ACTIVITIES OF RESEARCH WING OF HARYANA FOREST DEPARTMENT

Chief Conservator of Forests (Development) with headquarter at Panchkula, is the head of research wing of Haryana Forest Department. He is assisted by Conservator of Forests, (Research). The following main activities are being carried out by the Research wing of Haryana Forest Department:

- Bio-diversity Conservation
- Tree Improvement Works
- Species Introduction
- Introduction of Exotics
- Provenance Trials
- Progeny Trials
- Nursery Research
- Medicinal Plants
- Agro Forestry Research
- Testing Of Species For Problematic Soils
- Establishment of Tissue Culture Laboratory
- Mist Chambers
- Germination And Viability Studies
- Bio fuel Studies
- Establishment of Ficatum

Introduction
Research related to forestry activities was initiated in Haryana Forest Department ever since the birth of separate state of Haryana from its parent state Punjab in 1966. DFO research headed then forestry wing. Later on research wing was headed by conservator of forests (development). In 2006, erstwhile research division was elevated to level of circle by merging research and seed collection divisions, which is now being headed by a conservator of forests. In August 2009, two divisional forest officers one DFO Research and another DFO Seed belonging to state forest service have been posted in research circle. Accordingly two divisions viz. research and seed have been created.
The main function of research circle is to conduct research on forestry matters, collect seed from superior trees and supply it to plantation divisions. There are four geographical zones in the state namely Shivalik, central plains, Semi arid western zone and southern Aravali region. The agroclimatic conditions and silvicultural conditions vary in these regions. To cater to the forestry research needs of the entire state as per difference climate conditions. We have established research stations at Seonthi, Bithmara, Jhumpa and Sohna. We are in the process of establishing modern seed processing unit and seed testing laboratory at Pinjore. There are well established modern high tech seed and research nurseries in the state equipped with green houses. All seed and research nurseries have vermiculture and compost pits. All weeds and organic matter produced or generated in the nursery is used for the production of compost. All research nurseries are producing quality seedlings including tall plants. Forest research includes screening of species for problematic soils like alkali, saline, sand dunes and denuded Shivalik hills, to grow crop under poplar and eucalyptus for maximum environmental and economic returns, testing of clones of different species; establishment of Clonal Seed Orchards, Seedling Seed Orchards; selection and marking of plus trees, identification and setting up of seed stands, selection of suitable species and their clones for agroforestry specially for low rainfall arid region; creation of germplasm bank for economic and endangered species; progeny and provenance trials; to suggest suitable package and practices for cultivation of medicinal plants; identification of suitable and high yielding species for agroforestry; to conduct studies on dying of Shisham and Kikar trees and to identify suitable cultivars tolerant/resistant to Fusarium and Ganoderma fungi; to suggest suitable package and practices for the control of pests and diseases of important tree species of Haryana like poplar, eucalyptus etc.

Forestry Research In The Past: The following are the achievements of the forest department Haryana since the inception of Haryana state in 1966.

1. Evaluation of growth of eight arid zone species in the northern arid region of Haryana.
2. Introduction trial of different species in Shivalik hills.
3. Species/provenance trial of eucalyptus.
4. Evaluation of eucalyptus species and provenances for northern region of Haryana.
5. Afforestation trials for Morni hills.
7. Development of technology for afforestation of sodic soils (leguminous species).
8. Work study on uprooting of Lantana.
10. Trial of fruit species in sodic soils.

12. Eucalyptus full sib (clonal) progeny trial and clonal garden.

13. Clonal Teak Orchard.

Brief notes on the above mentioned research work is given as under:

1. Evaluation of growth of eight arid zone species in the northern arid region of Haryana.

Various species of indigenous and exotic trees were tried at Jhumpa Research Station in Bhiwani district, which is true representative of arid zone. The purpose was to screen various species for arid zone of Haryana having annual rainfall of about 250 mm and also to stabilize sand dunes besides providing fuel wood and fodder to the people. The species included Acacia mulga, Acacia albida, Acacia tortilis, Acacia nilotica, Roheda (Tecomella undulata), Jand (Prosopis cinerea) and Eucalyptus camaldulensis. The results were as under; the top most show the best and lower most the poorest:

Fatherbia albida (Acacia albida)

Eucalyptus camaldulensis

Vachellia tortilis) (Acacia tortilis)

Vachellia catechu (Acacia catechu)

Prosopis cinerarea

2. Introductory trial of different species in Shivalik hills

The experiment was started during 1983 in Bir Shikargah forest of Morni division to find suitable species which can grow well in Shivalik foot hills which can grow well under well drained and loamy soil conditions. The following species were tried.

