The demand of flowers and ornamental plants is increasing day by day and a large number of people in India earn their livelihood by either producing or marketing flowers and ornamental plants. Floriculture business is expanding rapidly worldwide. Recognizing the importance of ornamental plants in general and floriculture in particular, Council of Scientific and Industrial Research (CSIR) initiated a major network programme on floriculture at National Botanical Research Institute (NBRI), Lucknow. Research and development projects were started with the main objective of promotion of floriculture in India. All research and developmental activities on floriculture are essentially multi-disciplinary in nature and based on a conscious effort to interlink science and society to promote sustainable development of floriculture. The main objective and efforts have been made to take the research from laboratory to the field so that it can be applied at the grassroot level for the benefit of the society. A long concentrated efforts of CSIR has so far resulted in a number of success stories and the effort in this direction is continuing. The primary objective of the article is to give a coherent and concise account of all floriculture work done at CSIR-NBRI with an emphasis on recent developments.

Floriculture is a fast emerging and highly competitive industry. It is one of the important high value agricultural industries in many countries of the world. Floriculture, now, is an important sector of horticulture which provides the livelihood security to small and marginal farmers besides providing ample opportunities for domestic and export markets. Floriculture is developing as an area of high technology based frontier interdisciplinary area on scientific excellence. Floriculture business covers all aspects related to germplasm, cut flowers and foliage, dry flowers and plant parts, potted flowering and foliage plant, flower seeds, bulbs, tubers, corms, tissue culture plants, sapling (trees, climbers, shrubs and herbaceous plants), essential oil, concrete, attar and flower perfumes, floral pigments, landscaping, floral ornaments and arrangements, garlands, veni, bouquets and even hiring of potted plants etc.

Established in 1942, the Council of Scientific and Industrial Research (CSIR) is an autonomous Society. CSIR is amongst the foremost and largest publicly funded scientific and industrial research organizations in the world. CSIR-National Botanical Research Institute (NBRI), Lucknow is one of the pioneer and leading research institutions in India where extensive work is going on both basic and applied aspects for the improvement of floriculture for over more than 50 years. All research and developmental activities of the institute are essentially multi-disciplinary in nature recognizing local issues as well as country issue. CSIR-NBRI has been working on a multidisciplinary research programme and has made a significant contribution towards promotion of floriculture in the country. A number of classical and modern techniques have been standardized for development of crop wise agro-
technology and techno-economic data, new and novel varieties, micropropagation for development of large scale quality planting materials, characterization of germplasm, dehydration of flowers, training packages etc. CSIR-NBRI also promotes plant-people centric out-reach and extension activities aimed at rural development and empowerment of rural women and farmers through training and capacity building in floriculture. This article presents a complete scenario on floriculture activities at CSIR-NBRI, so that innovations made so far can be used judiciously for the development of this sector. Monumental literature have been developed by NBRI and it provides an illustrated horto-taxonomical account of important ornamental species and cultivars, germplasm status and their usages, propagation, nursery management, techno-economics, conventional breeding, induced mutagenesis, new varieties, cytogenetics, tissue culture, characterization of varieties, management of disease, dehydration of flowers, training packages etc.

Results: NBRI is situated in the heart of the great Gangetic plain, Lucknow city. Lucknow is one of the subtropical region placed in the North East of Uttar Pradesh State of India situated at 80°59’E longitude and 26°55’N latitudes at an altitude of 112 meters above sea level. CSIR-NBRI is a multi-disciplinary plant research centre equipped with state-of-art laboratories of international repute, undertaking basic and applied R&D programmes in several strategically important emerging and innovative areas of plant sciences 1-5. Summary of Aims and Objectives of Floriculture Research of CSIR-NBRI are:

Germplasm Collection: *Acclimatization, *Characterization-Morphological, Anatomical, Palynological, Cytological, Biochemical, Fingerprinting, *Screening, *Assessment, *Agrotechnology; Crop Familiarity; Nursery Management; Horto-Taxonomy; Improvement [*Conventional breeding, *Induced Mutagenesis, *Management of Chimera, *In vitro mutagenesis]; Multiplication and Assessment [*Conventional, *Mist Propagation *Clonal Propagation]; Tissue Culture [*Clonal propagation, *In vitro protocol from different explants, *Acclimatization in non-traditional area, *Management of chimera - Spontaneous mutation, Induced Mutation, *Maintenance of F1 hybrid, *Direct shoot organogenesis, *Direct somatic embryogenesis]; Cytogenetics; Disease Management; Post Harvest Management; Marketing; Dehydration [Dry Flowers]; Societal Interaction [*Training, *Organization of Flower shows].

