Uttarakhand Decentralized Watershed Development II Project (GRAMYA II)

Manual of Forestry



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PREFACE

Since the evolution of mankind, forests have been most important factor for the survival of the humanity and will retain that status in the years to come. History of development of mankind can be traced along with the gradual destruction of forests by them. In early ages, man completely depended upon the forests for their survival, food and shelter. As the man gradually progressed and learnt other things like domesticating animals and farming, it was the forest which provided essential inputs for this. Man cleared forests for farming and cut trees for making houses and various implements. Everything was quiet right as long as population was marginal and man lived in complete harmony with the nature including forests. But as the time passed on, man gathered knowledge with the great rapidity and desire for development acquired greater momentum. In this process, the greatest sufferer was the nature. In quest of attaining new heights of development, forests got a very rough treatment by man and consequently area under the forests cover declined rapidly. This process caused a lot of pollution which made lives miserable and put up a big question mark for the future.

As the situation started worsening, the man woke up slowly but having no fruitful improvement of forests, the process of waking up acquired some sort of momentum. In recent years, there is a lot of hue and cry to improve the condition of forests and bringing more and more area under the vegetation and it is a concern of everyone including the highest authority of the justice on this land. But this objective can't be seen and solved in isolation and therefore it must be seen in a broad perspective of overall development of the country. People who pass their most of time in earning their means of livelihood can't be made champions for the cause of improvement and conservation of the forests unless their problems of livelihood including their demand of the fuel wood, small timber and fodder is addressed . Since the success and failure of improving forests lie with the cooperation of the common people which form majority for the population, we cannot achieve it without making sincere efforts for solving their very basic problems.

As we know, the traditional rural development schemes, somehow, could not address this problem effectively in order to reduce the dependence of the rural people on forest resources. Therefore, it has not been possible to establish linkages between rural

development, and forest conservation. It is, therefore, the need of the hour to closely inter-link the two approaches of integrated forest development and rural development into a single umbrella scheme. Therefore under this situation these sort of projects, which demand not only the improvement of forests but also seeks overall development of the rural areas by managing natural resources with active cooperation of population become, most valuable. This is even more important for a State like Uttarakhand which has 64.79 % of its land area under forests and is home of a number of sacred rivers, which originate from the mighty Himalayas and provide water to the millions of people of the country. However, due to increasing pressure of the population and unsustainable harvesting, these resources are depleting day by day and it is a great challenge to stop further depletion of these resources, otherwise very existence of the mankind will remain under threat. The State is characterized by young fragile ecosystem, diminishing biodiversity, marginalized and resource poor inhabitants with inadequate infrastructure. The intricate relation of poverty, unemployment and environment poses the most difficult challenge of sustainable development of hills. A large number of people migrate to other states in search of jobs. Under these circumstances, this proposed project provides an ideal opportunity of providing water conservation, water harvesting and drought proofing including afforestation and tree plantation. These activities are labour intensive and serve the noble purpose of providing the employment to the people at their doorstep as well as augmenting the forests and ameliorating the climate, for which the state is known. This manual has been prepared with the idea to describe the forestry based activities which will be taken up in UDWDP-II.

The present project, being funded by the World Bank, will encompass all those activities which aim at managing natural resources along with improvement in the overall condition of the people residing in the project area through the participation of local village community. This present project will cover the hill districts of Uttarakhand and will commence in the financial year 2013-2014 and will last till 2020-2021.

CHAPTER-1

INTRODUCTION

Forests are among the most important support systems of our life. Our food security and water security is embedded within it. The manual consists of four chapters. The First one gives a brief profile of climate, people inhabiting and other physical features. The Second chapter deals with the Nursery Technology, i.e. how seedlings of the forest trees can be raised by the community. Local names of the prevalent species in the State have been used in this manual to make people know easily. The complete process of nursery development and raising of seedlings i.e. selection of proper site, lay out plan, preparation of nursery beds, seed collection period of important species of the state and the precautions required during collection of seeds, pre-sowing treatment of seeds, preparation of potting mixture, watering of seedbeds and seedlings and transportation of seedlings to the plantation sites have been described in a simple manner. The detailed process of raising plantation models has been explained in the third chapter. Proper selection of species is very important for the success of plantation programme as climatic conditions vary with the altitude and aspect. Species, suitable for different zones have also been mentioned. The detailed process of plantation i.e. selection and preparation of site, digging of pits, spacing between the pits, alignment and size of pits, planting of seedlings, protection of plantation sites, weeding and other maintenance operations have been described in a simple language. Information on the plantation of grasses and shrubs has also been provided as tree planting is not possible at all the places. Forests through its thick cover of vegetation provide protection to the land surface against splash erosion and surface runoff. Its root system which anchors and reinforces the soil layers against sliding and slumping. Leaves intercept rain water to percolate down to the ground. The last/Fourth chapter deals with the Schedule of Rates (SOR) for carrying out these works. The SOR has been worked out separately for different categories of work such as raising of seedlings in a nursery, plantation, and soil and water conservation measures. Since Uttarakhand is a hilly state,

the costs as well as items of work vary with the altitude, therefore, SOR for nursery, plantation, and soil and water conservation measure works has also been prescribed for three zones viz. Tropical, Sub tropical and Temperate zones. Suitable units of work have been used to quantify different categories of work, such as area in hectare, earth work in cubic meter and number of seedlings in hundreds. execution of forestry works at all levels; District, Block, Gram Panchayat and Gram Sabha in Uttarakhand State.

Uttarakhand: A Brief Introduction

The Uttarakhand located between $28^0$53'24" and $31^0$27'50"N latitudes and between $77^0$34'27" and $81^0$02'22" longitudes is comparatively a new state, which was carved out of erstwhile Uttar Pradesh on 9th Nov, 2000 by taking hill districts of Almora, Bageshwar, Chamoli, Champawat, Dehradun, Nainital, Pauri Garhwal, Pithoragarh, Rudraprayag, Tehri Garhwal, Uttarkashi with the districts of Udham Singh Nagar in the Terai and Hardwar in the foothills,as the 27th state of the Republic of India. The state is strategically located and forms part of the northern boundary of the country sharing its border with China and Nepal. Himachal Pradesh and Haryana lie to its West and Uttar Pradesh to its South. Blessed with natural beauty and for historical and mythological regions, the state has its own uniqueness. About 64.7 % of the area is covered by forests and is rich with numerous species of plants, animals and birds. About 93 % area is hilly and the remaining 7 % is covered by plains. The elevation extends approximately from 300 m to over 7,000 m msl.

Uttarakhand, divided into two administrative units of Garhwal and Kumayun with provisional capital at Dehradun, is predominantly a rural state with about 69.45 % of its population living in 15,761villages and remaining 30.55% in 86 towns and cities. The state forms the catchments of three major river systems viz., Yamuna, Ganga and Kali.Several tributaries viz., Alaknanda, Bhagirathi, Mandakini, Pindar and Vishnu Ganga of the region feed the river Ganga . Area wise, Uttarakashi is the biggest district of the State, followed by Almora and Pithoragarh ,while Champawat is the smallest district. The population density is 189 persons per km^2 and population wise, Haridwar has the largest population followed by Dehradun and Udham Singh Nagar, while the lowest population is in Rudraprayag. A brief account of population of the state is given below.

1.Geographical Area (Km2) - 53484

2. Population - 10116752

3. Population Density - 189

4. Male Population - 5154178

5. Female Population - 4962574

6. Sex Ratio - 963

7. Rural population

a) Male 3512456

b) Female 3513127

c) Total 7025583

d) Percentage 69.45%

8. Urban Population

a) Male 1641722

b) Female 1449447

c) Total 3091169

d) Percentage 30.55%

7. Literacy Rate (%)

a) Total 79.63

b) Male 88.33

c) Female 70.70

8. No. of Districts 13

GEOLOGY

Uttarakhand Himalayas have wide range of intra regional variations in respect of topography, geology and texture of soil. The region is characterized by a rough mountainous terrain ,rocky mountains, high peaks , deep valleys and high altitude plateaus. The region has abundance of various kinds of minerals such as limestone, dolomite, phosphorite, magnetite etc. There is predominance of boulders and gravels in Bhabhar and marshy tract containing fertile soil with good water retention capacity in Terai.

