Training manual on

Propagation Techniques of Commercially Important Medicinal Plants

Prepared for
Andhra Pradesh State Forest Department

Manual designed and developed by
B S Somashekkhar
Manju Sharma

Foundation for Revitalisation of Local Health Traditions,
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Introduction to the manual

Background
Medicinal plants constitute a considerably large component of natural vegetation. Several of these species are in great demand for domestic consumption as well as for commercial use by the herbal industry. About 800 species are estimated to be in trade with a turnover of Rs.4000 crores per year. Except about 60-80 species whose produce comes from cultivated sources, the rest of the raw material being traded comes from the wild collections. This high demand by the herbal industry has put enormous pressure on the wild populations leading to destructive collection of the produce. Absence of commercial cultivation of these species, results in increased dependence on the wild collections, which has further aggravated the situation.

Today, a large number of medicinal plants species are considered threatened due to such high demand and destructive collection practices. Thus, the conservation efforts are of immediate need to save these species in the wild by maintaining their wild populations, without which the species may be wiped out.

Propagation of such prioritised species in the nurseries is a means towards conserving their genetic stocks. Through the nurseries it is possible to make available planting material of these species for cultivation. Bringing more species under large-scale cultivation helps reduce the pressure on the wild stocks. However, in the absence of comprehensive information on the propagation techniques, nursery management and agro-technology of medicinal plants, the initiatives to establish medicinal plants nurseries and cultivate them as
commercial crops have not witnessed considerable success in the past.

**Manual and its purpose**

This manual is a step towards bridging this gap. It has attempted here, to bring together the available information on the propagation techniques of 81 medicinal plant species and discusses the basic principles of plant propagation and nursery management. The species included in the manual are of the following category:

- Species, which are native and are suitable to the soil and climatic conditions of Andhra Pradesh.
- Species, which witness a high demand by the herbal industry and vigorously traded
- Species, which have a potential for commercial cultivation
- Species which witness a high degree of collection from the wild, hence require possible remedial measures to replenish the stock
- Species which are recommended by the local communities as they are found in the local trade
- Species which are already in cultivation to a certain extent
- Species, which are red listed, hence require possible remedial measures to replenish the stock

The manual has tried to make available the information in a user-friendly style.
Objectives of the manual
While doing so, the manual focuses on the following objectives.

- To make the VSS understand the significance of raising nurseries of commercially important medicinal plants
- To orient the VSS towards the techniques for raising and managing medicinal plants nurseries
- To familiarise the VSS with the propagation methods of commercially important medicinal plants species
- To provide an overview of the cultivation status of commercially important medicinal plant species

Structure of the manual
While addressing these objectives, the manual has been structured keeping the needs of the VSS. In order to facilitate easy understanding, the information has been made available in two sections. The first section provides an overview of the cultivation and propagation of medicinal plants and illustrates the basic principles involved in plant propagation and nursery management. The second section describes the propagation techniques of the selected medicinal plants species. Information in this section is presented in the form of easy to follow step-by-step instructions.

How to use the manual
The manual is user friendly. It can readily serve as a training tool. The manual has to be referred and used by a VSS member as a reference guide for training and orientating the VSS and the local communities about the propagation of medicinal plants.

The first section of the manual helps in discussing the necessary background information about the cultivation and propagation. It further orients the VSS to the principles of plant propagation. In the
second section, a VSS can concentrate on its choice of species. Details of the propagation techniques of such selected species may be explained, retold and discussed. The information gathered from the local experience and local examples may also be pooled up to enhance the quality of the sessions.

While the manual explains the methods and shows the techniques of propagating the plants, it is the individual skills of the nurserymen of the VSS that decide the success of the nursery. All the prescriptions and procedure of the individual species as detailed in the manual need to be followed carefully for the propagation success. Details of the material used and the methods followed in a propagation exercise need to be documented properly that can contribute to the nursery data.

Taking care of the seedlings is as challenging and as rewarding as taking care of one’s children. VSS can certainly benefit from this.
1. Medicinal plants and their cultivation

Medicinal plants under cultivation in Andhra Pradesh

There are more than 1400 medicinal plants native to the state of Andhra Pradesh. Many of these feature in the local and international trade. However, the current scenario of medicinal plants cultivation is not an encouraging one. Several medicinal plants species are seen in the cultivated habitats only as representative plantings. Thus, about 125 species have been recorded as stray planting in Andhra pradesh. Some are the preferred species for home gardens and backyards. Species such as *Michelia champaca* (Champakamu, Gandha phali), *Moringa oleifera* (Munaga) and pomegranate (Dalimba) are such medicinal plants seen growing in the gardens.

![Moringa oleifera](image1.png)  ![Michelia champaca](image2.png)

Only a few species are found to be “cultivated” in the real sense. Of the 80 species that have the cultivation potential, only three are presently cultivated in Andhra Pradesh - *Bixa orellana* (Jabra), *Lawsonia inermis* (Goranta, Krommi) and *Trachyspermum ammi*. The rest are found as wild populations.
Of the 50 red listed species so far assessed in Andhra Pradesh, only ten species are found in the cultivated habitats.

- *Acorus calamus* - Vasa
- *Aegle marmelos* - Maredu
- *Plectranthus barbatus* -
- *Gloriosa superba* - Kalappa gadda
- *Piper nigrum* - Mirriyalu
- *Plumbago indica* - Erra chitramulamu
- *Pterocarpus santalinus* - Raktagandhamu
- *Rauvolfia serpentina* - Patalagandhi
- *Santalum album* - Chandanam, Gandhapu-ckekka
- *Saraca asoca* - Asokamu

Thus, the current scenario of medicinal plants cultivation in Andhra Pradesh is not comprehensive.
Area under medicinal plants cultivation in Andhra Pradesh

Details relating to the area under cultivation of medicinal plants in Andhra Pradesh are equally grim. Even though the following species are reported to be “cultivated”, details of the area under cultivation are not available.

Table. I. Medicinal plants “cultivated” in Andhra Pradesh

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Vernacular name</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pippalu</td>
<td><em>Piper longum</em></td>
</tr>
<tr>
<td>2.</td>
<td>Kalappa gadda</td>
<td><em>Gloriosa superba</em></td>
</tr>
<tr>
<td>3.</td>
<td>Vasa</td>
<td><em>Acorus calamus</em></td>
</tr>
<tr>
<td>4.</td>
<td>Maredu</td>
<td><em>Aegle marmelos</em></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td><em>Plectranthus barbatus</em></td>
</tr>
<tr>
<td>6.</td>
<td>Mirriyalu</td>
<td><em>Piper nigrum</em></td>
</tr>
<tr>
<td>7.</td>
<td>Erra chitramulamu</td>
<td><em>Plumbago indica</em></td>
</tr>
<tr>
<td>8.</td>
<td>Raktagandhamu</td>
<td><em>Pterocarpus santalinus</em></td>
</tr>
<tr>
<td>9.</td>
<td>Chandanam</td>
<td><em>Santalum album</em></td>
</tr>
<tr>
<td>10.</td>
<td>Asokamu</td>
<td><em>Saraca asoca</em></td>
</tr>
<tr>
<td>11.</td>
<td>Munaga</td>
<td><em>Moringa oleifera</em></td>
</tr>
<tr>
<td>12.</td>
<td>Ganja chettu</td>
<td><em>Cannabis sativa</em></td>
</tr>
<tr>
<td>13.</td>
<td>Champakamu</td>
<td><em>Michelia champaca</em></td>
</tr>
<tr>
<td>14.</td>
<td>Dalimba</td>
<td><em>Punica granatum</em></td>
</tr>
</tbody>
</table>

However, such details relating to the total area under cultivation in the country are available for the following 3 species.
### Table. II. Area under medicinal plants cultivation in selected states

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Telugu name</th>
<th>Botanical name</th>
<th>States</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Davana</td>
<td><em>Artemisia spp.</em></td>
<td>Karnataka, Andhra pradesh</td>
<td>500</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td><em>Catharanthus roseus</em></td>
<td>Andhra pradesh, Karnataka, Maharashtra</td>
<td>4,000</td>
</tr>
<tr>
<td>3.</td>
<td>Sarpagandha</td>
<td><em>Rauvolfia serpentina</em></td>
<td>Madhya Pradesh, Chota Nagpur, Bengal, Assam, Tamil Nadu, Kerala, Andhra pradesh.</td>
<td>2,500</td>
</tr>
</tbody>
</table>

Besides these three species cultivated in Andhra Pradesh, some other medicinal plants are under cultivation in other parts of the country. The following tables lists out such species with their acreage. However, these are currently not seen cultivating in Andhra Pradesh.

### Table. III. Medicinal plants under cultivation in the states other than Andhra Pradesh

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Vernacular name</th>
<th>Botanical name</th>
<th>Producing states</th>
<th>Estimated area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Suna mukhi</td>
<td><em>Cassia senna</em></td>
<td>Tamil Nadu, Kerala, Rajasthan, Uttar Pradesh</td>
<td>20,000</td>
</tr>
<tr>
<td>2.</td>
<td>Safed Musli</td>
<td><em>Chlorophytum spp.</em></td>
<td>Madhya Pradesh, Gujarat, Uttar Pradesh</td>
<td>5,000</td>
</tr>
<tr>
<td>3.</td>
<td>Basil</td>
<td><em>Ocimum basilicum</em></td>
<td>Uttar Pradesh</td>
<td>500</td>
</tr>
<tr>
<td>4.</td>
<td>Psyllium</td>
<td><em>Plantago ovata</em></td>
<td>Rajasthan, Gujarat, Punjab, Uttar Pradesh</td>
<td>55,000</td>
</tr>
<tr>
<td>5.</td>
<td>Khai Katari</td>
<td><em>Solanum spp.</em></td>
<td>Maharashtra</td>
<td>4,000</td>
</tr>
<tr>
<td>6.</td>
<td>Ashwagandha</td>
<td><em>Withania somnifera</em></td>
<td>Madhya Pradesh, Gujarlat, Rajasthan, Uttar Pradesh, Punjab, Kerala, Haryana, West Bengal, Karnataka, Maharashtra</td>
<td>5,000</td>
</tr>
<tr>
<td>7.</td>
<td>Amla</td>
<td><em>Emblica officinalis</em></td>
<td>Throughout India</td>
<td>Acreage</td>
</tr>
</tbody>
</table>
It may be noted here that the species suggested for cultivation in Andhra Pradesh such as *Cassia senna* and *Withania somnifera* are presently cultivated in its neighbouring states such as Karnataka and Tamilnadu. Species such as Amla, Kavach, Amritavalli and Vetiver can be readily considered for cultivation as their soil and climatic requirements are fulfilled in Andhra Pradesh also.
2. Medicinal Plants Nurseries and the VSS

Nursery in the context of VSS
A nursery may be treated as a place where the seedlings and young ones of a plant are raised, nurtured and maintained with care and attention till they attain a specified stage of maturity and ready for transplanting into the main field or for distribution.

A nursery may also be defined as a pool house of seedlings and juveniles of various species of plants.

Significance of a nursery
The significance of a nursery lies in the multi-faced roles it assumes in the context of VSS. It serves as a means of *ex situ* conservation, it becomes a place of education and learning; it also serves as a common forum for community participation. Its significance may be summarised as follows.

- Nurseries serve as an *ex situ* gene pool of different species. They provide a viable means for the collection and maintenance of seeds and seedlings of commercially important species.
- Nurseries are the reliable source of authentic planting material of medicinal plants for local healers and households.
- A nursery is an open-air classroom to study propagation and nursery related subjects. A nursery often assumes the shape of a manmade forest and provides ample scope to study a plant from a close distance. Thus it also serves as conservation education and learning centres.
- Since it serves the community at one hand it can also become a common forum for the local healers and medicinal plants growers to come together and share their experience.
**VSS and medicinal plants nurseries**

In the context of VSS, a medicinal plants nursery assumes a proactive role in providing genuine planting material to different user groups. They also serve as learning centres and common forum for community participation activities. Besides, the nurseries can also contribute to the village economy to a certain extent via income generation activities.

The user groups in the context of VSS nursery would comprise the VSS members, local folk healers, NTFP collectors, households, school and religious institutions and the visitors. The user groups would be benefited either monetarily or indirectly by way of procuring plants from the nursery. While the local communities depend on the nursery for genuine and quality planting material, the local healers can also consider procuring their regular supply of specific raw material from the nurseries without having to extract from the wild.

The school, temple and other religious institutions in the vicinity of the VSS can actively involve in the nursery by bringing up a garden of medicinal plants in the school, temple, and common lands and in the VSS premises.