Germplasm Collection: The main aim of germplasm collection is to develop a national network of genetic resource centre for different ornamentals. It is one of the most significant and paramount activities of CSIR-NBRI in view of the enrichment of germplasm collection and wide genetic base for researchers and plant lovers. Seeds and plant materials have been procured from over 250 Botanic Gardens in India and abroad on exchange basis. CSIR-NBRI is well known for supply of authentic plant materials to other sister organizations within and outside the country for R&D work. CSIR-NBRI has been recognized as a National Reference Centre in respect of Bougainvillaeas, Chrysanthemum and Gladiolus for possessing the largest authentic and well documented germplasm collection of these ornamentals 5,6. Summary of germplasm collections are :

Amaryllis/Hippeastrum (nearly 137 cultivars);
Bougainvillea (approx. 180 species/cultivars comprising both single bracted and double or multibracted varieties);
Gladiolus (approx. 105 cultivars of Indian and exotic origin);
Chrysanthemum [more than 300 cultivars collected from all over India and abroad comprising almost all bloom types and colour]; Rose (approx. 250 cultivars); Canna (approx. 80 cultivars); Lotus (30 Indian and 25 exotic races); Cacti and Succulents (Cacti and succulents at NBRI are grown in specially designed pagoda-shaped glass house sheltering about 500 species/varieties of cacti and succulents); House Plants (it plays very important role in floriculture industry and therefore, house plants have been broadly classified and maintained under different categories - Foliage Type; Variegated Foliage; Flowering Type; For Pot Culture: For Training on Moss Column; For Hanging Basket; Ferns suitable for house plants; Palms suitable for decoration); Ornamental Climbers 5.

Crop Familiarity: For cultivation of ornamental plants knowledge on planting time, soil preparation, cultural practices, storage, forcing, harvesting, postharvest management and all other cultural practices are essential. CSIR-NBRI has developed full packages of all these information on different crops.

Bulbous ornamental crops: Bulbous ornamentals are used for garden beautification and also for cut flowers. Bulbous ornamentals have been categorized as Bulb (Hippeastrum, Tulips, Hyacinths, Daffodils, Muscari, Tuberoses, Lilies, Agapanthus, Iris reticulate), Corm (Gladiolus, Freesia, Crocus, Liatris, Crocosmia), Tuber (Caladium, Gloriosas, Zantedeschia), Rhizome (Alstroemeria, Canna, Lily), Tuberous root (Dahlia, Ranunculus, Hemereocallis), Enlarged Hypocotyl (Cyclamen, Gloxinia, Tuberous begonia), Flowering bulbous (Achimenes, Alstroemeria, Amaryllis, Anthurium, Canna, Cooperia, Crinum, Dahlia, Eucharis, Erycyles, Gladiolus, Gloriosa, Haemanthus, Hedychium,
Hemerocallis, Hippeastrum, Hymenocallis, Nelumbo, Nymphaea, Pancratium, Polyanthus, Sinningia, Zantedeschia, Zephyranthes etc.), **Foliage bulbous** : (Alocasia, Asparagus, Caladium, Calathea, Kaemferia, Sansevieria etc.).

**Annuals** : It plays very important role in floriculture trade. Information on classification of annuals according to use, designing and colour scheme, cultivation, pest and disease management, pot culture, commercial use etc. have been compiled.

**Seasonal (Annual) Plants** : Annuals are roughly put under following three groups :

**Summer seasons** (Coreopsis tinctoria, C. drummondii, Cosmos sulphureus, Gaillardia pulchella, Helianthus annus, Kochia scoparia trichophylla, Portulaca grandiflora, Rudbeckia biocolour, Tithonia rotundifolia, T. speciosa); **Rainy seasons** (Amaranthus, Impatiens balsamina, Celosia argentea, C. sulphureus, Gaillardia purchella, Gomphrena globosa, Marigold - Jafari, Frenchmarigold, Hazara, African Marigold, Tagetes patula; Mirabilis jalapa, Torenia fournieri, Tithonia rotundifolia, Zinnia elegans) and **Winter seasons** (Aster, Carnation, Statice and Cineraria).

**Winter Seasons Annuals** : This is most important group and used for different purpose :

**Annual Creeper** (Clitoria ternateae, Pharbitis purpurea, Quamoclit lobata, Tropaeolum majus, Lathyrus odoratus, Thunbergia alata); **Annuals Suitable for pots** (Ageratum, Antirrhinum, Aster, Balsam, China aster, Annual Carnation, Calendula, Petunia, Gazania, Pansy, Senecio, Cock’s comb, Cineraria, Clarkia, Clianthus, Lupin, Marigold, Nasturtium, Petunia, Nemesia, Brachycome, Phlox, Salvia, Marigold, Mesembryanthemum, Godetia, Matricaria, Sweet alyssum, Verbena, Dianthus, Sweet William, Viola, Arctotis, Dimorphotheca, Linaria, Portulaca, Wall flower, Kochia, Daisy, Eschscholzia, etc.) and **Annuals Suitable for cut flowers** (China aster, Annual Carnation, Cornflower, Stocks, Clarkia, Gypsophila, Statice, Lupin, Antirrhinum, Bells-of-Ireland, Sweet Sultan, Annual Chrysanthemum, Dianthus, Gomphrena, Gaillardia, Pimpinella, Calendula, Larkspur, Candytuft, etc.).