Soil

The state is bestowed upon with a large varieties of soil types. It varies from alluvial and fertile soils of terai region to the thin fragile soil of shiwalik hills. The temperate zone and the arid zone has different type of soils. Various parameters which include nature, structure and texture of the parent rock, altitude and aspect, climatic conditions, process of formation have a significant bearing on the soil types of the state.

Climate

The Himalayas, the youngest mountain system greatly influence the climate of the State. There are mainly three prominent seasons, viz., Winter, Summer and Rainy. South-West monsoon causes rains from July to September. During winters, there are occasional rains in the plains and snowfall in the higher reaches due to Western disturbances. Within the Himalayas, climate varies with the elevation and location. It ranges from sub-tropical in the southern foothills, with average summer temperature of about 30^0C and average winter temperature of about 18^0C. Warm temperate conditions prevail in the Middle Himalayan valleys, with average summer temperature 250^0C with cool winters. A cold alpine climate is observed at higher elevation where summers are cool and winters are chilly. The State has approx. 64.79% of its geographical area under forest with a forest cover of 46%. The major forest types found in the state are sub-tropical, temperate and alpine forests.

The Himalayas form three parallel zones: the Great Himalayas, the Middle Himalayas and the Sub-Himalayas which includes the Shiwalik range in foothills and the Terai. The Greater Himalayas is the highest zone consisting of snowy peaks with an average elevation of 6100 m. These are the source of great and holy rivers which flow down to form fertile plain. Some high valleys in the Great Himalayas, where there is extremely cold winters and a short growing season, are occupied by small clustered settlements. These mountains have got high passes through which trade was prevalent with Tibet before Indo-China war. The Middle Himalayas consisting of high ranges both within and outside of the Great Himalayan range, have an altitude between 1800 and 3050 mt.asl The major hill stations like Mussoorie, Pauri, Almora etc. lie in this zone. The regions are moderately populated. The Sub –Himalayas forms the southernmost and the lowest zone, bordering the Great Plains. It comprises of Shiwalik range and the Tarai forests. Characteristic feature of the sub- Himalayas is the large number of long, flat-bottomed valleys known as duns. These valleys are thickly populated and people practice agriculture in a big way. The State can be divided into four zones on the basis of altitudinal range and climate

District wise details of the forest area in Uttarakhand

Name of the District	District Geographical Area (km^2)	Forest Cover (km^2)	Forest Cover (%)
Almora	3139	**1557**	**49.60**
Bageshwar	1696	**1380**	**61.44**
Chamoli	7520	**2698**	**33.60**
Champawat	2004	**1622**	**91.85**
Dehradun	3088	**1593**	**51.59**
Name of the District	**District Geographical Area (km^2)**	**Forest Cover (km^2)**	**Forest Cover (%)**
Haridwar	2360	**634**	**26.86**
Nainital	3422	**3094**	**72.78**
Pauri Garhwal	5329	**3271**	**61.38**

Name of the District	District Geographical Area (km^2)	Forest Cover (km^2)	Forest Cover (%)
Pithoragarh	7169	**2077**	**29.29**
Rudraprayag	2439	**1120**	**56.45**
Tehri Garhwal	3796	**2138**	**58.70**
Udhamsingh Nagar	3055	**577**	**22.70**
Uttarkashi	8016	**3144**	**39.22**
Total	**53483**	**24905**	**46.57**

Zone wise distribution of districts in Uttarakhand

1. Tropical Up to 1000m

Almora (Part), Champawat (Part),Pauri-Garhwal (Part), Haridwar,Udham Singh Nagar, Nainital (Part),

2. Sub-Tropical 1,000 to 1,500m

Almora (Part), Dehradun (Part),Nainital (Part), Pauri - Garhwal (Part),Champawat (Part)

3. Cool temperate 1500 to 2400m

Almora (Part), Naini tal (Part), Pauri -Garhwal (Part), Dehradun (Part), Tehri Garhwal (Part), Champawat (Part),Chamoli (Part), Rudra prayag (Part),Uttarkashi, Pithoragarh and Bageshwar

4. Sub- Alpine/Alpine Above 2,400m

Chamoli (part), Uttarkashi (Part)I

CHAPTER-2

NURSERY TECHNOLOGY

Forests play an important role in the economy of the State. They meet our requirement of timber, fuel wood, fodder, paper pulp, sports goods, match wood, plywood, resin, packing cases, agricultural implements, other minor forest produce and medicinal plants. Owing to increasing pressure on forests due to enhanced grazing and other human interference, the natural regeneration on which we had depended a few decades ago is now very scarce. It has therefore, become necessary to restock them by planting suitable tree, shrub and grass species. The UDWDP Phase-II provides opportunity of restocking these valuable forests with the participation of the Van Panchayats in various forestry works such as nurseries, plantations, soil and water conservation works, fire protection etc. thus increasing their productivity and economic value. Raising of plantation is a technical process which require quality and healthy seedlings and nursery is a place where quality and healthy seedlings are grown. Nurseries can either be permanent or temporary depending upon duration and site of the plantation. In a plantation programme that is likely to continue for more than five years, it is advisable to have a few permanent nurseries. However ,since the project will be implemented for a 7 years period, nurseries raise under the project will be handed over to the community for future maintenance and operations. The establishment of a nursery is a technical process which involves following steps.

1-Selection of Site

Selection of site is of utmost importance because it has a significant bearing on the raising of seedlings. Therefore following points must be kept in mind while selecting a site for the establishment of a nursery.

a. Location: The site should be centrally located and easily accessible for transportation. Sites used earlier for agriculture should be avoided and preference to forest sites, where weed problem will be less and useful mycorrhizae will be available, should be accorded.

b. Water: Enough water should be available especially during summers. A natural source of water at a higher altitude is preferable but if there is no natural water source, ground water may be used. It is estimated that during peak summers 2000lts of water is required for 100000 seedlings.

c. Topography and drainage: The site should be almost flat with good drainage. This can be done by providing gentle slope and channels to drain out excess water from the nursery. In the hills northern aspect is desirable up to 1,200 m elevation and beyond it, Western or South Western aspect is best for moist areas and Northern for dry areas. Nursery site should not be selected close to the edge of a high forest or in the middle of the grassland. Frost pool should be avoided.

d. Soil: The ideal forest nursery should have sandy loam to loamy texture. Sandy soils having pH between 5.5 to 8.0, moderate fertility, with a minimum of 2.5% organic matter may be given preference over heavy soils. The higher the organic matter content of the nursery soil, the better it is because it ensures good retention of nutrients and water and may improve the working properties of the soil. The depth of soil should not be less than 25 cm. It is not always possible to get good soil everywhere. Under such circumstances, one has to get extra soil, sand as well as farm yard manure from outside.

2- LAYOUT OF NURSERY

a. Size and shape: As far as possible the nursery should be rectangular in shape so that it could be divided into smaller nursery beds of rectangular shape, leaving space for inspection paths, storage of tools and essential ingredients required to raise a nursery, hut for Mali and space for people working in the nursery to rest during rains or intervals. In a bigger nursery (one ha and above), a road of a minimum width of 3 m should be

constructed to facilitate transportation of nursery items and plants . The requirement of the total area for the nursery can be calculated by adding together the area required for mother beds, polybags, entire plant/root shoot cuttings and beds required for rooted cuttings. Another 40% area may be added for making the path. Area will also increase if seedlings are kept in the nursery for more than one year, specially for raising tall plants. Area required for sheds, water tank, storage of seed, manure etc. should also be kept in mind. Polybags of size 18 x 5.5 cm need 1sqm for keeping 772 bags and poly bags of size18 x 7.5 cm need 1sqmt. for keeping 400 polybags. Accordingly 1,00,000 polybagss will require 250 sqmt. area plus 40% for paths. Thus for raising 1,00,000 polybag seedlings, an area of 350 sqmt. be sufficient.

