FOREST WORKS MANUAL
AND
SCHEDULE OF RATES FOR FORESTRY RELATED WORKS IN UTTARAKHAND

Under

THE MAHATAMA GANDHI NATIONAL RURAL EMPLOYMENT GUARANTEE ACT

सत्यमेव जयते

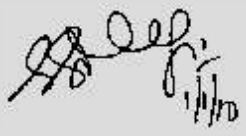
MINISTRY OF RURAL DEVELOPMENT
(Government of India)

Foreword

The National Rural Employment Guarantee Act (NREGA), 2005 was enacted by the Ministry of Rural Development, Govt. of India, New Delhi to guarantee 100 days of employment in a financial year to any rural household whose adult members are willing to do unskilled manual work. The basic objective of the Act is to enhance livelihood security in rural areas. Uttarakhand is predominantly rural with about 74 per cent of its population living in the rural settlements. The Government of Uttarakhand in 2006 has issued the guidelines for Uttarakhand State Employment Guarantee Scheme as per the provisions of NREGA keeping in view Operational Guidelines issued by the Ministry of Rural Development, Govt. of India.

Large scale urbanization and industrialization in the Himalayas have led to the expansion of severely eroded, barren and denuded areas in many parts of Uttarakhand. The activities like planting of multiple tree species on village common land, degraded areas and various soil and water conservation activities based on watershed approach can be implemented through NREGA in Uttarakhand. The convergence under NREGA will provide employment to the poor rural people under many activities with help of line departments of the state. NREGA has also accorded priority to the activities pertaining to the conservation of water and water harvesting through construction of check dams and other structures which have immense potential in a hilly state like Uttarakhand. It will not only help in raising the economic status of the local people but would go a long way in increasing the tree cover, recharging of aquifers, conserving soil as well as reducing the impact of the green house gases for which the whole mankind is worried palpably. The manual on forestry related activities for Uttarakhand prepared by the Forest Research Institute, Dehradun with the support of Ministry of Rural Development, Govt. of India, New Delhi will be a useful tool for carrying out various forestry related activities of the State. The Schedule of Rates (SoR) for carrying out these activities has also been worked out. As the topographical situation of the state varies from tropical, sub-tropical, temperate and sub-alpine to alpine, the schedule of rates therefore, differs for different zones.

I congratulate the team of the Silviculture Division of Forest Research Institute for this effort.



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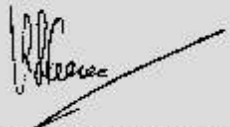
Preface

The primary objective of National Rural Employment Guarantee Act (NREGA), 2005 which was enacted by the Ministry of Rural Development, Govt. of India, is to provide wage employment guarantee for 100 days of rural masses. Its auxiliary objective is to maintain sustainable development in the hilly regions of India. NREGA is also encouraging the work which gives sustainable livelihood in Uttarakhand state. Ministry of Rural Development, Govt. of India, New Delhi and UNDP have assigned the task to Forest Research Institute, Dehradun for the preparation of work manual on forestry related activities in Uttarakhand State. To accomplish the task a series of meetings and workshops were conducted to consider the views of all those associated with the forest and welfare of rural masses. The preparation of this manual was a team work in which many experts from different disciplines have contributed. The Joint Secretary, NREGA and other officers of Ministry of Rural Development, Govt. of India, New Delhi; Officers from Forest Department, Uttarakhand; Officers, Department of Rural Development, Uttarakhand have also been consulted and their views were also accommodated in the manual.

The manual comprises of 7 chapters on different aspects of NREGA. Chapter First outlines the brief description about Uttarakhand State, Chapter second highlights the NREGA features and permissible works under NREGA, Chapters 3rd, 4th and 5th describe the techniques of raising plants in the nursery, plantations and their management, soil and water conservation activities which can be taken up under NREGA in Uttarakhand. Sketches and cross sections have also been given wherever desired to make the things clear. Chapter 6th describes the brief outlines of convergence of other activities that can be taken up under NREGA. The activities will also include preparation of micro-plans of villages in the pilot districts of Uttarakhand. The works will be carried out considering the micro-plans. The convergence of NREGA will be based on activities of multi-departments for sustainable development of the hill people. The last chapter 7th deals with the Schedule of Rates (SoR) for carrying out these works. The SoR have been worked out separately for different categories of work such as raising of seedlings in a nursery, plantation in the field and soil and water conservation measures. Hope, the manual will serve its purpose to the satisfaction of all those involved in implementing NREGA in its true spirit. Suggestions, if any are welcomed. This would help in improving and updating the manual for use in the years to come.



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Executive Summary

Forests are among the most important support systems of our life. Our food security and water security is embedded within it. Their importance is even higher for a State like Uttarakhand which has 64.79 % of its land area under forests. The State is bound with a number of pious rivers, which are originated from the mighty Himalayas and providing water to the millions of people of the country. However, due to increasing pressure of the population and unsustainable harvesting, these resources are being depleting day by day. It is a great challenge to stop further degradation of these resources, which are essential for the very existence of the mankind. 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 agriculture development in hills. A large number of people migrate to other states in search of jobs. Under these circumstances, the National Rural Employment Guarantee Act provides an ideal opportunity of providing a minimum of 100 days wage employment in a financial year to every household, whose adult member is volunteer to do unskilled manual work. Another important feature of NREGA is that it has assigned important attention to the forestry based activities to generate wage employment viz., water conservation, water harvesting and drought proofing including afforestation and tree plantation. Both of these are labour intensive activities and serve the noble purpose of providing the employment opportunity to the people at their doorstep as well as augmenting the natural beauty of 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 can be taken up for employment generation under the NREGA by the village people or other grassroots level implementing agencies. The manual consists of seven chapters. The First one gives a brief profile of climate, people inhabiting and other physical features. In the Second chapter, the salient features of NREGA, 2005 have been mentioned to benefit its end users. The Third chapter deals with the Nursery Technology, i.e. how seedlings of the forest trees can be raised by the people under this scheme. 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. Simple sketches and photographs have also been provided to make the whole process clear and easily understandable.

The detailed process of raising a plantation has been explained in Fourth 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 protective armour 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 various

methods of soil and water conservation, which can be taken up under NREGA have been described in Fifth chapter. This includes gully plugging, brushwood check dams, stone check dams, crate wire check dams, diversion drains, bench terracing, contour trenching, stream bank protection and stabilization of land slipped slopes. Sketches and cross sections are also given to make things clear. The Sixth chapter deals with the convergence of others activities with NREGA. The activities are defined under micro-plans of the villages situated in the pilot districts of Uttarakhand. The activities would provide employment opportunities to the villagers through involvement of various organizations on sustainable basis.

The last/Seventh 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.

The Ministry of Rural Development, Govt. of India, New Delhi and UNDP has assigned task to Forest Research Institute, Dehradun for preparation of works manual on forestry related activities in Uttarakhand state. The manual is prepared after a series of Meetings and Workshops. The preparation of this manual was a team work in which many experts from different disciplines have contributed. The Joint Secretary, NREGA, Ministry of Rural Development, New Delhi, the officers from Forest Department, Uttarakhand and the Secretary, Ministry of Rural Development, Uttarakhand have been consulted and their comments were incorporated in the manual. Forestry related activities mentioned in the manual that can be taken up under NREGS programme to enable in the choice of execution of forestry works at all levels; District, Block, Gram Panchayat and Gram Sabha in Uttarakhand State. The Divisional Forest Officers of respective forest divisions should be declared as the Nodal/Programme Officers under the scheme. All the activities under different headings are described in simple language. Forestry operations, being labour intensive, can prove to be good employment under NREGA for people, right at their doorsteps and thus also add to tree cover and soil and water conservation measures.

INTRODUCTION

Trees are one of the most prominent constituents of our ecosystem because of their conspicuous size and shape. Trees are important to the mankind not only economically, environmentally, industrially but also spiritually, historically and aesthetically as they sustain human life by providing a large number of goods such as food, fodder, fuel and services like soil and water conservation, pollution control, climate regulation, recreation aesthetic functions etc. Trees improve the quality of air we breathe and play a vital role in maintaining the oxygen cycle, which is essential for the survival of all living being. When properly grown, they act as barriers against sun, wind, dust, noise and other pollutants. Even individual tree, if strategically planted adjacent a house, can provide relief from dust, noise and annoying lights at night. Trees thus reduce stress on human beings (Seth, 2004) They help to reduce temperature by providing shade and by intercepting, absorbing and reflecting solar radiation, specially in warmer places, where there is year round warmth and sunshine (Schubert, 1979). Trees also function as natural air conditioners by evaporating water from their leaves through the process of transpiration.

Large scale urbanization and industrialization in the Himalayas have led to the development of severely eroded, barren and denuded areas in many parts of the state. Afforestation under NREGA thus has immense potential to bring not only greenery to the Himalayas and other urban and rural regions of the state but also stability to the environment by restoring the ecological balance. There is an immense scope of undertaking plantation works on community and panchayat lands, van panchayat areas, civil and soyam areas, road side plantation along national and state highways and other village roads under NREGA. Trees intercept rains and help in the percolation of water thus play an important role in the recharging of the natural aquifers. NREGA has also accorded priority to activities pertaining to the conservation of water and harvesting such as construction of check dams and other structures which have immense potential in a hilly state like Uttarakhand. It will not only help in raising the economic status of the local people but would go a long way in increasing the tree cover, recharging of aquifers, conserving soil as well as reducing the impact of the green house gases for which the whole mankind is worried palpably.

1.1 Uttarakhand: A Brief Profile

The Uttarakhand is comparatively a new state, which came into existence on 9th Nov, 2000 as the 27th state of the Republic of India. It was carved out from the larger state Uttar Pradesh 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. It lies between 28^{0}53'24" and 31^{0}27'50"N latitudes and between 77^{0}34'27" and 81^{0}02'22" longitudes. 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 (Fig. 1.1). Blessed with the enchanting beauty of nature 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 amsl.

1.2 GEOLOGY

Uttarakhand Himalayas have wide range of intra regional variations in respect of topography, geology and texture of soil. The region is characterized by mountains broken by valleys and deep gorges. It consists of faulted and folded mainly sedimentary rocks. 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.

Fig. 1.1: Political map of Uttarakhand (not to the scale)

The highest peak is Nanda Devi (7,817m) in the Chamoli district. The other important peaks include Gauri Parvat, Kamet, Trishul, Chaukhamba, Dunagiri, Panchchuli and Nanda Kot. Gaumukh, Pindari and Milam are the major glaciers in the State. Starting from the foothills in the South it extends to snow clad mountains in the North. Nature has endowed this land with so much beauty and spiritual bliss that it is also known as “Dev Bhoomi” – the Abode of God. The important features of the state are mentioned in Table 1.1.

Table 1.1: Uttarakhand: A brief Profile

Sl. No.	Parameter	Census Year	
		1991	2001
1.	Geographical Area (Km^2)	-	53,484
2.	Population	70,50,634	84,79,562
3.	Population Density	133	159
4.	Male Population	36,40,904	43,16,401
5.	Female Population	34,09,739	41,63,161
6.	Sex Ratio	936	964
7.	Rural Population	54,16,550	63,09,317
8.	Urban Population	16,34,084	21,70,245
9.	Rural Male Population	27,38,148	31,43,380
10.	Rural Female Population	26,78,402	31,65,937
11.	Urban Male Population	9,02,756	11,73,021
12.	Urban Female Population	7,31,337	9,97,224
13.	Scheduled Caste Population	12,32,316	12,32,316
14.	Percentage of SC Population	17.48	14.5
15.	Scheduled Tribe Population	2,11,864	2,11,864
16.	Percentage of ST Population	3.1	2.5
17.	Literacy Rate (%)		
a)	Total	48.4	72.3
b)	Male	60.9	84
c)	Female	35.7	60.3
18.	Literacy Rate of 0-6 year age group		
a)	Total	-	64.6
b)	Male	-	52.6
c)	Female	-	
19.	No. of Districts	8	13
20.	No. of Tehsils	43 (1998)	49
21.	No. of Urban Centers	68	84
22.	No. of Villages (Inhabited)	*	15,651
23.	Uninhabited Villages	-	955
24.	Total Villages	-	16,606

(Source: Census, 2001)* Data not available

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. The State has two administrative divisions, viz. Garhwal and Kumaun, comprising of 13 districts with its capital located at Dehradun. Area wise, Uttarakashi is the biggest district of the State, followed by Almora and Pithoragarh (Table 1.2), while Champawat is the smallest district. The population density is 154 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 Champawat. The sex ratio ranges from the lowest of 868 females per 1000 males in Haridwar to 1,147 in Almora.