Broussonetia papyrifera (Paper Mulberry)
Eucalyptus hybrid
Dalbergia sissoo (Shaisham)
Bombax ceiba (Indian Red Cotton Tree or Seemal)
Terminalia tomentosa (Sain)
Albizzia procera White Siris)
Holoptelea integrifolia (Hill Papri or Kanju)
Grevillea robusta (Silver Oak)
Cedrella toona (Tun)
Terminalia bellerica(Beleric myrobalan) or Baherha

The results revealed that in the case of Eucalyptus, Grevillea robusta (Silver Oak), Terminalia bellerica (Beleric myrobalan) or Baherha, and Terminalia tomentosa (Sain), the survival was satisfactory. Dalbergia sissoo (Shaisham) and Albizzia procera (White Siris)
showed excellent growth and survival. However, in the case of Broussonetia papyrifera (Paper Mulberry), *Holoptelea integrifolia* (Hill Papri or Kanju) and *Cedrella toona* (Tun), neither the growth nor the survival was satisfactory.

3. **Species/provenance trial of eucalyptus:** Various Eucalyptus species and provenances were received from Eucalyptus Research Station, Hyderabad, in October, 1984. The experiment was conducted at Saraswati in Kaithal district. The results showed that provenances of *Eucalyptus camaldulensis* and *E. tereticornis* were promising ones.

4. **Evaluation of Eucalyptus species and provenances for northern region of Haryana:** The study was conducted at Jhumpa with a view to evaluate growth, survival and adaptability of 12 provenances of *E. tereticornis* and one provenance of *E. hybrid*. The results indicated that ET2 of *E. tereticornis* were superior to the other provenances of *E. camaldulensis* and *E. hybrid*.

5. **Afforestation trials for Morni hills:** Studies on tree and crop interaction in *Populus deltoides* G3 on the growth and yield of wheat crop under irrigated conditions.

   This experiment was conducted to determine the effect of one sided row of poplar on growth and yield of wheat. The study was done at farmer’s field in Sherpur village of Yamunagar district in 1986. It was concluded that growing poplar with wheat in single row on southern aspect of field in east western direction combined with crop under irrigated conditions is economically viable.

6. **Development of technology for afforestation of sodic soils (leguminous species)**

   The study revealed that the dug up soil mixed with 3kg gypsum, 20 gm urea, 50 gm single super phosphate, 25 gm muriate of potash, 5 gm B.H.C., 0.2 gm Zinc sulphate and two kg rice husk when refilled and planted with seedlings gave best results. Among five species tried, Prosopis chilensis was the best, followed by *Tamarix articulata* and *Acacia nilotica*. *Pongamia pinnata* survived but did not put on good growth during first three years. Albizzia lebbek was not found to be a suitable species for sodic soils.

7. **Work study on uprooting of Lantana:**

   Lantana an exotic weed locally called Balari is obnoxious weed. It has replaced local biodiversity and is Invasive Alien Species (IAS). A work study was conducted in Bir Shikargah forest to study the cost of its uprooting. Three types of areas were selected for uprooting depending upon the density of Lantana. Traditional implements which were used by the local labourers were used for the uprooting. It was found that the number of maydays required for the cutting and uprooting of Lantana were 84, 196 and 208 days for 0.45, 0.70 and 0.85 density respectively. Thereafter, the uprooting was done with Lantana extractor during different parts of the year. It was found that the number of days required for uprooting of Lantana during May and after rains were 60 and 100 respectively per hectare. For extraction of root stocks of Lantana after the rains with the extractor with the aerial portion cut only 60 days were required.
8. **Observation on the performance of *Acacia albida***:

*Acacia albida* is a species which can grow very well under arid conditions. Its adventitious roots being very deep do not compete with the crop. It produces profuse suckers and therefore be easily propagated by the root suckers. It is a good species for agroforestry as well. It was concluded that though it is a good species for agroforestry in arid areas but its wood is not suitable as timber as it is badly attacked by Pin Hole Borer insect. The wood is also not a good fuel wood species either due to low calorific value.

9. **Propagation of Shisham : Trial at Bir Shikargah**:

A study was conducted to compare the growth of seedlings raised from root shoot, root and shoot cuttings. It was found that plants raised from root shoot cuttings performed better compared to other two techniques.

