Plant propagation is the first phase of complete package of production technology of herbal medicines that passes through cultivation, post harvest drying, herb storage, primary processing, drug extraction and quality control. Ultimate efficacy of herbal drugs mainly depends on its starting materials i.e. characterized germplasm having desired marker (bioactive) compounds. Therefore, outsourcing of right propagules for further large scale multiplication is very important.

Site selection for nursery, construction of greenhouses, soil mixes, successful germination, how to coax herb seeds out of hibernation, time saving equipment for herb farming, organic plant protection measures, finding your niche in the herb growing business and adoption of package approach for individual plant species are the main concern of successful plant propagation.

**Plant Propagation and Propagules:**

Plant propagation multiplies plants in bulk and preserves their essential genetic characteristics. Plants usually reproduce in two ways by seeds and by vegetative parts of plants.

Seed is a best source of multiplication of most of the plant species. There are different types of seeds some are germinate easily and some are very difficult to germinate under normal conditions. Seeds of some of the species germinate uniformly and some are very erratic in germination. These variations in germination are due to environmental and physiological factors.

Vegetative methods may employ use of different plant parts such as root, crown, rhizome, runner, stolon, sucker, tuber, stem cutting, bulb, bulblet, corms, cormelet, scales, offsets, leaf cutting, bulb cutting. It may include different methods of propagation like layering, grafting and budding.

**Growing Environments:**

Climate and soil are the two most important environmental factors that affect propagation rate and further growth of nursery grown saplings or seedlings.

**Climatic factor:**

This includes all the conditions of the atmosphere such as rainfall, temperature, humidity, light, wind etc. affecting both, rooting rate and shoot growth of saplings. Climatic factors are modified by use of plant protecting infrastructure like greenhouse and irrigation devices. Greenhouse is a structure where transparent glass, fiberglass reinforced plastic (FRP), polycarbonate, polythene sheets etc. are used as the cladding material on an iron, aluminum, wooden or bamboo structures to provide the protection to the green plants from the vagaries of weather. Depending on the cladding material the greenhouse is known as glasshouse or plastic greenhouse or polyhouse. The plants growing under the greenhouses are getting the protections from the ultraviolet radiations, hails, high rainfall, insects, diseases, very low temperatures etc. Growing the plants under greenhouse conditions can help us in getting increased production of quality planting materials. For early raising of
seedlings and plants, for rapid multiplication of selected plant materials and for increased yield, greenhouses are very much useful.

**Soil (edaphic) Factor:**

Soil is an important growing media for plants. Soil has a different meaning from plant propagator point of view as it is always modified to suit particular plant species and referred as potting (growing) media. Successful nursery production is largely dependent on the chemical and physical properties of the growing media. An ideal potting medium should be free of weeds and diseases, heavy enough to avoid frequent tipping over and yet light enough to facilitate handling and shipping. The media should also be well drained and yet retain sufficient water to reduce the frequency of watering. Other parameters to consider include cost, availability, consistency between batches and stability in the media over time.

There are several media components in this trade. Peat is a very common component in both nursery and greenhouse mixes. Peat is usually included in a mix to increase the water-holding capacity or to decrease the weight.

Coir is a relatively new organic amendment primarily used in the greenhouse industry. It has been suggested as a potential substitute for peat moss. The raw material, which looks like peat but is more granular, is derived from the husk of the coconut fruit.

A large variety of compost or animal manure products is available in the marketplace.

**Manures:** Disadvantages include possible high salts, fine particle size and weed seeds. The advantages include the nutrient contribution and potential improvement in media physical properties.

**Sludge:** A primary consideration when evaluating sludge is the potential for elevated heavy metals including cadmium, lead, zinc, copper and mercury.

**Plant-based composts:** In some areas compost products provide a low-cost media amendment.

Among the group of inorganic amendments, perlite is most commonly used as a component in greenhouse growing media or nursery propagation applications. It is produced by heating igneous rock under high temperatures (1,100 to 1,600 °F). Perlite differs from vermiculite in that the finished product is a “closed cell” that does not absorb or hold water. For this reason, it is usually included in a mix to improve the drainage or increase the percent of aeration.