Uttarakhand is predominantly rural with about 74 % of its population living in 15,667 rural settlements. Of the total villages, more than four-fifths are small villages with population less than 500 persons. Another 10 per cent have population between 500 to 1,000 persons and the remaining 6 per cent villages are with over 1,000 persons. Small-sized scattered villages without road connectivity pose a major challenge to the development process. Hill districts are at a disadvantage compared with districts in the plain areas. A brief account of district wise details of area, number of tehsils, blocks and population are mentioned in Table 1.2.

Table 1.2: District wise details of number of villages and population in Uttarakhand

District	Geographical Area (km^2)	Tehsils	Village Inhabited	Blocks	Population	Males	Females
Almora	3139	-	2159	11	6,30,446	293576	336870
Bageshwar	2246	2	865	3	2,49,453	118202	131251
Chamoli	8030	6	1144	8	3,69,198	183033	186165
Champawat	1766	1	651	4	2,24,461	110916	113545
Dehradun	3088	4	746	6	2,79,083	675549	603534
Haridwar	2360	6	503	6	14,44,213	773173	671040
Nainital	4251	4	1095	8	7,62,912	400336	362576
Pauri Garhwal	5329	6	3137	15	6,96,851	331138	365713
Pithoragarh	7090	8	1568	8	4,62,149	227592	234557
Rudraprayag	1984	2	660	3	2,27,461	107425	120035
Tehri Garhwal	3642	5	1791	10	6,04,608	294842	309766
Udhamsingh Nagar	2542	4	671	7	12,34,548	649020	585528
Uttarkashi	8016	4	677	6	2,94,179	151599	142580
Total	53,483	52	15667	95	84,79,562	4316401	4163161

The Himalayas greatly influence the climate of the State. They are the youngest mountain system in the world having the most fragile geo-morphological formations. Rains occur from July to September due to South-West monsoon. In winter months, 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. Climate 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 25^0 C with cool winters. A cold alpine climate is observed at higher elevation where summers are cool and winters are severe. There are mainly three prominent seasons, viz., Winter, Summer and Rainy, while a short period for autumn and spring is noticeable. The State is rich in forest wealth. It has approx. 64.79% of its geographical area under forest with a forest cover of 46% (Table1.3). 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 Tarai. The Greater Himalayas is the highest zone consisting of snowy peaks with an average elevation of 6100 m. These are the source of great northern rivers which flow down to form fertile plain. Some high valleys in the Great Himalayas are occupied by small clustered settlements. Extremely cold winters and a short growing season limit the farmers to practice few crops per year. These mountains have got high passes through which trade was prevalent with Tibet till Indo-China war. The Middle Himalayas have an altitude between 1800 and

3050 m amsl. It consists of high ranges both within and outside of the Great Himalayan range. All 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 4 zones on the basis of altitudinal range and climate (Table 1.4).

Table 1.3: District wise details of the forest area in Uttarakhand

District	Geographical Area (km^2)	Forest Cover (km^2)	Forest Cover (%)
Almora	3139	1557	49.60
Bageshwar	2246	1380	61.44
Chamoli	8030	2698	33.60
Champawat	1766	1622	91.85
Dehradun	3088	1593	51.59
Haridwar	2360	634	26.86
Nainital	4251	3094	72.78
Pauri Garhwal	5329	3271	61.38
Pithoragarh	7090	2077	29.29
Rudraprayag	1984	1120	56.45
Tehri Garhwal	3642	2138	58.70
Udham Singh Nagar	2542	577	22.70
Uttarkashi	8016	3144	39.22
Total	53,483	24905	46.57

(Source: State of Forest Report, 2005)

Table 1.4: Zone wise distribution of districts in Uttarakhand

Sl. No.	Name of the Zone	Altitudinal range	Districts
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)

NATIONAL RURAL EMPLOYMENT GUARANTEE ACT

2.1 SALIENT FEATURES

The National Rural Employment Guarantee Act, 2005 was enacted by Ministry of Rural Development (Govt. of India) to guarantee 100 days of employment in a financial year to any rural household whose adult members are willing to do unskilled manual work. The act came into force initially in 200 districts of the country to be gradually extended to other areas to be notified by the Central Government. The basic objective of the Act is to enhance livelihood security in rural areas by providing atleast 100 days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work. The other objectives that can be served by the Act are:

- Generating productive assets,
- Protecting the environment,
- Empowering rural Women,
- Reducing rural urban immigration and
- Fostering Social Equity.

2.2 WORKS PERMISSIBLE UNDER NREGA

As per the Schedule I of the Act, the focus of the Rural Employment Guarantee Scheme (REGS) shall be on the following works:

i. Water conservation and water harvesting,
ii. Drought proofing, including afforestation and tree plantation,
iii. Irrigation from canals, including micro and minor irrigation works,
iv. Provision of irrigation facility to land owned by households belonging to the SC/ST or to land of the beneficiaries of land reforms or to land of the beneficiaries under the Indira Awas Yojana,
v. Renovation of traditional water bodies, including de-silting of tanks,
vi. Land development,
vii. Flood-control and protection works, including drainage in waterlogged areas.
viii. Rural connectivity to provide all-weather access. The construction of roads may include culverts where ever necessary and within the village area along with drains and
ix. Any other work that may be notified by the Central Government in consultation with the State Government.

The operational guidelines as issued by the Ministry of Rural Development, Govt. of India on the NREGA have made it clear that the above list of permissible works represents the initial thrust

areas. In some circumstances, locations and seasons, it may be difficult to guarantee employment within this initial list of permissible works. In such circumstances, the guidelines provide that the State Government may make use of Section I (ix) of schedule I, whereby new categories of work may be added to the list on the basis of consultations between the State Government and the Central Government. Proposal for new categories of work should be framed by the State Employment Guarantee Council and referred to the Ministry of Rural Development.

The operational guidelines provide that atleast 50 % of the works in terms of cost will be allotted to the Gram Panchayats for execution. This is the statutory minimum and the Programme Officer or the District Programme Coordinator may allot more, if deemed feasible.

As per the operational guidelines the other implementing agencies can be intermediate and the district panchayats, line departments of the government, public sector undertakings of the Central and State Governments, co-operative societies with a majority shareholding by the Central and State Governments and reputed NGOs having a proven track records of performance. The self-help groups may also be considered as possible Implementing Agencies.

The operational guidelines of the Govt. of India provides for setting up of Technical Resource Support Groups at the State and District level to assist in the planning, designing, monitoring, evaluation and quality audit of various initiatives.

The guideline also suggests that, to facilitate technical resource support to the implementing agencies, specially at the district level, the resource institutions be identified by the Government concerned and panel of institutions/agencies for technical resource support may be prepared. The functions of the identified institutions may be as under:

a) Identify effective labour-intensive technologies for water conservation, water harvesting, drought proofing, flood control, all-weather rural connectivity and other works approved under the Act, appropriate for the Sate and various climatic regions of the State,
b) Standardize the estimation procedures and prepare software for estimation,
c) Prepare standard model estimates for works (or elements of works) that are to be executed repeatedly,
d) Simplify and demystify the process of estimate preparation to enable Panchayats and non-technical persons to prepare estimates for small works, assess the labour and material requirements and estimate the cost of completed woks,
e) Prepare manuals that explain the process of estimation and lay out procedures for the use of technical staff,
f) Prepare software/manuals/pamphlets/charts for estimation for use of Panchayats, Vigilance and Monitoring Committee and non-technical persons,
g) Propose quality parameters for various types of works,
h) Prepare 'People's Manuals' for quality checking,
i) Coordinate and train State/District-level Technical Coordination Agencies to bring about uniformity and harmony in estimation, quality parameters, quality-monitoring systems and quality-evaluation systems,
j) Undertake quality appraisals in different District on a sample basis and send reports to the Central Government, the State Government and the District Panchayat concerned,

k) Suggest and devise ways of removing deficiencies in quality and achieving quality up gradation and

l) Any other functions assigned by the Secretary (RD/NREGA) of the State concerned or by the Ministry of Rural Development.

The Government of Uttarakhand vide their order no. 678/UO/XI/2006 dated 27.09.06 has issued the guidelines for Uttarakhand State Employments Guarantee Scheme as per the provisions of NREGA keeping Operational Guidelines issued by the Ministry of Rural Development Govt. of India in mind. Some important features of these guidelines are:

- Under the provisions of Sec. 4(1) of NREGA, 2005 the programmes shall be called Uttarakhand State Rural Employment Guarantee Programme, 2006,
- Principal Secretary / Secretary, Rural Development, Govt. of Uttarakhand shall be the State Coordinator of the programme who will also be the Member secretary of the State Employment Guarantee Council and
- The permissible works under NREGA in the State shall be the same as mentioned in the Operational Guidelines issued by Ministry of Rural Development, Govt. of India, New Delhi.

The following line departments of the State Government shall be mainly responsible for implementation of the permissible works:

i. Rural Development Department,
ii. Soil Conservation Department,
iii. Irrigation Department and Minor Irrigation Department,
iv. Rural Engineering Services Department,
v. Public Works Department,
vi. Watershed Management Department,
vii. Revenue Department,
viii. Forest Department,
ix. Horticulture Department,
x. Panchayati Raj Institutions including Gram Panchayat, Kshetra Panchayat, District Panchayat and
xi. Self Help Groups / NGOs / Cooperative Societies / Undertakings of Central and State Governments etc.

The other important features of the programme include:

- The District Collectors shall be the District Programme Coordinators in the District,
- The State Government has nominated the Block Development Officers as Programme Officers at the Block Level for implementation of NREGP,
- 50% of the works in terms of their costs under the scheme is to be implemented through Gram Panchayats,
- Self Help Groups constituted under SGSY can also be the implementing agency,
- Selection of implementing agency shall be made on the basis of their technical know how, available infrastructure, their ability to complete the works within stipulated time frame, their general reputation in implementation of Departmental works and benefit to beneficiaries,

- The Divisional Commissioner shall prepare a Works Manual for the technical sanction of the works under NREGP which shall lay down the technical specifications of various works,
- The Works Manual shall lay down the model designs, measurement quantities and costing of each work. For the items of works for which schedule of rates is not available in the works manual, the current rates and technical specifications of PWD, Irrigation, Implementing Departments shall be applicable and
- At all the levels the labour component shall not be less than 60% and the material component shall not be more than 40% of the project cost.

Forest Panchayat being an important body in majority of Gram Panchayats in Uttarakhand, the State Government has included this institutions in the list of Implementing Agencies vide Govt. order no. 279/8(3)NREGA/ 2006 dated 7.12.2007 for forestry, pasture development and water conservation works to be implemented under National Rural Employment Guarantee Scheme of the State Government.

In Phase I only three districts, namely Tehri, Chamoli and Champawat were taken up under NREGA where the scheme started from Feb. 02, 2006. The Udham Singh Nagar and Haridwar districts were included in Phase II where works under NREGA started in 2007-08 and the remaining 8 districts viz, Uttarkashi, Rudraprayag, Pauri Garhwal, Dehradun, Pithoragarh, Almora, Bageshwar and Nainital are being taken up in Phase III which is started from 1.04.2008.

NURSERY TECHNOLOGY

Seedlings are the basic pre-requisite of an afforestation programme. The success of plantations depends primarily on the quality of seedlings. A nursery can be defined as the site or place where quality seedlings are produced. Nurseries can be permanent (also known as central or main nursery), or temporary (also known as site nursery, field nursery, or flying nursery), depending upon the duration of the plantation programme. In a continuing programme that is likely to go on for more than five years, it is desirable to have atleast a few permanent nurseries with proper infrastructure. However, in case of afforestation project lasting five years or less, temporary or semi-permanent nurseries can be established in which the cost can be reduced by dispensing with some of the infrastructure elements such as construction of permanent structures for green houses, store and other nursery sheds, fencing with angle iron posts and irrigation facilities. The establishment of a nursery and raising of quality seedlings is a technical process. It has been described systematically in the following steps:

3.1 SELECTION OF SITE

It is one of the most important aspects for the establishment of a proper and quality nursery. One has to consider not only the physical aspects for the selection of the site but also the end use of the seedlings. Following points may be kept in mind while selecting a site for the nursery.

3.1.1 Location

The site should be centrally located with easy access for transportation of seedlings. It should be close to the area where seedlings are to be utilized. The site should be as square as possible. Sites used earlier for agriculture may be avoided and preference be given to former forest sites where weed problems will be less and beneficial mycorrhizae forming fungi are often endemic.

3.1.2 Water

Enough water should be available especially during the dry season. A natural source of water, at a higher level, will be cheaper, as it can be tapped by gravity. If no natural source of water is available, ground water may be used. It is estimated that the water requirement for a semi-arid area is minimum of 2,000 lit per day during summer, for every 1,00,000 seedlings. Requirement of water will be somewhat less for moist or cold areas.

3.1.3 Topography and drainage

The area should be almost flat with good drainage. This can be managed by providing gentle slope (5 degrees) and channels should be dug 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.

