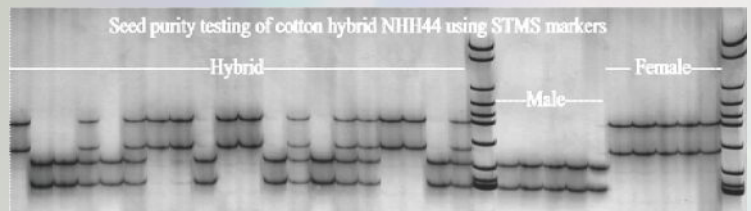


DNA fingerprinting (DNA typing/ DNA or molecular profiling/ genetic fingerprinting) is a technique by which crop varieties are identified by variation in their DNA. This technique was developed by Sir Alec Jeffreys of England in 1984 for human identification. The same principle is used in plants for cultivar identification. In India, plant DNA fingerprinting was started with the establishment of NRC on DNA Fingerprinting at ICAR-NBPGR, New Delhi in 1996 which later on was converted to Division of Genomic Resources in 2013. Molecular profiling is one of the activities of the Division which includes identification of markers, standardization of protocols, statistical tools and basic supportive research for DNA profiling of Indian crop cultivars and elite plant genetic material .

Applications of Molecular Profiling for Cultivar Identification

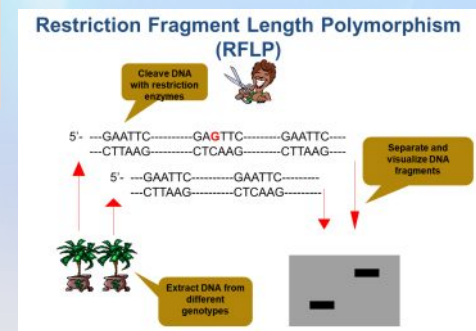
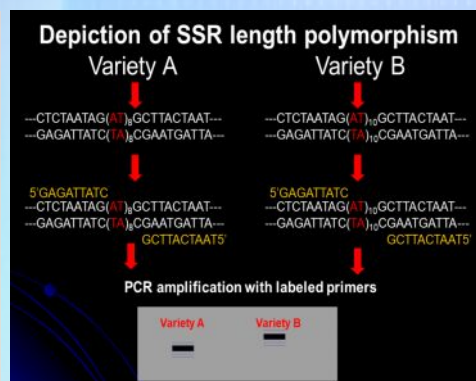
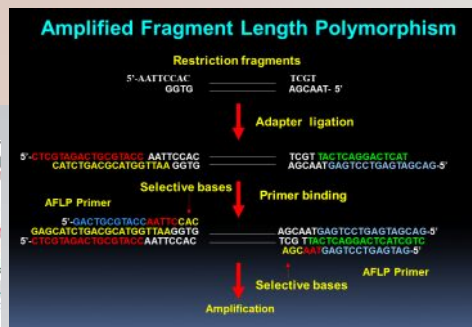
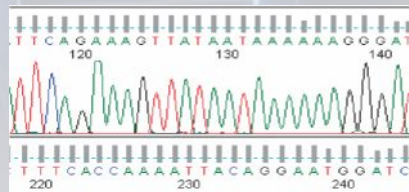
- Seed purity testing of crop varieties (to identify admixtures)
- Hybridity testing of commercial hybrids to ensure genetically pure seed
- Investigating the declared parentage of varieties
- Enforcement of Protection of Plant Varieties and Farmers' Rights Act, 2001
- Support and improvement of the effectiveness and efficiency of the DUS testing procedure
- Investigation on infringement of Plant Breeders' Rights and protection of plant biodiversity



Techniques for Molecular Profiling

Various molecular tools are used for genotyping cultivars. The specific tool selected depends on several criteria including precision, technology available, cost of assay etc.

- Restriction Fragment Length Polymorphism (RFLP)
- Random Amplified Polymorphic DNA (RAPD)
- Amplified Fragment Length Polymorphism (AFLP)
- Simple Sequence Repeats (SSR)
- Sequence Related Amplified Polymorphism (SRAP)
- Single Nucleotide Polymorphism (SNP)



Achievements

- DNA profiling was completed for protection of over 6,400 released varieties of 52 species and native landraces to help prevent unauthorized commercial exploitation.
- During last three years molecular profiling of varieties, landraces, parental lines of hybrids and registered material of crops such as rice (729), maize (143), sorghum (175), cotton (76), pearl millet (49), Indian mustard (30), chilli (41), sunflower (20), mungbean (52), urdbean (45), mothbean (225), safflower (47), finger millet (46), bottle gourd (29), wheat (434), pigeon pea (71), sunflower (96) and barley (96) has been carried out.
- Genetic diversity assessment in crops such as *Allium* spp., bottle gourd, *Brassica*, buck wheat, cotton, cucumber, finger millet, flax, foxtail millet, *Jatropha*, jute, kodo millet, little millet, *Luffa*, maize, melon, *Morinda*, pearl millet, pigeon pea, pomegranate, safflower, sesame and wheat has been undertaken.
- Genotyping of core collections of *Cucumis*, finger millet, foxtail millet, *Lathyrus*, mothbean, mungbean and sesame was accomplished successfully.
- Hybridity and hybrid seed purity testing was carried out in mango, cotton, sorghum etc.