In some ways vermiculite is similar to perlite in that they both originate as mined minerals that are then heated to produce a finished product. Perlite and vermiculite differ, however, in the rationale for including them in a mix. Perlite is usually included in a mix to increase drainage but does not increase the retention of nutrients. In contrast, vermiculite with its plate-like structure holds large quantities of water and positive charged nutrients like potassium, magnesium and calcium.

Sand is a common amendment used in propagation applications and is occasionally used in a greenhouse or nursery mix. Sand is typically selected as a media component to improve the drainage or to act as a ballast to decrease container blow-over in outdoor container nurseries. While sand represents a wide range in particle sizes, growers generally use medium to coarse sands (0.25 to 2 mm). Preference should be given to deep-mined sharp sands which are mostly silicon dioxide. Avoid using calcareous sands or sands from the ocean that are obviously saline in nature. Sand rarely
occupies more than 10 percent of the volume of a mix simply due to the tremendous weight (bulk density of 80 to 100 lbs/ft³).

Premixed media is a common sight in the greenhouse industry. Suppliers offer a diversity of mixes in either prepacked (bags, bales, super sacks) or bulk forms. Recipes are specially formulated for propagation, specific crops (e.g., Poinsettia mix) or general crops. If significant quantities are required, growers can purchase media customized to their specific operation by requesting specific amendments including lime, wetting agents and fertilizer. Primary components in a greenhouse mix are peat moss, vermiculite and perlite.

**Propagation Package for Important Medicinal Plants:**

**Aloe vera:** Commercial aloes are obtained from wild and cultivated plants. Propagation is primarily by means of suckers or offsets which are separated carefully from mature plants and transplanted.

**Indian belladonna (Atropa belladonna L. and L. accuminata royle), Family Solanaceae**

Belladonna is generally propagated by seeds, shoot cuttings or root cutting. It can also be propagated by sprouting old root stocks or by divisions from roots of 3-4 year old plants. For commercial crop, the seeds may be directly broadcasted or nursery raised seedlings may be transplanted in the field.

**Liquorice, Mulahathi (Glycyrrhiza glabra L.), Family Fabaceae**

In India, seed production in Liquorice is scarce, thus it is propagated by freshly dug 15 to 25 cm long stolons with two or three buds. Mother crowns are also used for planting. At planting, the cuttings should be dipped in 0.1 % Bavistin solution for about 10 minutes for protection from soil borne diseases. In field, the cuttings are planted 6-8 cm deep at a distance of 90 cm x 45. The rows may be raised 45-60 cm to facilitate irrigation. About 250-300 kg fresh stem cuttings are required for plantation of 1 ha. The plantation is generally raised during July-August. If the irrigation facilities exist, the crop may be planted during February-March.

**Ashwagandha or Asgandh (Withania somnifera dunal), Family Solanaceae**

Asgandh is normally broadcasted, which requires 10-12 kg seed /ha. Line sowing is not adopted in this crop, though studies have indicated that line sown crop facilitate better inter-culture and sowing should be done in lines 25 cm apart (Nigam and Kandalkar, 1995). In Madhya Pradesh, the ideal sowing time is second or third week of August. Sufficient soil-moisture after sowing helps good emergence of the crop. Excessive rains or water-logging may adversely affect the crop-stand. In order to protect the seedlings from seed borne diseases, the seeds should be treated with Thiram or Dithane M-45 at 3g/kg seed before sowing.

**Safed Musli (Chlorophytum species), Family Liliaceae**

The seeds are black in colour like onion and have dormancy of about 10 months. Seeds take about 12-16 days to sprout and the germination rate is about 10-60 %. Seeds should be sown during first fortnight of June, in a fine seed bed rich in organic matter. The seedlings take nearly a year to be ready for transplanting in the next Kharif season. The general plant spacing is 30 cm x 15 cm.