**Nursery Management** : To start floriculture activities/ business one should develop basic knowledge on different cultural practices/ operations related to floricultural crops. NBRI has developed full package and practices on Plant Propagation Techniques and Cultural Operations. Different floricultural crops are propagated/multiplied by different means like sexual propagation (by seeds), asexual propagation (cuttings, layering, grafting, budding) and micropropagation :

**Asexual/Vegetative Propagation** : Cuttings (Stem Cuttings, Softwood cuttings, Hardwood cuttings, Leaf Cuttings, Ground Layering, Air Layering, Divisions); Bulbs and Corms; Tubers and Rhizomes; Grafting; Root Stocks; Pruning; Budding; Pinching (Soft pinching –Hard pinching –Disbudding and Dis-shooting); De-suckering; Preparation of Cuttings and Suckers; Staking; Sterilization; Preparation of Earthen Pots and Thalis; The Art of Training (Chrysanthemum – Standard, Sen Rin Tsukuri, Bush Form, Pot-Mums, Cascade Form, Coniform, Fan Form); Hedge Preparation; Edge Plants; Topiary; Preparation of Lawn; Bonsai; Seed Production; Seed Sowing; Potting Mixture.

**Hortorium Taxonomy** : Characterization and documentation of ornamental germplasm are one of the major activities of CSIR-NBRI. Horto-taxonomical study deals with the fixity of names to the cultivars according to the rules of ‘International Code of Nomenclature for Cultivated Plant’, their detailed morphological account including ancestry, habit, growth, flowering behaviour, affinities with colour illustrations and their usage. Considering the importance of characterization and identification of plants, a number of classical and modern techniques have been standardized and intense R & D activities are going on at NBRI on this subject in different areas on high scientific excellence.

**Characterization** : Characterization of Bougainvillea (75 cultivars), Rose (80 cultivars), Chrysanthemum (250 cultivars), Gladiolus (100) etc. on the basis of different cytomorphological and biochemical characters have already been completed. Different characters have been identified for preparation of description list of different ornamentals like : Bract Colour, Bract Size, Flower Size, Leaf Colour, Leaf Size, Number of Branch, Number of Leaf, Shape of the Leaf Apex, Number of Spine, Size of Spine, Stem Colour, Stomatal Index, Moisture Content of Bracts, Pollen Grain Sterility, Pollen Grain Size, Pollen grain ornamentations, Chlorophyll Content of Leaves, estimation of carotenoids, Phenolic Compounds in Leaves, Phenolic Compounds in Bracts, Bract Pigment etc.

**Passport Data of Germplasm** : NBRI has prepared passport data of entire ornamental germplasm. This is a permanent record giving brief description and other details of the varieties. Following is a model example of passport data :

**Ganus** : *Chrysanthemum morifolium* Ramat.

Name of variety : ‘Cosmonaut’
Form : Small flowered, Anemone type  
Colour : White  

Source & date of collection : Gamma ray induced (1.5 & 2.0 Krad), The experiment was conducted during August 1980 and the mutant was detected in M1V1.

Salient characters : Mutant of ‘Nirmod’, a small, white, Korean type cultivar.

Name of the person: NBRI, Datta, S.K. and Gupta, M.N. 1984

**Cosmonaut**

**Registration of New Varieties : Rose** : Following gamma ray induced mutants have been Registered with the International Registration Authority For Roses (IRAR), the American Rose Society, USA (Ref. American Rose Annual, 1985, pp. 197, 201, 205) : 1. SHARADA : Mutant of ‘Queen Elizabeth’. 2. SUKUMARI : Mutant of ‘America’s Junior Miss’. 3. YELLOW CONTEMPO : Mutant of ‘Contempo’. 4. TANGERINE CONTEMPO : Mutant of ‘Contempo’.

**Bougainvillea** : Following gamma ray induced mutants have been registered to the International Bougainvillea Registration Society, Division of Floriculture & Landscaping, Indian Agricultural Research Institute, New Delhi : 1. ‘Arjuna’ - Mutant of ‘Partha’. 2. ‘Mahara variegata’ - Mutant of ‘Mahara’. 3. ‘Pallavi’ - Mutant of ‘Roseville’s Delight. 4. ‘Los Banos Variegata’ - Mutant of ‘Los Banos Beauty’. 5. ‘Los Banos Variegata Jayanthi’ – Mutant of ‘Los Banos Variegata’.

**Dahlia** : One variety developed through breeding has been registered with The Royal Horticultural Society, International Registration Authority for the genus Dahlia : 1. ‘NBRI’S PINKI’.  

All gamma ray induced mutant varieties of different ornamentals have been reported at Mutant Database of International Atomic Energy Agency, Vienna from time to time 5,10.

**Patent** : NBRI has patented one chrysanthemum variety : ‘Mother-Teresa’ (Datta, S.K. 1997) : Selection from an open-pollinated seedling. Anemone type mini chrysanthemum, No Pinch No Stake type, dwarf, bushy, compact, round shaped, profuse blooming habit in early December. Flowers small, white. Suitable for mini culture.

**Characterization of Germplasm / Hybrids, Varietal identification, mutants and assessment of genetic relationships using RAPD markers** : Correct identification of new hybrids is extremely important to protect plant breeders’ rights for commercial exploitation. Use of molecular markers in addition to the classical methods provides more positive identification of new varieties. Random Amplified Polymorphic DNAs (RAPDs) analysis has been used to characterize genotypes of known and unknown origin and to measure genetic relationships among the hybrids and mutant varieties. Work already completed on : Hippeastrum (24 varieties); Bougainvillea cultivars at intra- and inter-specific levels (92 cultivars); Chrysanthemum (250 cultivars - Mini Chrysanthemum cultivars; mutants and germplasm); Rose mutants (18 cultivars)11-16.