3- ESTABLISHMENT OF NURSERY

a. Site preparation: The site should be cleared off by removing all stumps, roots, lops and tops. Stones collected from the site may be used for constructing the main nursery road. Thorough hoeing to a depth of 30 cm should be done, especially in places where plants are to be raised in the nursery beds. The soil should be leveled to form an even slope or, if a site is flat, should be slightly domed. As far as possible, removing of top soil must be avoided. Drainage channel of adequate slopes and steps on both sides of the paths should be dug as early as possible to avoid soil erosion.

b. Types and size of beds: Beds are prepared to germinate seeds, keep polybags and transplant pricked out seedlings. In the hills beds of 2 x 1 m are prepared. However, size can be changed depending on the availability of the area. Width of beds should not be more than 1.2 m otherwise watering of seedlings; especially in the middle part of the bed shall be a problem. The beds should be oriented to follow contours in the hills. In areas where lifting may be restricted due to frozen ground, orienting beds in a North-South direction will facilitate early thawing by the morning sun, and thereby lifting. Following types of beds are generally prepared in a nursery.

c. Sunken beds: These are made 15 cm deep and used in arid areas and hot places to protect young seedlings from hot winds, and also to reduce the rate of evaporation, thus reducing the consumption of water.

d. Raised beds: These types of beds are raised 15 cm above the ground to increase drainage and promote warming of seedbed and are generally made in moist areas. Beds are given side supports of bamboos, twigs, bricks or other locally available materials.

e. Preparation of seedbeds: The plot where seedbeds are to be prepared must be ploughed , levelled and sloped (1 to 3%), depending upon the texture of soil (less slope for sandy soils). It should be ascertained that the soil in the seedbed is light and if necessary, sand and soil (1:1) may be mixed so that the seedlings can break through in the process of germination, and this will also be helpful when plants are lifted for pricking out . The seed beds should not be filled in completely, to avoid the washing away of top soil and seed and its surface should be made firm by sprinkling water and then using a wooden plank. These type of beds are generally used for the following reasons:

- To provide a small reserve of seedlings which can be used to replace direct seeded plants that did not germinate or died,
- For sowing seeds which germinate slowly or unevenly, like teak and
- For the seeds whose quality is unknown.

f. Components of forest Nursery: Poly house Seedlings from cuttings, Seedlings grown in polybags Temporary green house Trolley for transportation, Barbed wire fencing Stand for seedlings transportation Composting unit

4- SEED COLLECTION AND STORAGE

Seeds can either be purchased from reputed nurseries or collected from known stands of trees. However, seed collection is considered the best approach since the quality of seeds are known but seeds should be collected only from healthy and middle aged trees of good

quality and if the required seed is not available, it can be purchased from the reputed nurseries or suppliers. It is improper to collect seeds from a mongrel population of trees and to use them in a nursery. Since,different species have different seeding time; therefore it is necessary to have a time table for collection or purchase of seeds. Seed viability and dormancy are also important factors, which decide the sowing time. Species with very short seed viability must be sown immediately otherwise the germination percentage will go down drastically. Seeds with long viability should be sown when temperatures are moderate, i.e. between July to October and February to March. Whether the required plants are to be of six months, one year or one and a half year age will also affect the sowing time. Following precautions are required to be followed at the time of seed collection:

- Only fully matured seeds should be collected as the unripen seeds of most species do not germinate e.g. Haldu, Harar, Bahera, Arjun and Walnut.
- Mother trees should not the damaged or heavily lopped for seed collection, otherwise the seed tree may die or stop seeding.
- The seeds of coniferous trees like pine or other should be dried in sun instead of breaking them by hard hitting because drying in sun helps in opening spontaneously.
- Seeds of pulpy fruits can be collected by rubbing them in water followed by washing, drying and cleaning respectively e.g. Mehal, Bakain, Mulberry, Bel, Kadam etc.
- The collected seeds must be dried properly before storing to avoid any possibility of its damage. However, excessive drying should be avoided and
- Properly treated seeds should be stored in a place having good ventilation and devoid of moisture to safeguard them from decaying or losing viability.

b. Estimating seed quantities: It is necessary to compute the required quantities of seeds and consider factors like germination percentage, number of plants to be raised and amount of wastage involved, because all these affect the quantity of seeds. It is convenient to have a seed weight chart having the species wise details of the number of seeds per

kilogram to make it handy while computing the quantity of seed required. Per kilogram number of seeds, collection period, viability and pre-sowing treatment of some of the common species is mentioned below Table.

Table Details of Various Species of Seeds

S. No	Local Name of Species	Seed collection time	Number of seeds/kg	Viability (Months)	Treatment
1.	Akhrot	Sep-Oct	75	6	Keep in refrigerator for one month and sow
2.	Amltas	Mar-April	6000	Many years	Soak in hot water for one hour
3.	Amla	Nov-Mar	900	1-6	None
4.	Angu	Oct-Dec	7400	2	None
5.	Ardu	Feb-Mar	9600	3-4	None
6.	Bahera	Nov-Feb	425	12	Soak and dry alternately 5-6 times
7.	Ban Oak	Nov-Jan	600	13	None
8.	Bel	May	5300	1-6	None
9.	Bheemal	Dec-Feb	12000	12	Soak in hot water for one hour
10.	Chir	Dec-Mar	9000	24	Soak in water for 24 hour
11.	Cheura	June-July	1000	Less than one month	Sow immediately after collection
12.	Deodar	Oct-Nov	7000	1-6	Store without drying and sow in March
13.	Fir	Sep-Nov	27000	3	None
14.	Gulmohar	Jan-Mar	2500	Very long	None
15.	Gutel	Jul-Dec	6800		None

S. No	Local Name of Species	Seed collection time	Number of seeds/kg	Viability (Months)	Treatment
16.	Haldu	Jan-Mar	110000	12	None
17.	Harad	Jan-Mar	150-250	12	Sow after breaking the seed coat
18.	Jamun	June-Aug	1200	One week	None
19.	Kachnar	May-June	2500	12	None
20.	Kadam	Jan-Aug	1600000	12	Treatment for fungus before sowing
21.	Kail	Sep-Nov	20000	12	Soak in water for 24 hour
22.	Kanju	Apr-May	27000	6	None
23.	Khair	Oct-Nov	40000	6-12	Soak in cold water
24.	Kharik	Feb-Mar	4600	12	Soak in boiling water or hot water
25.	Kharsu oak	June-July	400	1	None
26.	Kwiral	Jan-May	4000	12	None
27.	Neem	June-Aug	3000	2 Weeks	None
28.	Pangar	Sep-Oct	30-40	Less than month	Sow immediately after collection
29.	Pula	Mar-Apr	32000-37000	12	None
30.	Reetha	Nov-Dec	650	24	Soak in Conc. Sulphuric Acid for five minutes
31.	Robinia	July-Aug	50000	36-48	Soak in hot water
32.	Sagaun	Nov-Jan	1800-3000	24	Soak and dry in water alternately 6-7 times
33.	Semal	Mar-May	20000	12-24	None
34.	Shisham	Nov-Mar	50000	6-12	None

S. No	Local Name of Species	Seed collection time	Number of seeds/kg	Viability (Months)	Treatment
35.	Silver oak	June	100000	12-24	None
36.	Siris	Jan-Mar	7000	12	Soak in hot water for one hour
37.	Spruce	Oct-Nov	62000	12	Soak in water for 24 hour
38.	Tun	May-June	550000	12	None
39.	Utis	Dec-Jan	570000	6	Keep in refrigerator for one month and sow