A well-established and well managed nursery can ensure a constant flow of benefit ploughed back into the local community. The following kinds of income generation activities are possible for the local community through a VSS nursery.
Getting involved in nursery activities such as seed collection, raising seedlings and nursery maintenance.

- Mass propagation of seedlings for supplying to distribution nurseries.
- Helping in the distribution and sale of seedlings.

Medicinal plants that contribute to the village economy in Andhra Pradesh

At least three medicinal plants species have been contributing significantly to the village economy in Andhra Pradesh. These are Usirikaya (*Phyllanthes emblica*), Karakkaya (*Terminalia chebula*) and Mushti (*Strychnos nux-vomica*). In several villages in the state, during February – April, the fruits of Usirikaya are collected in large quantities from the forests. Similarly, almost 2000 tonnes of Karakkaya are collected during October – April and over 500 tonnes of Mushti fruits are harvested during November- March. GCCL (Girijan Co-operative Corporation Limited), which is organising this collection via a network of gatherers is looking into fair-pricing of the produce and benefit sharing among the local communities.
3. Principles of Nursery management

Establishing a nursery and running it efficiently calls for careful planning at every stage of its development. This warrants selection of appropriate site, proper planning and careful implementation of the strategy. Establishing a nursery undergoes the following steps.

a. Site selection

While selecting the site for establishing a nursery, the following key points have to be considered. The selected site-

- would be located on a fairly level ground free from boulders,
- will be receiving sufficient light,
- has good drainage facilities,
- will have good water source and irrigation facilities; it is essential that there is year round supply of water,
- would be free from strong winds,
- would have good soil which is porous and free from salts.

b. Design and layout

Once the site is selected, a proper design and lay out has to be worked out. Following elements need to be included in the design.

- Fencing along the boundary
- Trees along boundary to serve as wind break
- Scattered trees inside the nursery for shade
- Nursery beds, mother beds, germination beds
- Well, water tank and pipeline
- A pump house cum store watchman shed
- Manure pits
- Pandals and temporary shade houses for the germination beds.
- Mist chamber and other permanent propagation chambers
c. Land clearing
Once the design is ready, the nursery site has to be made ready for development. All the weeds and unwanted vegetation that is seen on the site needs to be removed. Only well grown trees are retained for permanent shade. In case there is excess shade, some tree branches can be removed to allow more sunlight. Land has to be levelled and the area demarcated based on the layout. It is advisable to maintain a gentle slope of 1% while levelling the land.

d. Developing the nursery infrastructure
Based on the local needs and conditions, minimum nursery infrastructure could be developed. A store cum shed to keep the nursery equipments, seeds and planting material, manures and fertilizers, watering tools and garden equipments, is the minimum infrastructure in a nursery. Water tanks and irrigation supply are the other necessary infrastructure. Erecting suitable propagation chambers may also be considered based on the need.

e. Equipments and tools
Maintaining a stock of planting material, rooting medium, manure and fertilizers, garden tools, containers, seed storage equipment (glass bottles, paper bags), chemicals, registers, data entry book, field notebook, etc. are equally essential.

f. Demand assessment and Species choice
Deciding the species choice is a significant step in developing the production schedule. Species choice is usually decided based on the demand assessment that can be carried out with the different user groups, through PRAs and user-group surveys. The demand by the user groups decides the species to be raised in the nursery. The Species choice may be based on the species in demand, ability of the
nursery to raise the species, climatic adaptability of the selected species to grow in a given nursery, facilities for seedling distribution and other local parameters. Considering the species choice, number of seedlings to be raised and the prevailing climate in the region, a suitable production schedule may be drawn up.

g. Managing the nursery
Managing the nursery efficiently is a crucial element that decides the success of the nursery. Seedlings and the young ones have to be taken care properly. Routine operations such as sowing, planting, watering, weeding, transplanting, prophylactory sprays, seedling sale & distribution are to be carried out as per the schedule.

It is equally important to maintain a record of the production and sales for managing a nursery efficiently. One or two members in the VSS could take up the responsibility of making a note of different details such as, species raised, expenditure incurred, stock status of fertilizer/manure material, monthly sales, etc.

h. Seedling distribution
Once the seedlings are raised in the nursery and ready for distribution, it is important to develop a proper distribution strategy. Proper distribution strategy ensures proper disposal of the seedlings among the user groups as per their demand. The surplus stock of the seedlings may be kept for sale among the visitors. Based on the type of user groups, species and the demand, VSS can decide the price of seedlings.
i. Nursery terms frequently used in this manual

**Tillers:** New shoots arising from the base of a monocot plant especially in the grass family.

**Divisions:** Piece of rhizome, tuber and tuberous root with a vegetative bud.

**Root suckers:** Young shoots that arise from the adventitious bud on a root and those arise from below the ground. Suckers are treated essentially as a rooted layer or as a cutting in case few or no roots have formed.

**Slips:** Adventitious shoots develop into slips when the mother plant is placed under warm, moist conditions.

**Coppice shoots:** New shoots arising from the adventitious buds of a damaged trunk.

**Polybags:** Small polythene bags used for sowing the seeds or for transplanting seedlings.

**Polyhouses:** Structures constructed to raise the seedlings under artificial growing conditions in which the temperature and humidity are regulated.

**Pots:** Conventional propagation structures used to rear the young plants. These are containers usually with a broad neck and a narrow base. Conventionally, pots are made of mud.

**Nursery beds:** Rectangular or a square shaped beds prepared on the ground with soil, clay, sand and manure for raising the seedlings. The beds are usually 1 m wide and of convenient length. Two types of beds are commonly seen - raised and sunken.
Raised seedbeds

**Seedbeds dug in the soil** with straight sides. Better during rainy season (depth 15cms.)

**Seedbeds made with sidings** of bamboo or boards stalked in place; better during wet season.
How to make the VSS nurseries sustainable?

Following are some of the broad elements that contribute to the sustainability of the nursery activities. VSS need to consider these.

- The local community needs to be involved in the development and management of the nursery. This makes the local community to collectively own up the cause and work towards the continuity of the activities and bring in the sustainability. Nursery operations such as seed collection, sowing, watering, and aftercare of seedlings can be the means of involving the women folk and self-help groups.
- The nursery should meet the requirements of the different user groups. Proper fulfilment of the demand not only satisfies the requirements of the user groups but also instils confidence among them to place the orders with the nursery on a regular basis. Ensuring the clients is another key to the sustainability.
- A proper demand assessment among the user groups helps VSS determine the species that are in demand. Proper demand assessment provides a feedback to the nursery, which helps in raising only those species, which are in demand. Species in demand find a ready market and in turn lead to a ready flow of money to the nursery. Need assessments can be carried out on a routine basis by regular follow-ups among the user community and by maintaining a register at the nursery to enter the demands of the visitors to the nursery.
- Encouraging the VSS members and self-help groups to take up activities that favour the nurseries, such as preparation of simple drugs, raising kitchen herbal gardens, conducting self-help programs, organising education and awareness activities in the nursery premises contribute to the sustainability of the nursery.

4. Understanding the principles of plant propagation

What is plant propagation?
Propagation is a natural phenomenon in all plants. It is the process of multiplication of a plant by sexual or asexual means to ensure the
continuation of its progeny. This is achieved artificially on the field by adopting techniques suitable to the specific plant and its growth cycle.

**What is the significance of propagation in the life cycle of a plant species?**

Propagation ensures the continuation of the progeny of a species. In nature it allows a plant species to enter into different growth stages and cope up with the climatic changes. Propagation allows a species to flourish and develop into a population by making use of the available resources in a given region.

**What are the methods of plant propagation?**

Plants perpetuate in nature through seeds or through vegetative parts or special and modified organs. Plants have evolved different methods of propagating themselves. Based on the mode of propagation, two types of propagation are usually recognised among plants- sexual and asexual propagation.

**Sexual method of Propagation**

It is the method of propagating a plant using the seed, which is a reproductive part that carries both the sexes of the parents. Since a seed is the product of the union of two sexual parts of a plant (ovule, the female part and pollen, the male part), propagation with the help of seeds is called sexual propagation. Seeds are the fertilised ovaries due to pollination and fertilisation and are developed inside the fruits. On germination, a seed gives rise to a young sapling.
Since seeds are produced periodically or regularly in the reproductive phase of a plant’s lifecycle, this is a rather convenient method of propagation plants.

**Seed propagation has some advantages and limitations**

**Advantages:**
- Sexual method of propagation is simple to follow and generally does not require any special care as the seeds germinate easily.
- Each plant will be able to produce a huge number of seedlings, since the number of seeds available on a single plant is usually high.
- Since the seed production is a seasonal or an annual event in a plant’s life cycle, this method can be followed regularly.
- As the seeds of many species are generally small in size with less water content, they facilitate cost effective storage in a smaller space for a longer period.

**Limitations:**
- Since the seeds are the product of the union of two sexes of a plant, the seedlings obtained from such seeds will not resemble the mother plant completely. This is more widely seen with seedlings of those plant species that are cross-pollinated.
- Seeds of certain species are known to exhibit dormancy and propagation of such species using seeds is not easy.
- Seeds of certain species are known to exhibit poor viability and propagation of such species using seeds is not easy.
- Special qualities or plus traits of a mother plant cannot be passed on in total to the young ones produced by this method.
- Plants raised by this method take a long gestation period before attain the maturity.
**Seed dormancy** is the inherent physiological condition of a seed in which, it is unable to sprout and germinate on sowing. Such a state can be overcome by specific physical and chemical treatments based on individual species. Seed dormancy is often noticed with certain medicinal plants too. Seeds of Gacha kaya (*Caesalpinia bonduc*), *Plantago ovata*, and tubers of Kalappa gadda (*Gloriosa superba*) exhibit such dormancy. Under such situations, they require specific treatments to overcome the dormancy.

**Seed viability** is the natural capability of a seed to retain the potential of germination over a certain period of time. This viability period varies with the species. Seeds of Tani or Thandra (*Terminalia bellirica*) are viable for a year while the seeds of Nelavemu (*Andrographis paniculata*) remain viable up to 6 months. Seeds of Usirikaya (*Phyllanthes emblica*) remain viable only for a month once their fruit pulp is removed.

**Asexual method of Propagation**

In asexual mode of propagation, a plant perpetuates with the help of plant parts other than the seeds. It is carried out either by using the vegetative parts such as stem, leaf and root, or by using special and modified parts such as tuber, rhizome, corm, bulb, sucker, etc. Asexual propagation in nature is seen in many plants.

**Asexual method of propagation has certain advantages:**

- Since the propagating material used is a part derived from a mature plant, the young ones always resemble the mother plant in all respects and retain all the features of the mother plant.

- This method is useful for propagating those plants, which do not set seeds, those which set seeds irregularly, those which set sterile seeds, and those which are male by sex.

- This method helps in maintaining the progeny of those plants which exhibit special characters and plus qualities.
• Since the parts used for propagation, would have attained physiological maturity at the time of planting, the young ones come to bearing at an early age.

**Asexual propagation has some limitations too:**

• Since the method involves separation and severing of the propagating organs from a mother plant, intensive collection of the planting material may damage a mother plant.

• A single mother plant may not provide the required planting material in a large quantity, since the parts used are of a specific type.

• Since the method of propagation involves a definite procedure, it demands proper skills and time to carry out the exercise.

• This method cannot be planned all through the year, since the planting material is specific and available only during certain growth stages of a plant.

• The propagation material cannot be stored for longer periods of time under room conditions, since the parts used are quite often fleshy.

• Since the new plants raised from this method are not capable of developing a strong tap root system, they are more prone to wind damage.

**Different methods of asexual propagation**

Asexual methods of propagation are carried out usually by cuttings, grafting, budding, layering and planting of modified organs.

