania University, Hyderabad Indian Institute of Science Education and Research, CET Campus, Kulathur National Centre for Biological Sciences, GKVK Campus, Bangalore
11. Marker Assisted Elimination of off-flavour generating lipoxygenase-2 gene from kunitz trypsin inhibitor free soybean genotypes	Directorate of Soybean Research, Indore, Madhya Pradesh Indian Agricultural Research Institute, New Delhi Agharkar Research Institute, Pune, Maharashtra
12. Marker Assisted Pyramiding Of Apr And Seedling Resistance Genes For Durable Rust Resistance in Wheat ( <i>Triticum Aestivum L.</i> )	G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand Indian Agricultural Research Institute, RS, Wellington Indian Agricultural Research Institute, New Delhi



13. Development of high yielding eater and labour saving rice varieties for dry direct seeded aerobic conditions utilizing recent discoveries on traits, QTLs, genes and genomic technologies	ICRISAT-IRRI
	CRRI, Cuttack
14. Development of consensus genetic linkage map for Gossypium L. spp. with SNP markers and QTL analysis for fiber traits	CSIR-National, Botanical Research Institute, Lucknow
	University of Agricultural Sciences, Dharwad, Karnataka
	Central Institute for Cotton Research, Nagpur
	Tamil Nadu Agricultural University, Coimbatore
15. Characterization, Race Profiling and Genetic Analysis of Wheat Powdery Mildew Pathogen ( <i>Blumeria graminis</i> f. sp. <i>tritici</i> (DC) Speer (Syn. <i>Erysiphe graminis</i> DC f. sp. <i>tritici</i> ) in India.	Indian Agricultural Research Institute, New Delhi TNAU, Coimbatore, Tamilnadu.
	Directorate of Wheat Research, RS, Shimla, HP Indian Agricultural Research Institute, RS, Shimla, HP
16. Pyramiding of Rust Resistance Genes into High Grain Quality Wheat Lines Developed Through Marker-assisted Selection	PAU, Ludhiana
	ARI, Pune
	BHU, Varanasi
	CCSU, Meerut
	GBPUAT, Pantnagar
17. From QTL to Variety: Genomics-Assisted Introgression and Field Evaluation of Rice Varieties with Genes/QTLs for Yield under Drought, Flood and Salt stress	National Research Centre On Plant Biotechnology Pusa, New Delhi, Delhi, 110012
18. Marker-Assisted Breeding and Mapping of QTLs for Drought Tolerance in Wheat.	Indian Institute of Wheat & Barley Research, Karnal Indian Agricultural Research Institute, New Delhi Ch. Charan Singh University, Meerut
19. Development of micronutrient enriched maize through molecular breeding - Phase II	VPKAS, Almora, Uttarakhand
	Indian Agricultural Research Institute, New Delhi
	CSK HPKV, Hill Agricultural Research and Extension Centre, Bajaura, Distt. Kullu (H.P.)
	ANG Ranga Agricultural University, Rajendranagar.
20. Cloning and Characterization of Genes Expressed in Response to Leaf Rust Infection in Bread Wheat	Chaudhary Charan Singh University
	CCSU, Meerut -
	Directorate of Wheat Research, RS, Shimla IARI, New Delhi
21. Rice bio-fortification with enhanced iron and zinc in high yielding non-basmati cultivars through marker assisted breeding and transgenic approaches- Phase II	M.S. Swaminathan Research Foundation, Chennai
	Tamil Nadu Agricultural University, Coimbatore
	Inidra Gandhi Krishi Vishwavidyalaya, Raipur
	University of Agricultural Sciences, Bangalore
	Indian Institute of Rice Research (IIRR), Hyderabad
22. Bio-fortification of wheat for micronutrients Through conventional and molecular approaches-Phase II	Indian Agricultural Research Institute, New Delhi
	Punjab Agricultural University, Ludhiana, Punjab
	Eternal University, Baru Sahib (HP)
	G B Pant University of Agriculture and Technology, antnagar (Uttarakhand)
	Agharkar Research Institute, Pune
	Indian Agricultural Research Institute, RS, Indore
	Indian Institute Of Technology, Roorkee, Uttarakhand
	Eternal University, Baru Sahib, Nahan, HP
	Ch. Charan Singh University, Meerut- 250 004
	Punjab Agricultural University, Ludhiana, Punjab
23. Mobilizing QTL/Gene s for quality Traits into High Yielding Wheat Varieties Through Marker-Assisted Selection	G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand
	Banaras Hindu University, Varanasi-221 005
	Agharkar Research Institute, Pune-411004