3.1.4 Soil

The ideal forest nursery should have sandy loam to loamy texture. Sandy soils may be given preference over heavy soils. Soil should have pH 5.5 to 7.5, moderate fertility, with a minimum of 2.5% organic matter. The higher the organic matter content of the nursery soil, the better it is. A high organic matter content 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; therefore, location of nursery should be close to such areas.

3.2 LAYOUT OF NURSERY

3.2.1 Size and shape

As far as possible the nursery should be of a rectangular shape; so that it can be divided into smaller nursery beds of rectangular shape, leaving space for roads, inspection paths, dumping of manure, hut for Mali and space for people working in the nursery to rest during rain or intervals. In bigger nursery (one ha and above), a road of a minimum width of 3 m should be constructed to facilitate transport of sand and manure inside the nursery and to carry the plants from the nursery, leaving space for turning of the vehicle.

The requirement of the total area for the nursery can be calculated by adding together the area required for mother beds, polypots, 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.

Polypots of size 18 x 5.5 cm need 1 m^2 for keeping 772 bags and slightly larger bags 18 x 7.5 cm need 1 m^2 for keeping 400 polypots. Accordingly 1,00,000 polypots will require 250 m^2 area plus 40% for paths. Thus for raising 1,00,000 polypot seedlings, an area of 350 m^2 may be sufficient.

3.3 ESTABLISHMENT OF NURSERY

3.3.1 Site preparation

The site should be cleared properly by removing all stumps, roots, lops and tops. Stones collected from the site may be used for metalling the main nursery road. Thorough ploughing or 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 levelled 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 should be dug as early as possible to avoid soil erosion. Drains should be dug on both sides of the paths and connected to main drain. In plains, drain should be adequately sloped and steps should be used in hills to check the flow of water.

3.3.2 Types and size of beds

Beds are prepared to germinate seeds, keep polypots and transplant pricked out seedlings. In the plains, beds of 10 x 1 m size and in the hills beds of 2 x 1 m are generally 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 in East-West direction in the plains and should 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 prepared in the nursery.

3.3.3 Sunken beds

These are 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.

3.3.4 Raised beds

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

3.3.5 Preparation of seedbeds

The plot where seedbeds are to be prepared must be ploughed and 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. If necessary, sand and soil (1:1) may be mixed so that the seedlings can break through when germinate, and this will also be helpful when plants are lifted for pricking out (Plate-1). The seed beds should not be filled in completely, so as to avoid the washing away of top soil and seed. The surface of the seedbed should be made firm by sprinkling water and then using a wooden plank. These 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 that died,
- for sowing seeds which germinate slowly or unevenly, like teak and
- for the seeds whose quality is not known.

Plate - 1

Nursery seedlings raisings methods

Sand

Soil

Farm yard manure

Seed bed

Sunken bed

Line Sowing

Filling of polythene bags

Plastic cane used for watering

Transplanting of seedlings

Plate - 2

Components of forest Nursery

Poly house

Seedlings from cuttings

Poplar seedlings from cuttings

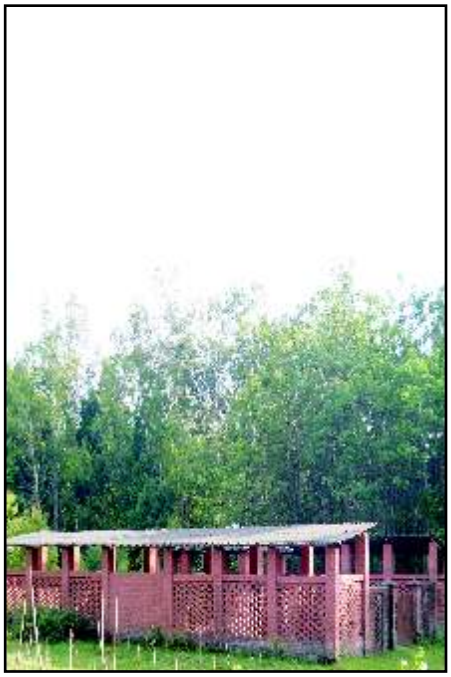
Seedlings grown in polybags

Temporary green house

Trolley for transportation

Barbed wire fencing

Stand for seedlings transportation



Composting unit

3.4 SEED COLLECTION AND STORAGE

3.4.1 Whether to buy or to collect seeds

Seeds can be purchased from reputed nurseries or collected from known stands of trees. Seed collection is considered as the best approach since the quality and provenance of seeds are known (Plate-3). Seed sellers may, of course, also offer good quality seeds and sometimes even better than what one has at hand in the local stands of trees. Moreover, all required species may not be available locally. In any case, it is better to divide seeds into two categories: those that are used in the main afforestation programme and are locally available and those which are raised for distribution to the general public and usually not available locally. The former should be collected from healthy middle-aged trees of good quality and the latter 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. 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 unripe 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 cones of trees like pine or other coniferous trees 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 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 of good ventilation and free from moisture to safeguard them from decaying or losing viability.

3.4.2 Estimating seed quantities

It is necessary to compute the required quantities. Factors like germination percentage, number of plants to be raised and amount of wastage involved, all affect quantity of seeds. It is convenient to have a seed weight chart depicting 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 in Table 3.1.

3.5 PRE-SOWING TREATMENT OF SEEDS

Seeds contain tiny, fragile plants that live under the hard seed shell. They 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 facilitate germination, therefore, all plants will be of the same size and will be ready for out planting at the same time. Following methods can be used for the treatment of different seeds to enhance their germination:

3.5.1 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 2 minutes, pour off the water and replace it with the cold water. Let the seed soaked in cold water for 2 to 3 days or until the seed swells. Seeds are sown immediately after the treatment.

3.5.2 Hot water treatment

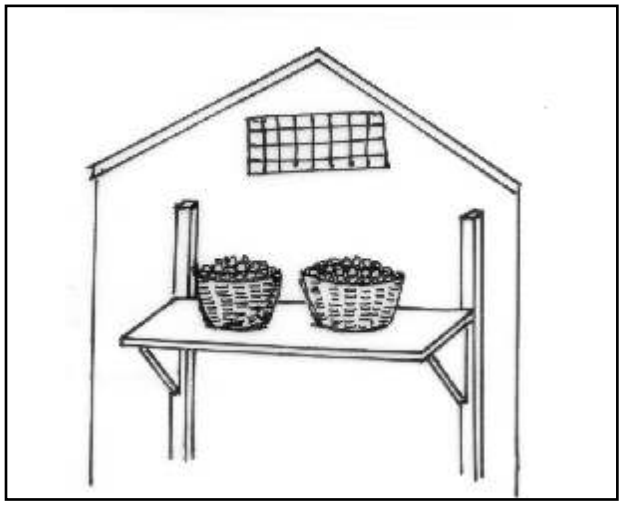
This method is generally used for the species which have a hard shell e.g. *Albizia, Cassia, Callindra, Leucaena, Sesbania, Samanea* etc. Sufficient quantity of water is boiled in a container. Once it is boiled, water is taken off the fire and allowed to cool for about 10 minutes. After that, the seeds 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 everyday and seeds are sown immediately after the treatment.

3.5.3 Cold water treatment

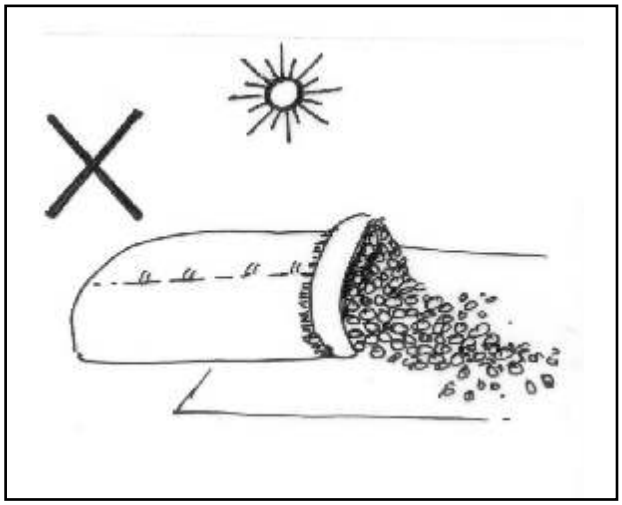
Some seeds need lots of water to facilitate germination. Others may have chemicals inside the seed which must be removed before the seed can germinate. Examples are *Citrus*, *Gliricidia*, Neem and *Pinus*. Seeds are kept in sufficient water for 1 to 2 days. Water can be changed after every 12 hours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

Plate-3

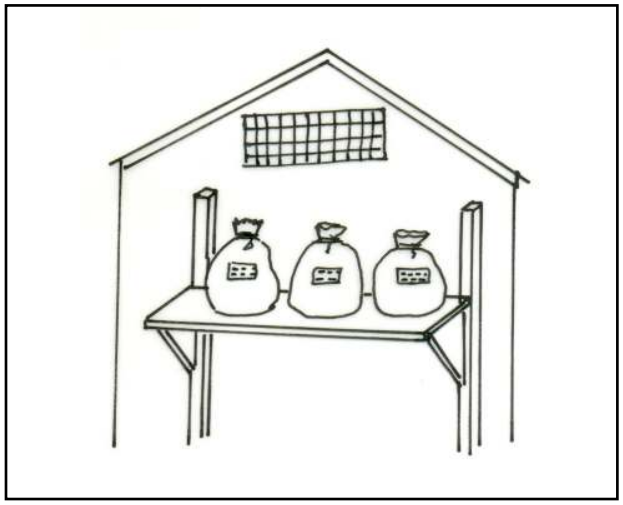
Precautions required during seed collection and storage



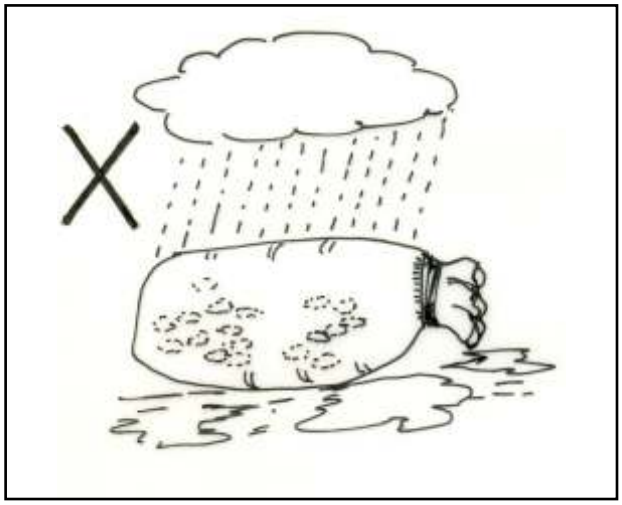
Seeds must be stored in a dry cool place. Store large and soft seeds in open baskets



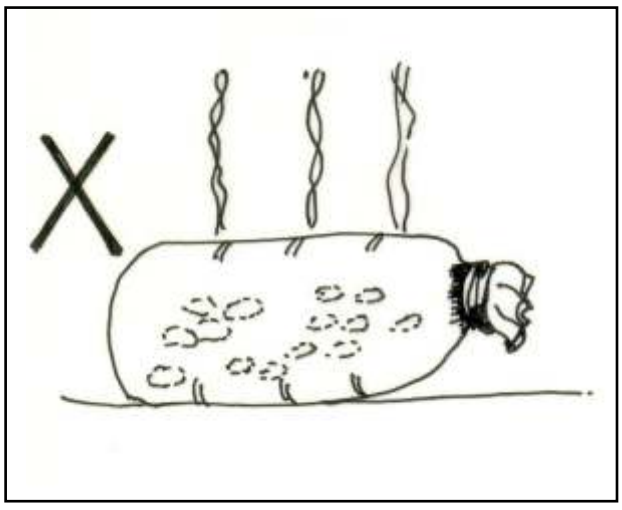
Do not place the freshly collected seeds in the sun. They may get killed due to excessive heat



Hard shelled seeds e.g. subabul, teak, pine, *eucalyptus, 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 root and die.



Do not put soft seeds like neem in a large gunny bag. It may generate much heat to kill the seeds.