**Propagation through cuttings:**

![Fig. 6. Cuttings can be extracted from stem, root and leaves of a plant](image)
Propagation through cuttings is an easy and less expensive method of vegetative propagation. A cutting is usually a division of the stem, or root or leaf of a plant. Cutting is extracted from a plant part and planted in the soil. Based on the requirement, the cuttings are extracted from a mother plant of a definite age. The extracted cuttings are trimmed and planted in the soil either horizontally or vertically depending on the need. Among all the type of cuttings, stem cuttings are most widely used.

a. **Hardwood cuttings:**
Cuttings taken from the branches of the current year’s growth of a plant are usually considered to be Hardwood cuttings. These cuttings usually measure 25-30 centimetres with 4-5 nodes. Cuttings of pencil thickness with uniform internodal growth are preferred. Some of the medicinal plants that are usually propagated by hardwood stem cuttings are, *Hibiscus rosa-sinensis* (Mandara), Pomegranate (Dalimba), *Lawsonia inermis* (Goranta or Krommi).

b. **Semi hardwood cuttings:**
These are cuttings prepared from tender shoots and branches of the current year’s growth that are not too hard but show brown blotches on the green stem. They usually measure about 20 centimetres with a pair of leaves retained at the tip. Some of the medicinal plants that are usually propagated by Semi hardwood stem cuttings are, *Adhatoda vasica* (Adda sarap), *Tinospora cordifolia* (Jivantika, Tippatiga), *Eclipta alba* (Gunta-galijeru, Gunta-kalagara), *Gymnema sylvestre* (Poda patri, Putla podra), and *Piper spp*.

c. **Softwood stem cuttings:**
Those cuttings prepared from the soft tender shoots that are still green are considered softwood cuttings. These cuttings usually measure 8-10 cms with a growing tip and the leaves are usually retained at the tip.
Some of the medicinal plants that are usually propagated by semi hardood stem cuttings are, *Bacopa monnieri* (Brahmi), *Gymnema sylvestre* (Poda patri, Putla podra).

**Propagation through layering:**
In this technique a vegetative branch is made to root while it is still attached to the mother plant. The rooted branch will be later excised and planted as a new seedling. Different layering techniques such as air layering, mound layering and serpentine layering are commonly practiced.

**Air layering:**
Air layering is carried out as follows:

- Pencil size shoot of the current year’s growth is to be selected. On the selected shoot, preferably on the basal portion, a ring of bark is removed and the exposed wood is scraped.
- The exposed portion is further wrapped with moist inert rooting medium like Sphagnum moss, moist coir etc. and covered with a polythene sheet making it air tight.
- This branch is left undisturbed on the mother plant for about 2 –8 weeks depending on the species.
During the course several adventitious roots emerge from the base of the exposed bark, which is covered.

The rooted branch will be later cut below the covered portion and planted as a separate seedling.

In the case of medicinal plants, air layering is frequently followed in Goose berry (Amla), Tamarind (Chinta) and *Ficus spp.*

**Mound layering:**

It is another technique of layering and carried out as follows:

- A long and supple branch is selected
- Ring of bark is removed at the base and buried in the soil.
- In the due course, roots emerge from the buried portion.
- After sufficient emergence of the roots the branch will be separated from the mother plant and planted as an independent plant.
A series of such layering done on a single long branch that is buried and exposed alternately makes serpentine layers. Serpentine layering can be tried for species, which have drooping long and supple branches. In the case of medicinal plants, serpentine layering is seen in very few species such as *Tinospora cordifolia* (Jivantika, Tippatiga), *Celastrus paniculatus* (Gundameda, Pallerutiva)

**Propagation through grafting:**
Grafting is a propagation technique usually employed to improve the quality of the nursery stock or to produce seedlings that carry the plus qualities of a mother plant. It is carried out by bringing together two vegetative parts from two different plants of a same species and joining them together to grow as a single plant. Usually the stem branches are used for the purpose of grafting.

The plant part that receives another plant part is called the **stock**, while the plant part that serves as the graft is called the **scion**. When these two are joined together, **graft union** takes place.

The scion always carries the positive qualities of the mother plant while the stock serves as the root system for the seedling. After the graft union is taken place, scion becomes the upper part while the stock becomes the basal part of the new plant.

Fig. 8. Process of grafting (clockwise from the top)- Scion, Scion and stock, Scion and Stock are joined together, Graft Union
The stock plant is usually a plant that is already established and growing. During the process of grafting, certain portion of the stem from the stock plant is removed. The selected scion is brought either as a whole plant or as a part and inserted on to the stock plant so that the cut portion of the stock and the scion remain in contact. The stock and scion are tied together with the help of a tape to ensure the union.

The graft is maintained in that condition for a specified time period. After the graft union is ensured, the remaining portion of the stock plant above the graft union is removed and the scion is encouraged to grow. After this, the graft is ready for planting.

Different techniques of grafting are seen in use for propagating different plants. The commonly followed techniques are the following.

- **Approach grafting**: The method involves causing the graft union between the two selected branches of Stock and Scion while the branches are still growing on the parent plants.
- **Wedge grafting**: The method involves causing the graft union by inserting the scion, which is in the form of a wedge, on to an incision on the stock plant. The scion is usually a branch excised from the mother plant.
- **Epicotyl grafting**: Grafting is done on the tender shoot of about 5-7 days old of a germinated seed with its epicotyl seeds still intact.
- **Softwood grafting**: Grafting is done on the soft shoot of the stock plant which is a seedling of about 6 months.

However in the case of medicinal plants grafting is seen only with selected species of the genera *Artocarpus* (Panasa), *Syzygium* (Neredu), *Myristica*, *Garcinia* (Tamalamu) etc.
**Propagation through budding:**
It is yet another propagation technique where a vegetative bud is excised from a mother plant and used as the scion material. The technique involves,
- The removal of selected vegetative bud along with a patch of bark from the scion plant and inserting it on to the stock plant.
- The graft is further tied to keep the bud in place and maintained till the union takes place.
- After the union is ensured, the portion of the stock above the bud union is removed and the sprout from the scion bud is encouraged to grow further.

Different budding techniques such as Shield budding, Patch budding, Ring budding are seen in use, in which the scion material (in the shape of a shield, a small rectangular patch, a ring respectively) is inserted on to the stock plant. However, in the case of medicinal plants, budding is very rarely practiced.

**Propagation through modified organs:**
Several species of plants ensure their propagation with the help of modified organs that serve as the propagules. Following are some such special organs.

**Sucker:** A sucker is a small plantlet that appears around a mother plant from its base. These plantlets remain attached to the mother plant and continue to grow. They assume to grow as independent plants when they are separated from the mother plant and planted elsewhere. Suckers are the propagating material of medicinal plants such as *Aloe vera* (Kalabanda), *Aegle mormelos* (Maredu), *Holorrahena antidysenterica* etc.
**Tuber:** Tuber is the swollen and fleshy underground stem or root. These are found attached at the base of the stem. On separation, tubers or pieces of a tuber will grow into independent plants. Tuber is the propagating material of many medicinal plants such as *Asparagus racemosus* (Challa gaddalu, Pillipichara), *Dioscoria spp.* (Chedupaddudumpa, Karrapendalamu), *Adenia hondala*, *Gloriosa superba* (Kalappa gadda), *Ipomoea spp.* (Nagaramukkatte, Thooti koora, Nelagummudu) etc.

**Rhizome:** Rhizome is the swollen and compressed underground stem with short scaly leaves and vegetative buds. A piece of rhizome with a bud, if planted, will grow into an independent plant. Rhizome is the propagating material of medicinal plants such as Ginger (Allam), Turmeric (Pasupu), *Costus speciosus* (Chengalvakoshtu, Kushthamu) etc.
Section 2

Propagation techniques of prioritised Medicinal plants for the VSS of Andhra Pradesh

Different propagation methods are described in the following pages for 81 medicinal plants prioritised for the VSS of Andhra Pradesh. The species included here are the following:

The synonyms, family names and vernacular names have been included for all the species. The propagation mode and stepwise propagation methods have been described for individual species.
1. *Achyrantes aspera*

Family: Amaranthaceae

Apamargamu

**Mode of propagation:**

It is easily propagated through seeds. It cannot withstand water logging.

**Steps to follow:**

- Seeds are minute and have to be collected from the fruits on aerial shoots at full fruiting stage. Seeds may be later mixed with fine sand and sown.

- Sow the seeds during March-April either randomly or in rows at spacing of one and a half feet within and between the rows.
2. *Acorus calamus*

Family: Araceae

Vasa, Vadaja

**Mode of propagation:**
This aquatic herb can be propagated through rhizomes. It prefers moist clayey loams, sandy loams and alluvial soils.

**Steps to follow:**

- Take the rhizomes from earlier planting and keep them preserved in the soil and constantly moist.

- Once the sprouts emerge, cut these rhizomes into smaller pieces consisting of 2 to 3 nodes and plant in the nursery.

- In the month of July-August, these sprouted rhizome pieces may be planted at half a finger depth at a distance of one foot from each other.

- Second fortnight of June is the best time for planting.

- As the growth is fast, one can see the sprouts on the very second day of planting. 90 % of the rhizomes sprout. 90 % of them successfully establish in the field.

- For transplanting, pick the sprouted rhizomes from the nursery and plant directly in marshy open field.
3. *Aloe barbadensis*
Synonym: *Aloe vera*
Family: Liliaceae
Kalabanda

**Mode of propagation:**
*Aloe vera* can be propagated with suckers having 4-6 leaves. A healthy mother plant produces about 6 suckers at a time.

**Steps to follow:**
- Plant the suckers in rows at spacing of 1 foot. The rows have to be 2 feet apart formed on a well-prepared and manured loamy soil having plenty of broken bricks and coarse sand.

- With a shallow root system, the roots do not penetrate deep into the soil. Therefore whenever the manure is to be applied to the soil, it has to be applied near the base.

- Plant the stocks in October –December.
4. *Andrographis paniculata*

Family: Acanthaceae

*Nelavemu*

**Mode of propagation:**
It can be propagated by seeds and stem cuttings. It prefers open loamy soil.

**Steps to follow:**

- Harvest mature pods and dry under sun. Collect the dried seeds, discard the chaffy seeds. Healthy seeds are viable for 6 months. Since the seeds are too small, mix them with sufficient quantity of fine sand and sow on raised beds.

- Sow in the months of July- November.

- 80% of the seeds would germinate within 10 days.

- Young seedlings may be later transplanted to nursery beds. Avoid deep sowing.

- Maintain the seedlings in the nursery for 2-3 months.

- For vegetative propagation, semi-mature stem cuttings 4-6 inches long with 3 nodes are used. These cuttings have to be planted in either polybags or raised beds to a depth of at least 9 cm with one node exposed.

- 80% of them would sprout within a week.

- These cuttings may be transplanted to the main field after 1-2 months.
5. *Bacopa monnieri*
Synonym: *Herpestis monnieria*
Family: Scrophulariaceae
Sambrani chettu

**Mode of propagation:**
This herbaceous creeper is propagated mainly by stem cuttings. Sometimes it can also be propagated by seeds.

**Steps to follow:**
- For vegetative propagation, cut the whole plant into small units with 4-6 nodes each.
- Dip the cuttings in cow dung slurry to ensure better rooting.
- Plant these stem cuttings directly in the field. Use marshy open fields for the cultivation of the plant.
- The plantlets sprout and establish as independent plants within a few days.
6. *Boerhavia diffusa*

Synonym: *B. retusa*

Family: Nyctaginaceae

Punarnava, Atikamamidi

**Mode of propagation:**
The plant is propagated through seeds.

**Steps to follow:**
- Collect fresh seeds.
- Sow them directly in raised beds or polybags. May-June is the favourable season for sowing.
- In 7-8 days the seeds germinate. They show 70-90% germination.
7. *Cassia absus*
Family: Caesalpiniaeae
Chanupalavittulu

**Mode of propagation:**
It is propagated through seeds.

**Steps to follow:**
- Collect the mature and ripe fruits. Separate the seeds, discard the chaffy seeds
- Sow the seeds in polybags kept under shade.
- The seeds will begin to germinate 4-7 days after sowing, with 60 % of germination.
8. *Catharanthus roseus*
Synonym: *Vinca rosea*
Family: Apocynaceae

**Mode of propagation:**
It is propagated by seeds. It grows on all types of well-drained soils except saline or alkaline soils.

**Steps to follow:**

- Use freshly collected seeds for sowing, as the seeds are viable for a very short period of about 8 months.
- Soak the seeds in water for 12-24 hours to increase the germination percent.
- Sow them in nursery beds. Germination is seen in about 10 days. The young seedlings may be transplanted to the main field later.
9. *Centella asiatica*
Synonym: *Hydrocotyle asiatica*
Family: Apiaceae
Saraswati Aku

**Mode of propagation:**
It is propagated by seeds as well as by stem divisions.

**Steps to follow:**
- Collect the fresh seeds during February-March.
- Sow them on nursery beds or directly in the fields.
- 60% germination would be obtained within 10 days.
- When the stem divisions are used as the planting material, the selected division should have 3-4 nodes. 100% sprouting will be seen in 7-10 days.
- Whenever the plant is to be grown as a pure crop, the land has to be ploughed well and weeds removed. About 2 tonnes of cow dung manure has to be applied for an acre of land. The land has to be divided into smaller beds with small canals for irrigation. On these beds the stem divisions may be planted at close distance.
- Planting may be done in the month of June.
10. *Chlorophytum borivilianum*

Family: Liliaceae

**Mode of propagation:**
The plant is usually propagated through seeds as well as by root divisions. It prefers well drained loamy to sandy soil rich in organic matter.