10. **Trial of fruit species in sodic soils**:

A study was conducted at Bichhian Reserve Forest in Kaithal district in 1991 to study the performance of different fruit species in sodic soils having pH more than 10.5. The species included were Jujube (Ber), Jamun, Bael, Chickoo, Mango, Guava, Karaunda, Date Palm, and Phalsa. None of the plants were found economically suitable for sodic soils.

11. **Eucalyptus full sib(clonal) progeny trial and clonal garden**

The experiment was conducted at Seonthi in 1993. Seven clones procured from Bhadrachalam and six from TERI and one local as control were planted at 3m by 3 m spacing. Bhadrachalam clones were found better.

12. **Clonal Teak Orchard**:

Clonal Seed Orchard for teak has been established at Mirpur in Yamunanagar district in 1992. The orchard has 85 clones procured from Nagpur Genetic Research Station. The orchard has now started setting seeds. The seed was collected in January 2013 from different clones. This seed was grown with nursery and was compared with seed brought from Haldwani. This seed proved inferior to Haldwani seed. The teak is not native to this area and hence efforts will be made to introduce new genetic material of teak in the state.

**Germination Studies:** Under Haryana conditions germination studies are being conducted for all species. We have recently concluded germination studies on Neem or Margosa Tree (*Azadirachta indica*), Jamun or Black Plum (*Syzygium cumini*) and Sita Ashok or Sorrowless Tree (*Saraca indica*). Our findings are that in the case of neem the seeds of which are supposed to have viability only upto one week or so, remained viable in the nursery and laboratory upto 61 days. Similarly Jamun seeds also remained viable upto one and half months.
Germination studies on *Saraca indica* (Ashok): A rare and endangered medicinal and religious plant.

Sorrowless Tree or Ashok is not common in Haryana. It has lots of medicinal value. The bark of this tree is useful in urinary infections, high blood pressure and stomach ailments. It does not grow in Haryana as natural species either. We collected the seeds of this species from
the nearby areas of Pinjore. We collected vital statistics for this species and the results are as under:

<table>
<thead>
<tr>
<th><strong>Length of pods:</strong></th>
<th>upto 19.5cms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of seeds per pod:</strong></td>
<td>One to seven</td>
</tr>
<tr>
<td><strong>No. of seeds per Kg:</strong></td>
<td>110 to 120 (At the time collection as the seeds are to sown fresh)</td>
</tr>
<tr>
<td><strong>Germination Period:</strong></td>
<td>(Treated 26 days to 1.5 Months) (Germination 18 days to 1.5 Months)</td>
</tr>
<tr>
<td><strong>Percent Germination:</strong></td>
<td>80.12%</td>
</tr>
<tr>
<td><strong>Viability Period:</strong></td>
<td>1.5 Months</td>
</tr>
</tbody>
</table>

We have introduced this species in Shiwalik at a place called Naulita near Pinjore in 2011. We have watch its performances up to 2014. We have concluded that *Saraca indica* cannot grow in rocky Shiwaliks and it needs soil with high moisture content.

**Biodiversity Conservation:**

Many species of plants and animals in Haryana are threatened with extinction. Each and every species plays very important role in conserving ecology. The fact that only 10 to 15 percent species have been described out of total range of 30 lakhs to 5 crores, proves the necessity to conserve all species as extinction of any species may lead to ecological disaster. It is with this aim that Haryana Forest Department has identified the conservation of species of plants and animals as its priority area. Main species of plants which have been identified for this purpose are: Hararh or Chebulic Myrobalan (*Terminalia chebula*), Baherha or Beleric Myrobalan (*Terminalia belerica*), The Sacred Barna (*Crataeva religiosa*), Tat Bharhang (*Oroxylum indicum*), Bakar (*Premna barbata*) in northern Haryana, Guggal (*Commiphora mukul/ Commiphora wightii*) in Aravalli hills and Jand/Shami (*Prosopis cinerea*), Marwarh Teak (*Tecomella undulata*) and Hingot (*Balanites aegyptica*) in western and southern Haryana. Various aspects related to their propagation, growth behaviour, susceptibility/ tolerance to pests, frost and drought are being studied. Ex situ and in situ conservation of medicinal plants has also been taken up. Ten hectares area of Guggal under MPCA was taken up at Rasoolpur forest in Mahendergarh district in February 2013. Guggal area has now been handed over to territorial wing.
Tat Bharang (*Oroxylum indicum*): Now endangered species, has great medicinal value