Table 3.1: Seed weight, collection time, viability and pre-sowing treatment of some common species

Local Name	Seed collection Time	Number of seeds/kg.	Viability (Months)	Pre-sowing treatment
Akhrot	Sep-Oct	75	6	Keep in refrigerator for one month and sow
Amaltas	Mar-April	6000	Many years	Soak in hot water for one hour
Amla (gutli)	Nov-Mar	900	1-6	None
Angu	Oct-Dec	7400	2	None
Ardu	Feb-March	9600	3-4	None
Arjun	Mar-Apr	775	6-12	Soak in water for 48 hours
Bahera	Nov-Feb	425	12	Alternate soaking and drying 5-6 times
Bakain	Jan-Feb	800	12	Soak in water for 24 hours
Ban oak	Nov-Jan	600	13	None
Bel	May	5300	1-6	None
Bhimal	Dec-Feb	12000	12	Soak in hot water for one hour
Bhojpatra	Aug-Oct	150000	6	Keep in refrigerator for one month and sow
Cheura	Jun-Jul	1000	<1	Sow immediately after collection
Chir	Dec-Mar	9000	24	Soak in water for 24 hours
Deodar	Oct-Nov	7000	1-6	Store without drying and sow in March
Eucalyptus	Sept-Oct	360000	24	None
Fir	Sep-Nov	27000	3	None
Gulmohar	Jan-Mar	2500	Very long	None
Gutel	Jul-Dec	6800		None
Haldu	Jan-Mar	110000	12	None
Harad	Jan-Mar	150-250	12	Break seed coat and sow
Jamun	Jun-Aug	1200	1 week	None
Kachnar	May-June	2500	12	None
Kadam	Jan-Aug	1600000	12	Fungus treatment before sowing
Kail	Sep-Nov	20000	12	Soak in water for 24 hours
Kanji	Mar-May	800-1500	3-6	Soak in water for 24 hours
Kanju	Apr-May	27000	6	None
Khair	Oct-Nov	40000	6-12	Soak in cold water
Kharik	Feb-Mar	4600	12	Boiling water or hot water
Kharsu oak	Jun-July	400	1	None
Kwiral	Jan-May	4000	12	None
Neem	Jan-Aug	3000	2 weeks	None
Pangar	Sep-Oct	30-40	<1	Sow immediately after collection
Pula	Mar-Apr	32000-37000	12	None
Reetha	Nov-Dec	650	24	Soak in Conc. Sulphuric acid for five minutes
Robinia	Jul -Aug	50000	36-48	Hot water
Sagon	Nov-Jan	1800-3000	24	Alternate soaking and drying in water for 6-7 times
Semal	Mar-May	20000	12-24	None
Shisham	Nov-Mar	50000	6-12	None
Silver oak	Jun	100000	12-24	None
Siris	Jan-Mar	7000	12	Soak in hot water for one hour

Spruce	Oct-Nov	62000	12	Soak in water for 24 hours
Subabul	Jan-May	12000-2000	12-24	Boiling water
Tun	May-Jun	550000	12	None
Utis	Dec-Jan	570000	6	Keep in refrigerator for one month and sow

3.5.4 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 atleast 1 day. When dry, they are again soaked for overnight. The process is repeated for about 20 to 30 days after that seeds are sown in a germination bed.

3.5.5 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.

3.5.6 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 start germinating and must be transplanted immediately when the roots emerge.

3.6 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 (Plate-1), 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 as deep (0.3 to 0.6 cm) as 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 retain moisture, reduces weeds and improves 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. For example, seeds of 'Siris', 'Mango' etc give 90-100 per cent germination whereas in case of 'Pipal', germination is only 1-5 per cent. Sometimes instead of seeds the whole fruit

can be sown to obtain better results i.e. 'Timla', 'Pipal', 'Bedu' and 'Banyan', etc. Germination percentage of some seeds is given in Box – 1.

Box-1
Germination Percentage of Some Tree Species

Species	Germination percentage
Amla, Chullu, Jackfruit, Kachnar, Khair, Malu, Mango, Sal, Siris, Tungla	90-100
Bakain, Bhimal, Cheura, Dhak, Kharik, Maple, Mehal, Pine, Ritha, Robinia, Wild cherry, Walnut	70-90
Bamboo, Birch, Kafal, Ringal, Rohani, Shisham, Imli	50-70
Cedar, Chamkharik, Hisaru, Ruins, Semal, Teak	50-70
Kakra, Fir, Thuza, Tun	20-30
Amaltas, Jecaranda, Sadabahar	10-20
Kumkum Papri, Surai, Spruce	5-10
Alder, Bakli, Banyan, Bedu, Khaina, Pipal, Timla	1-5

3.6.1 Direct sowing of seeds in polythene bags

Sometimes seeds are directly sown in the polythene bags viz. seeds of gulmohar. 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 the day 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.

3.7 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 sand and compost mixed with it. 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 (Plate-2). Some of the common species which are raised through cuttings are mentioned in Box 2.

Box – 2
Species Raised Through Cuttings

Species raised through cuttings	Period of planting
Chullu , Mehal , Mulberry , Poplar, Siris, Subabul	February to March
Cheura, Timla	July to August

Some species such as Shisham, Arjun, Kanji, Jamun, Aam, Neem and Imli grow slow. These species should be grown in beds and should be taken out for planting as ball plants.

3.8 PROVIDING SHADES IN THE NURSERY

Most of the tree species need shade in the early stage of germination while the seedlings are still tender. Studies at FRI, Dehradun have shown that the shade is more important before and after the monsoon, and had 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.

3.9 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 delaying or leading to poor germination.

3.10 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 and 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
- It must be well drained and not hold too much water
- It must be free from insects, diseases and weed seeds
- It must not contain clay soil or large amount of ashes and
- All materials must be well decomposed.

3.10.1 Filling of polythene bags

The polybags should be punched with a sharp punching tool to make 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 (Plate -1). After first fill the bags should be struck on ground to let the soil settle in and firm in 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 heavy mortality of plants during handling. Atleast 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.

3.10.2 Transplanting of seedlings

Plants 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 them 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 plantlets can be separated and inserted into holes made in the polybag soil by thrusting a sharp punch (Plate-1). 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 plantlet 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 in hot sun. A bed of polybags is gently irrigated after all the pots 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.

3.11 AFTER CARE OF SEEDLINGS

Young seedlings are vulnerable to many factors and major losses can occur if these 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, scorching sun, 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.

3.11.1 Weeding

Weeds come with manure, clay or sand transported from outside. Sometimes undesirable seeds get mixed with the seed sown. It is a simple matter to remove weeds by pricking them out. This operation should be carried out at the earliest opportunity after the weeds have 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.

3.11.2 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. Excess watering promotes the growth of fungi by decreasing the temperature and increasing soil moisture (Plate-4).

Light and frequent watering of polypots is not as good as more thorough, but less frequent watering. Light watering results in the water not penetrating deep into the soil and the seedlings soon dry out. In the exposed surface of the nursery bed, soil surface temperatures can rapidly rise to over 45^{o}C 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 water by a rose can or through hoses (Plate-4). 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,
- 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 and
- Plants need more water, often on windy days.

3.11.3 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 captan, zineb, blitox, cumin, dithane M-45, thimet, endosulphan, chloropyrophos etc. These should be used immediately when disease or insects appear according to the manufacturers' instructions.

3.11.4 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 increase rapidly where vegetative waste is available. In order to control them, Endosulphan 20 EC or Chloropyrophos 20 EC should be sprayed after mixing 3 to 4 litres of any of these insecticides in 1000 litres of water. For the control of rats zinc phosphide or aluminum phosphide should be used.

3.11.5 Shifting and grading of plants

It is essential to provide adequate growing space in the beds for speeding up 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.

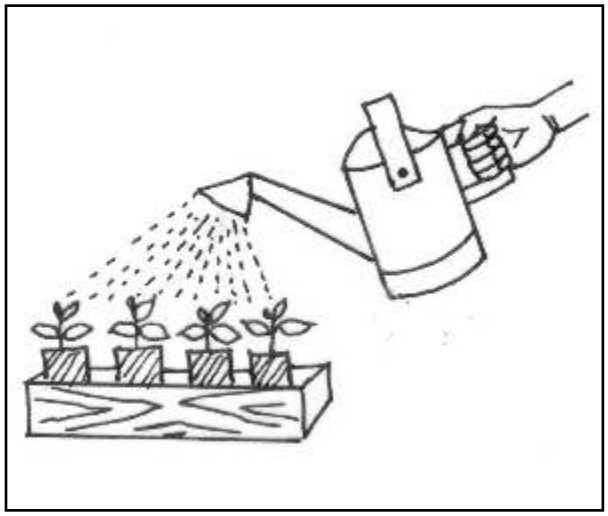
While shifting the polythene bags, the roots of the plants protruding outside the bags should be cut with sharp scissors. It is better to keep these bags over a polythene sheet to avoid roots penetrating the soil. However, keeping such bags on mounted beds gives better result and avoids root coiling by facilitating air pruning of roots.

3.11.6 Pruning

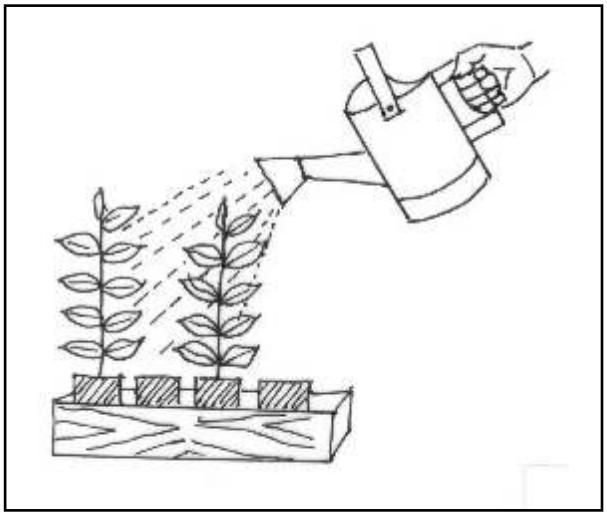
Some species grow very fast in the nursery. Sometimes tall seedlings do not have enough roots to support the many leaves. When these seedlings are planted in the field, they may grow slowly or even die because of roots cannot supply enough water to the leaves. In order to avoid this problem, cut off the tops of seedlings that have grown too tall. Use a sharp knife to trim the tops of these species. For example *Casuarina, Eucalyptus, Leucaena, Gliricidia,* Neem, *Sesbania* etc. Root pruning is also essential to avoid deep penetration of roots in the soil and in the process, the plant gets hardened. Pruning of roots helps in the development of tertiary roots.

Plate-4

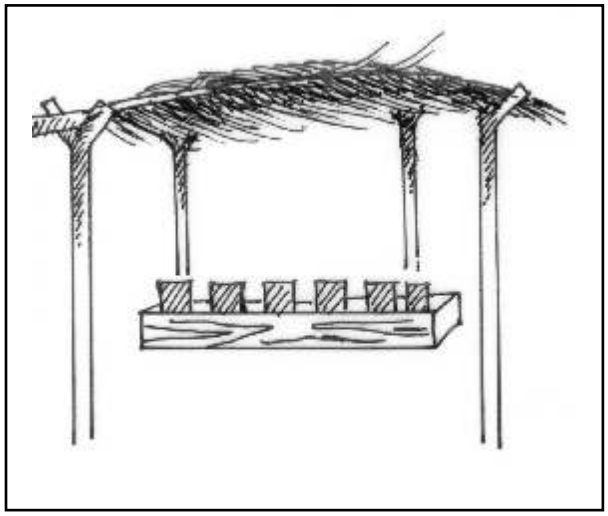
Precautions to be followed during watering the seedlings



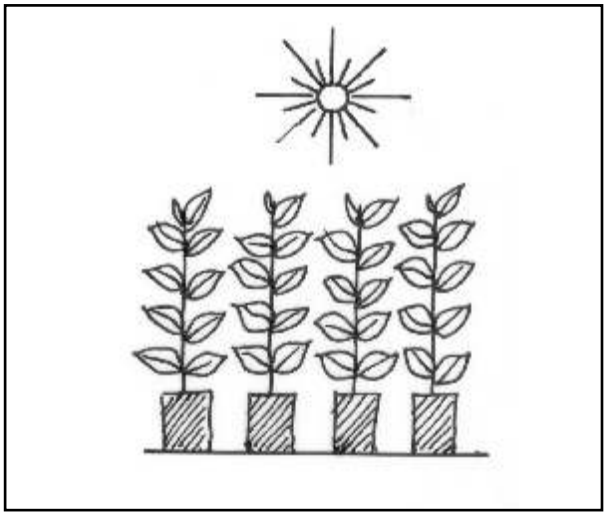
Pour small quantity of water on small seedlings whenever they need it



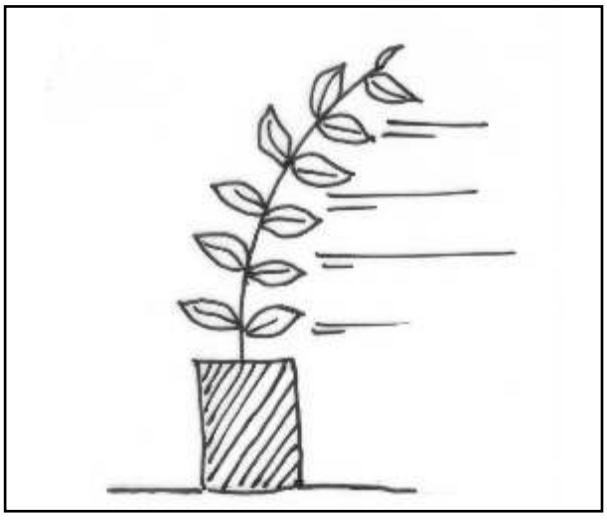
Big plants should be regularly watered with larger quantity



Watering to seedlings, when kept under shade, should be less and not very often



Watering to the seedlings/plant, kept in open or under sun, should be more often



During dry and windy days watering to seedlings/ plants should be more and often

3.11.7 Hardening off of seedlings

Life is easy for the plants in the nursery since they receive good care there. 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 are not burnt in the process.