**Steps to follow:**
- The plant exhibits shy flowering and poor seed setting. Flowering and fruiting are seen during June-September.
- Since the fruits dry and split open to disperse the seeds, it is not easy to collect them. Cover the inflorescence with a bag after the fruits are developed. This would ensure the collection of the seeds otherwise dispersed.
- Seeds are to be sown in very well prepared seedbeds, which need to be heavily manured with farmyard manure or well rotten leaf manure. First or second week of June is ideal for sowing.
- The germination extends up to 16 days with 11 to 24% germination.
- More vigorous plants are produced when the root divisions are used.
- These root divisions are to be taken from the tough root system before the plant begins new growth. Collect the sprouted seedlings between 10 to 30 days after the rains or take out the fleshy root bunches from the ground during May and store in polythene bags.
- Even a small (1 cm), slightly shrunken fleshy root has the capacity to reproduce a new plant. In case of roots that could not be taken out and have already started sprouting, separate them with a sharp blade so that a part of the stem disc remains attached to the fleshy root. These divisions may be used for planting.
The first or second week of June is the appropriate planting season.

One can see the seedlings emerge out of the ground within 4 to 6 days after rains.

Degeneration of tuberous roots during storage affects their growth rate. Hence one must take special care while storing the fleshy roots for propagation.

Storage methods:
Spread the root bunches taken from the field under shade for 15 to 20 days so that moisture content of the root bunches is reduced. Store this planting material in a dry place for the next 7 to 8 months by covering the root at half a foot depth below the ground under the shade.

Another storage method is to pack the root bunches in about 1/2 to 1 Kg bundles in perforated plastic bags having an equal amount of soil, tie at the mouth and keep in a cool dry room. Care should be taken not to include the damaged and fleshy roots without the skin.
11. *Coleus forskohlii*

Synonym: *C. barbatus*

Family: Lamiaceae

**Mode of propagation:**
It is propagated through seeds as well as stem cuttings. It prefers porous and well-drained loamy or sandy loam soils.

**Steps to follow:**
- Collect the seeds in spring. Sow sufficient quantity of fresh seeds in the nursery beds to obtain good germination.
- Seeds may be sown on raised beds.
- In 15 to 20 days, they germinate. The seedlings have to be maintained in the nursery for 6-8 weeks.
- Use semi hardwood stem cuttings for vegetative propagation. These are planted in summer. Cuttings root quickly and easily even in water.
- For this purpose cuttings 4-5 inches long comprising 3-4 pairs of leaves are taken from the tip portion of rapidly growing shoots.
- Plant the cuttings in well-prepared nursery beds under shade. Ensure regular watering.
- Cuttings produce sufficient roots in a month’s time and they are ready for transplanting.
- When the seedlings are 45 days old and are 8 to 10 cm tall, they are transplanted.
12. *Curculigo orchioides*
Family: Hypoxidaceae
Nelatadi

**Mode of propagation:**
Propagation of this plant is through rhizomes. It prefers laterite or well-drained sandy loam to loamy soil.

**Steps to follow:**
- Plant the rhizomes obtained from the previous year’s growth.
- Cut the rhizome into pieces and plant horizontally in nursery beds.
- August-September is the favourable time for planting.
- Root initiation is seen 40 days after planting while sprouting is seen after 60 days of planting.
13. *Cyperus rotundus*
Family: Cyperaceae
MUSTAKAMU, GANDALA

**Mode of propagation:**
This grass is easily propagated either by seeds or slips. It prefers sandy loam to moderate black soil.

**Steps to follow:**
- Collect mature seeds between January - April.
- Since the seeds are small, mix them with sufficient quantity of fine sand and sow them on sunken moist seedbeds in April.
- In 15-20 days, the seeds germinate with a germination percentage of 60-70.
- For propagation through rhizomes or slips, they have to be collected from well-grown grass clumps.
- Plant these slips into moist beds at a spacing of 3-4 inches.
- Water the seedbeds frequently to keep the soil moist.
- June –July is the favourable planting season.
14. *Cyperus scariosus*
Family: Cyperaceae

**Mode of propagation:**
This grass can be propagated through seeds and rhizomes. It prefers sandy loam or damp black soil.

**Steps to follow:**
- Collect the mature seeds between January-April.
- Sow the seeds on sunken moist seedbeds in April. (As described for *C. rotundus*.)
- Seeds complete their germination in 15-20 days and there is 60-70% germination.
- It is propagated vegetative by rhizomes during June-July.
- Cut the rhizomes into pieces and plant at a distance of half a foot between them.
15. *Eclipta prostrata*

Synonym: *E. alba*

Family: Asteraceae

Glagara

**Mode of propagation:**

The plant is propagated through seeds and root suckers. It prefers clayey damp soils under shade conditions.

**Steps to follow:**

- Collect the mature seeds from well grown plants.

- Dry them and soak in water for 24 hours.

- Sow the seeds in raised beds during rainy season since water logging would be injurious to the seedling. In other seasons you could sow the seeds in sunken beds.

- In 6-7 days, 80-90% germination is obtained.

- For vegetative propagation, plant the root suckers in small pits, cover with loose soil and allow for sprouting.

- Transplant the seedlings when they have 4 leaves.
16. *Phyllanthus amarus*
Synonym: *P. fraternus*
Family: Euphorbiaceae
Nelausirika

**Mode of propagation:**
This herb is propagated through seeds. It prefers calcareous well-drained, light textured soils.

**Steps to follow:**
- Sow the seeds in well-prepared nursery beds. Sowing in April-May will help obtain a higher germination rate.
- Apply sufficient quantity of well-decomposed FarmYard manure to the topsoil while preparing the beds.
- Mix the minute seeds with sufficient quantity of fine sand to ensure uniform distribution of seeds on the nursery bed. Later spread a thin layer of soil to cover the seeds in the nursery beds.
- Keep the beds sufficiently moist till the seeds have germinated.
- Transplant 30-40 day old seedlings at a distance of half a foot between them.
17. *Plumbago rosea*

Synonym: *P. indica*

Family: Plumbaginaceae

**Mode of propagation:**

This herb can be propagated either by seeds or stem cuttings. It grows well in intense sunlight and partial shade.

**Steps to follow:**

- Soak the freshly collected seeds in water for 24 hours.

- Dibble the seeds in polythene bags filled with the rooting medium prepared by mixing equal quantities of sand, red earth and manure.

- About 70% of seeds germinate within 7-12 days.

- The plant is also propagated through stem cuttings or semi-hardwood cuttings. Prepare 4-6 inches long cuttings with 3-4 nodes and plant them closely on the raised beds.
18. *Plumbago zeylanica*
Family: Plumbaginaceae
Chitramulamu

**Mode of propagation**
The plant is propagated both by seeds and semi-hardwood cuttings.

**Steps to follow:**
- Soak the freshly collected seeds in water for 24 hours.
- Dibble the seeds in polythene bags filled with the rooting medium prepared by mixing equal quantities of sand, red earth and manure.
- About 70% of seeds germinate within 7-12 days.
- The plant is also propagated through stem cuttings or semi-hardwood cuttings. Prepare 4-6 inches long cuttings with 3-4 nodes and plant them closely on the raised beds.
19. *Psoralea corylifolia*
Family: Fabaceae
Bavancalu

**Mode of propagation:**
It is propagated through seeds. It prefers well-drained soils and intense light conditions.

**Steps to follow:**
- Collect the seeds from mature fruits in November-December.
- Dry them under shade and store. May - June is the right season for sowing.
- Soak the seeds in hot water for good germination. Seeds may also be soaked in water for 12-24 hours.
- Sow these seeds on raised beds. Seeds can also be sown directly in the field.
- Seeds germinate within 7-12 days with a success rate of 65-70 percent.
20. *Solanum nigrum*
Family: Solanaceae
Kakamanchi

**Mode of propagation:**
This herb is easily propagated through seeds. It grows on all types of soils, but prefers loamy soils.

**Steps to follow:**
- Seeds may be collected from ripe fruits dried under shade and stored in room condition. Seeds do not lose their viability during storage at room temperature.
- Since the seeds are small and sometimes it is difficult to separate them from the fruits, entire fruit may also be sown. However care should be taken not to sow them deep.
- Fruits/ seeds are sown in rows or in flat beds after mixing them with fine soil for better distribution.
21. *Tephrosia purpurea*
Family: Fabaceae
Tella Vempali, Vempali

**Mode of propagation:**
This herb can easily be propagated by seeds. It prefers light sandy or loamy soils.

**Steps to follow:**
- Collect the seeds in October-November from well-grown and healthy plants.
- The seeds have a waxy layer around the thick seed coat and therefore do not germinate easily. Therefore, the seeds are treated with hot water.
- The thick seed coat may also be softened by rubbing against a rough surface like sand paper.
- Seeds thus pre-treated, are sown with a seed drill during June - July.
22. *Trachyspermum ammi*

Synonym: *Carum copticum*

Family: Apiaceae

**Mode of propagation:**

This plant is propagated through seeds. It grows best in humus rich loamy soil.

**Steps to follow:**

- Freshly collected seeds are used for raising the crop during November. Seeds are sown in rows with the help of a seed drill. Rows are usually at a distance of one and a half feet.
23. *Tribulus terrestris*
Family: Zygophyllaceae
Palleru, Cinnapalleru

**Mode of propagation:**
Propagation of this herb is through seeds alone.

**Steps to follow:**
- Collect the fruits during December.
- Crush the fruits and sow them in polybags.
- Sowing is usually during the months of May-June.
- In 10-15 days, the seeds germinate. Success rate is about 80%.
24. *Vetiveria zizanoides*

Family: Poaceae
Vettiveru, Wuttee

**Mode of propagation:**
This plant can be propagated through seeds and slips. It prefers loose sandy soils. Even though Vetiver grass produces viable seeds, they are not preferred to raise commercial crops because of the variability in the seed-raised crop.

**Steps to follow:**

- Slips are favoured for planting, since tillers take longer time for growing.
- Collect the slips and plant them directly in the nursery beds or polybags during the rainy season.
- Cut down the top of slips before planting to prevent transpiration loss, thus giving a better chance for survival of the slips.
- If the rooted slips are of palm length, plant them at a finger’s depth in holes made with a peg at a spacing of one and a half feet within the line and less than a foot between the rows.
- Plant two or three slips in each hole. Press the soil around the slips firmly and level them.
- Slips sprout in 7 to 10 days.
- After 60 days, carry out earthing up operation to promote good root development.
1. *Abelmoschus moschatus*

Synonym: *Hibiscus abelmoschus*

Family: Malvaceae

Kasturi-benda vittulu

**Mode of propagation:**
This erect under-shrub can be propagated by seeds and stem cuttings.

**Steps to follow:**
- Soak the seeds in water for 24 hours. Dibble 2-3 seeds to a depth of 1 to 2 cm and cover with soil. Sow the seeds at least a foot apart.

- Seeds may also be dibbled 1 cm deep at a distance of 1m. Give a spacing of 2 feet between rows. Sow the seeds during early summer or rainy season.

- Seeds take at least 15 days to germinate, even though early germination is seen after 8-10 days.

- Non-leafy semi-hardwood cuttings are also used for propagation. These cuttings are planted directly in the main field.
2. *Acacia sinuata*
Synonym: *A. concinna*
Family: Mimosaceae
Sikaya

**Mode of propagation:**
The plant is propagated through seeds and stem cuttings.

**Steps to follow:**
- Sow the seeds directly in the main field. Seeds are sown about 3 m away from the supporting tree preferably along stream banks. Seeds exhibit a low success rate of about 26%.
- To propagate vegetatively, about-a-metre long cuttings with a circumference of 4 inches are used. These cuttings have to be extracted from the young portion of the stem.
- These cuttings are planted during the first rains.
3. *Adhatoda zeylanica*
Synonym: *Adhatoda vasica*
Family: Acanthaceae
Adasaramu

**Mode of propagation:**
Propagation of this shrub is usually through stem cuttings alone. It prefers loamy soils.

**Steps to follow:**
- Take semi-hardwood and softwood cuttings, 3-4 inches long with 3-4 nodes.
- April-June is the best time for planting.
- Plant the stem cuttings in polythene bags or raised beds.
- Cuttings will take 15-20 days to sprout and 30 days to root.
- 10 days after root initiation, they will harden (cuttings will be fit enough to be transplanted) and 80% establishment can be obtained.
4. *Baliospermum montanum*
Synonym: *B. axillare*
Family: Euphorbiaceae
Kondamudam, Nelajidi

**Mode of propagation:**
This shrub is propagated by seeds and stem cuttings.

**Steps to follow:**
- Collect mature fruits in polybags and dry in sun. On drying, the pods open and liberate seeds.
- Sow these fresh seeds on raised beds at a distance of more than half a foot and cover with sand. Water the seedbeds twice daily.
- Germination commences from the sixth day onwards and will be complete in twelve days. The average germination percentage is around 50.
- For vegetative propagation use semi-mature, stem cuttings with at least 3 nodes, measuring half a foot long.
- Plant the cuttings in polybags filled with loamy soil or plant on raised beds.
- For better rooting, the cuttings may be treated with rooting hormones such as IBA, NAA or Boric acid.
- This will also improve the sprouting per cent to nearly 90 to 100 %.
- Transplant the seedlings soon after the plant has reached 2-3 inches in height after about a month.
5. *Bixa orellana*
Family: Bixaceae
Jabaru Kaya, Jabura, Jaffra.