**Tree Improvement Works:**

Tree improvement is the application of knowledge of art and science to produce trees capable of performing better than others. The aim of tree improvement is to produce superior genetic resource for future by improving growth, pest resistance and other desirable traits like straight bole and quality of fiber etc. The following tree improvement works are being taken up in Haryana:

**Selection of Candidate Plus Trees (CPTs):**

A plus tree is a phenotypically superior tree in any given population in terms of height, bole, crown or any other desirable trait. It is of about half the rotation age, has crown not more than one third of its bole, has straight bole with less taper and produces superior seeds. We have marked a total of 798 trees belonging to Eucalyptus, Sissoo (*Dalbergia sissoo*), Kikar or Gum Arabic (*Acacia nilotica*), Khair or Black Cutch (*Vachellia catechu*), Neem or Margosa Tree (*Azadirachta indica*), Shami or Jand (*Prosopis cinerea*) and Ailanthus etc. The details are as under:
<table>
<thead>
<tr>
<th>Name of species</th>
<th>No. of CPTs marked</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vachellia tortilis</em></td>
<td>3</td>
</tr>
<tr>
<td>Amaltash</td>
<td>6</td>
</tr>
<tr>
<td>Amla</td>
<td>6</td>
</tr>
<tr>
<td>Arjun</td>
<td>9</td>
</tr>
<tr>
<td>Bahera</td>
<td>19</td>
</tr>
<tr>
<td>Bakain</td>
<td>9</td>
</tr>
<tr>
<td>Bel</td>
<td>9</td>
</tr>
<tr>
<td>Black Siris</td>
<td>5</td>
</tr>
<tr>
<td>Dek</td>
<td>1</td>
</tr>
<tr>
<td>Euc.</td>
<td>55</td>
</tr>
<tr>
<td>Gold Mohar</td>
<td>8</td>
</tr>
<tr>
<td>Imli</td>
<td>2</td>
</tr>
<tr>
<td>Jamoa</td>
<td>14</td>
</tr>
<tr>
<td>Jamun</td>
<td>17</td>
</tr>
<tr>
<td>Jand/Jandi</td>
<td>20</td>
</tr>
<tr>
<td>Kachnar</td>
<td>1</td>
</tr>
<tr>
<td>Kadam</td>
<td>8</td>
</tr>
<tr>
<td>Hathiphal</td>
<td>11</td>
</tr>
<tr>
<td>Khair</td>
<td>61</td>
</tr>
<tr>
<td>Kikar</td>
<td>245</td>
</tr>
<tr>
<td>Neem</td>
<td>28</td>
</tr>
<tr>
<td>Pahari Papri</td>
<td>1</td>
</tr>
<tr>
<td>Rohera</td>
<td>36</td>
</tr>
<tr>
<td>Sahtoot</td>
<td>1</td>
</tr>
<tr>
<td>Shisham</td>
<td>200</td>
</tr>
<tr>
<td>Silver Oak</td>
<td>10</td>
</tr>
<tr>
<td>Seemal</td>
<td>11</td>
</tr>
<tr>
<td>Siris</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>798</strong></td>
</tr>
</tbody>
</table>
Establishment of Seed Orchards:
A seed orchard is an area where plantation of genetically and phenotypically superior trees is isolated to reduce pollination and varietal admixture from the nearby inferior sources. It is established by setting out clones or seedling progeny of trees selected on the basis of certain desirable traits. A seed orchard is extensively and intensively managed to produce superior and abundant seeds. There are two types of seed orchards:

Clonal Seed Orchards (CSO): CSOs are raised from selected clones which are propagated by vegetative means i.e. by budding, grafting, layering, stooling, cuttings and tissue culture. At present we have established CSOs for Eucalyptus and Sissoo. Our CSOs have all improved clones brought from the reputed organisation.

We have collected 9.5 kg seed from Eucalyptus CSO in 2014. With efforts being made to make trees set more seed, it is expected that the total seed collection from Eucalyptus CSOs in Haryana in 2015 will be the same. This seed is used for raising superior seedlings.