**Crop Improvement** : NBRI exploited following methods for development of new varieties : spontaneous mutations, hybrid seed technology, classical breeding, chromosome manipulations, induced mutagenesis, management of chimera, *in vitro* mutagenesis etc. Such studies have facilitated charting out genetic evolutionary race histories of several important crops like Amaranth, Amaryllis, Bougainvillea, Canna, Chrysanthemum, Gladiolus, Hibiscus etc.5,17.

**Breeding** : Voluminous breeding work have been done on different ornamentals at CSIR-NBRI on breeding for development of new and novel varieties. The breeding programme is so extensive and elaborate, it is not possible to highlight on individual crop. Crops included in breeding programme are : Amaranthus, Antirrhinum, Bougainvillea, Gladiolus, Gloriosa, Cannas, Amaryllis/Hippeastrum, Dahlia, Rose, Marigold, Verbena, *Rosa damascena* Mill etc.

**Induced Mutagenesis for Development of New Ornamental Varieties** : For a modern science based and industrialized floriculture there is always demand and necessity for new varieties. CSIR-NBRI is one of the pioneer institutions where commendable work has been done on induced mutagenesis. Appreciable information have been accumulated on different aspects like radiosensitivity, selection of material, methods of exposure to gamma rays, suitable dose of gamma rays, colchicine treatment, recurrent
irradiation, detection and isolation of mutants, commercial exploitation of mutant etc. Crops included under induced mutagenesis programme are - Bougainvillea, Canna, Chrysanthemum, Gerbera, Gladiolus, Rose, Rose – Grussanteplitz, Essential Oil Bearing Roses, Rudbeckia laciniata, Sunflower, Marigold, Tuberose, Portulaca, Dahlia, Hibiscus 17-20.

Management of Chimaera: In mutation breeding, the main bottleneck with vegetatively propagated plants is that the mutation appears as a chimera. Chimera means existence of mutated and non-mutated cells side by side and there is competition between normal and mutated cells i.e. diplontic or intrasomatic selections. The size of the mutant sector varies from a narrow streak on a petal to the entire flower and from a portion of a branch to the entire branch. Many new flower colour/shape mutants, induced by mutagens, are lost due to the lack of a regeneration system from small mutated sectors either in vivo or in vitro. CSIR-NBRI has standardized techniques for the management of such chimeric tissues through direct shoot regeneration from flower petals of chrysanthemum 21-32.

Analysis of Mutants: Mutants are phenotypically different from parental variety only in flower color/shape and leaf variegation. CSIR-NBRI made extensive comparative analysis of original cultivars and their respective induced mutants on cytomorphological, radiosensitivity, anatomical, palynological, biochemical and molecular characters for better and clear understanding of the exact mechanism involved in the origin and evolution of somatic flower colour mutations at molecular level. The analysis included different parameters like Morphological characters (plant height; branch, leaf and flower-head number per plant, floret number per flower-head; size of leaf, flower-head and floret; weight of flower-head and moisture content of the floret); Anatomical characters (stomatal index and size, number of chloroplast/guard cell and palisade cells); Micromorphological characters (petal and leaf epidermal micromorphology); Epidermal (pigment in epidermal cells); Palynological (pollen grain size, sterility, exine ornamentation pattern); Cytological analysis (determination of Ploidy level (Chromosome number), Chromosomal abnormalities, Karyotype, Interphase Nuclear Volume (INV), Interphase Chromosome Volume(ICV) and DNA content); Biochemical analysis (TLC and Spectrophotometric studies of petal pigments) 5.

Screening of ornamentals and development of new varieties suitable for salt affected soil: Information on salt tolerance of different ornamentals is very scanty in India. CSIR-NBRI took initiative for screening different floriculture crops suitable for growing under alkaline soil. Attempt was also made to induce desirable genetic variations through gamma ray induced mutations and selection of strains resistant to alkaline soil. The ultimate approach of CSIR-NBRI was to develop an effective breeding programme so that sodic soil can be exploited more economically through the plantation of various ornamental crops and to induce genetic variability of economic character suitable for stress soil through mutation.

Development of NaCl-tolerant line through shoot organogenesis of selected callus line: Attempt has been made at NBRI to develop stable NaCl-tolerant chrysanthemum plants by selection of NaCl-tolerant callus line and their subsequent differentiation under NaCl stress condition. It would help direct utilization of saline soil meeting the increasing demand of floriculture trade 33,34.

Development of NaCl-tolerant strain in Chrysanthemum through in vitro mutagenesis: Experiment was conducted to develop a NaCl-tolerant chrysanthemum strain in a stable form through in vitro mutagenesis with Ethylmethane sulfonate (EMS) 35,36.

Cytological Studies: A systematic programme of genetics and plant breeding of ornamental plants has been in progress at NBRI. The objectives of the programme are both basic or creative (experimental analysis of the causes of variation and evolution) and applied or productive (experimental synthesis of new and novel variation with better putative parents). Race histories of a number of ornamentals with different genetic systems have been worked out. Evaluation of colchiploids of ornamentals with different genetic systems was being carried out at CSIR-NBRI, with a view to explore the possibility of their introduction in floriculture trade. Different ornamentals included for cytological studies are:

Amaranthus, Amaryllis, Anthurium, Antirrhinum, Balsams, Bougainvillea, Canna, Garden Chrysanthemum, Cockscomb (Celosia cristata), Crinum augustum, Cosmos (Crossandra infundibuliformis), Gerbera, Gladiolus, Gloriosa, Hedychium, Helianthus, Hemerocallis, Hibiscus, Hymenocallis, Lantana, Marigold, Matricaria, Nymphaea, Orchid, Garden Pansy, Pentapetals Rhoeo, Petunia, Phlox, Portulaca, Roses, Sansevieria, Tithonia, Verbena, Zephyranthes, Zinnia 5,37.