**Mode of propagation:**
Seeds are used for propagation of the plant. Well-drained rich soil with moisture retaining capacity is most suitable for this plant.

**Steps to follow:**
- Raise the nursery in April-May.
- Sow the seeds in the nursery or polythene bags containing a rooting medium prepared by mixing equal quantities of soil, sand and manure.
- The seeds germinate in about 8-10 days.
6. *Caesalpinia bonduc*
Family: Caesalpiniae
Gacha kaya

**Mode of propagation:**
The plant is propagated by seeds.

**Steps to follow:**
- The seeds usually exhibit dormancy. This may be overcome either by acid scarification, light and temperature treatment, or treatment with conc. sulphuric acid for 30-90 min.
- The acid treated seeds, if exposed to light for 72 hrs, exhibit 100\% germination.
7. *Caesalpinia digyna*
Family: Caesalpiniaceae
Nunegacha

**Mode of propagation:**
The plant is propagated by seeds.

**Steps to follow:**
- The seeds have a hard seed coat, which sometimes affects the germination. To ensure good germination, treat the seeds with hot water or puncture the seed coat.
- These seeds are later sown.
8. *Cassia angustifolia*

Synonym: *C. senna*

Family: Caesalpinaceae

Nellopanna

**Mode of propagation:**

It is usually propagated by seeds. As a pure crop, it is raised on red loams including coarse gravelly soils or alluvial loams and even on the rich clayey rice fields. However it is sensitive to water logged conditions.

**Steps to follow:**

- Soak the seeds in cold water for 8 hours and then dry in shade.

- The seeds have a hard seed coat, and it may be softened by rubbing the seeds against a rough surface like a sandpaper.

- In the main field beds of suitable size have to be prepared. In these beds, ridges and furrows have to be opened at a distance of one and a half feet.

- Dibble the seeds on one side of the ridge at a distance of 1 foot and 2 cm deep. Irrigate the beds lightly.

- Seeds may also be broadcast the seeds on a raised bed of less than 4 m long and less than 3 m broad.

- Sow the seeds either during the months of January - February or June - July.

- Germination starts after 13 to 15 days of sowing and is over in another one week.
9. *Catunaregam spinosa*
Family: Rubiaceae
Manga Chetti

**Mode of propagation:**
Propagation of this small tree is by seeds, root suckers and stem cuttings. It prefers loamy soils with good drainage and slight acidity.

**Note:** Field data on the propagation of this species is unavailable. It may be possible to propagate it by using seeds, root suckers or stem cuttings. There is no further information available on the details of any of these methods or their success. However sources indicate that the use of root suckers may be more effective.
10. *Helicteres isora*
Family: Sterculiaceae
Adasamati

**Mode of propagation:**
This plant is propagated by seeds and stem cuttings. It grows on sandy and laterite soils.

**Steps to follow:**
- Sow the seeds in beds during July-August.
- When the seedlings grow almost 2 inches tall, transplant them to polybags.
- To propagate vegetatively, use pencil thick semi-hardwood cuttings about a foot long.
- Plant them in moist beds. Planting should be done during February-March.
- Initial rooting takes about 25-35 days.
11. *Holarrhena pubescens*

Synonym: *H. antidysenterica*

*Family: Apocynaceae*

Tedla pala

**Mode of propagation:**

The plant is propagated by seeds.

**Steps to follow:**

- Take freshly collected seeds in a cloth bag and soak in cold water for 24 hours.
- Sow them in polybags or raised beds.
- 80% of the seeds germinate in 7-10 days.
12. *Lawsonia inermis*

Synonym: *L. alba*

Family: Lythraceae

Goranta, Gorata, Gorinta, Gorintaku, Krommi

**Mode of propagation:**

This hardy plant is propagated either by seeds or cuttings. It prefers light loam to clay loam soils with organic matter and retentive soil moisture.

**Steps to follow:**

- Keep the seeds in moist cloth for 6-8 days till they sprout.
- Spread randomly in well-prepared nursery beds during March-April. Prepare raised nursery beds in shaded areas. Keep the seed beds moist by light irrigation.
- Seeds germinate after 10-20 days.
- To keep the seedlings healthy, spray Neem leaf solution at an interval of 15-20 days.
- When the seedlings attain a height of 1 to 1 and a half feet, they may be transplanted.
13. *Rauvolfia serpentina*
Family: Apocynaceae
Patalagandhi

**Mode of propagation:**
It is propagated through seeds, stem and root cuttings. It grows on clayey loam or clayey soil with humus and good drainage.

**Steps to follow:**
- Collect the seeds between June-October. Seeds exhibit a short viability of 6 months.

- To test the seeds, soak them in 5% common salt solution, discard the floating seeds and select those that sink. Now place these under a moist piece of cloth for 24 hours to soften their hard covering.

- Sow or dibble them into seedbeds to about 1 cm deep in lines about a foot apart at a finger’s distance between them. The third week of May is the most favourable time for sowing.

- Irrigate the beds soon after sowing and keep moist till the seeds germinate. Then carefully transfer them to the nursery beds. In 3-8 weeks the seeds sprout with 10-50% germination. Maintain in the nursery for 7-8 weeks.

- For vegetative propagation, take 6-9 inches long stem cuttings and plant in the nursery during June. Keep the bed moist until the cuttings root. These can later be transplanted to the main field.

- For propagation through root cuttings, plant thumb long cuttings during June-July and completely cover with soil, exposing only 1 cm of the tip above the surface. Within 3 weeks, roots give out new sprouts. The success % is 50-80%.
14. *Withania somnifera*
Family: Solanaceae
VAJIGANDHA, ASVAGANDHI

**Mode of propagation:**
This under shrub is propagated by seeds. It prefers sandy loam or light red silts.

**Steps to follow:**
- Collect the fruits during November-December, crush open the fruit to obtain the seeds. Wash the seeds to remove mucilage and dry under shade.
- Soak the seeds for 24 hours before sowing.
- Sow the seeds directly in the main field by broadcasting and covering with a thin layer of soil. Alternately, they may be sown in sunken beds at a distance of 2 inches in between.
  - Sow during October-January or from July to September.
  - In 6 to 7 days 80% of the seeds germinate.
  - Transplant the seedlings when they are 6 weeks old.
CLIMBERS

1. *Abrus precatorius*
Family: Fabaceae
Guruginja

**Mode of propagation:**
The species is easily propagated through seeds.

**Steps to follow:**
- Soak the seeds in hot water for 5 minutes and then in cold water for 24 hours. This will assure better germination.
- Dibble the seeds in polybags.
- In 7-10 days, the seeds begin sprouting, the germination percent being 70%. 
2. *Asparagus racemosus*
Family: Liliaceae
Challa-gaddalu, Pillipichara

**Mode of propagation:**
This sun loving species is propagated either by seeds or vegetatively by tillers. It grows on sandy loam well-drained soil.

**Steps to follow:**
- Collect ripe fruits preferably during December-April. Wash thoroughly to remove the pulp and dry in the sun.
- Seeds are sown in June-July. As a pre-treatment, soak the seeds in water for 2 days or treat with gibberelic acid to obtain higher and early germination.
- Sow the seeds 2 cm below the soil on raised beds measuring 4 and a half metres long, more than a metre broad and a foot high. Space the lines at about 4 inches.
- Germination takes place in 15 to 20 days and about 70 to 80% seeds germinate.
- Vegetatively the plant can be propagated through tillers. Separate the tillers arising from the base of a mature plant and plant individually.
- Remove the seedlings of 5 cm height from beds without damaging the roots and transfer to polybags. After 2 to 3 months, plant them in the field.
3. *Celastrus paniculatus*

Family: Celastraceae

Gundumeda

**Mode of propagation:**

It can easily be propagated by seeds and cuttings. It grows in soils with sufficient aeration and drainage.

**Steps to follow:**

- The fruits ripen in December; the seeds are collected in January.
- Place the collected ripe fruits in polythene covers and then dry in sun for 3 – 4 days, fruits on drying spilt open and liberate the seeds.
- Sow fresh seeds on raised nursery beds by dibbling them into the beds to a shallow depth. In 45 days, they would sprout, the percentage germination being 30-40%.
- Seedlings are maintained in the nursery for 1 – 2 months.
- For vegetative propagation, take softwood cuttings in midsummer or hardwood cuttings in winter. Make 3 – 6 inch long cuttings with at least 3 – 4 nodes.
- Treatment with IBA talc and Thiram for summer cuttings and IBA treatment for hardwood and root cuttings ensures good rooting.
- Plant them directly in small pits, leaving one node above the ground.
- Transplant 1-month-old seedlings or well – rooted cuttings to the main field.
4. *Citrullus colocynthis*

Family: Cucurbitaceae
Chitti-papara

**Mode of propagation:**
This shrub is propagated by seeds and prefers sandy and deep soils.

**Steps to follow:**
- The best time for raising this crop is during June -July at the onset of monsoon.
- For improving seed germination, wrap the seeds in gunny bags and soak in water. They are later buried in 1 to 1 and a half feet deep pits.
- To keep the seeds moist, water is sprinkled regularly.
- After 3-4 days, remove the seeds and rub on the gunny bags and air-dry.
- In case of direct planting, the pre-treated seeds are dibbled 2 cm deep in the soil at a spacing of 3m in a line and 1m between the lines. 500g seed is sufficient for one-hectare area.
5. *Decalepis hamiltonii*

Family: Asclepiadaceae

**Mode of propagation:**
Propagation of the plant is by seeds, cuttings and root suckers. Seeds require a combination of sustained high temperature and high humidity for rapid germination and establishment.

**Steps to follow:**
- During March, when the green pods start turning yellow, collect and dry them in shade or partial sun till they become brown, wrinkled and split open. Collect the seeds from the pods.
- During the same month, sow the seeds in seed pans or trays. Seeds germinate better when planted in polyhouses than in open seedbeds.
- The initial germination time is 5 days and the germination percent is 5 times higher when seeds are sown in polyhouses (55-60%) than in open seedbeds. Maintain in the nursery for 100 days.
- For vegetative propagation through cuttings, select soft green stems of 6-8 inches long with 2 nodes and plant them in poly houses. Percentage rooting with stem cuttings and is about 20%.
- Root suckers normally establish readily. These may be used as an alternative to vegetative propagation. Root suckers of pencil length and wire thickness are used for planting.
- Cuttings establish in the field within 6-8 weeks. In the case of root suckers there is no failure in field establishment.
- The plants may be shifted after 50-60 days.
6. *Embelia ribes*
Family: Myrsinaceae
Vaividungalu/ Vidangamu

**Mode of propagation**
The plant is propagated by seeds. It grows under diffused sunlight conditions.

**Steps to follow:**
- Collect fresh seeds during March-April
- Sow directly in raised beds.
- Within 20-25 days, about 50% of the seeds show germination.
- Maintain in the nursery for 60 days.
- Transplant the seedlings when they are as tall as a thumb. Water the plants thrice a day.
7. *Gloriosa superba*
Family: Liliaceae
Adavi nabhi, Kalappa-gadda

**Mode of propagation:**
The climber is propagated through seeds and tubers. It prefers red or black loamy soils with good water holding capacity and good drainage.

**Steps to follow:**
- Collect the fresh seeds during October
- Soak them in water for 24 hours and sow in beds.
- In 20 to 30 days, 50% of the seeds germinate.
- For vegetative propagation, cut the tubers into divisions with at least two eye buds and weighing not less than 50 to 60 grams.
- Plant the tubers horizontally finger deep in furrows opened at 2 feet apart. The ideal planting season is during March-April.
- The dormant tubers start sprouting from the month of May till August.
8. *Gymnema sylvestre*
Family: Asclepiadaceae
Poda patri

**Mode of propagation:**
This plant can be propagated by seeds, cuttings, and apical shoots. The plant prefers humus rich loamy soils with good shade.