**Vegetative propagation:** For raising the crop, either the sprouted seedlings should be collected from wild after a fortnight of onset of rains or fleshy root bunches should be dug out during mid May. In the later case, the fleshy roots should be separated into individual roots with a part of stem disc attached.
to them. The separated roots may be mixed with equal amount of moist soil and kept in perforated ploy bags in a cool room. These roots sprout within 20-25 days. The sprouted plantlets may be transplanted in the main field during first fortnight of June at 30 cm x 15 cm spacing on the 15-20 cm high. About 250-300 kg fresh roots are required for 1 ha plantation. It has been recorded that the vegetative propagation produced three times more yield of fleshy roots than the seed-raised crop.

**Woolly Foxglove, Tilpushpi (Digitalis lanata ehrh. and D. purpurea l.), Family Scrophulariaceae**

Seeds of *D. lanata* are very small (test weight 0.7 g) with longevity of about 2 years. For direct sown crop, seed rate is 8 kg/ha. As the seed are minute in size, the depth of sowing should be from 1 to 2 cm only. Spring season is the favourable time of sowing the seeds after pre-sprouting them by soaking in water and incubating at about 30°C for 2-3 days. April is the optimum time for transplanting seedlings in main

**Turmeric (Curcuma longa):** Whole or split mother rhizomes are used for planting. Well developed healthy and disease free rhizomes are to be selected. Rhizomes are treated with 0.3% Dithane M-45 and 0.5% Malathion for 30 minutes before sowing. Small pits are made with a hand hoe in the beds in rows with spacing of 25 cm x 30 cm and covered with soil or dry powdered cattle manure. The optimum spacing in furrows and ridges is 45-60 cm between rows and 25 cm between plants. A seed rate of 2,500 Kg of rhizomes is required for planting one hectare.

**Ginger (Zingiber officinale):** is one of the important spices grown in India. Ginger of commerce is the dried rhizome. It is marketed in different forms such as raw ginger, dry ginger, bleached dry ginger, ginger powder, ginger oil, ginger oleoresin, gingerale, ginger candy, ginger beer, brined ginger, ginger wine, ginger squash, ginger flakes etc. Ginger is always propagated by portions of the rhizome known as seed rhizomes. Carefully preserved seed rhizomes are cut into small pieces of 2.5-5 cm length weighing 20-25 g each having one or two good buds. The seed rhizomes are treated with 0.3% Dithane M-45 (39 in one litre of water) for 30 minutes, drained and planted at a spacing of 20-25 cm along the rows and 20-25 cm between the rows. The seed rhizome bits are put in shallow planting pits prepared with a hand hoe and covered with well rotten farm yard manure and a thin layer of soil and leveled.

**Thyme (Thymus serpyllum L.):** Thyme can be propagated by seeds, cuttings or root splitting. Seeds are sown in nurseries or directly broadcasted in the field. The seeds are drilled in rows about 90cm apart and the seedlings may be thinned out to 30-45 cm apart and 30-15 cm apart and 60 cm between rows. 50-80 g seed is sufficient for generating the desired 160,000 to 240,000 seedlings per hectare.

**Micropropagation:** Protocols for micropropagation have been standardised using shoot tips and nodal explants derived from *in-vitro* germinated seedlings. Slow growth was induced and shoot cultures of these herbs can be maintained for 4-12 months without subculture in minimal growth medium.

**Germination of basil seed:** Basil seed is large and is germinates easily; hence field establishment by direct drilling is a good production option. However, Basil is a frost tender annual, and in areas where the frost free period is short, establishment by seedlings is more viable.
Jatamansi (Nardostachys grandiflora/jatamansi DC.), Family Valerianaceae:
There are two methods of propagation:
a. Sexual propagation through seeds.
b. Vegetative propagation through root cuttings.
   a. Through seeds: The seeds are very small and have short viable period though when stored at low
   temperature and dry conditions seeds can be viable upto 5-6 months. Approx. 600gm seed is
   required for 1 ha area and each plant produce 40-89 seeds.