5- PRE-SOWING TREATMENT OF SEEDS

Seeds, which contain tiny, fragile plants that live under the hard seed shell, need water to germinate. Some seeds have such a hard shell that water cannot easily enter the seed to help it sprout. Pre-sowing treatment of seeds quickens germination, so that all plants would be of the same size and ready for planting at the same time. Following methods can be used for the treatment of different seeds to enhance their germination:

a. Boiling water treatment: This method is generally used for the species which have a very hard coat e.g. Acacia and Prosopis. Water is boiled in a pan and seeds are kept in the water only for 1 to 2 minutes after which hot water is poured off and replaced with the cold water. Let the seed soak in the cold water for 2 to 3 days or until the seed swells. Seeds are sown immediately after the treatment.

b. Hot water treatment: This method is generally used for the species which have a hard shell e.g. Albizia, Cassia,Callindra, Leucaena, Sesbania, Samanea etc. Sufficient quantity of water is boiled in a container and after boiling it is allowed to cool for about 10 minutes. After that, the seeds are poured into the container and kept as such for 2 days or until most of the seeds have swelled. The water of the container can be changed every day and seeds are sown immediately after the treatment.

c. Cold water treatment: Some seeds need lots of water to facilitate germination. Others may have chemicals inside the seed which must be removed before the seed can germinate. Examples are Citrus, Gliricidia, Neem and Pinus. Seeds are kept in sufficient water for 1 to 2 days. Water can be changed after every 12 hours and seeds that float on the top must be discarded. All swollen seeds should be planted immediately

Precautions required during seed collection and storage

- Seeds must be stored in a dry and cool place. Store large and soft seeds in open baskets
- Do not place the freshly collected seeds in the sun. They may get damaged due to excessive heat. Hard shelled seeds e.g. teak, pine, acacia, etc. can live for a long time in storage.
- Dry them properly before putting them in plastic bags. Be sure that all the air is forced out of the bag before you close and seal it. Never store seeds on the ground. Store seed bags on shelves in a rat proof shed.
- Do not leave seeds in the rain, or in wet areas. Seed will rot and die.
- Do not put soft seeds like neem in a large gunny bag. It may generate much heat to kill the seeds.

d. Wet and dry method: This method is generally used for teak seeds. Seeds are soaked in the cold water for one day. Next day, they are spread in the sun to dry for at least 1 day. When dry, they are again soaked in water for overnight. The process is repeated for about 20 to 30 days after which seeds are sown in a germination bed.

e. Cracked shell treatment: The method of seed treatment is generally used for the seeds which are contained within a nut. When the shell is cracked, water enters the seed and they germinate immediately. The nuts are kept on a solid surface and hit with a piece of wood or a small hammer. One has to be careful not to hit too hard to crush the seed inside. Once the seed is cracked, sow it immediately.

e. Pre-sprouting treatment: This method is used for the seeds which have a very short viability e.g. neem. Seeds are spread between the pages of newspaper. Wet the paper and put them in the shade. Seeds which start germinating must be transplanted immediately when the roots emerge.

6- SEED SOWING

Sowing can be done either by broadcasting/scattering, or in lines along the width of the bed. Broadcasting method is used for minute seeds such as Eucalyptus. These are generally mixed with equal amount of fine sand to facilitate uniform seed distribution. Better germination can be obtained if such seeds are sown in small wooden boxes or other containers, which can be kept under controlled environment, so as to protect seeds from excessive heat, rains etc. The small and medium sized seeds are sown in lines or drills 5 to 10 cm apart, the seed is covered with sand or sieved soil and gently firmed. Sowing depth is crucial for the production of a uniform bed of seedling. Best germination is obtained in the case of small and medium sized seed, when they are sown 0.3 to 0.6 cm deep which is necessary to cover them. The general rule is that the upper surface of the seed should be at a depth equal to the diameter of the seed. Seedbed density and spacing also play an important role in germination. Too dense sowing may result in damping off disease. Mulching by covering the seedbed with dry grass or paddy straw is helpful, as it helps in retaining moisture, reducing weeds and improving germination. Seed beds sown with minute seeds should be well shaded. After germination, the shade should be removed gradually in stages and the mulch should also be removed. It has been found that different species have different germination potential. Percentage of some seeds is given below.

S. No	Species	% Germinations Potential
1.	Amla, Chullu, Kachnar, Mango, Sal,Siris	90-100
2.	Bhimal, Cheura, Kharik, Maple, Mehal, Pine,Ritha, Robinia, Walnut	70-90
3.	Bamboo, Kafal, Ringal, Rohani, Shisham,	50-70

S. No	Species	% Germinations Potential
4.	Cedar, Chamkharik, Hisaru, Ruins, Semal, Teak	50-70
5.	Kakra, Fir, Thuza, Tun	20-30
6.	Amaltas, Jecaranda, Sadabahar	10-20
7.	Kumkum Papri, Surai, Spruce	5-10
8.	Alder, Bakli, , Bedu, Khaina, Timla	1-5

Direct sowing of seeds in polythene bags

Sometimes seeds are sown directly in the polythene bags. In such cases the bags should be completely filled with dry soil and left standing for few days, so that the soil settles. The bags should be watered well before sowing. Two seeds should be sown per bag and then covered with sand or with a mixture of sand and soil. Heavy soil should not be used for covering, as the germinating seeds may not be able to break through this hard covering. Seeds directly sown into bags normally attain more growth compared to pricked out seedlings and become ready for planting much earlier. After germination, only one healthy seedling per bag should be retained and the other be pricked out into vacant bags.

7- PROPAGATION OF PLANTS BY CUTTINGS

Seedlings are generally raised from seeds but, in some cases where seed is difficult to get or germination is poor due to small size of seed or infertility, plants are raised by vegetative methods. Cuttings of sections of roots, stems, branches or twigs, which are taken from suitable mother trees. A light, loose rooting medium should be used for this purpose. The soil should be dug 30 cm deep and mixed with sand and compost. Cuttings of 5–10 mm diameter and 15–20 cm length should be obtained from young vigorous trees. The leaves should be stripped off the cuttings to reduce the transpiration. It is better to keep such cuttings for rooting into small poly houses to maintain humidity and temperature . Some of the common species which are raised through cuttings are mentioned below.

S. No	Species raised through cuttings	Period of planting
1.	Chullu , Mehal , Mulberry , Siris,	February to March
2.	Cheura, Timla	July to August

8- PROVIDING SHADES IN THE NURSERY

Most of the tree species need shade in the early stage of germination when the seedlings are still tender. Studies have shown that the shade is more important before and after the monsoon, and has a great effect in increasing the survival of seedlings. Dry grass, bamboo mat, palm leaves or wheat straw can be used as shading material but tin sheets should be avoided. Shade should be slanting towards North-South to protect the seedbeds or seedlings from the hot sun.

9- MULCHING

It is also beneficial, before and after the monsoon, to protect the surface of seedbeds against becoming hard, and thereby inhibiting seedlings in breaking through resulting in delay or poor germination.