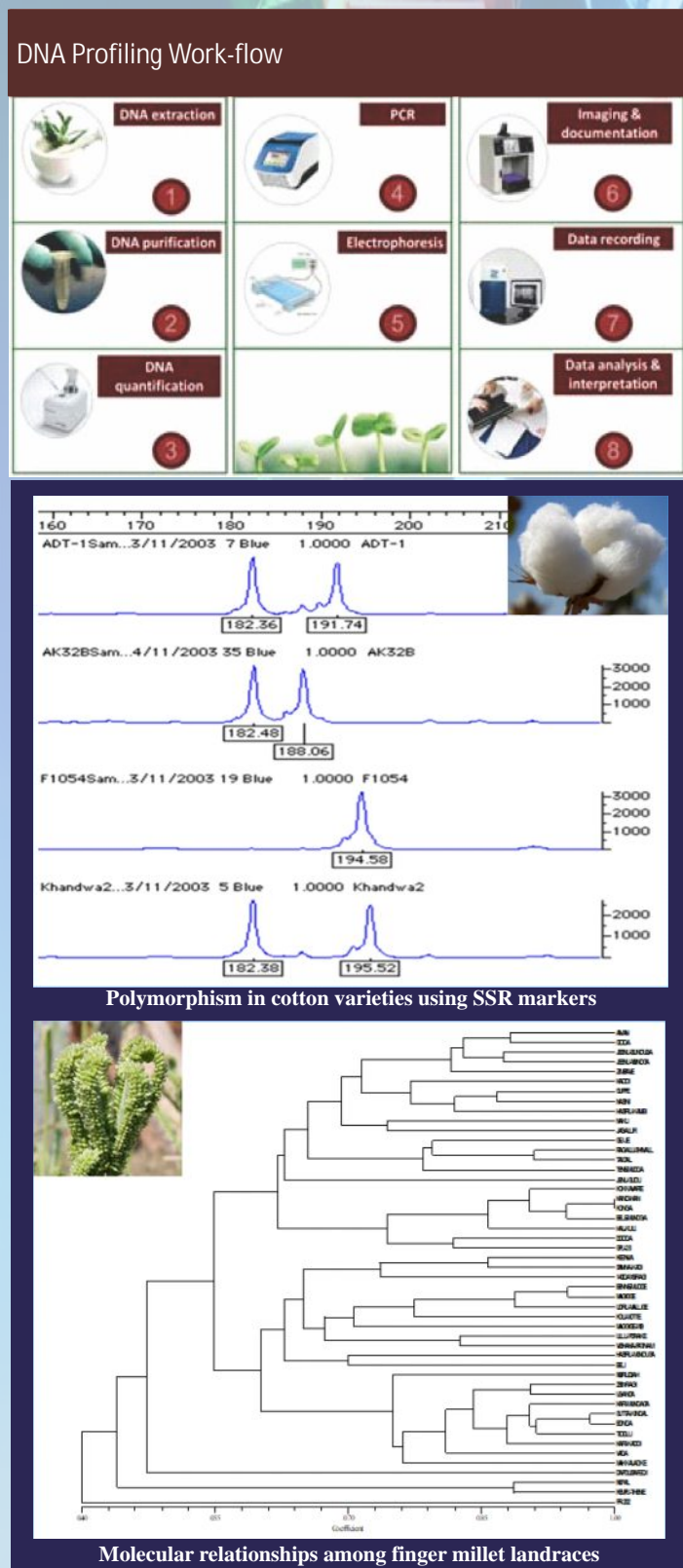


Table: ICAR-NBPGR's Private Sector Clients (2014-2017)

| S. No. | Company Name |
|--------|---|
| 01 | M/S Ankur Seeds Pvt. Ltd. |
| 02 | M/S Deepak Bioseeds Pvt. Ltd. |
| 03 | M/S Hindustan Insecticides Ltd. |
| 04 | M/S Hytech Seed India Pvt. Ltd. |
| 05 | M/S Kohinoor Seed Fields India Pvt. Ltd. |
| 06 | M/S Krishna Seeds Pvt. Ltd. |
| 07 | M/S Mahyco Hybrid Seeds Co. Pvt. Ltd. |
| 08 | M/S Manthan Nursery |
| 09 | M/S MR Seeds Pvt. Ltd. |
| 10 | M/S Nandi Seed Pvt. Ltd. |
| 11 | M/S Nirmal Seeds Pvt. Ltd. |
| 12 | M/S PCS Agrotech Industries |
| 13 | M/S Pioneer Overseas Corporation |
| 14 | M/S Pradham Biotech Pvt. Ltd. |
| 15 | M/S Savannah Seeds Private Ltd. |
| 16 | M/S Shakti Vardhak Hybrid Seeds Pvt. Ltd. |
| 17 | M/S Super Seeds Pvt. Ltd. |