Disease Management in Ornamentals: The floriculture industry is being affected due to infection/infestation of virus diseases, resulting in drastic reduction in quality and quantity of flowers. Among various
pathogens, viruses play an important role in the deterioration of ornamental quality of blooms/flowers, which ultimately affects the floriculture trade in India. CSIR-NBRI has done excellent work on disease management of ornamental crops like: Alstroemeria, Begonia, Carnation, Calendula officinalis, Chrysanthemum, Crotons, Dahlia, Freesia, Gerbera, Gladiolus, Hibiscus, Hymenocallis, Iris, Lily, Lisanthus, Marigold, Narcissus, Ornamental Aroids, Orchid, Ornithogalum, Petunia, Pelargonium, Rose, Desert rose (Adenium obesum), Tuberose.

In Vitro (Tissue Culture) Technology: One of the major constraints of floriculture industry is non availability of large scale quality planting materials. Conventional methods of propagation can not meet the increasing demand of propagating materials. Micropropagation is perhaps the most widely used biotechnology tool for large scale propagation of floricultural. CSIR-NBRI has done extensive work on tissue culture of ornamentals. Tissue culture work started with following objectives – Clonal propagation for development of large scale quality planting materials Standardization of in vitro protocol from different explants Acclimatization of ornamentals in non-traditional areas Management of chimera Maintenance of F1 hybrids Direct shoot organogenesis Direct somatic mutagenesis.

Programmed Blooming: Concentrated efforts were made by CSIR-NBRI to classify the leading chrysanthemum varieties into their response group and their sensitivity to photoperiodism for year round programmed blooming. By manipulating the planting date and the light inside the greenhouse, the grower can coordinate the blooming. By manipulating the planting date and the light sensitivity to photoperiodism for year round programmed blooming, chrysanthemum varieties into their response group and their sensitivity to photoperiodism for year round programmed blooming. By manipulating the planting date and the light sensitivity to photoperiodism for year round programmed blooming, chrysanthemum varieties into their response group and their sensitivity to photoperiodism for year round programmed blooming. 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Manipulation of flowering period: Keeping in view the market demand, NBRI has been successful in developing techniques for manipulation of flowering period for commercial purpose - Amaryllis (Early flowering and Delayed flowering); Gladiolus (blooming has been extended from one month to seven months).

Post Harvest Management: Fresh flowers lose their freshness and quality both during travel and also during and after arrangements due to flower specific short vase life. Such deficiencies can be ameliorated through application of nutrient additives to vase water. Preservative solutions: NBRI has standardized use of preservative solutions (holding solution) to increase the vase life of cut flowers like cut Roses, Chrysanthemum, Gladiolus, Bougainvillea, Hippeastrum etc.

Storage of Bulbs/corms/tubers/seeds: NBRI has standardized storage of bulbs/corms under sub-tropical climatic conditions for Gladiolus, Hippeastrum, Tuberose, Marigold, Carnation, Dahlia.

Biochemical approach: Senescence - Senescence is a genetically programmed step wise biochemical changes which varies from flower to flower. Extensive work has been carried out on Changes in Antioxidant Activities in Chrysanthemum cut Sprays during Storage and Packaging; Tepal senescence in Gladiolus; Changes in lipid peroxidation and membrane deterioration; Endogenous production of hydrogen peroxide; Changes in antioxidant behavior over the senescence period; Flower senescence in Hemerocallis (day lily); Senescence in chrysanthemum florets; Oxidative stress and antioxidant activity.

Essential Oil: Rose cultivation is an agro-industry, involving cultivators, distillers, perfumers, druggists and other traders. Considering its importance, agro-techniques of essential oil bearing Rose cultivation has been developed by CSIR-NBRI. CSIR-NBRI has designed a new apparatus and developed a process as well as a field distillation unit for distillation of rose flowers which can be utilized by small-scale cultivators/manufacturers (aparatus- Indian Patent No. 130396).

Dehydration of Flowers and Foliage and Floral Craft: Dry flowers that are near naturals, dried and preserved, have an ever lasting value that can be cherished for longer periods and require little care. There are wide range of wild/unutilized/underutilized plant species which have the potential for commercial exploitation in different forms. Rural and hilly areas are covered with different types of colourful flowers and foliage at different seasons round the year and all these are wasted under natural process. The entire seasonal colourful vegetations can be converted into value added products by using dehydration technique. CSIR-NBRI is the pioneer institution in India where work on dehydration of flowers and foliage and also floral craft is being carried out extensively. Simplified indigenous techniques have been developed by which flowers, branches, twigs, foliage etc. retain their fresh look for several months or even years. A full package of technology protocol is available for dehydration of flowers and foliage and floral craft.