**Steps to follow:**
- Collect the seeds during February-April.
- Sow them directly into polybags during June. The potting mixture for polybags is prepared by mixing 2 parts of FYM/compost, one part sand and one part clay.
- Within 7-10 days, about 40% seed germination can be observed.
- For vegetative propagation, prepare semi-hardwood cuttings of 6-8 inches long taken from the apical shoots.
- Plant these cuttings in polybags and transplant on sufficient rooting. Alternately these cuttings may also be planted directly near a tree.
- Rooting would initiate in about 6 days and the success percent is 60.
- In the mist propagation technique, the apical shoots are buried and covered with soil leaving a lightweight on it. It takes about 30 - 40 days to produce roots.
- Do not over-water the pots/polybags/beds at any time, as water logging is very harmful for this plant. Once it is about 10-15 centimetres tall, transplant it near a large tree that will support this climber.
- Plant the cuttings at the onset of rains with a spacing of 2 metres within and between the rows in less than 2 feet deep cubic pits.
8. **Hemidesmus indicus**  
Synonym: *Periploca indica*  
Family: Asclepiadaceae  
Sugandhiphala

**Mode of propagation:**  
This plant is propagated by seeds and root cuttings. The plant prefers garden loam soil.

**Steps to follow:**
- Collect fresh seeds any time of the year (since fruiting is observed throughout the year).
- Soak them in water for 24 hours and sow in raised beds at the onset of monsoon for better growth.
- 60% of the seeds germinate within a fortnight.
- For vegetative propagation, plant root cuttings 4 inches long in polybags or raised beds. They sprout in 15-20 days with 40% success.
- Transplant the seedlings to polythene bags when they are four leaved.
10. *Holostemma ada-kodien*
Family: Asclepiadaceae
Bandigiruvinda teega, Palagurugu

**Mode of propagation:**
This plant is propagated mainly by seeds. However stem cuttings are also used.

**Steps to follow:**

- Collect the seeds from the plants during November-December before the seeds fall. Clean the seeds, dry them and store for later use.

- Before sowing, the seeds have to be soaked in water for 4-5 hours.

- Fill the polybags with a rooting medium prepared by mixing equal quantities of soil, sand and dried cowdung.

- Water soaked seeds are sown in nursery beds.

- About one-month old seedlings are then planted into the polybags.

- Keep the polybags in shade and irrigate well. You may transplant 1 to 1 and a half-month-old seedlings into the main field.
11. *Jatropha curcas*
*Family*: Euphorbiaceae

**Mode of propagation:**
This shrub can be propagated both by seeds as well as vegetative means. It grows on gravely, sandy or saline soils and also on the poorest stony soils and rock crevices.

**Steps to follow:**
- Seeds are collected in May-June.
- Soak the large and heavy seeds overnight and sow at the onset of monsoon.
- Seeds are sown in polybags or in raised beds at a depth of 2 inches. Seeds can also be dibbled at the rate of two seeds for each spot at a depth of half a finger.
- Seed germination is 95% and takes 10 to 15 days.
- For vegetative propagation, plant 12-16 inches long semi-hardwood cuttings 2 inches thick from the base of the stem with short internodes in polybags.
- Root initiation takes place in 15 to 20 days and about 80% of the cuttings root.
12. *Piper longum*
Family: Piperaceae
PIPPALLU, PIPILI

**Mode of propagation:**
This creeper can be propagated by stem cuttings. It prefers laterite soils in shaded moist conditions.

**Steps to follow:**
- For vegetative propagation, get 4-5 inches long semi hardwood cuttings with at least 3 nodes.
- Plant them in shaded nursery beds with the upper most bud exposed. Maintain a spacing of at least half a foot distance between each pair of cuttings.
- Tillers arising from the base of a mature plant may also be used for propagation. Separate the tillers and plant them individually.
- Plant the sprouted cuttings in the main field at a spacing of 2 m within and between the lines in 8 inches cubic pits.
- These plants are prone to many diseases during the early stages of development and hence care should be taken to prevent their occurrence.
- *Piper longum* is a shade loving plant but for better fruiting, 50 % shade is ideal.
13. *Mucuna pruriens*
Synonym: *M. prurita*
Family: Fabaceae
Tita-kogila, Pilliadugu

**Mode of propagation:**
This twining shrub can easily be propagated through seeds. It prefers well-drained sandy to clay loam soils.

**Steps to follow:**
- Collect fresh seeds during winter and soak them in water for 24 hours.
- Sow them in raised beds in polybags in the nursery to a half a finger-depth. Maintain a distance of 2 feet between them. Sowing is done preferably during May-June or at the onset of monsoon for better growth.
- In about 4 to 12 days 90% of the seeds germinate.
- Seedlings are transplanted to the field two months after planting. Bamboo sticks of suitable length are used as a stake.
14. **Rubia cordifolia**
Family: Rubiaceae
Manderti

**Mode of propagation:**
It can be propagated by seeds and tillers. It grows in well drained soil.

**Steps to follow:**
- Collect the mature fruits and separate the seeds.
- Wash the seeds thoroughly to remove the pulp. Seeds exhibit longevity of 3 months.
- Sow the seeds in raised beds.
- To propagate vegetatively, separate the tillers arising from the base of the mature plant and plant them individually.
- Planting may be taken up anytime between winter and summer.
- Transplant the seedlings to polythene bags when they attain 4-leaf stage.
15. *Tinospora cordifolia*
Family: Menispermaceae
Manapala, Tippatiga

**Mode of propagation:**
The plant is propagated either through seeds or through cuttings.

**Steps to follow:**
- Soak the seeds in cold water for 24 hours for better germination.
- Sow these in polybags during May-July.
- It takes 10 to 12 days for the seeds to germinate with the germination success being 80 to 90%. Seeds sown without pre soaking show only 30 to 35% germination success.
- Maintain the seedlings in the nursery for about one and a half months.
- During June-July, plant 4-6 inches long, pencil thick semi-hard wood cuttings having 4 to 8 nodes, cuttings have to be planted in polybags in a slanting manner with two nodes buried in the rooting medium.
- Nearly all the cuttings root in about 20 to 30 days. About 90% of the cuttings sprout in 45 days.
**TREES**

1. *Aegle marmelos*
   Family: Rutaceae
   Maredu, Bilvam

**Mode of propagation:**
The plant can be propagated by seeds and root suckers. It prefers stiff, dry, clayey, alluvial soils.

The seeds are perishable and recalcitrant and cannot withstand storage for long and have to be sown immediately after collection.

**Steps to follow:**
- During March- May, collect the ripe fruits from the branches on the tree and open the rind. Fallen fruits are not to be collected.
- Separate the seeds from the fruit pulp and wash them thoroughly until the mucilage is completely removed; then dry in the sun for a few days.
- Soak the seeds in water for about 12 hours and then dibble into polybags or raised beds. Fresh seeds may also be sown in nursery beds during June-July and covered with earth, at a spacing of less than a foot in a row and 4 inches between the rows. The beds should be regularly watered.
  - 56-80% of the seeds germinate in a period of 21 days.
  - After maintaining in the nursery for 3-12 months, plant the seedlings in the main field. As the growth is slow in the initial stages, it may be desirable to retain the seedlings with undergrowth for another 1-2 years.
  - Entire planting is done in pits of convenient size.
2. *Anogeissus latifolia*

Family: Combretaceae
ELAMA

**Mode of propagation:**
The tree prefers alluvial soils with good drainage and can be propagated through seeds.

The natural reproduction of this species is not yet fully understood. The tree seeds abundantly every year but the fertility of the seeds is very poor.

**Steps to follow:**
- Collect the fruits when the flower heads begin to break open preferably after a dry season.
- Sow the seeds in heaps of loose soil and rubble or in irrigated raised beds with the soil mixed with sufficient quantity of coarse sand. This is essential for successful germination. Too much of water and calcium are harmful to the growth of the plant.
- Germination commences about twenty days after sowing.
- Very few seeds germinate. Light and moisture favour successful germination of the seed.
3. **Azadirachta indica**
   Synonym: *Melia azadirachta*
   Family: Meliaceae
   Vepa

**Mode of propagation:**
It can be propagated by seeds and vegetatively by cuttings. Neem grows on a variety of soils from sandy to clayey to black cotton soils that are well drained.

**Steps to follow:**

- Collect the fruits when they are fully ripe or sweep the fallen fruits from the ground. Wash off the pulp, dry in shade and keep in airtight containers. Seeds have a viability of two weeks.

- Soak the seeds for 24 hours in cold water and remove the endocarp. This will increase the germination percentage.

- Sow the depulped seeds in nursery beds made of preferably fine river sand. Seeds are sown in rows at a distance of 1 or 2 inches in between, at a depth of 1 to 2 cm and cover lightly with soil. Rows are opened at a distance of more than half a foot. Water the beds sparingly to prevent caking.

- The seeds take 1-2 weeks for germination.
4. *Boswellia serrata*
   Family: Burseraceae
   Anduga, Anduku

**Mode of propagation:**
It can be propagated by seeds, cuttings and root suckers. The tree is a good drought resistant species found growing best on fertile soils. It is planted in shallow ferrugenous soil and intense light conditions.

**Steps to follow:**
- Collect the ripe seeds from the trees during May. Seeds should be sown immediately after collection.
- Before sowing the seeds, soak the seeds in lukewarm water for 24 hours. Select only those that sink in water and sow.
- About 50% of the seeds germinate in 7-15 days.
- For vegetative propagation, hardwood stem cuttings are used. These cuttings measure 3-4 inches in diameter and less than 2 metres long. Give the thick end a slanting cut and coat the thin end with white oil paint.
- The cuttings should be buried to a depth of about half a metre in 60 cubic pits. The soil should be properly pressed around the cuttings. The right season for planting is the latter half of April or the first week of May about 2 months before the rains.
- 76% cuttings sprout and 70-80 % of them establish on the field.
- While using root suckers for propagation, they have to be extracted from trees of about 2 feet girth. Root suckers are planted in June and July. In about a fortnight to 30 days, the sprouts are seen.
- In April-May raise 8-10 week old transplants in containers.
5. *Buchanania lanzan*

*Synonym: B. latifolia*

*Family: Anacardiaceae*

**SARA**

**Mode of propagation:**
This frost sensitive sub deciduous tree is found to regenerate naturally and can also be propagated using seeds as well as vegetative means. It grows on clayey soils.

**Steps to follow:**
- The fruits fall immediately before or at the commencement of the rains. If they are quickly covered with earth or debris by the rain or are protected by grass or other low cover, germination will soon start and the seedlings have a chance of establishing themselves by developing slowly. Cover the seeds quickly to allow free regeneration under favourable conditions.

- Fruits ripen from April to May and remain on the tree for quite a long time. Collect the seeds in April- May. Fresh seeds should not be exposed to the sun. Collect the fruits from the trees and de-pulp them mechanically to extract seeds; then dry in the shade for a day.

- Radicles may dry up or may be damaged by insects. It has poor coppicing capacity and produces root suckers sparingly. Part of natural regeneration is from root suckers on hill ground where roots are liable to be exposed.

- Seed viability is found to be variable, usually up to 1 year when stored in sealed tins.

- Since the seeds have a hard and stony seed coat, the following seed pre-treatment options are considered necessary:

  i) Soaking in cold/tepid water for 4-6 days;
  ii) Immersion in hot water (80-100°C) then allowing it to cool followed by soaking for 24 hours;
  iii) Mechanical disruption of seed coat;
iv) Soaking in concentrated sulphuric acid;
v) Soaking in GA3 5ppm for 24 hours.

- Sow the seeds directly for better success than transplanting from nursery beds. Seeds can be sown in seed pans or trays or in polybags in June and a layer of hay is spread over bags.

- Germination of seeds is completed in 15 to 25 days. 60 to 70 % seeds germinate.

- For vegetative propagation, pencil thick hardwood cuttings of half a foot length with two nodes are used.
6.  **Butea monosperma**  
Synonym: *B. frondosa*  
Family: Fabaceae  
Moduga  

**Mode of propagation:**  
The tree is propagated through seeds and root suckers. The plant can be grown on black cotton soils, clay loams and even on saline soils.

**Steps to follow:**  
- The seeds mature in May. Extract them from the pods during April June.

- Sow the seeds soon after collection, as they lose viability within 5-6 months.