10- PREPARATION OF POTTING MIXTURE

The potting mixture should be prepared with meticulous care and control. A fine mixture of soil, sand and manure in the ratio of 6:1:3 should be prepared. Before mixing, the soil and sand should be sieved and pebbles and other undesirable material separated. The manure should not be sieved but rubbed with hands to make it fine. Twigs and other impurities should be removed. Insecticides in the prescribed proportion should be mixed in the mixture. The main characteristics of a good potting mixture are:

- It must be light in weight, well drained
- It must not hold too much water
- It must be free from insects, diseases and weeds
- It must not contain clay soil and
- All materials must be well decomposed.

a. Filling of polythene bags: The polybags should have sufficient number of holes to enable drainage of excess water. By using a pincer like punch, twenty or thirty bags can be punched together. A scoop can be used for filling the potting mixture into the polythene bags or it can be made from locally available materials. After first filling the bags should be struck on ground to let the soil settle in and and then the pot should be filled again. If loosely filled, soil will settle later and make polybags limp, resulting in dislodgement of roots and mortality of plants during handling. At least half to one inch from top of the pot should be kept empty to avoid spillage. Filled polybags should be placed erect within the sunken beds meant for the purpose.

b. Transplanting of seedlings: Seeds sown in germination beds have to be transplanted into polybags. Transplanting age and time vary, but on an average, it has been seen that earlier transplants are more successful. Too big plants in germination beds may have their roots entangled, and disentangling of the roots may cause seedlings to die. As a general guide to transplanting age, 20 to 30 days (excluding germination period) is adequate for most of the species. For transplanting, a scoop may be used to lift a group of plants with soil. From this soil the individual plants can be separated and inserted into holes made in the polybag soil by thrusting a sharp punch. The depth of the hole should be equal to the length of the root of the seedling, so that the root does not bend while being pushed into the hole. After inserting the plant roots, the hole is closed over up to the collar of the plantlet. The transplanting work should be done in the afternoon so as to avoid mortality of plants due to hot sun. A bed of polybags is gently irrigated after all the bags have been transplanted in. If transplanting is done in hot weather, proper shade should be provided over the beds to prevent the tender seedlings from getting scorched to death.

11- AFTER CARE OF SEEDLINGS

Young seedlings are vulnerable to many factors and major losses can occur if they are not taken care of. Seeds may not germinate or may be lost to predators or diseases, if proper

care is not taken. In addition, seedlings may have to survive pricking out shock, dry conditions, heavy rains and hail storms,high temperature and weed competition. Seedlings require after care till they are planted out in the field. This includes weeding, watering, manuring, hardening, protection against adverse climate, diseases and insect pests.

a. Weeding: Weeds come with manure, clay or sand transported from outside. Sometimes undesirable seeds get mixed with the seed sown. It is very simple to remove weeds by pricking them out but this operation should be carried out at the earliest when the weeds become visible. If two seedlings of the species sown have come up in a polythene bag, one of these should be immediately pricked out and transplanted into another polybag. If any clutter or muck fills up the bags, these should be cleaned. In the mother beds, it is also desirable to hoe the soil periodically, apart from removing the weeds. These seemingly simple operations matter a great deal in determining the growth of plants.

b. Watering: The soil surface of the seedlings should not be allowed to dry. As a rule, finer textured soils require more frequent watering than coarser ones. Seedbeds and transplant beds should be watered twice a day. Too much watering during germination, however, is not desirable because the excess watering causes the growth of fungi by decreasing the temperature and increasing soil moisture. Mild but frequent watering of polybags is not as good as more thorough, but less frequent watering. Mild watering results in the water not penetrating deep into the soil and the seedlings may dry out soon. In the exposed surface of the nursery bed, soil surface temperatures can rapidly rise to over 45^0C on a warm sunny day. It can damage the root-collar area and kill the seedlings. To prevent damage, the soil surface should be kept cool by proper watering. There are a number of methods of watering. The one most commonly used is sprinkling of water by a rose can or through hoses .Following points must be remembered while watering in a nursery:

- Do not water at a fixed time each day. Water when the plants need it and pour small quantity of water on small seedlings whenever they need it
- All species do not require the same amount of water,

- Small seedlings don't need much water; large plants need more water and more often,
- Plants growing in the shade need less water; plants growing in the sun need more water, more often
- Plants need more water, often on windy days.

c. Control of diseases: Periodical spray of insecticides and fungicides is essential to control insect and fungal diseases in the nursery. Some of the common fungicides and insecticides are M-45, and chloropyrophos etc. These should be used immediately according to the manufacturers' instructions, when disease or insects appear.

d. Protection against white ants and rats: Considerable damage is caused by white ants and rats in the nurseries. White ants live in colonies deep inside the soil and their number increases rapidly where vegetative waste is available. In order to control them, Chloropyrophos 20 EC should be sprayed after mixing it with 3 to 4 litres of any of these insecticides in 1000 litres of water. For the control of rats zinc phosphide or aluminum phosphide may be used.

e. Shifting and grading of plants: It is essential to provide adequate growing space in the beds for accelerating the growth of plants in the nursery. Therefore, the surplus plants should be removed carefully and planted in new beds. The beds should be irrigated before the shifting and grading operations. The ultimate spacing between the plants at the time of final shifting should be 15x22 cm. While shifting, plants should be graded according to their heights and put in the beds grade wise. While shifting the polythene bags, the roots of the plants protruding outside the bags should be cut with sharp scissors. It is better to keep these bags over a polythene sheet to avoid roots penetrating the soil. However, keeping such bags on mounted beds gives better result and avoids root coiling by facilitating air pruning of roots.

f. Pruning: Some species grow very fast in the nursery. Sometimes tall seedlings do not have enough roots to support the many leaves. When these seedlings are planted in the field, they may grow slowly or even die because of roots cannot supply enough water to

the leaves. In order to avoid this problem, cut off the tops of seedlings that have grown too tall. Use a sharp knife to trim the tops of these species. Root pruning is also essential to avoid deep penetration of roots in the soil and avoid hardening of the plants. Pruning of roots helps in the development of tertiary roots.

Precautions to be followed during watering the seedlings

g. Hardening off of seedlings: Life is easy for the plants in the nursery since there they receive good care. However, once planted in the field, life is much harder for them. They may not have enough water or food to live very well. Therefore, seedlings must be made tough to survive well in the field. This is called hardening off. It is achieved by gradually reducing the frequency of watering before one month of planting. However, care must be taken that seedlings do not dry out in the process.

h. Replacement of dead/damaged plants: Care should be taken to replace the dead or damaged plants immediately by sowing of fresh seed or replacing the dead or damaged plants from the existing seedling beds.

12- TRANSPORTATION OF SEEDLINGS

Seedlings are very delicate and should be handled properly. The polybag seedlings should always be held by the bag and never by the plant itself. Seedlings should be watered thoroughly before carrying them to the field. Seedlings should be transported in the trays, boxes or baskets and not tied in bundles with strings or grass. In case of stumps, they should be bundled, wrapped with a wet sack and transported to the field. The plants should be kept in shade and plants not being planted the same day should be sprinkled with water in the morning and evening. While transporting bare root seedlings, the nursery beds from which the plant is taken should be irrigated so as to facilitate making of ball plants. After making ball plants, they should be graded according to their height and put in shade. In order to keep the earthen balls around the roots intact it should be wrapped in grass and tied by sutli (Thick thread).:

SELECTION OF SPECIES

Tree line in the Himalayas extends up to 3500 m altitude. Climatic variations occurring due to altitudes, aspects, temperature, rain fall, soil types have resulted into a number of forest types and vegetation types that vary from place to place due to these factors. Because of this, it is not possible to recommend any particular tree species for every area. However, while selecting the species for planting in a particular area the following points should be considered:

- The soil and climate of the area is suited to the growth of particular tree species,
- The species selected for planting are in accordance with the plantation policy of the
- Government,
- The species selected meet the fodder, fruit and other requirements of the villagers living in the vicinity,
- The species selected suit the needs of birds and wild animals dwelling in the area. The species selected for planting should provide suitable cover and food to herbivores and carnivores.
- The species should be useful for water and soil conservation such as Banj oak, Pangar and Burans etc. and
- The species should be able to meet the needs of the rural inhabitants.

CHAPTER -3

PLANTATION TECHNIQUES

Introduction: Following three plantation models will be taken up in this project,viz;

- Silvipasture Development (800 plants and 400 trenches per ha)
- Afforestation (1000 plants per ha)
- Fuelwood Plantation (1600 plants per ha)

In **silvipasture development plantation** those species of trees and grasses will be preferred for plantation which are used as fodder in the project area. In **afforestation programme**,those areas will be taken up where already some plants are existing, but the density of existing vegetation is less and there are open patches available for the plantation. Under **fuelwood plantation programme**, almost blank patches will be taken up for plantation and those species will be preferred which provide good source of fuelwood. In all these three types of plantation models, plantation techniques which include site selection and development, digging and filling of pits, construction of protection wall or fence, plantation of saplings and its after care will be similar.