The seed collected from CSOs of Shisham during the last three years is as under:

<table>
<thead>
<tr>
<th>Name of Range</th>
<th>Year of collection</th>
<th>Seed collected in Kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Range, Hisar</td>
<td>2012-13</td>
<td>2200</td>
</tr>
<tr>
<td></td>
<td>2013-14</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td>2014-15</td>
<td>2500</td>
</tr>
<tr>
<td>Name of Range</td>
<td>Year of collection</td>
<td>Seed collected in Kgs</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Seed Range, Pinjore</td>
<td>2012-13</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>2013-14</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>2014-15</td>
<td>500</td>
</tr>
</tbody>
</table>

**Eucalyptus Trials:**

**Establishment of Clonal Testing Area (CTA) for eucalyptus:** 33 individuals in three replications (33x9bx3) =891 seedlings in RBD of nine plants from the same treatment were planted in the month of March, 2002 at Bithmarha at a spacing of 3x3 meters. The promising clones are S-C 271, SC-6.

**Eucalyptus Provenance Trial 0.5 Hectare (2001-2002):** 450 plants from six Australian seeds lots were planted during August, 2002 at Bithmarha at spacing of 3x3 m in 18 randomized blocks in three replications taking 25 seedlings of same seed lots in one block. Seed lot number 20231 and seed lot number 18548 are doing well.

**CTA JK Papers, 2.3 hectares (2003-2004):** A total of 2500 plants 2208 from JKSC and 292 local in three guard lines were planted in the month of November, 2003 at a spacing of 3x3 m in four replications. Clones planted were 2, 4,5,8,9,11,17,19,16,6 were planted. The clones which proved better are 2, 4 and 8.

**Eucalyptus CTA Haldwani 0.4 Hectare:** 448 plants of four cultivars (412 in plot+ 36 in lines) were planted at Bithmarha in the month of November, 2003 are a spacing of 3x3 m in the year 2003-2004. Clones planted were G1, G2, G17, G22; Best clones were 1 and G17.

**Eucalyptus CTA Australian Seedlings:** 1.35 Hectares(2003-2004): A total of 1448 seedlings from 64 cultivars (1368in plot+120 in guard rows) were planted at Bithmarha in a plot of size 90by 150 m at spacing of 3by 3m in the m/o Nov.,2003 in four replications. The best clones were 26, 34 and 88.

**Eucalyptus Trial of CPTs of Haryana:** 12 Hectare (2003-2004): A total of 1248 seedlings from 33 CPTs (1148 in plot+ 100 in guard rows) were planted in Nov. 2003 at Bithmarha at spacing of 3mby 3m in four replications. The best seedlings belonged to group 20-FN, 14HHR.

**Evaluation of Clones CSO’s CPT’s & Progenies :** The germplasm of Eucalyptus in the state was evaluated in May 2012. The results are as under:

- Clone No.105 topped the list with respect to biomass production both in normal and high pH soils. It has perfect clean and round bole. Based on its performance throughout the state, now it is being taken up for multiplication in mist chambers.
- Clone No.132 occupied second in overall performance.
- Clone No. 83, 272, 286, 159 & 84 are suitable for normal soils.
- Clone No.10 occupied 3rd position in performance. However, it has proved most susceptible to Gall Wasp. Hence, for the time being it has been rested for propagation.
Sissoo: Shisham or Sissoo is the most important species of Haryana. It is also called Tali locally. So far 200 CPTs of this species have been marked and we are in the process of selecting some more CPTs. We have identified two local cultivars of this species. These are called Tahala and Tahali. The former has thick bark and has vertical fissures only: whereas the latter has both vertical and horizontal thin fissures on the bark giving the appearance of biscuit like flakes. Tahala has more of sapwood and less of heartwood and, therefore, fetches very less price in the market. On the other hand Tahali has very thin heart wood and, therefore, fetches very good price in the market. We have also planted 30 FRI clones in the state at Bithmarha Research Station in Hisar district. These clones are 9,10,14,19,33,38,41,42,44,51,52,60,62,66,76,79,94,101,103,105,106,108,204,215,239,324, 361,384,394 and one local. It has been found that the clones of 100 series are producing quality seed. All these clones in general and clone no. G-113 in particular is doing very well in the state of Haryana. A bulk of plants in the nursery are being raised from this clone. However, the problem of drying of Shisham still remains. Number of young plants have to be removed every year as they are dying premature. FRI variety No.14, which is said to be tolerant to *Ganoderma & Fusarium*, has been introduced in the year 2009. It will remain under observation for another five years.

Tahala cultivar of Sissoo
**Progeny Trial of Shisham:** A total of 2.6 hectare area was planted at Bithmarha in the year 2004 with the progeny of CPTs belonging to Haldwani area. Some of the CPTs are: CG32, B266, TH2, TH6, CPH40, TH5, SPH11, SPH14, SPH13, LP1, CPH39, EH4, CG36, PH1, SPH12, EH4, LP7, LP10, SPH12, LAM 3, LAM4, B281, TH 27 and TH4. The progeny trial is under observation and nothing can be concluded right now.