- Sow the seeds directly in rows 3-5 m apart. Pod segments containing seeds are sown in polybags in May. In nursery sowing, give a spacing of half a foot within and between the rows. Normal germination in the nursery takes 15 days. 75-80% is the germination success.

- For stump planting, stumps with about 2 inches long shoot and about a foot long root obtained from 1-year old seedlings (root suckers) are used. Stumps have to be prepared at the onset of rains. Stump plants show higher percentage (80%) of survival and satisfactory growth.

- July – August is the favourable time for transplanting.
7. *Cassia fistula*
Family: Caesalpiniaee
Rela

**Mode of propagation:**
The tree is propagated by seeds.

**Steps to follow:**
- Collect the ripe pods from the trees during March-April. Remove the seeds from the soft pulp and wash before drying. Seeds can be stored for several years without any loss of viability.
- Since the seeds have a thick seed coat, it is necessary to pre-treat them with hot water or sulphuric acid. Alternately the seeds may also be dipped in cow dung slurry (preferably buffalo dung) for 24 hours. Only the swollen seeds are picked for planting.

- During March- April, sow the seeds in primary beds to a depth equal to the thickness of seeds. They are sown in polybags containing a rooting medium prepared by mixing equal quantities of sand, red earth and manure.

- The seeds germinate with the onset of rains and continue to germinate for the next 6 to 7 weeks. The germination success would be 22 to 65 % for fresh seeds, while the seeds treated with hot water and sulphuric acid show success rate of 75% and 35% respectively.

- After 6 to 7 weeks (after the first rains) pick out the seedlings to polybags and in the second year, they may be planted in the main field.
8. *Cochlospermum religiosum*

Synonym: *C. gossypium*

Family: Cochlospermaceae

**Mode of propagation:**

This species is propagated by seeds.

**Steps to follow:**

- Collect the fruits, keep in the open and then separate the seeds by thrashing. Seeds remain viable for 1 to 2 months.

- Seeds should be soaked in warm water for 24 hours.

- Seeds are spread into the beds in June. Seedlings are pricked from the beds and placed into polythene bags.

- Seeds take 25 days to germinate and 8% of the seeds germinate.
9. *Emblica officinalis*
Synonym: *Phyllanthus emblica*
Family: Euphorbiaceae
Usiri, Usrikayi

**Mode of propagation:**
This medium sized tree can be propagated by seeds as well as by vegetative means. It grows in a wide range of soils including mildly alkaline, shallow, gravely soils, but prefers deep, moist, and loamy to alluvial soils.

**Steps to follow:**
- Collect the ripe fruits during January and dry in the sun.
- After removing the fleshy portion of the fruit, soak the seeds in water for 24 hours and wrap in a wet gunny cloth till roots emerge. Soaking the seeds in hot water for 5 minutes hastens the germination. Once the fleshy part of the fruit is removed, the seeds will be viable for a month.
- Sow fresh seeds immediately due to its low viability on storage. Sowing at the time of commencement of rainy season will give best results.
- Seeds germinate in about 3 to 4 days and there is about 70 to 80% germination.
- The advantage of the vegetative method of propagation lies in the fact that vegetatively propagated plants start fruiting in 5-6 years, while seedling trees take at least 10 years to fruit. Grafting, layering and budding are practised.
- For budding, shield budding has been found to be most practical and commercially viable method. It is important that proper mother plants are selected and buds are selected from a branch that has a good number of female flowers. Seedlings raised from seeds are used as rootstocks.
- Success rate in grafting is in the range of 60-70%, while in the case of softwood grafting it is about 42%.
10. *Gardenia gummifera*
Family: Rubiaceae
Bikki

**Mode of propagation:**
Grown on laterite type of soil, this plant is propagated by stem cuttings.

**Steps to follow:**
- Semi hardwood stem cuttings measuring 6 – 8 inches long are preferred. These cuttings are planted in nursery beds. Cuttings are maintained until they root and later transplanted to the main field. November – December is the favourable time for planting.
- In 20 – 30 days, rooting can be observed.
- Regular watering should be done. There should be sufficient shade in the nursery.
- Cuttings exhibit about 40% establishment success.
11. *Ichnocarpus frutescens*
Synonym: *Apocynum frutescens*
Family: Apocynaceae

**Mode of propagation:**
This climbing shrub can be propagated using vegetative means.

**Steps to follow:**
- Plant hardwood cuttings of 15 cm length 2 to 3 cm deep in polybags or beds.
- Sprout initiation commences from the 13th day of planting. About 50 % of the cuttings sprout.
- Suckers are formed by digging around the plant resulting in the production of numerous root suckers.
- These root suckers are collected during May-June and planted during July-August. 90 % of these suckers sprout.
12. **Limonia acidissima**  
Synonym: *Feronia elephantum*  
Family: Rutaceae

**Mode of propagation:**  
This small tree can be propagated both by seeds as well as vegetative means. It is recommended for plantation in black cotton soils.

**Steps to follow:**
- Ripe fruits are collected and the hard rind is broken to get the pulp, which on continuous washing gives the seeds. Seeds should be sown as quickly as possible after collection because they have a short viability.
- Mix the seeds with ash and then dry them.
- Soak the seeds in cold water or lukewarm water for 24 hours.
- Seeds are sown in October-November in the polybags and a thin layer of hay is spread over the polybags.
- Germination occurs within 10 to 15 days and 70 % seeds germinate.
- About 63 % seedlings establish.
- For vegetative propagation Approach Grafting and Softwood Grafting are highly successful methods.
- For softwood grafting, rootstocks should be raised in polybags and seedlings of 3 to 4 months should be used.
- Scion should be 8 to 15 centimetres long. Wedge shape scion should be inserted in the rootstock and firmly tied with polythene strips.
- Successful grafts can be planted within 6 to 8 months.
13. *Litsea glutinosa*
Family: Lauraceae

**Mode of propagation:**
It can be propagated both by seeds and by vegetative means. It prefers shaded places.

**Steps to follow:**
- It is a fast growing species.
- New shoots sprouting from damaged adventitious buds (called coppice shoots) are used for propagation.
14. *Madhuca indica*
Family: Sapotaceae

It is known to be propagated in a similar method as the closely related species *Madhuca longifolia*. Given here are the propagation details of the former.

**Mode of propagation:**
This drought hardy species can be propagated using seeds as well as by vegetative means. It grows best on deep loamy soils with good drainage.

**Steps to follow:**
- Collect the seeds between June-August.
- This species is self sown, i.e. the seeds dispersed from the tree sprout readily in wild conditions. The same seeds may be picked for sowing in the nursery. Such seeds are collected when the pre-monsoon rains begin.
- The seeds thus collected are to be spread on seed beds or planted in polybags in the nursery & covered with soil to prevent any damage to the germinating seeds either by soil borne fungi or insects.
- Alternately the seeds may be collected from the mature fruits. Sow the seeds in seedbeds soon after their collection after immersing in hot water (80-100°C) with immediate cooling followed by soaking for 24 hours.
- Cover the sown seeds with thin layer of soil. Beds are to be irrigated after sowing. Direct sowing of seeds can also be done using 2 to 3 fresh seeds planted per pit at a depth of half a finger.
- 85 % of the seeds germinate in about 10 to 15 days.
For vegetative propagation through grafts, one-year-old seedlings are used as root stock. Scion is prepared from a defoliated branch to ensure dormant apical buds. Either whip or cleft methods of grafting are used. Grafting shows a success rate of 87% in 46 days.

Budding: One-year-old seedlings in the field are used as root stock. Buds taken from semi-hardwood branches are used, patch budding or modified forket or H-budding are usually followed with almost 100% success.

Transplant the seedlings when they are 2 to 3 months old in July.
15. *Mesua ferrea*
Family: Clusiaceae

**Mode of propagation:**
This evergreen tree can be propagated through seeds. It prefers deep, moist, fertile and well-drained soils.

**Steps to follow:**
- Collect the brownish coloured fruits during the month of April either from the ground or from the tree.
- Alternately the seeds may also be collected in the third week of April with the onset of seed fall.
- Spread out the fruits in the sun until they split open and then dry in shade.
- Sow the seeds soon after collection. Sow directly in rows 1.8 m apart. Seeds may be sown in double lines each row and with a cover crop of *Tephrosia candida*.

- Seeds are placed 3 inches apart in and across rows and at a depth 1 to 2 cm. They are covered with a thin layer of soil; seedbeds measure about 4 m long and about 2 m broad.
- 70 –95% germination can be observed in 25-30 days.
- Seedlings are maintained in the nursery for 1-2 years. Seedlings are transplanted with a ball of earth.
16. *Mimusops elengi*
Family: Sapotaceae
Pogada

**Mode of propagation:**
Propagation is through seeds. Even though it can grow on a variety of soils including laterite, it plant cannot withstand water logging conditions. It requires partial shade for germination.

**Steps to follow:**
- Collect the seeds during June and July. As the fruits have a fleshy pulp, wash them and dry the seeds. Seeds do not retain their viability for long.
- Soak the fresh seeds in cowdung slurry for 3 days. Alternately seeds are treated with warm water to soften the hard seed coat. Sow these seeds in polybags during July.
- Seeds may also be dibbled on the beds at a finger length apart from each other. A nursery bed requires 2 Kg of seeds.
- Fresh seeds take 30 to 45 days to germinate and the germination success is 60%. Seedling growth is slow.
- Transfer 60-day-old seedlings into polybags and retain them in the nursery for about 8 months.
17. *Pongamia pinnata*
Family: Fabaceae

**Mode of propagation:**
This drought resistant plant can be propagated by both seeds and vegetative means. It grows on a wide range of soils.

**Steps to follow:**
- Collect the mature pods during April and June and dry in the sun.
- The pods without breaking may be stored for a year in glass bottles or in airtight containers or in sand.
- Pods are split open using wooden mallets and seeds extracted. Seeds may also be extracted by pressing a knife along the sutures of the pod.
- Seeds remain viable for at least one year.
- Soak the seeds in water for 24 hours and dibble in beds during summer & early monsoons.
- Germination success varies between 60 and 89 percent. Germination is completed in about 10 to 60 days.
- Vegetative propagation is through root or shoot cuttings and root suckers. Use stem cuttings taken from mature shoots. Cuttings of sugarcane thickness measuring about 32 inches long are preferred.
- Dip the cuttings in IBA solution for 5 seconds. 70 % rooting can be observed.
- When the seedlings attain a height of 2 feet they are planted out with a ball of earth transplanted as stumps.
18. *Pterocarpus marsupium*
Synonym: *P. marsupium var. marsupium*
*Family:* Fabaceae

**Mode of propagation:**
This large deciduous tree is propagated using seeds. It grows in well-drained red soils and alluvial soils.

**Steps to follow:**
- Pods ripen from December to March and become dark reddish brown in colour and remain on the tree up to the end of May.
- Collect the pods during February to May from the trees or from the ground.
- Place the pods and dead leaves alternately in a pit. The pit is kept flooded with water. Pods can also be soaked for 48 hours in cowdung slurry. After a few days the pods start germinating.
- Pick up the germinating pods and sow.
- Soaking the clean seeds after extraction from pods before sowing reduces the germination period to a few days.
- Seeds can be directly sown in June, or sown in polybags, or the entire pods are dibbled with a distance of 5 inches in between.
- Germination commences in 7 days and completes in 56 days in the nursery. Germination percentage varies from 40 to 90%.
19. *Pterocarpus santalinus*
Family: Fabaceae
Raktagandhamu

**Mode of propagation:**
The tree can be propagated through seeds and stem cuttings. It prefers gravely soils with perfect drainage.

**Steps to follow:**
- Collect the dry pods from trees during February-June, and dry them in the sun for 3 days. Seeds are stored in bamboo baskets or gunny bags till used for planting.
- There is no loss of viability for at least 8 months. Seeds lose viability if kept for more than a year.
- Before sowing, soak the pods in cold water for 3 days to increase the germination success. Alternately the pods may be immersed in cowdung slurry for 48 hrs before sowing.
- Prepare raised or flat nursery beds 12m long and more than a metre broad with well drained soil. The soil should be dry, a foot deep and clods crushed. Mix sufficient quantity of farmyard manure.
- Sow the entire pods and cover with a thin layer of soil or hay and water profusely. July-September is the ideal time for sowing.
- The seeds start germinating in 15-20 days and the germination success varies from 10-80%.
When the seedlings are 2-4 inches tall, they may be transplanted into polythene bags kept under shade, duly watered for a month. Later the seedlings are shifted from the shade. They are maintained for another 3-4 months. At the end of this period roots develop.