3.11.8 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.

3.12 TRANSPORTATION OF SEEDLINGS

Seedlings are very delicate and should be handled properly. The polypot 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 (Plate- 2) 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 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 the balls should be wrapped in grass and tied by sutli *(Thick thread*).

PLANTATION TECHNIQUES

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 National Rural Employment Guarantee Scheme launched by the Govt. of India provides an opportunity of restocking these valuable forests with the participation of the villagers 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 and its various components and activities are discussed below:

4.1 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. In Tarai and Bhabar areas efforts should be made to plant Rohini, Bamboo, Sandan, Narkul and *Ficus* species for wild elephants,
- 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 industrial and other needs of the country. For example, *Eucalyptus* and poplar plantations in Tarai and Bhabar and Chir plantations in Garhwal and Kumaon.

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.

Table 4.1: Species recommended for plantation at different altitudes

400 to 1000 m	Aam, *Ailanthus*, Amaltas, Amrood, Anwla, Ashoka, Bakain, Bamboo, Bel, Ber, *Cassia, Eucalyptus, Ficus*, Gulmohar, Gutel, Haldu, Imli, *Jacaranda*, Jamun, Jhingan, Kathal, Khair, Neem, Paper mulberry, Haldu, Poplar, Pula, Ritha, Safed Siris, Sainjna, Sal, Salix, Shisham, Silver oak, Semul, Teak (in plain areas), Tendu, Tun
1000 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. Uttarakhand is located in the North of equator and sun is always in the South. Therefore, the Southern and adjoining Western and Eastern aspects are warm. Contrary to this, the Northern and adjoining North-Western and North-Eastern aspects are cool. Following species are recommended for planting in these cool aspects.

The success of some species is doubtful in hot aspects like - Akhrot, Angu, Banj, Burans, Chamkharik, Deodar, Kail, Maple, Moru, Pangar, Robinia, Ringal.

Bhojpatra, Deodar, Fir, *Juniperus*, Kharsu, Moru, and Spruce are suited to zones above 2,000 m.

Box-3
Classification of Species According to Their Uses

Timber: Aam, *Ailanthus*, Akhrot, Angu, Anwala, Bahera, Bamboo, Banj, Chamkharik, Chir, Deodar, *Eucalyptus*, Fir, Haldu, Harar, Jamun, Kafal, Khair, Maple, Neem, Poplar, Ringal, Sain, Sal, Salix, Semul, Shisham, Siris, Spruce, Surai, Tejpat and Tun.
Fuel-wood: *Acacia*, Banj, Haldu, *Eucalyptus*, Jamun, Kwiral, Kharsu, Moru, Sain, and Shisham.
Fodder: Bakil, Bans, Bhimal, Banj, Dhauri, Kharsu, Kharik, Kwiral, Maple, Moru, Neem, Phalyat, Robinia, Shahtoot, Siris and Timla.
Fruits: Aam, Akhrot, Amrood, Anwla, Bahera, Ber, Harar, Imli, Jamun, Kafal, Malta, Mehal, Nimbu, Shahtoot and Timla.
Rejuvenation of depleting water sources: Akhrot, Banj, Deodar, Maple, Phalyat, Ringal, Siris and Utis.

In Uttarakhand, in addition to the Govt. Reserve Forests, there are Civil and Soyam Forests, Van Panchayat Forest and Private Forests. For plantation works in the Reserve Forests working plans of various forest divisions prescribe the species of trees to be planted in particular area. In case of Van Panchayat, Civil and Soyam and Private Forests no such planting scheme has been prescribed. It is therefore necessary to plan plantation operations in these forests with the involvement and advice of local communities.

4.2 SELECTION OF SITE

The selection of site and selection of 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 neighbourhood, local factors and other conditions should be given due consideration and advice of the local villagers should be taken.

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. Therefore site selection has already been done for plantation works year wise. The position in case of Civil and Soyam and Panchayat Forests is however, different. In such areas plantations are taken up after obtaining resolution 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 or school, offices, road sides etc.

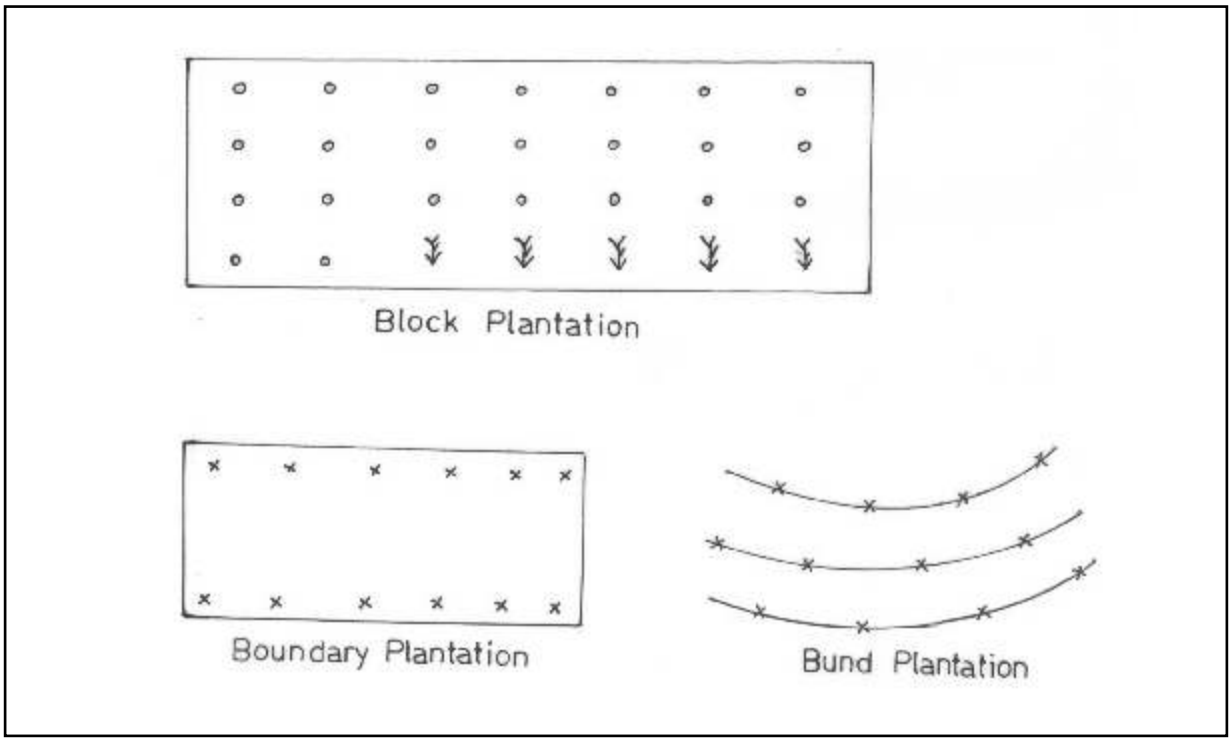


Fig. 4.1: Geometry of plantation

4.3 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 height from the ground. 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.

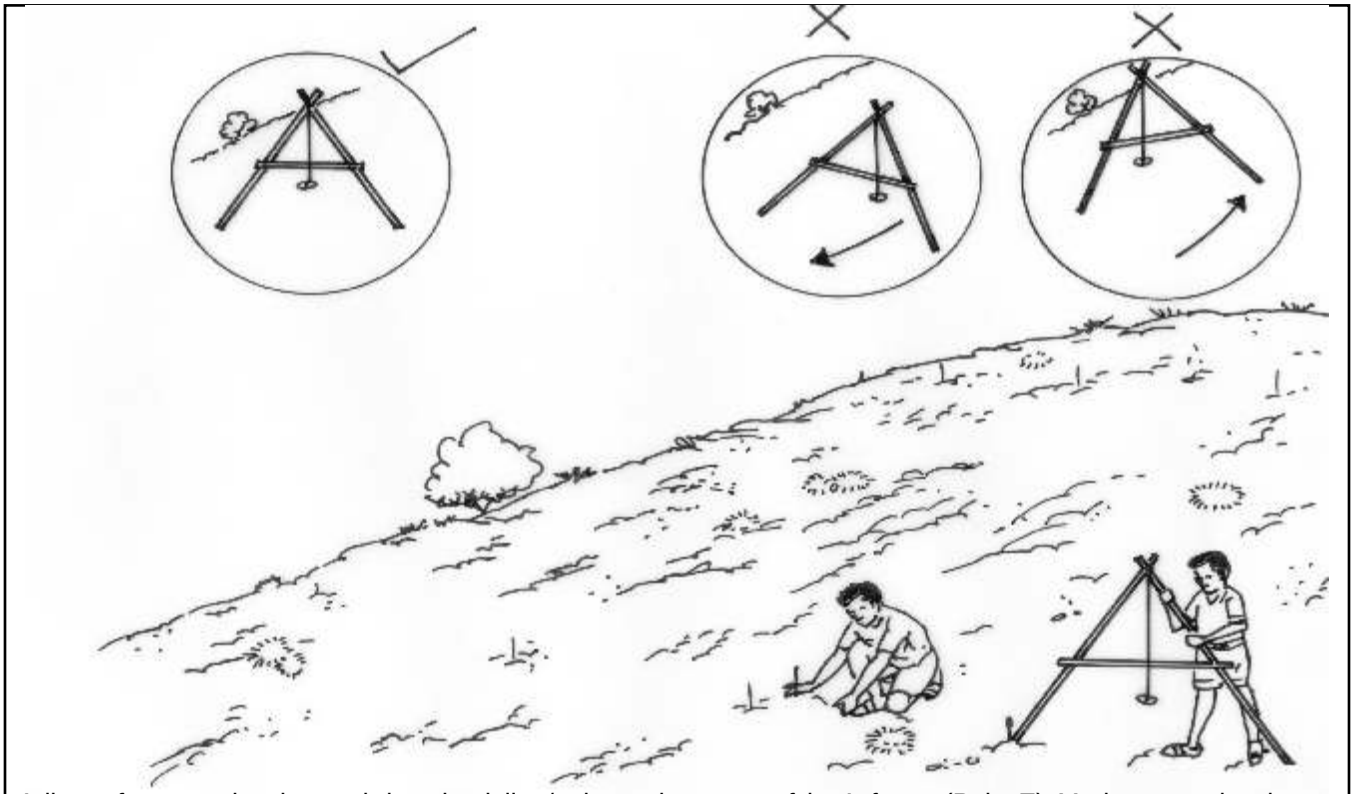
4.4 DIGGING OF PITS

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 procedure of making the contour lines has been described in Fig. 4.2. The pits in the second line should be dug in such a way that they fall between the pits dug in the first line as shown i.e., staggered (Fig. 4.3).