1- SELECTION OF SITE

The selection of site and species are interdependent. The selection of site is however more important as the selection of species depends upon the selection of site. The site selected for planting should be suitable for the growth of species desired to be planted. For this purpose, the soil type, its depth, study of vegetation in the adjacent areas, local factors and other conditions should be given due consideration as well as the advice of the local villagers. Selection of planting site should be done by the end of September. In case of Reserve Forests the areas to be taken up for planting are listed year wise in the working plans of the respective Forest Divisions. The position in case of Civil and Soyam and Panchayat Forests is however, different. In such areas plantations are taken up after

obtaining proposals from the Panchayats / villagers. Plantations can be raised as a block plantation if large area is available or trees can be planted along the boundary of agriculture fields.

2- SITE DEVELOPMENT

This includes clearance of planting site, bush cutting, control burning, lopping of tree branches, checking of soil erosion, soil conservation works in 'nalas', construction of vegetative or stone check dams, preparation for agave planting where necessary, marking of pits for planting of saplings and other soil works. In addition, demarcation of boundary wall or fencing and inspection paths should be made to facilitate the movement of people engaged in plantation works. This work should be completed by the end of November. In hilly areas, Lantana shrubs should be cut at one inch below the collar and turned upside down to avoid regeneration. These should not be uprooted to avoid soil erosion. Parthenium and other invading shrubs should be uprooted and burnt before the onset of rains. While developing the site for planting, care should be taken to retain all indigenous species of trees and shrubs that are naturally growing in the area. They should not be cut and burnt along with weeds and thorny species. Preferably they should be adopted in the plantation and thanwalas should be made around each of these plants for retention of moisture and for protection against fire and damage by grass cutters.

3- DIGGING OF PITS

After clearing the land and before digging of pits, pit sites should be identified by using a measuring tape to ensure the desired spacing and then mark with wooden or bamboo sticks at the spot that will be the centre of the pit. Pits of the size 30 cm x 30 cm and 45 cm depth should be dug. Pits should be deep enough to ensure that the roots of the plants do not curl up once the planting material is placed in it. The soil dug from the pits should be dumped close to the pit. While digging stones, roots of trees, grass or shrubs, if any, should be separated so that while filling the dug up earth back in the pits these are not mixed with the soil. The spacing of pits varies according to the planting scheme for

different areas. Generally the spacing between pit to pit along the contour line is 2 m and the distance between lines (Contour) is 3 m. In hilly areas, it may not be possible to follow this spacing strictly due to presence of boulders or trees. No pits should be dug within the vicinity of five meters from a tree. The spacing between the pits should however, not be less than 2 x 2 m. Pits should always be dug along the contour lines. The pits in the second line should be dug in such a way that they fall between the pits dug in the first line i.e., staggered .The triangular planting method, which is specially practiced in the hills, checks the flow of rain water and facilitates its percolation in the ground. This method should also be applied while digging contour trenches of size 3m x.3m x.3m.

4- PROTECTION OF PLANTATION SITES

The proper fencing of plantation areas is essential to protect the seedlings from damage by the cattle and wild animals. The choice of fencing depends on the type of terrain, soil depth and the kind of soil. Since most of the afforestation programmes are employment oriented, a fence type with high labour input is preferred. Cost of fencing is another important criterion, but normally no compromise should be made on this count, because if fencing is not effective, all other measures, howsoever effective, will come to a naught. Some of the common fencing types are discussed below:

a) **Stone-wall fencing:** A stonewall fence is the ideal choice in hilly areas where stones are generally available and local people are able to make it themselves. Dry stone masonry wall of sufficient height and width is constructed to keep cattle out. Specifications may vary, but it is better to adhere to standard sections only. The cost of stone wall fence depends upon the availability of stones and the average distance of their transportation. Sometimes stones may have to be quarried using the crowbar, in which case the cost may go up. The dimension and cross section of stone wall are mentioned in the cost table of forestry works. However, these can be modified according to the ground situations. The stone wall does not last long because it is built dry therefore, live hedge fencing can be developed by planting agave or euphorbia

species. For this purpose planting can be done at a spacing of 50 cm along the outer periphery of the walls during the rainy season.

b) **Barbed-wire fencing:** In areas where stones are not easily available or where cartage of stones is expensive due to long distances, the plantation area should be protected by barbed wire fencing. Wooden posts are used for this purpose with a length of 3 m and a girth of 30 cm to 45 cm. The upper ends of the posts are fashioned in conical shape to avoid rain water from rotting it. The lower end which remains in contact of the soil is painted with coal tar to avoid damage by white ants and wood decay fungi. The posts are dug 30 cm deep and placed 2.5 m to 3 m apart. Three strands of barbed wire at the height of 22, 52 and 74 cm from the ground level are stretched and fixed to these posts with the help of iron staples. To make this fencing more effective thorny bushes are put along the fencing. For entry in the plantation area wooden ladders are provided. From the landing point of the ladder an inspection path is made inside the plantation area. Areas having nilgai menace or damage by animals like deer etc. requires at least 4 rows of barbed wire fixed at an interval of 30 cm each with two strands of barbed wire inclined at 45o to the poles to provide extra strength.

c) **Social fencing:** In community areas and areas close to habitations, local villagers must be encouraged to resolve among themselves about not sending their cattle in plantation areas and protect grasses in the plantation areas to be cut after maturity by mutual agreement. Van Panchayats should be made models of such social fencing efforts. In such cases, the money earmarked for fencing must be utilized to pay the villagers who choose to stay at the plantation site and protect it from grazing. The grasses so produced can be shared by the villagers as per the mutual agreement.

5- **FIRE PROTECTION:**

A 1.5 m wide strip along the outer periphery of the fencing should be cleared of grass and bushes and the strip scrapped with spade for fire protection so that any fire from outside may not enter the plantation area. A hut should be constructed inside the

plantation area, preferably at the entrance point. This can be used for the stay of the people during rains and heat. After the plantation work is over, the hut can be used for the stay of Chowkidar deputed to look after the plantation.

6- **FILLING OF PITS:** This work should be completed in the first week of June. The dug earth dumped near the pits should be filled back after about a month or before the monsoon, so that the pit and the earth to be filled are exposed to sunlight. Insecticides may also be mixed in the soil while filling into the pit. The pit should be filled a little above the ground level so that after the earth settles the upper surface of the pit is level to the ground thus avoiding any water logging. While filling the pits, the area surrounding the pit should be scraped with spade to remove grasses or weeds. Top soil should be filled in the bottom of the pit and after this, subsoil should be filled.

7- **PLANTING OF SAPLINGS**

a) **Summer/ Monsoon Planting :** The plantation of sapling must be done in the first week of July after onset of the monsoon rains. Planting of naked root plants should be completed as early as possible so as to take full advantage of the rain. The planting work should be done either in the afternoon or during light rain or cloudy sky. The roots of the plants should be kept straight and the plant put straight in vertical position. For this a hole should be made with the help of a stick or small crow bar. The collar of the plant should be kept at the surface level of the pit. After planting the sapling, the earth around it should be firmly pressed by hands or feet and while doing so the plant should be pulled about half inch to make sure that its roots is not ending. Species suitable for naked root planting are Pangar, Akhrot, Angu, Utis, Deodar etc. Bagged plants should be sprayed with water before planting. The polythene should be carefully removed so that the plant is not damaged. The plant with the soil intact should then be placed in the pit in straight position, the collar of the plant being in level with the ground. The soil around the plant should then be pressed firmly by hands only. Pressing by feet is likely to

disturb the soil of the plant. The planted saplings should be of suitable thickness and height. Ideal plantable size of some species is given below.