Agro-Technology and Techno-Economics: For commercial cultivation of ornamental crops, full package of information on agro-technology and techno-economics of individual crop are essential. These informations are available from different crop specific Bulletins published by CSIR-NBRI.
**Bulletin**: Bougainvillea; Hippeastrum (NBRI Bulletin No.16); Chrysanthemum (NBRI Bulletin No. 1); Guldaudi (Hindi, Bulletin No. 6); Canna (NBG Bulletin No. 23); Coleus (Bulletin No. 2); Dahlia (NBRI Bulletin No. 10); Gladiolus (NBRI Bulletin No. 8); Gloriosa (NBG Bulletin No. 26); Marigold (NBRI Bulletin No. 7); Rose (NBRI Bulletin No. 9); Damask Rose For Rose Oil & Rose Water (Extension Bulletin No. 3); Tuberose (NBRI Bulletin No. 5); Ornamental Annuals (NBRI Bulletin No. 4); House Plants (NBRI Bulletin No. 15); Griha Saja Hetu Paudhya (Hindi, NBRI Bulletin No. 18); Dehydration of Flowers & Foliage and Floral Craft (NBRI Bulletin No. 3).

Leaflet: ‘Popularisation of No Pinch No Stake Mini Chrysanthemum’; ‘Dehydrated Floral Craft’; ‘Solar Cooker Dwara Phool-Pattiyo Ka Nirjaliyakarvan’ (Hindi); ‘Phool Sukhiya Babsa’ (Bengali).

**Technology Developed**: Following techniques have been standardized for commercial floriculture:
- Commercial cultivation and Techno-economics of Gladiolus, Chrysanthemum, Tuberose, Marigold etc.
- Induced mutagenesis and selective breeding for development of new varieties
- Tissue culture protocol for development of large scale quality planting materials (chrysanthemum, bougainvillea, marigold, Gerbera, Asiatic Hybrid Lily etc.)
- Acclimatization of ornamentals under Lucknow climate [sub-tropical] through tissue culture (Asiatic hybrid lily, Gerbera, Orchid)
- In vitro management of chimera for development of new variety
- Dehydration of flowers and foliage and floral craft
- Molecular (RAPD) technique for plant variety characterization
- Programmed blooming (chrysanthemum)
- Green House Cultivation etc.

Agro-technology for commercial cultivation of gladiolus: A success story: Lucknow is the city of culture and gardens. Today gladiolus has become the symbol of capital city of Uttar Pradesh. Model lay-out plan was translated in the field and techno-economics for the commercial cultivation of gladiolus was worked. Progressive growers were motivated for taking up the gladiolus cultivation on commercial scale. Under the lab to land programme, agro-technology for the commercial cultivation of gladiolus was transferred to more than 1000 progressive farmers along with the authentic plant material. The growers were fully satisfied by earning a net profit of Rs. 80,000/- per acre. Today in and around Lucknow more than 300 acres of land has been put under gladiolus cultivation. The total turnover from the gladiolus cultivation, sale and marketing is around Rs. 10 crores.

This has been the most successful story of the transfer of technology from NBRI where science has been linked with the cross section of the society. NBRI has put gladiolus in the floriculture map of India.

**New Varieties Developed by NBRI**: NBRI has developed a number of new varieties in different ornamentals through spontaneous mutation, classical breeding, chromosome manipulation, induced mutation and in vitro mutagenesis. Cropwise names of few new varieties are –

**Amaranthus**: NBRI has developed a number of unique fascinating foliage ornamental cultivars of amaranthus like ‘Amar Shola’, ‘Amar Jyoti’, ‘Amar Kiran’, ‘Amar Mosaic’, ‘Amar Parvati’, ‘Amar Peet’, ‘Amar Prithu’, ‘Amar Raktabh’, ‘Amar Sri Kiran’, ‘Amar Tirang’ and ‘Amar Tetra’.

**Bougainvillea**: Spontaneous mutation (Bud sport):
- ‘Archana’, ‘Hawaiian Beauty’, ‘Manohar Chandra Variegated’, ‘Nirmal’, ‘Parthasarathy’, ‘Shweta’, ‘Shubhra’, ‘Surekha’, ‘Abhimanya’.

**Bougainvillea**: Classical Breeding: ‘Begum Sikander’, ‘Chitra’, ‘Mary Palmer Special’, ‘Spectabilis Variegata’, ‘Tetra Mrs. McClean’, ‘Wajid Ali Shah’.