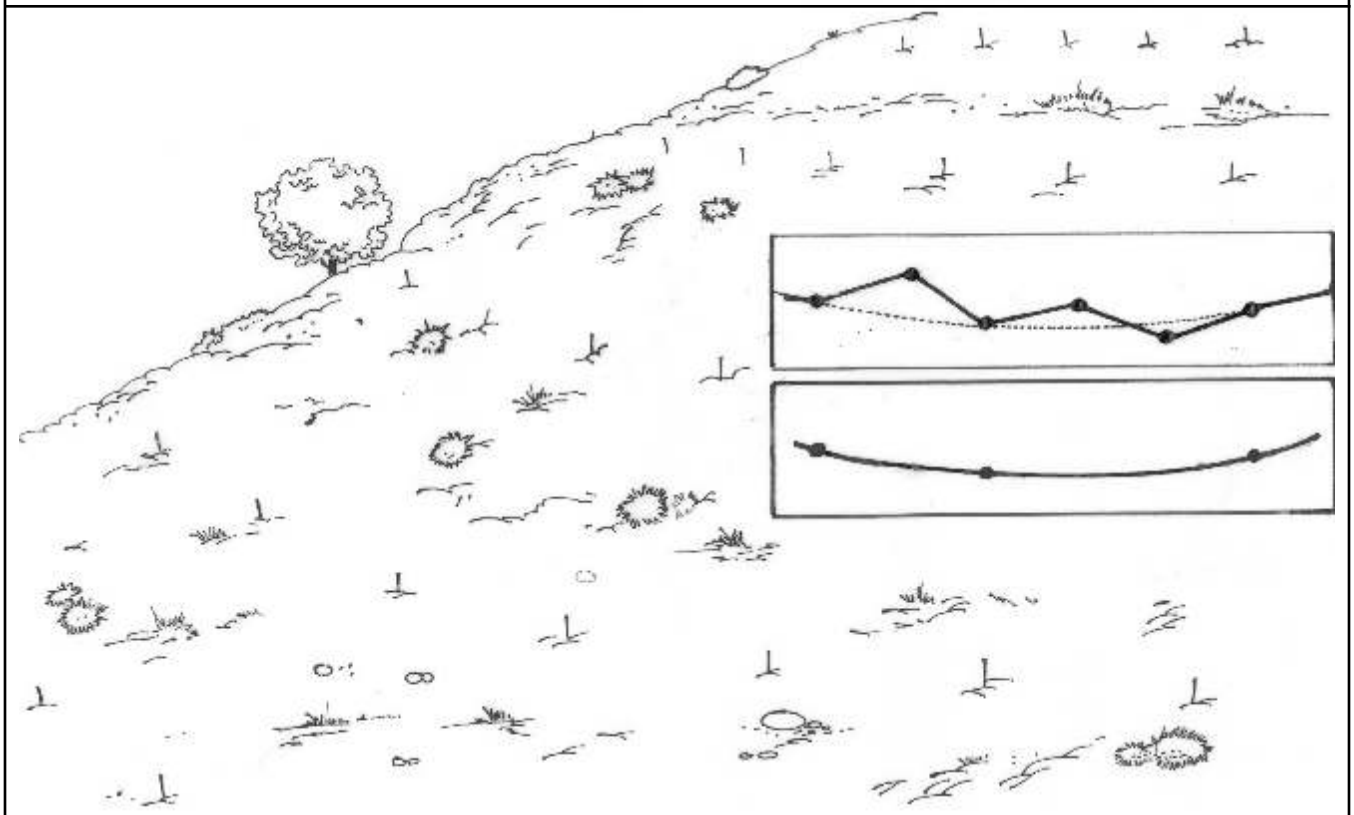
The triangular planting method, which is specially practiced in the hills, checks the flow of rain water and facilitates its percolation in the ground. This method should also be applied while digging contour trenches (Fig. 4.4).

4.5 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, how far effective, will come to a naught. Some of the common fencing types are discussed below:



Adjust a frame on the slope to bring plumb line/string to the center of the A -frame (Point E). Mark spot on the slope. These spots will form a contour line. Distance between contour hedgerows should be approximately 4 m - 6 m.



If the spots located by the A-frame zigzag too much, while planting consider only those points that form a smooth contour.

Fig. 4.2: Alignment of pits in areas with undulating topography

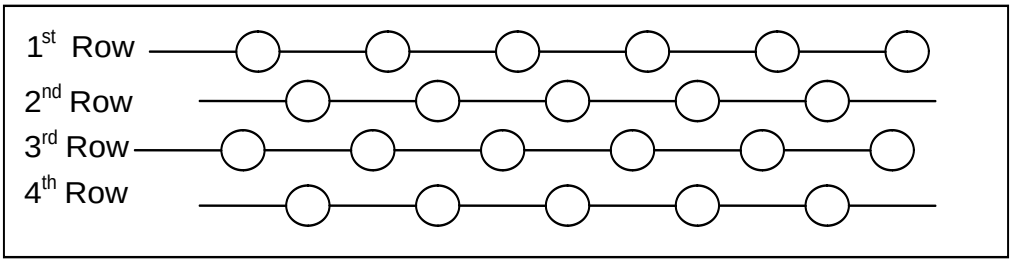


Fig. 4.3: Staggered alignment of the pits in plain areas

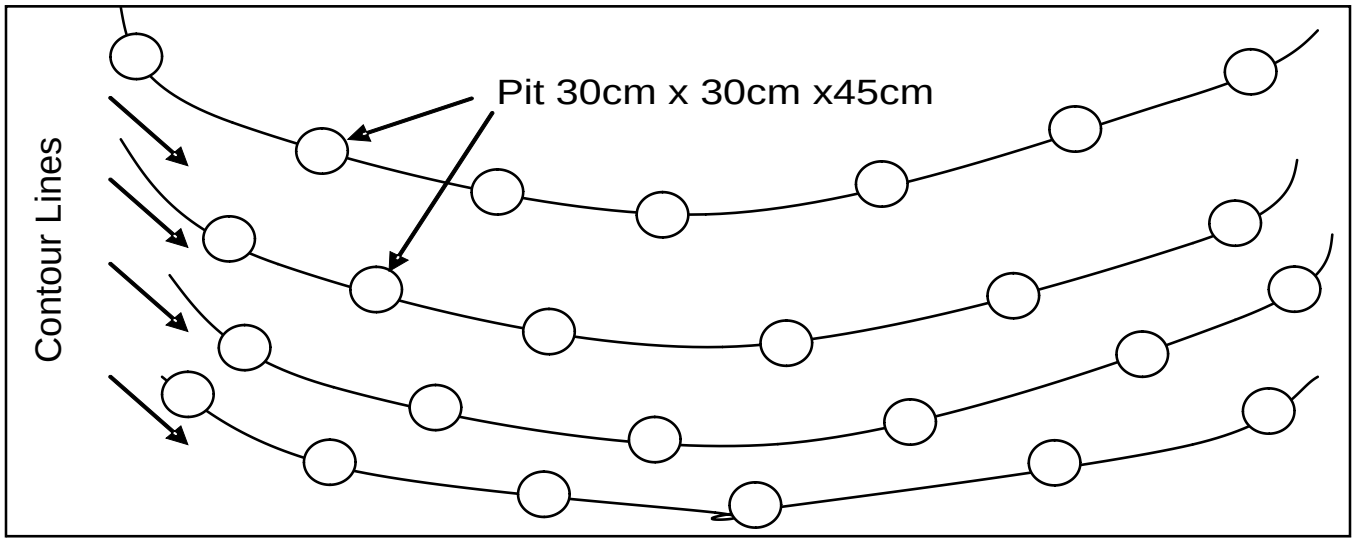


Fig. 4.4: Alignment of pits in hilly areas

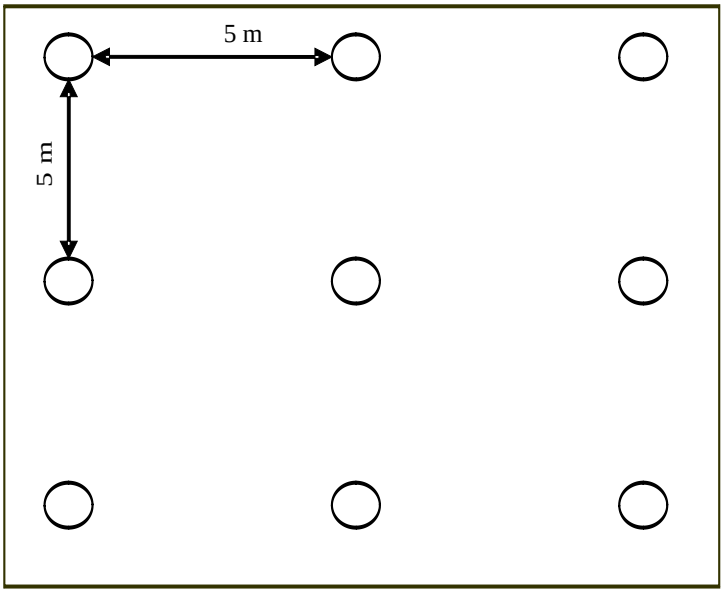


Fig. 4.5: Pits in row with equal square spacing

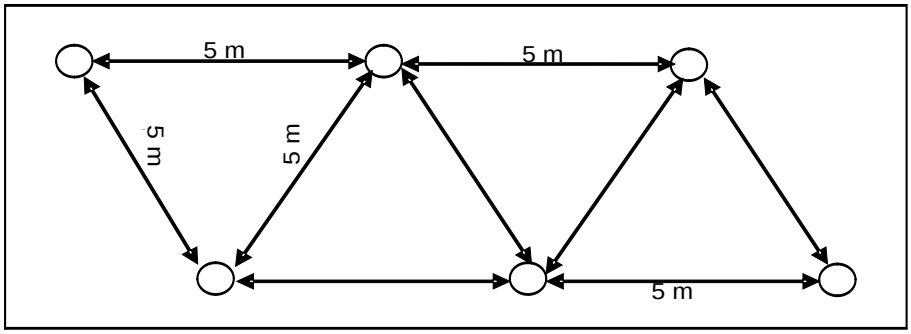


Fig. 4.6: Triangular spacing

4.5.1 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 Fig 4.7. However, these can be modified according to the ground situations.

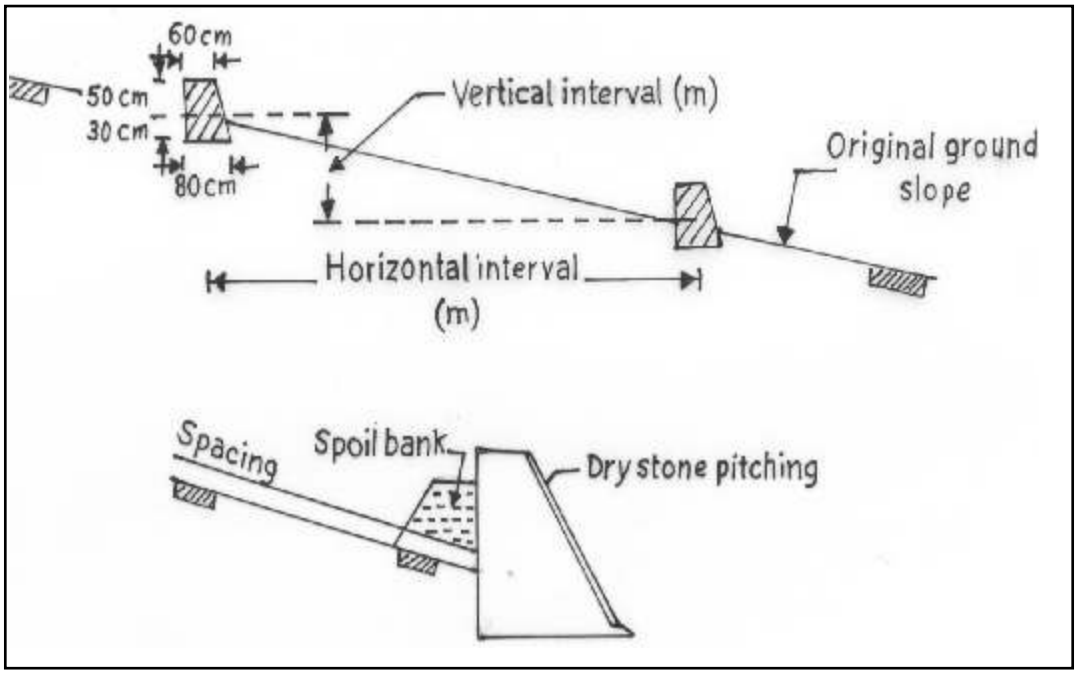


Fig. 4.7: Layout of stone wall fencing

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 (Fig. 4.8).

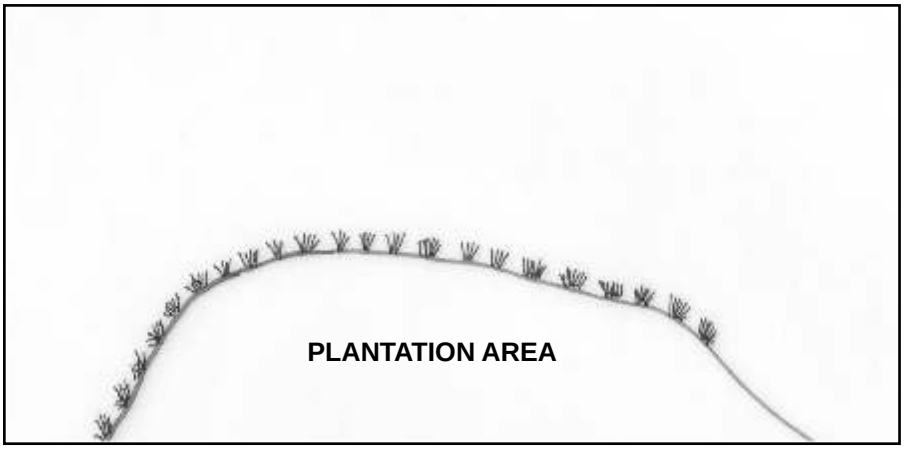


Fig. 4.8: Live hedge fencing

4.5.2 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 barbed wire 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 45° to the poles to provide extra strength (Fig. 4.9).