Ideal plantable size of some species

S. No	Species	Height (cm)	Age (Months)
1.	**Fir**	**45**	**40**
2.	**Deodar**	**40**	**26**
3.	**Tun**	**25**	**12**
4.	**Acacia**	**40**	**6**

Similarly, seeds of suitable fodder grasses will be sown on the contour trenches dug up in the plantation area**.**

b) Winter Planting: Species like Akhrot, Angu, Maple, Pangar, Salix, Utis etc. are planted in winter months. Most of these species remain leaf less during winter. These can be planted in January or beginning of February. By March the buds sprout. If at the time of planting there is lack of moisture in the soil, it is advisable to irrigate the plants once or twice after sprouting to ensure the success of the plantation.

8- REPLACEMENT OF DEAD PLANTS OR BEATING UP

Dead, dying or dry plants should be replaced within 15 days of completion of planting work.

9- SELECTION OF SPECIES FOR PLANTATION

It should be borne in mind that the growth behaviour of any plant is considerably influenced by sunlight, temperature and fertility of soil. Some species have low moisture requirement, such as Bakain, Khair, Amaltas, Tungla and can be grown on South facing slopes because these slopes are comparatively drier due to their exposure to direct sun.

Contrary to this, North facing slopes are much humid. Here species like Banj oak, Kafal, Anyar, Burans, Pangar and Maple can be grown successfully.

10- SPECIES RECOMMENDED FOR PLANTATION AT DIFFERENT ALTITUDES

a) Altitude 400m to 1000 m

Aam, Ailanthus, Amaltas, Amrood, Anwla, Ashoka, Bamboo, Bel, Ber, Cassia, Ficus, Gulmohar, Gutel, Haldu, Jacaranda, Jamun, Jhingan, Kathal, Neem, Paper mulberry, Haldu, Poplar, Pula, Ritha, Safed Siris, Sainjna, Sal, Salix, Shisham, Silver oak, Semul, Teak (in plain areas), Tendu, Tun

b) Altitude 1000m to 2000m

Acacia mollissima, Akhrot, Amla, Angu, Banj, Bans, Burans, Chinar, Chir, Deodar, Exotic Chir, Genthi, Kafal, Kail, Kala Siris, Kharik, Kweiral, Mehal, Moru, Padam, Pangar, Poplar, Putli, Ringal, Ritha, Robinia, Salix, Silver oak, Surai, Tejpat, Tun, Utis Proper selection of species according to the aspects is very essential between 1000 to 2000 m.

c) Altitude 2000m and above

Deodar,spruce,fir,kharsu,moru

11- CLASSIFICATION OF SPECIES ACCORDING TO THEIR USES

a) Timber: Ailanthus, Akhrot, Angu, Anwala, Bahera, Bamboo, Banj, Chamkharik,Chir, Deodar, Fir, Haldu, Harar, Kafal, Khair, Maple, Neem, ,Ringal, Sain, Sal, Salix, Semul, Shisham, Siris, Spruce, Surai, Tejpat and Tun.

b) Fuel-wood: Acacia, Banj, Haldu, Jamun, Kwiral, Kharsu, Moru, Sain, and Shisham.

c) Fodder: Bakil, Bans, Bhimal, Banj, Dhauri, Kharsu, Kharik, Kwiral, Maple, Moru,Neem, Phalyat, Robinia, Shahtoot, Siris and Timla.

d) Fruits: Aam, Akhrot, Amrood, Anwla, Bahera, Ber, Harar, Imli, Jamun, Kafal, Malta,Mehal, Nimbu, Shahtoot and Timla.

e) Rejuvenation of depleting water sources: Akhrot, Banj, Deodar, Maple, Phalyat, Siris and Utis.

12- SOILWORKING AND WEEDING

Thanwalas should be made around all the seedlings having inward slopes. For this purpose a semicircular pit about 15 cm deep, 25-30 cm apart from the plant should be dug. The earth taken out from the pit is put around the base of the plant. This has double advantages; firstly, there will be no water logging at the base of the plant which may otherwise cause damage to the plant; secondly, the rain water collected around the plant will help in retaining the moisture for the plant. Naturally growing species which have been adopted at the time of site development should also be included in Thanwala making and weeding / hoeing operations. After the rains are over, capillary actions begin in the pits. This causes loss of moisture due to evaporation in the hot sun. To check this, weeding should be done in and around the pits. During this operation, grasses and weeds should be removed and the earth clumps should not be broken. Second weeding should be done in September end. Third weeding should be done soon after the winter rains.

13- MAINTENANCE AND AFTER CARE

A Chowkidar must be deputed for five years in the plantation area to look after it soon after the planting work is over. Following duties should be assigned to him:

- Periodical weeding and removal of grasses suppressing the plants,
- Maintenance and repair of inspection paths,
- Repair of boundary wall or fencing where ever necessary,
- To protect the plantation area from grazing and damage by wild animals and villagers cutting grass,
- To protect the area from fire, cleaning of dry grass and twigs, etc. from the area and cleaning of inspection paths,
- Cleaning of the outer periphery of the plantation area in two meter width,

- ❖ Keeping regular watch over the plantation area during the fire season and
- ❖ Seeking help and co-operation of the villagers in the protection of the plantation area.

14- MAINTENANCE IN SUBSEQUENT YEARS

Second year

Beating up works should be carried out in the second year. In this operation the dead plants are replaced by planting fresh saplings immediately at the onset of monsoon rains. Under normal conditions not more than twenty per cent plants are required to be planted during the beating up operation in the second year. The reasons for mortality should be ascertained. The dead plants should be replaced by the species which are growing successfully. At least one weeding should be done and *thanwalas* be made. Protection wall or fencing should be repaired wherever necessary.

Third, Fourth and Fifth year

Normally no beatings up operations are carried out during these years but full attention is given to protect the area from grazing and fire. However, soil working and weeding around the plants during the rainy season promoted the growth of seedlings. Therefore, provision of sufficient funds should be made for this purpose too.

15- CAUSES OF FAILURES OF PLANTATIONS

Following are the main causes of failure of plantation works:

- ❖ Wrong selection of species such as planting of deodars at low altitudes,
- ❖ Planting of weak and damaged saplings,
- ❖ Untimely planting of saplings,
- ❖ Carelessness in cartage of plants. The bagged plants need very careful handling during loading/unloading. If, cartage is done by head load they should be carried in trays or baskets to avoid damage,

- ❖ Lack of supervision at the time of growing plants in the nursery and while planting in the plantation area,
- ❖ When proper shifting, grading and root cutting of plants is not done in the nursery as prescribed, before taking plants to the planting site and
- ❖ Proper attention is not paid in planting, weeding and other works.

In addition to the above, grazing, frost, lack of desired rainfall or excessive rain and fire are other adverse factors causing failure.

16- PLANTING OF GRASSES AND SHRUBS

Since vegetation of any particular area is always adapted to the local conditions of that place, therefore the varieties of grasses belonging to that place are different. According to the vegetative conditions, Himalayan forests can be divided into three categories.

- Humid temperate forests
- Dry temperate forests
- Alpine forests

As evident from the names of these forests that cold places having sufficient moisture are called 'Humid temperate forest'; forests where the moisture is comparatively low and climate is dry and cold are called 'Dry temperate forests' and the snow covered areas are called 'Alpine forests'. Similarly the grasses found in these three areas are also different.

Shrubs

Shrubs are important not only for men but for forests also. The forest composed of trees, shrubs and grasses is in fact a true forest. The middle portion is left which can accommodate plants of intermediate height. Shrubs are most suitable to fill up this gap. Thus shrubs can significantly contribute to the productivity of a forest area. Shrubs are generally considered as a nuisance when managing any piece of forest land. There are few shrubs which are weeds and cause problems in the area e.g. Lantana, Kalabansa, Sulla etc.