Table: DNA Fingerprinting of 2,124 Released Varieties of Agri-horticultural Crops using SSR Markers

| S. No. | Crop | No. of Varieties | S. No. | Crop | No. of Varieties |
|--------|---------------|------------------|--------|-------------|------------------|
| 01 | Rice | 729 | 16 | Safflower | 26 |
| 02 | Wheat | 108 | 17 | Saffron | 13 |
| 03 | Barley | 54 | 18 | Chickpea | 77 |
| 04 | Maize | 140 | 19 | Jute | 31 |
| 05 | Finger Millet | 11 | 20 | Oats | 9 |
| 06 | Sorghum | 57 | 21 | Pea | 43 |
| 07 | Pearl Millet | 53 | 22 | Lentil | 25 |
| 08 | Soybean | 69 | 23 | Mustard | 42 |
| 09 | Pigeonpea | 49 | 24 | Linseed | 46 |
| 10 | Mungbean | 78 | 25 | Cotton | 116 |
| 11 | Urdbean | 76 | 26 | Sunflower | 7 |
| 12 | Ricebean | 4 | 27 | Bittergourd | 38 |
| 13 | Mothbean | 2 | 28 | Mango | 23 |
| 14 | Cowpea | 11 | 29 | Cashew | 105 |
| 15 | Sesame | 52 | 30 | Tomato | 30 |

- DNA profiling service has been rendered to over three dozen of public and private sector organizations and resources to the tune of Rs. 14 lakhs have been generated.

Table: Details of Samples DNA Fingerprinted for Public and Private Sector Organizations

| Crop | Scientific Name | 2014-15 | 2015-16 | 2016-17 | 2017-18 | Total |
|--------------|--------------------------------|---------|---------|---------|---------|-------|
| Almond | <i>Prunus dulcis</i> | - | - | - | 4 | 4 |
| Arecanut | <i>Areca catechu</i> | - | 18 | - | 21 | 39 |
| Bayleaf | <i>Laurus nobilis</i> | 8 | - | - | - | 8 |
| Chickpea | <i>Cicer arietinum</i> | 3 | 5 | 2 | 4 | 14 |
| Cluster bean | <i>Cyamopsis tetragonoloba</i> | - | - | - | 1 | 1 |
| Cotton | <i>Gossypium</i> spp. | 28 | 37 | 20 | 30 | 115 |
| Cucumber | <i>Cucumis sativus</i> | 3 | - | - | - | 3 |
| Date Palm | <i>Phoenix dactylifera</i> | - | - | 4 | - | 4 |
| Frenchbean | <i>Phaseolus vulgaris</i> | - | - | - | 14 | 14 |
| Garlic | <i>Allium sativum</i> | - | - | 2 | - | 2 |
| Horsegram | <i>Macrotyloma uniflorum</i> | - | 3 | - | - | 3 |
| Lentil | <i>Lens culinaris</i> | - | - | 2 | 1 | 3 |
| Linseed | <i>Linum usitatissimum</i> | 2 | - | - | 2 | 4 |
| Maize | <i>Zea mays</i> L. | 23 | - | 5 | 40 | 68 |
| Mung bean | <i>Vigna radiata</i> | - | 3 | 4 | 5 | 12 |
| Mustard | <i>Brassica</i> sp. | 3 | 2 | 2 | 3 | 10 |
| Onion | <i>Allium cepa</i> | - | 1 | - | - | 1 |
| Paddy | <i>Oryza sativa</i> | 14 | 8 | 2 | 40 | 64 |
| Pea | <i>Pisum sativum</i> | - | - | 2 | 1 | 3 |
| Pearl millet | <i>Pennisetum glaucum</i> | - | 18 | 4 | 15 | 37 |
| Perilla | <i>Perilla frutescens</i> | - | - | 1 | - | 1 |
| Pigeon pea | <i>Cajanus cajan</i> | - | - | - | 13 | 13 |
| Ragi | <i>Eleusine coracana</i> | - | - | - | 48 | 48 |
| Raya | <i>Brassica juncea</i> | - | - | - | 2 | 2 |
| Sesame | <i>Sesamum indicum</i> | - | - | - | 8 | 8 |
| Sorghum | <i>Sorghum bicolor</i> | 4 | 4 | 4 | 4 | 16 |
| Soyabean | <i>Glycine max</i> | - | - | 12 | - | 12 |
| Sponge gourd | <i>Luffa aegyptiaca</i> | - | 2 | - | - | 2 |
| Sunflower | <i>Helianthus annuus</i> | - | - | - | 1 | 1 |
| Taramira | <i>Eruca sativa</i> | - | 3 | 3 | - | 6 |
| Radish | <i>Raphanus sativus</i> | - | - | 1 | - | 1 |
| Urd bean | <i>Vigna mungo</i> | - | 13 | - | 3 | 16 |
| Wheat | <i>Triticumaestivum</i> | 18 | - | 4 | 1 | 23 |
| Total | | 106 | 117 | 74 | 261 | 558 |