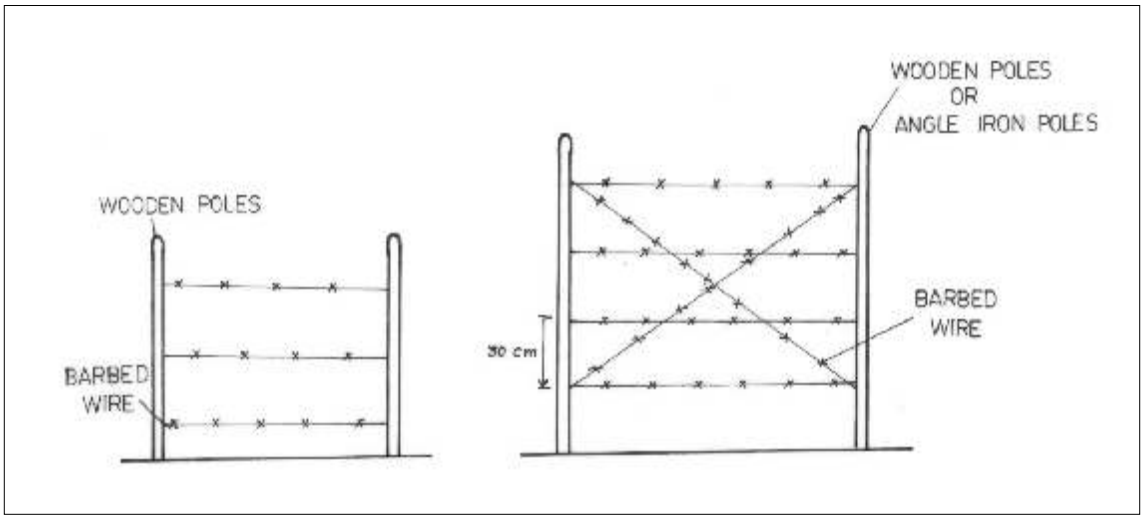


Fig. 4.9: Barbed wire fencing

4.5.3 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.

4.5.4 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.

4.6 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.

4.7 PLANTING OF SAPLINGS

The plantation of sapling must be done in the first week of July when monsoon rain has begun. 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 bending. 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 the 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 in Table-4.2.

Table 4.2: Ideal plantable size of some species

Species	Height (cm)	Age (Months)
Fir	45	40
Chir	25	9
Deodar	40	26
Khair	25	4
Bakli	45	4
Neem	50	12
Shisham	45	12
Tun	25	12
Acacia	40	6

4.8 WINTER PLANTING

Species like Akhrot, Angu, Maple, Pangar, Poplar, *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.

4.9 REPLACEMENT OF DEAD PLANTS OR BEATING UP

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

4.10 SOIL WORKING 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.

4.11 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 neighbouring villagers in the protection of the plantation area.

4.12 MAINTENANCE IN SUBSEQUENT YEARS

4.12.1 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. Atleast one weeding should be done and thanwalas be made. Protection wall or fencing should be repaired where ever necessary.

4.12.2 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.

4.13 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.

4.14 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'. Whereas, the snow covered areas are called 'Alpine forests'. Similarly the grasses found in these three areas are also different (Table 4.3)

Table 4.3: Classification of grasses according to forest areas and vegetation types

Type of forest	Vegetation type	Grasses inhabited
Humid temperate forests	Chir-Ban Oak forest (1500-1700m)	Batanya, Durva, Fulni, Fulkya, Hewaiya, Jhangori, June grass, Kummer, Kush, Naktura , Motia, Seru, Van-cheena, Vanjovata
	Ban oak- Blue pine (1700-2200m)	Batanya, Broom grass Chiruva, Durva, Faagu, Fulni, Jhangori, Kummer, Laaya, Nadi grass, Naktura, Paluva, Vanjovata
	Ban oak- conifers (2000-3000m)	Babula, Batanya, Broom grass, Durva, Faagu, Falwan, Jhangori, June grass, Khor, Kummer, Kush, Laaya, Nadi grass, Mathanya, Naktura, Phulakya, Vanjovata
Dry temperate forests	Ban oak- Blue pine (1700-2200m)	Same as above
Alpine forests	Above 3000m	Bughyali grass, Babula, Chirva, Cocks foot, Fulakya, June grass, Khor, Kush, Laaya, Prarhari grass, Naktura, Nadi grass, Sathia, Vanjovata, Van kauni
Sub-tropical forest	400-1400m	Baalo Doob, Dalis, Kaans, Khas-Khas, Kush, Kunura, Kumraya, Makhmali grass, Moonj, Palms, Reshmi grass, Tachula, Vanshi grass

4.14.1 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 m^3 in hills. This demand is likely to be increased 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.

4.15 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 km^2 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 under NREGA by the Van Panchayats and in other areas as well where damage by forest fires is common. The schedule or rates for this activity has been presented in table 6.5.

Table 4.4: Important shrubs of Uttarakhand and their uses

Uses of Shrubs	**Zone and District wise Distribution**			
	Zone A (upto 1000 M), Tropical Zone	**Zone B (1000-1500M) Sub Tropical Zone**	**Zone C (1500-2400M)**	**Zone D (>2400M)**
	Champawat (Pt.), Dehradun (Pt.), Udham Singh Nagar, Nainital (Part), Pauri Garhwal (Part) and Haridwar	Almora (Pt), Dehradun (Pt), Nainital (Pt), Pauri Garhwal (Pt), Champawat (Pt), Bageshwar (Pt)	Cool Temperate Zone Nainital (Pt), Almora (Pt), Pauri Garhwal (Pt), Dehradun (Pt), Chamoli (Pt), Rudraprayag (Pt), Uttarkashi (Pt), Pithoragarh (Pt) and Bageshwar (Pt)	Chamoli (Pt), Pithorgarh (Pt), Uttarkashi (pt), Tehri (Pt), Rudraprayag (Pt), Bageshwar (Pt)
Food and Fruit	*Berberis asiatica, Murraya koenigii, Zizyphus nummularia, Rhus parviflora, Indigofera cassidodes,*	*Berberis asiatica, Berberis lyceum, Tetrastigma serrulatum, Ampeloissus latifolia, Rhus parviflora, Rhus cortinus, Indigofera cassioides,*	*Berberis lyceum, Berberis chitria, Tetrastigma affine, Vitis himalayana, Ampeloissus latifolia, Rhus cortinus, Rubus*	*Berberis chitria, Vitis himalayana, Rubus paniculatus, Prinsepia utilis, Rosa*

	Cassia leavigata, Callicarpa macrophylla, Pyrus pashia, Rosa brunonii, Carissa opaca	*Cajanus cajan, Callicarpa macrophylla, Rubus ellptica, Pyrus pashia, Pyracantha renulata, Rosa brunonii, Punica granatum, Viburnum mullaha,*	*paniculatus, Rubus ellipticus, Prinsepia utilis, Pyrus pashia, Pyracantha renulata, Punica granatum, Viburnum cotinifolium, Viburnum mullaha*	*macrophylla Rosa rericea, Viburnum cotinifolium*
Fodder	*Murraya paniculata, Murraya koenigii, Rhus parviflora, Indigofera cassioides, Mucuna nigrians, Lespedeza stenocarpa, Millettia auriculata, Sesbania cannabina, Cajanus cajan, Cassia leavigata, Bauhinia vahlii, Callicarpa macrophylla, Pyrus pasha, Spermadictyon suaveolens, Artermisia vulgaris, Diospyrus motana, Sesbania cannabina, Adhatoda vasica, Xylosma longifolia, Xeromphi spinosa, Rhmnus verigata,*	*Rhus parviflora, Rhus cortinus, Indigofera cassioides, Indigofera heterantha, Mucuna nigrians, Lespedeza stenocarpa, Sesbania cannabina, Cajanus cajan, Bauhinia vahlii, Callicarpa macrophylla, Pyrus pasha, Spermadictyon suaveolens, Artermisia vulgaris, Diospyrus motana, Sesbania cannabina, Adhatoda vasica, Colebrookea oppositifolia, Ficus palmate, Dendrocalamus strictus, Xylosma longifolia, Dracacna uagustifolia, Pistacia khinjuk, Randia tetraparma Xeromphi spinosa, Rhmnus verigata, Eurya acuminate*	*Euonymus tingens, Rhus cortinus, Desmodium tiliaefolium, Indigofera heterantha, Pyrus pasha, Leptodermis lanceolata, Artermisia vulgaris, Colebrookea oppositifolia, Ficus nerifolia, Ficus palmate, Dendrocalamus strictus, Cotoneaster bacillaris, Dracacna uagustifolia, Randia tetraparma, Salix wallichiana, Symplocos chinensis, Eurya acuminate*	*Euonymus tingens, Desmodium tiliaefolium, Leptodermis lanceolata, Ficus nerifolia, Dendrocalamus strictus, Cotoneaster bacillaris, Salix wallichiana, Symplocos chinensis*
Fuel	*Cocculus laurifolius, Berberis asiatica, Cosearea elliptica, Xylosma longifolia, Urea lobata, Calastrus paniculatus, Rhus parviflora, Indigofera cassioides, Indigofera*	*Cocculus laurifolius, Mohonia borealis, Berberis asiatica, Berberis lyceum, Cosearea elliptica, Xylosma longifolia, Plttosporum erioarpum, Urea lobata, Calastrus paniculatus, Sageretia filliformis, Rhus parviflora Rhus cortinus, Coriaria*	*Mohonia borealis, Berberis lyceum, Berberis chitria, Zanthoxylum arimatum, Buxus sempervirens, Picrasma guassioides, Euonymus tingens, Sageretia filliformis, Rhus cortinus, Rhus wallichii, Coriaria*	*Berberis chitria, Zanthoxylum arimatum, Buxus sempervirens, Picrasma guassioides, Euonymus tingens, Rhus wallichii, Desmodium*

	heterantha, Sesbania cannabina, Cajanus cajan, Mimosa himalayana, Pyrus pasha, Rosa brunonii, Woodfordia fructicosa, Xeromphi spinosa, Diospyrus motana, Vitex negundo	*nepalensis, Indigofera cassioides, Indigofera heterantha, Sesbania cannabina, Cajanus cajan, Mimosa himalayana, Pyrus pasha, Pyracantha renulata, Rosa brunonii, Woodfordia fructicosa, Viburnum cylindricum, Viburnum mullaha, Randia tetraparma, Xeromphi spinosa, Diospyrus motana*	*nepalensis, Desmodium tiliaefolium, Pyrus pasha, Pyracantha renulata, Cotoneaster bacillaris, Lonicrea guinguelocularis, Viburnum cylindricum, Viburnum mullaha,Randia tetraparma, Symplocos chinensis*	*tiliaefolium, Rosa macrophylla, Rosa Rericea, Cotoneaster bacillaris, Lonicrea guinguelocularis, Symplocos chinensis*
Fibre	*Urea lobata, Mucuna nigrians, Millettia auriculata, Bauhinia vahlii, Purgularia daemia, Marsdenia roylei, Heterostemma alatum , Flacourtia indica, Calotropis procera*	*Urea lobata, Mucuna nigrians, Bauhinia vahlii, Cryptolepis bucnhaani, Marsdenia roylei, Heterostemma alatum, Flacourtia indica, Aechmanthera gossypina*	*Clematis buhananiana, Symplocos chinensis, Cryptolepis bucnhaani, Marsdenia roylei, Aechmanthera gossypina*	*Clematis buchananiana, Symplocos chinensis*
Toys and wooden Articles	*Cosearea elliptica, Flacourtia indica, Marsdenia roylei, Pyrus pasha, Xeromphi spinosa, Diospyrus motana*	*Cosearea elliptica, Flacourtia indica, Marsdenia roylei, Coriaria nepalensis, Pyrus pasha, Pyracantha renulata, Viburnum mullaha, Randia tetraparma, Xeromphi spinosa, Diospyrus motana, Dendrocalamus strictus*	*Marsdenia roylei, Buxus sempervirens, Coriaria nepalensis, Pyrus pasha, Pyracantha renulata, Cotoneaster bacillaris, Leycesteria formosa, Viburnum mullaha, Randia tetraparma, Dendrocalamus strictus*	*Buxus sempervirens, Cotoneaster bacillaris, Leycesteria Formosa, Dendrocalamu s strictus*
Manures	*Flemingia blacteata, Indigofera cassioides, Mucuna nigrians, Lespedeza stenocarpa, Millettia auriculata,*	*Flemingia blacteata, Indigofera cassioides, Indigofera heterantha, Mucuna nigrians, Lespedeza stenocarpa, Sesbania cannabina, Cajanus cajan, Mimosa himalayana, Bauhinia*	*Desmodium tiliaefolium, Indigofera heterantha*	*Desmodium tiliaefolium*