### C. Centre of Excellence Projects

1	Centre of Excellence on Germplasm Enhancement for Crop Architecture and Defensive Traits in <i>Brassica juncea</i> L. Czern and Coss.	Punjab Agricultural University, Ludhiana
2	Centre of Excellence on Genome mapping and molecular breeding of Brassicas (Phase	University of Delhi South Campus, New Delhi
3	Programme Support on enhancing durability of resistance to biotic stresses in selected cereal and fiber crops through biotech approaches	Punjab Agricultural University, Ludhiana – 141004
4	DBT Programme Support on development of sheath blight disease resistant transgenic rice: Resistance tests in PR-protein-expressing transgenic rice and discovery of new RNA silencing strategies	Madurai Kamaraj University, Madurai-Tamil Nadu.
5	Programme Support on Translational Research on Transgenic Rice (Phase II)	University of Calcutta, 35 Ballygunge Circular Road, Kolkata
6	Programme Support for Developing Resilient Rice through Genomics	Tamil Nadu Agricultural University (TNAU), Coimbatore
7	Biotechnological approaches to improve nutritional and post-harvest quality, drought tolerance and pathogen resistance in edible crops (for Project 1, 2 & 3)	National Institute of Plant Genome Research, New Delhi
8	Integration of plant and parasite omics to decipher the interactions and identify molecular targets for the management of root knot disease of rice	IARI, New Delhi.

\*\*\*\*\*

**Annexure-II****[Parts (c) & (d) and (e) of Lok Sabha USQ No. 5891 for 03/04/2018]****Funds released to the ICAR Institutes/projects for Plant Biotechnology research across the country during 2015-16 to 2017-18**

Name of Institute/Project	No. of centres	Budget (Rs. lakhs)			
		2015-16	2016-17	2017-18	Total
NRC on Plant Biotechnology	1	1542.91	1426.06	1452.00	<b>4420.97</b>
Network Project on Transgenic in Crops	20	749.99	445.95	308.00	<b>1503.94</b>
IIAB, Ranchi	1	200.00	231.55	223.30	<b>654.85</b>
CRP on Molecular Breeding	20	498.00	394.57	350.00	<b>1242.57</b>
CRP on Hybrid Technology	26	399.00	447.97	450.00	<b>1296.97</b>
CRP on Agrobiodiversity	64	716.00	570.00	200.00	<b>1486</b>
CRP on Bio-fortification	35	564	450	450	<b>1464</b>
Incentivizing Research in Agriculture	32	3000.00	2250.00	981.85	<b>6231.85</b>
<b>Total</b>		<b>7669.9</b>	<b>6216.1</b>	<b>4415.15</b>	<b>18301.15</b>

\*\*\*\*\*

**Technologies developed during last 3 years**

1. The ArborEasy™ DNA Isolation Kit was developed. The kit provides an indigenous, non-biohazardous, low cost spin column based system for isolation of plant genomic DNA from wide range of tissue types, specifically challenging tissues from tree species. The protocol involves quenching of polyphenols, polysaccharides and other bio-contaminants to facilitate high recovery of un-degraded genomic DNA. The kit has been validated in different tree and crop tissues by various national laboratories.
2. Nutritionally improved cauliflower using 'Or' gene introgression for enhancing  $\beta$ -carotene has been developed (via marker assisted backcross breeding). This is an important attempt to tackle beta- carotene deficiency related malnutrition problem in the country.
3. A diagnostic kit for the onsite detection and identification of Banana Bunchy Top Virus (BBTV) Diagnostic kit developed for onsite detection of Banana Bunchy top Virus. This method is much rapid, user friendly and easy to perform with bare minimum facility as compared to other techniques available for Banana bunchy top virus. Further the kit is under evaluation with a private firm and a Patent application has also been filed.
4. A diagnostic kit developed for the on-site detection and identification of Cardamom mosaic virus (CdMV).
5. **Varieties developed using marker assisted selection in different crops:** Following 22 varieties of different crops for various traits have been released and notified and are in the public domain for commercial cultivation by the farmers:

SN.	Crop	Variety	Trait
1.	Rice	IR 64 Drt-1	Drought tolerance
2.		DRR Dhan 42	
3.		Swarna Sub-1	Submergence tolerant
4.		Samba Sub-1	
5.		Pusa 1612	Blast resistance
6.		Pusa Basmati 1637	
7.		Pusa 1609	
8.		Pusa 1592	Bacterial leaf blight resistance
9.		Pusa Basmati 1718	
10.		CR Dhan 800	
11.		Punjab Basmati 3	
12.		Improved Lalat	
13.		Improved Tapaswini	
14.		Pusa Basmati 1728	
15.		Imp. SambhaMahshuri	
18.	<b>Wheat</b>	Unnat PBW-343	Yellow and brown rust
19.	<b>Maize</b>	Pusa HM – 8 Improved (AQH - 8),	Tryptophan and lysine
20.		Pusa HM – 9 Improved (AQH – 9),	
21.		Pusa HM – 4 Improved (AQH – 4),	
22.		Pusa Vivek QPM – 9 Improved (APQH – 9)	Provitamin-A, lysine and tryptophan

In addition, a number of genotypes in different crops are in advance stage of evaluation which will be released in due course of time.

6. **Transgenic varieties developed in cotton:** For the first time from public sector Organizations following eight *Bt* cotton (*Gossypium hirsutum*) varieties containing ‘cry1Ac’ gene to protect against bollworm insects and inbuilt tolerance to whitefly and Leaf curl virus disease have been released during 2017 which are higher yielder than their respective checks:

Sr. No.	Varieties/ Hybrids	Maturity (Approx. days)	Average yield (kg/ha)	Area of adaptability
1.	CICR Bt-6 (RS 2013)	150	2234	Irrigated Conditions of Haryana & Punjab
2.	ICAR-CICR GJHV 374 Bt	150	2525	Maharashtra
3.	ICAR-CICR PKV 081 Bt	150	2476	Maharashtra
4.	ICAR-CICR RajatBt	150	2283	Maharashtra & South Rajasthan
5.	ICAR-CICR SurajBt	150	2149	Maharashtra, Gujarat, Madhya Pradesh
6.	ICAR-CICR Bt 9	150	2934	Maharashtra
7.	ICAR-CICR Bt 14 (CPT 2)	150	2699	Maharashtra
8.	PAU Bt 1	160-165	2752	Punjab & Rajasthan

7. **Transgenic events in pipeline:** Present status of field trials and event evaluation for identification of superior events in GM development at various ICAR Institutes in different crops are as under:

Crops and Institutes	Traits/Events
1. ICAR-Indian Institute of Millet Research, Hyderabad – <b>Sorghum</b>	Evaluation of <b>one</b> event for resistance to stem borer (BRL-I trials)
2. ICAR-Indian Institute of Pulses Research, Kanpur – <b>Pigeonpea</b>	Evaluation of <b>five</b> events for resistance to pod borer
3. ICAR-Indian Institute of Pulses Research, Kanpur – <b>Chickpea</b>	Evaluation of <b>five</b> events for resistance to pod borer
4. ICAR-Central potato research Institute, Shimla - <b>Potato</b>	Evaluation of <b>five</b> events for potato apical leaf curl virus resistance
5. ICAR-Indian Institute of vegetable Research, Varanasi – <b>Brinjal</b>	Evaluation of <b>eight</b> events for resistance to fruit and shoot borer
6. ICAR-Indian Institute of vegetable Research, Varanasi – <b>Tomato</b>	Evaluation of <b>eight</b> events for resistance to fruit borer
7. ICAR-Indian Institute of vegetable Research, Varanasi – <b>Tomato</b>	Evaluation of <b>two</b> events for tolerance to drought, heat and salt stress
8. ICAR-National Research Centre on Plant Biotechnology, New Delhi - <b>Pigeonpea</b>	Evaluation of nineteen events for resistance to pod borer

\*\*\*\*\*