However, large number of useful shrubs are also found in hills of Uttarakhand which are closely associated with the culture of the region. At present per annum demand of forest products is 3.6 lakh cumt. in hills. This demand is likely to increase in near future. This enormous demand can only be met out if efforts are made to enhance the productivity of land. Shrubs may be one of the important tools in this regard. Shrubs may be advantageous in the following respects:

- They produce a variety of fruits, medicines, minor forest products like fibre, gum, lac and also provide fodder and fuel,
- Shrubs can be well adapted to the adverse climatic conditions and a variety of soils,
- Shrubs are suitable for soil conservation as their roots penetrate the soil densely.
- It helps similarly as iron rods in reinforced cement concrete,
- Being small, they can be pruned and easily managed,
- Being compact in size, these are resistant to high wind velocity,
- They can even be grown in areas having poor soil and dry conditions,
- They can be used for bio– fencing and
- Some shrubs are good for nitrogen fixing thus increase soil fertility.

17- MAINTENANCE OF FIRE LINES

Forest fires are a common feature in Uttarakhand, especially between 1,000 to 1,800 m in fire adapted chir-pine forests. As per the National Remote Sensing Agency (NRSA), Hyderabad report, in one of the greatest forest fires in the region in 1999, around 22.64 per cent forest area was affected by the fires and 1,225 km2 forest area got severely burnt. The extent of fire was more in the dense forests than in open forest area and the former suffered greater damage due to these fires. Almost all fires are man-caused (intentional or accidental). The total damage from forest fires is very large. Small trees and regeneration

are often killed; severe fire can kill the large trees also. Protection of forests against fires is one of the important operations in forestry. Fire lines of sufficient width are cleared of vegetation and maintained all around the forests and run criss-cross inside the forest so that a compact block or area is separated from other area. The width of these fire lines depends on many factors such as, type of forests, density, terrain, wind speed in the area etc. Such fire lines are usually cleared before the start of the fire season in order to avoid the spread of fires from one area to another. This activity can be taken by the Van Panchayats and in other areas as well where damage by forest fires is common.

CHAPTER- 4

COST TABLE

I- Cost for Advance Soil Work in the First Year

S. No.	Item	Unit	Fodder Plantation 400 Plant/ha	Afforestation 1000 Plant/ha	Fuel wood Plantation 1600 Plant/ha.	Remarks
1	Survey & Demarcation	Ha	49	49	49	Per ha.
2	Site Clearance	Ha	1628	1628	1628	Per ha.
3	Stone walling/fencing	Ha	8626.5	8626.5	8626.5	150 Rmt/Ha
4	Pit digging along alignment (30X30X45 cm)	No.	1386	3465	5544	Per pit
5	Alignment of contour Trenches size 30X20 cm and Khanti size 3.00x.50x.50 Mtrs	Rmt.	160	160	160	400 st/Ha.
6	i) Digging of contour (Khanti) 3.00x.50x.50 Mtrs	Rmt.	2020	-	-	101/ 20 RMT
	ii) Digging of contour Trenches size 30X20 cm	Rmt.	-	1010	1010	50.50/ 20 RMT
7	Cost of DAP 25 GM/pit	Kg.	120	300	480	as per pit digging
8	Cost of DAP for Contour (Khanti) (15 GM/Rmt)	Kg.	72	-	-	10 kg
	Cost of DAP for Trenches contour (25 GM/Rmt)	Kg.	-	120	120	10 kg
9	Cost of Urea for broadcasting 50 kg/ha/time	Ha.	900	-	-	3 times
10	Cost of Plant	No.	1096	2740	4384	-
11	Cost of raising grass	No.	1096	1096	1096	4000 Tufts
	Total		**17153.5**	**19194.5**	**23097.5**	
			17100	**19100**	**23000**	

II. Cost for Planting Work in the Second Year

(in Rs.)

S. No.	Item	Unit	Unit Cost	Fodder Plantation 400 Plant/ha.	Afforestation 1000 Plant/ha.	Fuelwood Plantation 1600 Plant/ha.	Remark
1	2	3	4	5	6	7	8
1	Pit filling with applying DAP	No.	61.50/100 pit	246	615	984	-
2	Transportation of plants	No.	1.65/plant	660	1650	2640	as per schedule
3	Planting	No.	120.50/100plant	482	1205	1928	-
4	Transportation of grass	No.	1.92/100slips/ 25 Tufts	1229	1229	1229	16000 slips 4 km.distance
5	(i) Sowing of seed on trenches(Khanti) including dressing cost of seed & applying furtilizar	Rmt.	L.S	335	335	335	400 mtr/ha
6	Applying Urea on plants including cost of urea	No.	22/100plant	88	220	352	400 mtr/ha
7	Weeding & mulching & applying fertilizar	No.	71.00/100plant	284	710	1136	as per planting
8	Cost of plant	No.	0.68/plant	272	680	1088	as per planting
9	Cost of raising grass	No.	11/tufts	440	440	440	4000 tufts
10	Planting of grass slips/grass on contour trenches (khanti)	No.	26/100tufts	1040	1040	1040	16000 slips or 4000 tufts
11	Watcher	Ha.	260/Ha./Month	1820	1820	1820	7 months
12	Applying Urea over whole area	Ha.	50.50/Ha./time	151	-	-	3 times
13	Applying Urea on contour trenches (khanti)	Rmt.	10.00/20Mtrs	200	-	-	400 mtr/ha.
14	Side clearance (Lentana,Gajer Ghash / Kala Bansa)	ha.	820/Ha.	820	820	820	1 ha.
15	Digging of grass in the Nursery cutting at 20cm.height	No.	3.70/100slips	592	592	592	16000 slips
	Total			**8659**	**11356**	**14404**	
			Or Say	**8650**	**11350**	**14400**	

C. Cost of 10% Beating up

(i) Third Year

S. No.	Item	Unit	Unit Cost	Fodder Plantation 400 Plant/ha	Afforestation 1000 Plant/ha	Fuelwood Plantation 1600 Plant/ha	Remark
1	Cost of Plants	No.	3.42/plant	136.8	342	547.2	-
2	Re-digging of pit & Planting	No.	204/100pit	81.6	204	326.4	-
3	Fertilizer in pits	No.	22/100pit	8.8	22	35.2	-
4	Fertilizer in pits Manure in pits (cost & cartage)	No.	60/100pit	24	60	96	-
5	Winter Mulching	No.	71/100plant	28.4	71	113.6	-
6	Watcher	Ha.	260/ha/Month	3120	3120	3120	For 12 Months
Total				**3399.6**	**3819**	**4238.4**	
Or Say				**3400**	**3800**	**4040**	

(ii) Fourth Year

S. No.	Item	Unit	Unit Cost	Fodder Plantation 400 Plant/ha	Afforestation 1000 Plant/ha	Fuelwood Plantation 1600 Plant/ha	Remark
1	Watcher	Ha.	260	3120	3120	3120	For 12 Months
	Total		**260**	**3120**	**3120**	**3120**	

(iii) Fifth Year

S. No.	Item	Unit	Unit Cost	Fodder Plantation 400 Plant/ha	Afforestation 1000 Plant/ha	Fuelwood Plantation 1600 Plant/ha	Remark
1	Watcher	Ha.	260	3120	3120	3120	For 12 Months
	Total		**260**	**3120**	**3120**	**3120**	

(iv) Abstract of costs for Forestry Works

S. No.	Year	Fodder Plantation 400 Plant/ha	Afforestation 1000 Plant/ha	Fuelwood Plantation 1600 Plant/ha
1	Ist year	17100	19100	23000
2	IInd year	8650	11350	14400
3	IIIrd year	3400	3800	4240
4	IVth year	3120	3120	3120
5	Vth year	3120	3120	3120
	Total	**35390**	**40490**	**47880**