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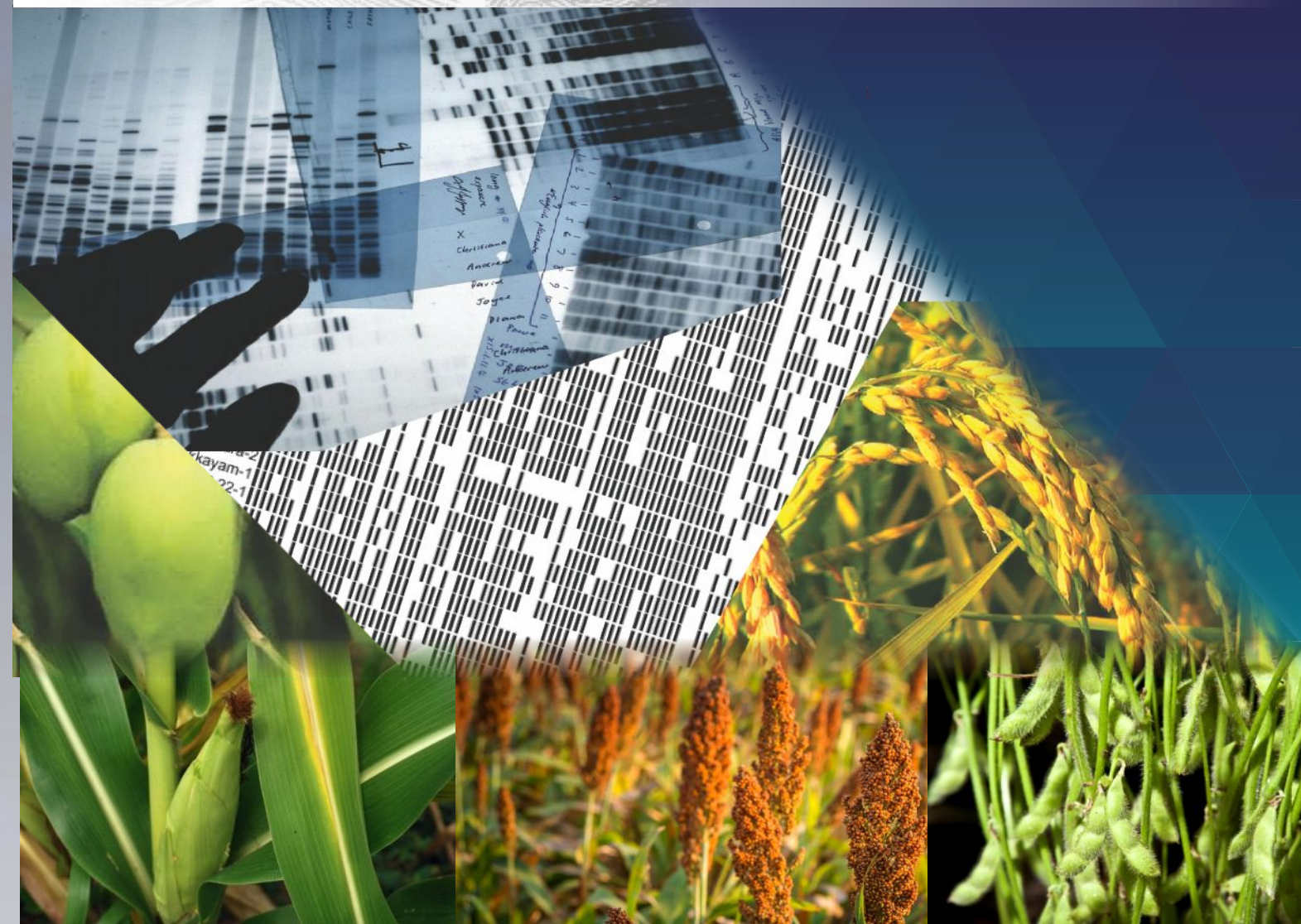
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MOLECULAR PROFILING OF VARIETIES OF AGRI-HORTICULTURAL CROPS



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