**Tahali cultivar of sissoo**

**Research Activities At Forest Research Station, Seonthi (Distt. Kurukshetra)**

Seonthi Research Station is primarily meant to conduct research on eucalyptus. Forest Research Station Seonthi was established in the year 1989 for carrying out research relating to forestry matters to cater to the local needs of Forest Department, Haryana. Out of the total 474 acres of Seonthi Reserve Forest, an area of 150 acres was transferred to erstwhile Research and Training Division, Pinjore in the year 1989 for carrying out forestry research. Another 50 acres of forest land was transferred in the year 1994 making total area of 200 acres devoted to forestry research. The soil of the area is clayey with pH ranging from 8.5 to 9.6. At present following main activities are going on at this research station:
1. Establishment of Clonal Seed Orchards (CSOs) of Eucalyptus

2. Establishment of Clonal Multiplication Areas (CMAs) of Eucalyptus

3. Clonal Propagation of Eucalyptus in Mist Chambers

4. Establishment of Tissue Culture Unit (TCU)

5. Progeny trial of *Eucalyptus tereticornis* (Clonal Seedlings)

6. Provenance Trial of *Eucalyptus tereticornis, E. camaldulensis var. robusta*

**Establishment of Clonal Seed Orchards (CSOs):** The brief description of various CSOs established at Seonthi is as under:

1. **CSO 1997-1998 (Area 6.7ha):** In this CSO 22 clones of ITC series viz. 1,3,4,6,7,8,9,10,27,71,83,99,105,115,116,119,128,130,132,142,147,157, 271 and 277 were planted in Randomized Block Designs (RBDs) in 42 blocks. Three guard rows of clone number 3 & 7 were also planted. This CSO is setting very less seed and that too on the top. As a result of this it has become difficult to collect the seed.

2. **CSO 1998-1999 (Area 1.5ha):** In this CSO 19 clones of ITC series viz. 3,7, 27,71,83,84,99,134,159,161,265,266,269,272,273,286,290 and 365 were planted in one block but each clone was randomized 45 times. For comparison local seed originated plants were also planted randomly. A guard row of ITC no.7 was also planted.

**Mist chambers at Seonthi for clonal propagation of plants**
3. **CSO 2005-2006 (Area 2.0 ha):** In this CSO 3 clones of ITC series viz. 3, 6, 7 raised in mist chambers at Seonthi were planted in single block. No guard row has been planted in this case. This CSO has not yet started setting seed.

These CSOs have been evaluated in 2012 for biomass production and other traits like pest attack and bole characters and accordingly the inferior one have been removed. Hygiene felling has also been completed in this CSO.

**Establishment of Clonal Multiplication Areas (CMA):**

1. **CMA 1999-2000 (2.5 ha):** This CMA was planted with six Bhadrachalam clones namely 3, 7, 8, 10, 27 and 130. Amongst the clones planted in this CMA at present clone numbers 27 and 128 are being used at present and other clones were uprooted as they had lost their vigour.

2. **CMA 2003-2004 (0.89 ha):** In this CMA six clones of JK Papers viz. JKSC5, JKSC2, JKSC2N, JKSC4, JKSC8, JKSC11 of Raighadha Orissa and one clone of Bhadrachalam origin viz. ITC 6 were planted. These clones are under testing.

3. **CMA 2004-2005 (10 ha):** In this CMA six clones of Bhadrachalam origin viz. ITC 3, 7, 6, 10, 99 and 130 were planted. These clones were integrated with local clonal plants raised after felling one eucalyptus tree at Western Yamuna Canal (WYC or WJC) and then multiplying it from the coppice shoots obtained from it. These clones are under observation. All these clones are being propagated at present in mist chambers at Seonthi except WJC clones as it did not perform better than Bhadrachalam clones.
4. **CMA 2006-2007 (8 ha):** In this CMA five clones of ITC series viz. 3,7,130,271 and one local Binjalpur clone have been planted. This CMA has not yet been felled for coppice shoots.

5. **CMA 2007-2008 (5 ha):** In these CMA seven clones of ITC series viz. 3, 7, 71, 99,130 and 271 have been planted. This CMA has not yet been felled for coppice shoots and has been established for the future needs.