**Chrysanthemum**: Classical breeding/bud sport:
- ‘Ajay’, ‘Appu’, ‘Apsara’, ‘Apurva’, ‘Apurva Singar’, ‘Arun Kumar’, ‘Arun Singar’, ‘Bindiya’, ‘Birbal Sahani’, ‘Dhawal’, ‘Diana’, ‘Gauri’, ‘Gulal’, ‘Guldasta’, ‘Haldighati’, ‘Hemant Singar’, ‘Himanshu’, ‘Jaya’, ‘Jayanti’, ‘Jubilee’, ‘Jwala’, ‘Jyoti’, ‘Jyotsna’, ‘Kargil 99’, ‘Kaumudi’, ‘Kiran’, ‘Kirti’, ‘Kundan’, ‘Lal Kila’, ‘Lalima’, ‘Lalpari’, ‘Lilith’, ‘Maghi’, ‘May-Day’, ‘Mayur’, ‘Mehghoot’, ‘Mini-Queen’, ‘Mohni’, ‘Mother-Teresa’, ‘NBRI Pushpangadan’, ‘NBRI Khosshoo’, ‘NBRI Kaul’, ‘NBRI Himanshu’, ‘NBRI Little Orange’, ‘NBRI Little Hemant’, ‘NBRI Little Kusum’, ‘NBRI Little Pink’, ‘NBRI Yellow Bud Sport’, ‘Neelima’, ‘Niharika’, ‘Nirmal’, ‘Pancho’, ‘Peet Singar’, ‘Phuhar’, ‘Priya’, ‘Prof. Harris’, ‘Puja’, ‘Ragini’, ‘Rangoli’, ‘Sadbhavna’, ‘Shanti’, ‘Ratna’, ‘Sharda’, ‘Sharat Kanti’, ‘Sharad Kumar’, ‘Sharad Mala’, ‘Sharad Mukta’, ‘Sharad Sandhya’, ‘Sharad Shobha’, ‘Sharad Singar’, ‘Shizuka’, ‘Shyamal’, ‘Suhag Singar’, ‘Sujata’, ‘Suneel’, ‘Sunayana’, ‘Suparna’, ‘Surekha Yellow’, ‘Surya’, ‘Swarn Singar’, ‘Sweta Singar’, ‘Tushar’, ‘Vandana’, ‘Vasantika’, ‘Vijay’, ‘Vijay Kiran’, ‘Vinaya’, ‘White Charm’, ‘White Profile’, ‘Y2K’, ‘Yellow Charm’, ‘Yellow Profilic’, ‘NBRI Yellow Bud Sport’.

**Dahlia**: Classical breeding: ‘NBRI’S Pinki’.
Gladiolus: Classical breeding except one (sport): ‘Archana’, ‘Arun’, ‘Dr. P.V. Sane’, ‘Jamuni’, ‘Neelima’, ‘Rashmi’, ‘Roshini’, ‘Suverna’, ‘Sydney Percy Lancaster’, ‘Tambari’, ‘Urvashi’, ‘Jagdish Chandra Bose’.

Hippeastrum: Classical breeding: ‘Agni’, ‘Apurb’, ‘Begum Secunder’, ‘Chitwan’, ‘Deepali’, ‘Dhruva’, ‘Garima’, ‘Jwala’, ‘Jyoti’, ‘Kiran’, ‘NBRI Kiran’, ‘Kiran Rekha’, ‘Meckan Hybrid Double’, ‘Miss Deepa Kaul’, ‘Mrs. Percy Lancaster’, ‘Mrs. Shelia Kaul’, ‘Niharika’, ‘Poonam’, ‘Prakash’, ‘Prof. K.N. Kaul’, ‘Raktamanjari’, ‘Samrat’, ‘Shah Najaf’, ‘Smriti’, ‘Tarang’.

Canna: Selection: ‘Bharat’.

Rose: Classical breeding: ‘Girija’.

New Mutant Ornamental Varieties Evolved Through Induced Mutations: Bougainvillea: ‘Arjuna’, ‘Los Banos Variegata’, ‘Mahara Variegata’, ‘Pallavi’, ‘Mahara Variegata abnormal leaves’, ‘Los Banos Variegata Silver Margin’, ‘Pixie Variegata’, ‘Los Banos Variegata ‘Jayanthi’, ‘Arjuna’, ‘Abhimanyu’, ‘Dr. P.V. Sane’.

Canna: ‘Agnisikha’, ‘Raktima’.

Chrysanthemum: ‘Agnishikha’, ‘Alankar’, ‘Anamika’, ‘Aruna’, ‘Asha’, ‘Ashankit’, ‘Basant’, ‘Basanti’, ‘Batik’, ‘Colchi Bahar’, ‘Cosmonaut’, ‘Gairik’, ‘Hemanti’, ‘Himani’, ‘Jhaar’, ‘Jugnu’, ‘Kenak’, ‘Kansya’, ‘Kapish’, ‘Kesar’, ‘Kumkum’, ‘Kunchita’, ‘Lalima Head Shape Mutant’, ‘Lalima Tubular Mutant’, ‘Lohita’, ‘Man Bhawan’, ‘Navneet’, ‘Navneet Yellow’, ‘Nirbhaya’, ‘Nirbhik’, ‘Pingal’, ‘Pitaka’, ‘Pitamber’, ‘Purnima’, ‘Raktima’, ‘Rohit’, ‘Shabnam’, ‘Shafali’, ‘Sharad Har’, ‘Sheela’, ‘Sheveta’, ‘Srekhya Yellow’, ‘Sonali’, ‘Subarna’, ‘Tamra’, ‘Taruni’, ‘Tulika’.

Hibiscus: ‘Anjali’.

Lantana depressa: ‘Lantana depressa Variegata’, ‘Lantana depressa Bicoloured’, ‘Niharika’.

Perennial Portulaca (Portulaca grandiflora Hook.): ‘Karna Pali’, ‘Mukta’, ‘Ratnam’, ‘Jhumka’, ‘Vibhuti’, ‘Lalita’.