During the rainy season the seedlings are transplanted into the main field. If you are trying stem cuttings then plant them in polythene bags with sandy-loam soil mixed well with FYM, water daily and keep till these are one year old.

Later plant these saplings on field during rainy season, at a spacing of 3 and a half 4 and a half metres in 30 cubic metre pits. Avoid waterlogged sites and over shading by other trees.
20. *Sapindus emarginatus*

Synonym: *S. trifoliatus*

Family: Sapindaceae

Kurkudu, Chellu

**Mode of propagation:**
This medium sized tree is propagated by seeds. It thrives well in almost any kind of soil but particularly drier soils.

**Steps to follow:**
- Collect the mature fruits during February-April as they fall from the trees.
- Dry them for 3 to 4 days and store in gunny bags. Viability of seed remains for one year.
- Seedlings may be raised by direct sowing of the seeds in the main field.
- They may also be sown in polythene bags during May-June. Germination success is 67%. The seedlings attain a height of 12-16 inches in one season and grow upto a metre in two seasons.
- 13 to 14 months old seedlings are planted out in the main field.
21. *Semecarpus anacardium*
Family: Anacardiaceae
Nallajeedi, Jidi

**Mode of propagation:**
This plant propagated through seeds. It grows on a variety of soils.

**Steps to follow:**
- Collect the nuts during December-January. Fertile seeds are seen at early age. Seed longevity is for 6-9 months; hence nuts are sown immediately after collection. Nuts have a hard cover.
- Before sowing, it is necessary to soften the hard coat of these nuts to ensure good germination. The nuts are treated with concentrated sulphuric acid for 10-15 min. and washed thoroughly in running water. Later the nuts are soaked in water for 24 hours and sown.
- Germination is noticed within 20 to 25 days with germination success being 70-80%. Polybags are covered over by spreading a layer of hay for maintaining uniform temperature.
- Saplings establish with a success rate of 53%.
- Pre-germinated seeds are preferred for raising nurseries.
- The plant does not withstand transplanting well. However seedlings about 2 inches tall are transplanted to polythene bags. 1-year old seedlings are planted 8 metres apart from each other in 18 inches cubic pits.
22. *Sterculia urens*
Family: Sterculiaceae
Yerrapoliki

**Mode of propagation:**
The plant prefers stony or rocky soils and shallow or ferruginous soils, and is propagated by seeds.

**Steps to follow:**
- Collect the seeds either from the ground or knock off the follicle bunch from the tree. Collected seeds can be stored easily for one year.
- Dry the pods in the sun so that the seeds burst out. It is difficult to handle the seeds with bare hands because of stinging bristles.
- Soak the seeds overnight in cold water. Sow the treated seeds in polybags during May without any shading.
- Seeds start sprouting in 10-15 days, with a germination success of 32-77%.
- Water the seedlings regularly and apply Copper fungicide to control damping off of the seedling.
- One-month-old seedlings are transplanted.
23. *Strychnos nux-vomica*

Family: Loganiaceae
Visha Mushti

**Mode of propagation:**
This tree can be propagated by seed and stem cuttings. It prefers well-drained, humus rich soil and partial shade.

**Steps to follow:**
- Collect the seeds during the period extending from December to the end of April.
- Wash the seeds to remove the adhering pulp of the fruit and dry the seeds in the sun.
- Store the seeds in gunny bags. Seeds can be stored for one year.
- Before sowing, the seeds are treated with warm water treatment and soaked for 48 hours. Alternately, the seeds may be dipped in cowdung slurry for 24 hours.
- During early summer, the seeds are sown on raised beds. They can be planted in polybags during March. A thin layer of hay is spread over the beds and the bags to maintain the temperature.
- The seeds germinate after 45 to 50 days. Seedling growth is very slow but the roots grow very fast.
- In 60-70 days, they would be seen sprouting with a success rate of 25%.
- Semi-hardwood cuttings are used for propagating the plant in early summer.
24. *Strychnos potatorum*
Family: Loganiaceae
Chilla

**Mode of propagation:**
The plant is propagated through seeds, stem cuttings and root suckers. It germinates only in soil and does not tolerate water logging.

**Steps to follow:**
- Collect the fruits between February & March. Remove the pulp to obtain the seeds. Dry the seeds in shade before use. Seeds have a poor viability. Since the seeds do not tolerate water logging, seedbeds are preferably made with sand.

- To ensure good germination, seeds are treated with warm water. They are soaked in water for 48 hours.

- Seeds are sown in polybags during April. After 45 days the shoot emerges with the cotyledons retained on the tip resembling a round cap.

- Root growth is faster than the shoot growth and hence a longer polythene bag is required for raising the seedlings.

- 30-40 days is the time taken for germination, with germination success being 40%.

- Maintain the seedling in the nursery for 60 days.

- For vegetative propagation, pencil thick and pencil long hardwood cuttings with 2-6 nodes are used.
25. *Terminalia arjuna*
Family: Combretaceae

**Mode of propagation:**
This drought and frost resistant tree is propagated through seeds and stump planting. It prefers loose fertile soils, moist alluvial loamy with good irrigation and drainage.

**Steps to follow:**
- Trees start fruiting 6 – 7 years after sowing; every third year is a good seed year. Collect the ripe fruits from trees or from the ground underneath the tree in April – May.

- Dry the fruits in shade for a month and remove the ribs to extract the seeds by rubbing with your hands.

- Seeds are viable for one year when stored dry in gunny bags, but germination is reduced to 10 – 20%.

- Soak the seeds in cold water for 48 hours before sowing.

- Sow 2 seeds in every polybag at a depth of an inch.

- In the nursery beds, seeds are sown in rows one foot apart with about 2 inches spacing between the seeds. February – March is the favourable time for sowing.

- Seeds germinate in 7 days and continue to germinate up to 60 days, with a germination success of 65%.

- Maintain the seedlings in the nursery for 3 – 4 months.

- Vegetatively, the plant is propagated through stump cuttings.
For this purpose, the stumps are cut from the roots as well as shoot. Use 15-month-old seedlings to make 8 inches long stumps from roots and 2 inches long if it is from shoots.

At first plant them in poly bags in the nursery and maintain there for 3-4 months.

Transplant the seedlings when they grow up to one and a half feet in height usually during July. Avoid deep planting.
26. *Terminalia bellirica*
Family: Combretaceae
Thandra

**Mode of propagation:**
This plant is propagated through seed, root-shoot cuttings and stump planting. It grows on a wide range of soils with sufficient moisture, under intense light conditions.

**Steps to follow:**
- Collect the freshly fallen fruits between November and February from healthy trees.
- Depulp and dry the seeds and store them. Seeds are viable for a year but their germination percent will be reduced to 40-50%.
- Soak the seeds in water for 24 hours for better germination. Alternately the seeds are dipped in cowdung slurry for two weeks or more till the seeds bulge and show signs of sprouting. Seeds are also immersed in hot water (80 - 100°C), allowed to cool and later soaked for 24 hours.
- Pre-treated seeds are sown directly in the field or in the nursery beds.
- **Nursery sowing:** March-April is the favourable time for sowing in the nursery. Sow the pre-treated seeds in the nursery beds in rows opened 8 inches apart within the lines and a thumb’s distance between the seeds.
- **Direct sowing** in the field can also be taken up during June-July at the start of the rains. Dibble the seeds to a depth of a fingernail at a spacing of less than a foot within the lines and 2 inches between the lines.
- In 10-40 days, the seeds germinate with germination success being 65-70%.
Vegetatively, the plant is propagated through stump planting from 12-15 months old plants. Plant the stumps in pits or crowbar holes at the onset of the rains.

In case of nursery raised seedlings or saplings, you have to transplant in June-July when the plants are about 3-4 months old. Establishment of the seedlings is 52%

Practice regular weeding and watering. When seedlings are about 2 inches tall, shift to polybags.
27. *Terminalia chebula*
Family: Combretaceae
Karakkaya

**Mode of propagation:**
This tree is propagated through seeds, root-shoot cuttings and stump planting. It prefers moist, sandy loam or clayey loam with low salinity, moderate fertility and good subsoil drainage.

**Steps to follow:**
- Collect the seeds from freshly fallen mature yellow fruits between January-March and December-May.
- Dry them in shade and store in gunny bags for a year.
- Seed treatment involves dipping the fruits in cowdung slurry for two weeks, till the seeds bulge and show signs of germination. Another method is to remove the pulp as soon as the fruits are collected; such fruits have to be soaked in tepid water for 4-6 days.
- **Nursery sowing:** During March-April sow the pre-treated seeds in the nursery beds in rows opened at a spacing of 8 inches, seeds are sown in these lines at a distance of about 2 inches. Nursery must be well shaded.
- **Direct sowing:** During June-July seeds can be sown in the main field. Dibble the seeds to a depth of a fingernail at a spacing of less than a foot within the lines and about 2 inches between the lines.
- The seeds germinate in 10-30 days, with a germination success of 60%.
Vegetatively, the plant is propagated through stump planting from 12-15 months old plants.

During June-July when the plants are about one year old, transplant the nursery-raised seedlings into one and a half feet cubic pits or crowbar holes at a spacing of 10 metres within and between the rows.

Saplings show 18% of establishment success. Carry out regular weeding and watering.
28. *Wrightia tinctoria*
Family: Apocynaceae
*Ankudu*

**Mode of propagation:**
This plant is propagated by seeds and stem cuttings. It prefers sandy loam soils.

**Steps to follow:**
- Collect the seeds after the fruit matures between November to January.
- Sow them without any pre-treatment. Alternately the seeds may be sown or after soaking in water for 2-3 hours. November – December is the favourable time for sowing.
- In 10-15 days, the seeds germinate with germination success being 60%.
## Species – Propagation method Matrix

### HERBS

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| 6.     | Boerhavia diffusa             | Punanava, atikammidi | Seeds             | Sowing fresh seeds                                         |
| 7.     | Cassia absus                  | Chanupalavittulu     | Seeds             | Sowing the seeds in shade                                  |
| 8.     | Catharanthus roseus           |                      | Seeds             | Sowing fresh seeds                                         |
| 9.     | Centella asiatica             | Saraswati akku       | Seeds and stem cuttings | Sowing fresh seeds  
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Propagation of Commercially Important Medicinal Plants
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<td>27.</td>
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<td>28.</td>
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<td>Kondamudam, Nelajadi</td>
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<td><em>Bixa orellana</em></td>
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<td><em>Lawsonia inermis</em></td>
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<td>Random sowing of moistened seeds</td>
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</tbody>
</table>
### Sl. No. | Species | Telugu name | Planting material | Method of propagation
---|---|---|---|---
37. | *Rauvolfia serpentina* | Patalagandhi | Seeds, Stem and root cuttings | Sowing moistened seeds, Planting stem and root cuttings
38. | *Withania somnifera* | Vajigandha, Asvagandhi | Seeds | Broadcasting the seeds soaked in water

**CLIMBERS**

| Sl. No. | Species | Telugu name | Planting material | Method of propagation
---|---|---|---|---
39. | *Abrus precatorius* | Guruginja | Seeds | Dibbling the hot water-soaked seeds
40. | *Asparagus racemosus* | Challa-gaddalu, Pillipichara | Seeds and tillers | Sowing water soaked seeds in rows, Planting the tillers
41. | *Celastrus paniculatus* | Gundumeda | Seeds, semi hardwood and soft wood cuttings | Dibbling the fresh seeds, Planting the semi hardwood cuttings (winter) and softwood cuttings (summer)
42. | *Citrullus colocynthis* | Chitti papara, Erripucha | Seeds | Sowing the seeds
43. | *Decalepis hamiltonii* | Maagali beru | Seeds, cuttings and root suckers | Sowing the seeds in seed pans, Planting soft green stems or root suckers under partial shade
44. | *Embelia ribes* | Vaivindugalu, Vidangamu | Seeds | Sowing fresh seeds
45. | *Gloriosa superba* | Adavi-nabhi, Kalappa-gadda | Seeds and tubers | Sowing seeds soaked in water, Planting the tubers in burrows
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| 79.   | *Terminalia bellirica* | Tani, Uthandra | Seeds, root-shoot cuttings and stumps | Sowing de pulped and dried seeds  
Planting the shoot stumps |
| 80.   | *Terminalia chebula* | Karakkaya    | Seeds, root-shoot cuttings and stumps | Sowing the seeds dried and treated in cow dung slurry, Planting shoot and root stumps |
| 81.   | *Wrightia tinctoria* | Ankuda       | Seeds and stem cuttings      | Sowing the water soaked seeds                                                        |