6. **CMA 2008-2009 (5 ha):** In this CMA six clones of ITC series viz. 52,83,105,130,271 and 290, three clones purchased from Pragati Biotech Hoshiarpur viz. 316(FRI) 413 (FRI), 526 and one from Punjab Forest Department i.e. 2070 have been planted. This CMA has been established for meeting the future needs.

**CMA 2011-12:** In this CMA six clones of ITC series viz. 52,83,105,130,271 and 290, three clones purchased from Pragati Biotech Hoshiarpur viz. 316(FRI) 413. This CMA has been established at Bithmarha as two new mist chambers have come up there.

**Clonal Propagation of Eucalyptus in Mist Chambers:**

- This facility was established for clonal propagation of *Eucalyptus* in 2001. At present twelve selected clones of *Eucalyptus* viz. 3, 7, 52, 83, 99, 105, 130, 132, 271, 286, 288 and 290 are being propagated. These are fast growing, high yielding clones and give 1.5 to 2 times more yield than the seed route plants as indicated by the research data.

- The planting stock is obtained from well developed CMA (Clonal Multiplication Area) available in the Seonthi Reserve Forest itself.

- In 2001, the capacity was to plant 65,000 cuttings in one batch in 5 mist chambers which was later increased to plant 1,53,500 cuttings in 11 mist chambers in 2002 in one batch. In 2008, with certain modifications in existing mist chambers, the planting capacity was increased to 3,38,000 and with the addition of new mist chambers in 2009.

- Cuttings are being propagated in state of Haryana in fully automatic mist chambers under high temperature (45°C) and high relative humidity (>90%) with the application of rooting hormones. The time period required to produce a well developed plant from a cutting is 16 to 20 weeks. The normal period of operation for mist chambers under climatic conditions of Haryana is from April to December in which maximum four batches of cuttings can be planted depending on the air temperature and availability of planting material.

- Success percentage at this facility for the cutting planted to the plants produced is more than 75% which is the highest ever reported for this species for commercial production in the country.

- These clonal plants are suitable for planting on field bund and boundaries, in block plantations and in Agro forestry systems as the trees are tall and straight growing, have self pruning ability, can be planted on variety of soils and require less management as compared to the other commercial species like Poplars.
Clonal eucalyptus plants

- **Mist Chamber at Bithmara**: Two Mist Chambers with a total capacity of housing 60,000 cuttings in one go have been commissioned in Bithmara in July 2012. The annual production of successful rooted Eucalyptus plants in these Chambers is around two and half lakhs. Combined with mist chambers of Seonthi, the total annual production capacity of clonal Eucalyptus plants under research wing is around 9.5 lakhs plants.

- **Establishment of Plant Tissue Culture Unit (PTCU)**:

  A Plant Tissue Culture Unit (PTCU) has been established at Seonthi and it has become operational. The species like *Dalbergia sissoo, Corymbia, Salvadora, Tecomella, Eucalyptus, Bamboo, Capparis* etc. have been identified for micro propagation. As of now success has been achieved in shoot proliferation in *Eucalyptus & bamboo*. However, the success in rooting of proliferated shoots has not been achieved. The PTCU is being run under the supervision of experts.

- **Provenance Trial of Eucalyptus tereticornis, E. camaldulensis var. robusta ;)**; 2001-2002 (*Area 0.6*): In this trial eight No. of seed source and 75 plants from per source were planted at Bithmarha in three replications according to RBD design to evaluate the source-cum-provenances of eucalyptus.

1. **Kikar/Gum Arabica**: This is often a neglected species but the fact is that it is really poor man’s timber. Right from windows and doors to bullock cart, benches and fuelwood, Kikar is extensively used in rural Haryana. We are testing the provenances of this species brought from all over the country at Bithmarha for bole, crown, and branchiness, resistance to pests and tolerance / resistance to frost. CTA for this was established in the year 1998. After 14 year we have found that the provenance of Dausa (Rajasthan) & M.P. have performed best under our conditions.
Neem: It is one the best shady trees of Haryana for afforestation in western and southern Haryana. Nowadays, it is valued more as medicinal tree rather than timber species. Extraction of antifeedant and bio pesticide from its kernels has attached greater importance to it. We have brought its provenances from all over the country to test them for good bole and crown and tolerance/resistant to frost. 255 plants from 51 CPTs marked by FRI Dehradun from different parts of UP and Haryana were planted in the month of August, 2001 at a spacing of 6x6m to test the suitability of these CPTs in agroclimatic conditions of this area. Best CPTs are: Palwal-8 and Bhiwani-8 after ten years observations we have concluded that Haryana germplasm is the best.