Rose: ‘Angara’, ‘Curio’, ‘Sharada’, ‘Sukumari’, ‘Tangerine Contempo’, ‘Pink Contempo’, ‘Yellow Contempo’, ‘Twinkle’, ‘Light Pink Prize’, ‘Pink Imperator’, ‘Summer Holiday Mutant’, ‘Salmon Beauty Mutant’, ‘Windy City Mutant’, ‘Mralinali Stripe’, ‘Mralinali Lighter Mutant’, ‘Zorina Pink Mutant’.

Tuberose (Polyanthes tuberosa): ‘Rajat Rekha’, ‘Swarna Rekha’.

Societal Benefits
A. Training courses in floriculture and tissue culture are organized for post graduate students.
B. Training courses in gardening, floriculture and commercial cultivation of ornamental are regularly organized for State and Central Government Officials and their staff, rural women, housewives, amateur growers, nurserymen etc.
C. For unemployed youths, housewives, retired person and challenged children special training courses on ‘Dehydration of Flowers and Foliage and Floral Craft’, are regularly organized.
D. Organization of flower shows has greatly helped in inculcating bio-aesthetic reuse in public besides promoting floriculture industry.

Annual Flower Show: For creating a bio-aesthetic sense and to develop a general awareness among the masses for keeping their dwellings and environment clean, healthy, green and colourful and also to generate self-employment, CSIR-NBRI organizes two Annual Flower Shows, namely, Chrysanthemum & Coleus Show in December and Rose & Gladiolus Show during January. These shows are of unique standard displaying R&D work on ornamental horticulture for promoting interest among the garden lovers, connoisseurs and the general public towards the cultivation of ornamental plants. Both the shows are very attractive and competitive to exhibitors due to presence of a good number of sponsored Cups and Trophies/Shields for different categories. Chrysanthemum and Coleus Show Cups and Trophies are: Nabi Mohd. Running Challenge Cup, M.Y. Khan Running Challenge Trophy, Savitri Devi Memorial Challenge Trophy, Mohammad Mullick Memorial Running Challenge Trophy, Shri Govind Prasad Prasad Memorial Challenge Trophy, Indian Explosive Ltd. (Fertilizer Division) Running Trophy, Begum Saeeda Khatoon Running Challenge Trophy, G.O.C.-in-C. Central Command Running Challenge Cup, Percy-Lancaster Challenge Cup, Ranjit Singh memorial Trophy, Smt. Ranjit Singh Memorial Trophy, Quazi Syed Masood Hasam Running Challenge Trophy, Smt. Madhuri Rai Challenge Shield, Ram Kishore Sharma Memorial Trophy, Mehboob Ali Memorial Running Challenge Trophy, Syed Shaheer Hasan Memorial Running Challenge Cup, Smt. Kumud Rastogi Memorial Running Challenge Trophy, Qazi Syed Hasan Memorial Running Challenge Trophy, Devi Shaker Sinha Memorial Challenge Trophy, Mahfooz Ali Memorial Running Challenge Trophy, R.V. Sitholey Memorial Running Challenge Cup. Rose and Gladiolus Show Cup and Trophies are: Commissioner’s Running Challenge Cup, Bonanza Decorator’s Running Challenge Cup.
Sale of Plants and Seeds: A wide variety of indigenous, exotic and ornamental plant species are propagated at NBRI for sale to inculcate the bioaesthetic sense among the general public and connoisseurs. It also provide the plant material for making herbarium specimens and research work for students and research scholars of various colleges, universities and institutions. The sale section of NBRI for sale of plants/seeds remain open from 2.00 to 4.30P.M. on working days. However, there are Time Schedule for sale of – Chrysanthemum mother plants: July 15 to August 30; Chrysanthemum Suckers: March 15 to April 15; Chrysanthemum Cuttings: August 16 to September 15; Bougainvillea: August-September; Gladiolus ( Corms & Cormels): October 20 to November 10; Gladiolus (Flowers): December-March; Amaryllis: October-November; Dahlia: November-December; Ornamental Annuals (seed): September-October; Ornamental Annuals (Seedling): October-November; Cut flowers (Chrysanthemum): December-January.

Training: NBRI renders the technical advice on landscaping and ornamental horticulture, for improving the environment, to individuals, private and public sectors, National Institutes and Government Organisations. Institute provide training for community members, teachers and botanic garden staff to increase their understanding of local and global development issues. List of training programme conducted by NBRI is huge. Following are few example of training programme organized:

Provided International Training On Induced Mutagenesis, Sponsored by International Atomic Energy Agency (IAEA), Vienna, Austria and Dr. S.K. Datta, NBRI was the resource person.

- Training at Cipanas, Indonesia for Students, Teachers, Researchers.
- Training at NBRI to Mr. Sarat Chandra, Sri Lanka (2 months).
- Training at NBRI to Mr. Somkid Popan, Thailand (3 months).
- Training at NBRI, Lucknow to Mr. Ridthee Meesat, Bangkok, Thailand, 1.9. to 15.11.2003
- Training at NBRI to Mr. Ilukehene GedaraMahinda Rajapakse, Sri Lanka (1 month).
- Training at NBRI to Mrs. Chaireni Martasari, Indonesia (4 months).

Summer Training/M.Sc. Students: NBRI arrange summer training for students to develop awareness for floriculture. For employment generation regular trainings are provided to unemployed youths, housewives, rural women, amateur growers, florists, businessmen, horticulture staff of different State Govt. etc. on dry flowers and fresh flowers.

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