Kutki (Picrorhiza kurroa Royle ex benth., Family: Scrophulariaceae,
Through seed: Under natural conditions seeds get dehisced during autumn and remain under snow for
6 to 7 months germinating readily with the melting of the snow and forming small colonies of seedlings
Seed collection: Seeds are collected from robust and disease-free mother plants. Seeds from natural
pockets are collected in September/October
Seed treatment: Seeds should be dried in sunlight and can be used for sowing. For seeds to
germinate under laboratory conditions, chilling treatment is recommended. Chilled seeds can then
germinate at 20 degree C.

Mushakbala (Valeriana jatamansi Jones.), Family : Valerianaceae
1. Through seed- sow the seed in the raised nursery beds in month of March- April.
2. By cuttings - Through rhizome (5 to 7 cm) cutting sown in the raised nursery beds in the month of
   Oct. or in the month of March and April.
   Seed Rate: 800 grams - 1 Kgs. seed of good quality and having good germination capacity is
   sufficient for one hectare.

Singli – mingle (Dioscorea deltoidea Wall. ex. Kunth.), Family : Dioscoreaceae
   • Through seed- sow the seed in the nursery beds in month of April to May.
   • By Rhizome cuttings -Plant round rhizome (2.5 to 3cm.) cutting having 20 to 25 gms. wt.
     should be sown in the nursery beds in the month of Oct. or in the month of Feb to March.

Plants of Apiaceae family:
   About 250 genera and more than 2500 species of Apiaceae are known in the world. The
   members of this family consist of mostly cool season crops. Seeds of Apiaceae play a major role in
   the economy of the country and used for extraction of volatile oils and oleoresins that are used in the
   flavour, perfumery and pharmaceutical industries. The aromatic and pungent principles of valuable
   products are found in their volatile oils and resins. The seeds produced in hilly areas are of superior
   quality owing to its moderate temperature in summer and low temperature in winter. But cultivation of
   these crops has not been popular among the farmers due to lack of information on their utility and
   agronomic practices. Mostly these are produced by seeds. Important plant species are: Ajowan
   (Trachyspermum coticum), Anise (Pimpinella anisum L.), Carrot, Gajar (Daucus carota L.), Ferula
   (Ferula jaeschkeana Vatke), Garden Angelica (Angelica archangelica L.); Kala zira (Bunium persicum
   and Carum carvi Linn.), Safed zira, Cumin (Cuminum cyminum L.) etc.
   Micro propagation protocol based on plant tissue culture tool is available for variety of plant
   species. Plant tissue culture techniques offers advantages like dizes free, faster rate of multiplication
and true to type vegetative propagation. This also handles the situations like difficult to rooting and seed germination problems. Techno-economic advantages are major concerned for adopting the technology. Institute of Himalayan Bioresource Technology, Palampur has developed micro propagation protocols for economic important plants like tea, bamboo, rose, ornamentals and medicinal plants and also provides services for setting up of commercial plant tissue culture units.

(Dr. Virendra Singh was born in August 1955 in district Bulandshahr of Uttar Pradesh. He belongs to a farmer’s family and has been a student of agricultural sciences so far. He did graduation in 1979 and post graduation in 1981 from Chandra Sekhar Azad University of Agriculture and Technology, Kanpur. He was awarded CSIR JRF in 1982 and since than he has been serving in CSIR institutions. He shifted from CIMAP field station Pantnagar to CSIR Complex Palampur in August 1988. With start of his career in CSIR organisation, he has been working on medicinal, aromatic and new crops developments in area of plant introduction, propagation, nursery raising, plantation establishment, crop husbandry, essential oils production, training, extension, management and planning of production strategies. He has been largely involved in agronomy of medicinal, aromatic and new crops, multiplication and distribution of seeds & plants, pilot scale production involving cultivation and processing, management of research farm, transfer of technology, information dissemination, training, demonstration, extension, consultancy, technical and advisory services. He has about 24 years of work experience in this field.)