2. Poplar: This is another excellent species for agroforestry. Poplar is very popular among the farmers especially of Ambala, Yamunanagar, Kurukshtra, Kaithal and Karnal.

However, it has limited range as it can grow only along Yamuna belt and requires lot of care. In 2012 we had introduced latest WIMCO, FRI and Pantnagar clones. We now have 28 latest clones of poplar. We have found that WIMCO clones number 109, 110 and Pantanagar clone number PP-5 perform well under Haryana conditions.

Establishment of Germ Plasm Bank: The purpose of establishing germplasm bank is to multiply genetically and phenotypically superior parents. This is done to preserve the genetic base of the plant. The germplasm banks form the future source of superior genetic material. We have started the establishment of germplasm bank for two species viz. Jamun or Black Plum (Syzygium cumini) and wild Mango (Mangifera indica). It is believed that there are over 50 cultivars of Jamun in and around Haryana. These cultivars start yielding delicious ripe Jamun...
fruits from the beginning of June and continue giving fruits up to early August. Not many efforts have been made to put them at one place and multiply them with the aim that the fruits are easily available throughout the season. Besides there are certain cultivars which are delicious but are known only to local people. One such example is “Shakarpara” cultivar of Jamun which has been named after popular sweet Shakarpara. The fruits of this cultivar are having very small and thick and soft pulp. Which when put in gets dissolved like Shakarpara. Till now we have identified 12 such cultivars and have planted at Manakpur in the year 2010. The performance as regards the growth is good. However, fruit setting has not yet taken place as yet.

**Biofuel Studies:** For conducting studies on biofuel species we have selected two species. One is Pongam oil tree or Badam Paparhi (*Milletia pinnata*) (=*Pongamia pinnata*) and other is *Jatropha curcas*. Later was planted over an area of 6 hectares at Jhumpa Research Station in Bhiwani district in the year 2006. *Jatropha curcas* plants here as well as in other parts of Haryana have been severely affected by frost during winter. All plants die as a result of frost bite followed by dieback disease. Every year new shoots emerge from the ground following the summer season. On the basis of poor seed yield, diseases and other parameters we have concluded that *Jatropha* cultivation is not economically viable in Haryana.

**Species Introduction:** Increased biomass production, resistance to frost and drought are some of the desirable characters in any species. We do not have many valuable timber species in Haryana. It is with view *Swietenia mahogany* has been introduced in Shiwalik foot hills in 2010. It is growing very well in Chandigarh as ornamental tree. It is frost resistant and one of the best 50 timbers of the country. We have planted 200 plants of his species in Bharagi forest of Morni Range. The height and girth data is being taken annually. Its tolerance to frost and
diseases is also being studied. Initial trend show that it may not perform well under Shiwalik conditions.

**Establishment of Ficatum:** All Ficus species of our country have special significance. They have special historical, religious and ecological value. As regards ecological value the Ficus species are excellent shade providers. They are excellent in absorbing sound and dust pollution. The ripened fruits of Ficus species are the excellent food for wildlife specially birds. However, most of the Ficus species are becoming endangered day by day. It is with view that Ficatum has been established in the state at Sohna and Jhumpa. This will not only serve as future source of seed of Ficus species but will also be a beautiful Ficus avenue. The following Ficus species have been planted:

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<tr>
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<th>Cluster Fig</th>
<th>Ficus glomerata</th>
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<tr>
<td>Peepal, Bodhi Vriksh</td>
<td>Tree of Penance</td>
<td>Ficus religiosa</td>
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<tr>
<td>Pilkhan</td>
<td>Wavy Leaved Fig</td>
<td>Ficus infectoria</td>
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<td>Krishan Vat Vriksh</td>
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<td>Ficus krishnae</td>
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<td>Anjir</td>
<td>Fig</td>
<td>Ficus palmata</td>
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<td>Ficus carica</td>
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<td>Taryambalu</td>
<td>Giant Fig</td>
<td>Ficus rumphii</td>
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**Introduction of Melia composita:** Melia composite Syn. *Melia dubia* is one of the fastest growing species suitable for growing under agroforestry. It has been introduced in the state in 2005. FRI has also laid experiments for testing various clones. The results are highly encouraging. The species has wider adaptability and success, it is going to give boost to agroforestry in the state.

**Screening of Eucalyptus clones**

Eucalyptus clones have been screened against *Leptocybe invasa* and no.288 has been found to be the most tolerant and no.10- most susceptible.