	Sesbania cannabina, Cajanus cajan, Cassia leavigata, Mimosa himalayana, Bauhinia vahlii, Adhatoda vasica	*vahlii, Adhatoda vasica*		
Medicinal Plants	*Berberis asiatica, Flacourtia indica, Urea lobata, Thespesia lampas, Murraya paniculata, Muraya koenigii, Calastrus paniculatus, Rhus parviflora, Indigofera cassioides, Millettia auriculata, Mimosa himalayana, Rosa brunonii, Viburnum mullaha, Vitex negundo, Xeromphi spinosa, Artemisia vulgaris, Diospyrus motana, Heterostemma alatum, Calotripis procera, Adhatoda vasica, Clerodendrum philippinum, Pogostemom benghalense, Hibiscus rosa-sinesis, Indigofera cassioides, Cassia leavigata, Bauhinia vahlii, Rosa brunonii, Jasminum multiflorum, Vallaris solanacea, Ichnocarpua fructescens, Trachelospermum*	*Mohonia borealis, Berberis asiatica, Berberis lyceum, Flacourtia Indica, Urea lobata, Calastrus paniculatus, Rhamnus virigatus, Rhus parviflora, Rhus cortinus, Indigofera cassioides, Mimosa himalayana, Rosa brunonii, Punica grnatum, Viburnum mullaha, Randia tetraparma, Xeromphi spinosa, Artermisia vulgaris, Diospyrus motana, Cryptolepis bucnhaani, Heterostemma alatum, Adhatoda vasica, Clerodendrum philippinum, Colebrookea oppositifolia, Pogostemom Benghalense, Roylea cinerea, Hibiscus rosa sinesis, Indigofera cassioides, Indigofera heterantha, Bauhinia vahlii, Rosa Brunonii, Inula cappa, Jasminum multiflorum, Trachelospermum lucidum, Buddleja necmdar, Periplcca calophylla, Buddleja necmdar, Brugmansia suaveolens, Duranta repens, Holmskioldia sanguine,*	*Clematis buchananiana, Schizandra grandiflora, Mohonia borealis, Berberis lyceum, Berberis chitria, Zanthoxylum arimatum, Picrasma guassioides, Euonymus tingens, Rhamnus virigatus, Rhus cortinus, Desmodium tiliaefolium, Prinsepia utilis, Punica grnatum, Lonicrea guinguelocularis, Viburnum cotinifolium, Randia tetraparma, Leptodermis lanceolata, Artermisia vulgaris, Cryptolepis bucnhaani, Colebrookea oppositifolia, Roylea cinerea, Hibiscus rosa sinesis, Euonymus echiatus, Indigofera heterantha, Spiraea cantoniensis, Inula cappa, Myrsine africana, Buddleja necmdar, Periplcca calophylla, Buddleja necmdar, Caryoptaris odorata, Litsaea*	*Clematis buchananiana, Schizandra grandiflora, Berberis chitria, Zanthoxylum arimatum, Picrasma guassioides, Euonymus tingens Desmodium tiliaefolium, Prinsepia utilis Rosa macrophylla, Rosa sericea, Lonicrea guinguelocularis, Viburnum cotinifolium, Leptodermis lanceolata, Rhododendron anthopogan, Euonymus echiatus, Rosa macrophylla, Rosa rericea, Spiraea cantoniensis, Myrsine africana, Rhododendron anthopogan, Litsaea umbrosa*

	lucidum, Telosma cordata, Brugmansia suaveolens, Tecoma stans, Vitex negundo, Duranta repens, Holmskioldia sanguine	*Caryoptaris odorata*	*umbrosa,*	
Bio-fencing	*Murraya koenigii, Rhus parviflora*	*Mohonia borealis, Sageretia filliformis, Rhamnus virigatus, Rhus parviflora, Rhus cortinus, Coriaria nepalensis*	*Mohonia borealis, Zanthoxylum arimatum, Sageretia filliformis, Rhamnus virigatus, Rhus cortinus, Rhus wallichii, Coriaria nepalensis*	*Zanthoxylum arimatum, Rhus wallichii,*

SOIL AND WATER CONSERVATION MEASURES

Forests play a very important role in soil and water conservation. Tree leaves intercept the rain and allow its water to percolate deep into the ground thus charge the ground water reservoir. The dense network of roots hold the soil and prevent erosion thus plays an important role in maintaining soil fertility. The productivity of agricultural lands is decreasing day by day due to population pressure and unsustainable exploitation of natural resources. The ground water table is also going down very fast due to excessive tapping. The development of lands and water resources cannot be considered independent of each other for sustainable natural resource management. Conservation and management of rain water is very important for the development of agriculture especially in the hills where most of the agriculture is rain fed. This situation can be improved by taking suitable soil and water conservation measures at appropriate places with the involvement of local communities under NREGA, 2005. As per schedule 1 of the Act, the focus of the Rural Employment Guarantee Scheme must be on the following works:

- water conservation and water harvesting and
- drought proofing, including afforestation and tree plantation

Following remedial measures are being suggested under these activities:

5.1 GULLY PLUGGING AND NALA CONTROL

In control of gullies and nalas the erosive velocities are reduced by flattening out the steep gradient of the gully by constructing a series of checks which transform the longitudinal gradient into a series of steps with low riser and long flat treads. This involves construction of check dams (vegetative, stone and crate wire or wire mesh check dams). Spur walls and retaining walls can also be constructed for bank protection to save valuable agricultural fields from being cut up. Mechanical measures (check dams) are supplemented by planting in gullies behind check dams. All *gully* or *nala* control work should start from the top of *gully/nala* and this activity must cover both non-arable and arable land.

The stabilization of gullies through vegetation is difficult task as gullies have to be used for conveying run off during the time vegetative measures are undertaken and these measures get damaged by run off. Therefore, mechanical measures have to be adopted to prevent washing away of vegetative measures by large volume of run off. Vegetation once established is able to take care of gully. Thus mechanical measures, temporary or permanent, are necessary in gully control to be supplemented by vegetative measures since mechanical measures weaken and vegetative measures get strengthen with the passage of time. Following types of check dams are being suggested under mechanical measures:

5.1.1 Brushwood check dams

The main requirement of temporary control structures is that they must be quick and easy to construct and use cheap readily available materials. In brushwood check dams small branches preferably of coppiceable species are fixed in two parallel rows across the gully or nala and packed with brushwood between the rows of these vertical stakes (Fig. 5.1). The vertical stakes can be tied down with wires or fastened with sticks across the top. The important point in erecting brushwood check dams is to pack the brushwood as tightly as possible and to secure it firmly. Brushwood check dams are generally meant for small gullies or at the starting stretch of the gullies.

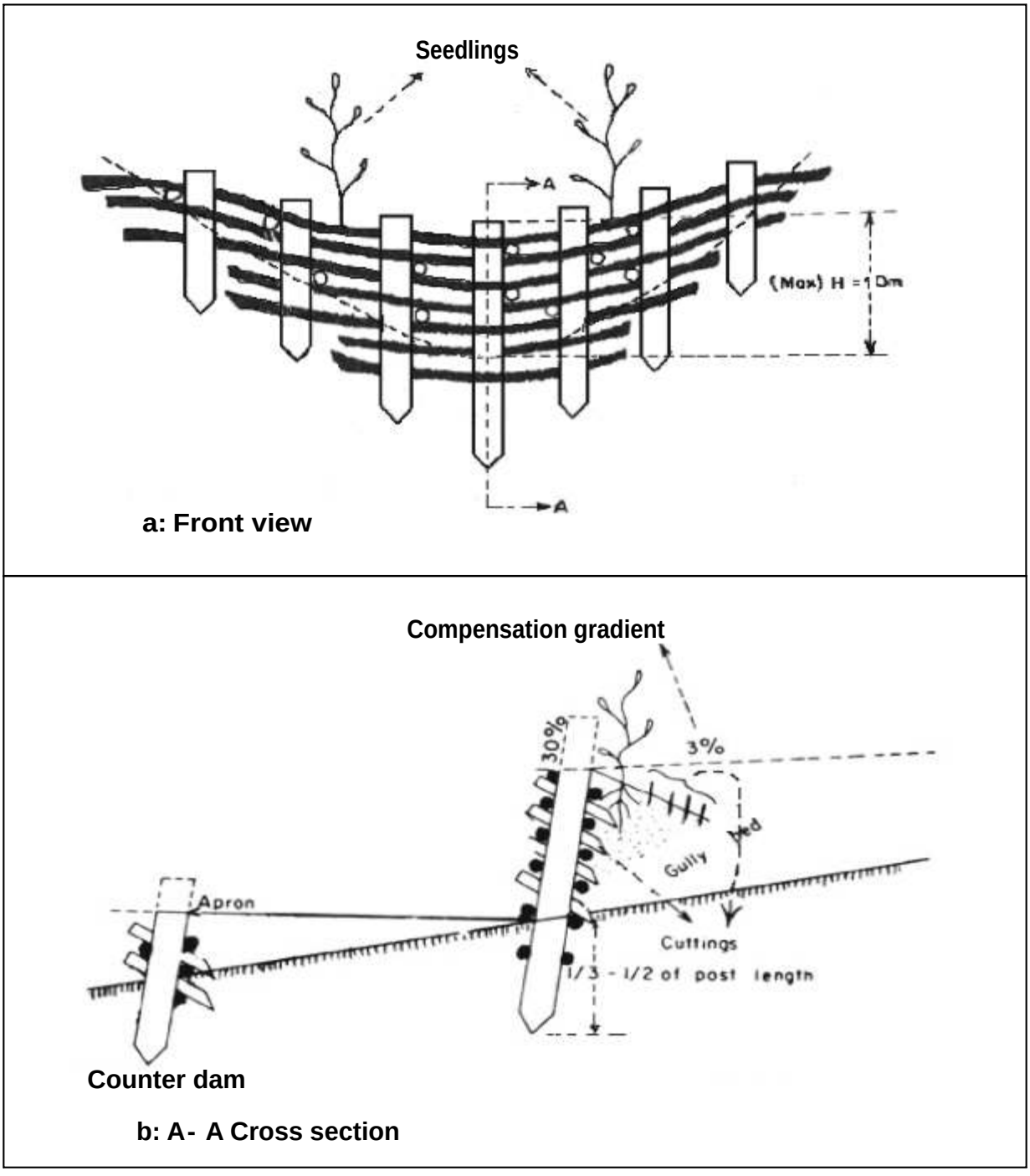


Fig. 5.1: A double row brushwood check dam

Posts are set in trenches (0.3 x 0.2 m in size) across the gully to a depth of about 1/3 to 1/2 of the post length, and about 0.3 to 0.4 m apart. The length of the posts is 1.0 to 1.5 m and their top-end diameter is 3 to 12 cm. Any tree or shrub species, such as *alnus*, pine, bamboo, *salix*, poplar, etc., can be used as posts. The flexible branches of trees (*Salix, Poplar, Gliricidia, Cassia,* etc.) flexible stems of shrubs (*Tamarix, Arundinaria,* etc.), and the strips made of bamboo stems may be used as interlink material. These materials are woven between wooden posts driven into the ground. The ends of interlink materials should enter at least 30 cm into the sides of the gully. The space behind the brushwood check dams must be filled with soil to the spillway. If sprouting species (*Salix,* Poplar, etc.) are selected as posts and interlink materials, brushwood check dams should be constructed when the soil in the gully is saturated or during the early rainy season. If non-sprouting species (pine and alnus as posts, bamboo strips as interlink materials) are used, brushwood check dams can be constructed during any season.

5.1.2 Stone check dams

For constructing R.R. dry stone check dams, the site where it is to be constructed is cleared and the sides are sloped 1:1. The bed of gully is excavated for foundation to a uniform depth of 0.45 m to 0.60 m and dry stones are packed from that level (Fig. 5.2). Over the foundation, R.R. dry stone masonry super structure of check dam can be constructed. The stone are dressed and properly set in with wedges and chips. The width of check dam at the base should be approximately equal to maximum height and successive courses are narrower so the section is roughly a trapezium. It is common to find upstream face of check dams vertical with all slopes on the down stream face but while there is sound engineering reason for this in case of large dams but it is not of any consequence in small gully control dams. In the centre of the dam portion sufficient waterway is allowed to discharge the maximum run off. The dry stone work should go up to 0.30 m to 0.60 m in the stable portion of the gully side to prevent end-cutting. Sufficient apron should be provided to prevent scouring of the structure. The thickness of the apron packing should be about 0.45 m and gully sides above the apron have to be protected with packing to a height of atleast 0.30 m above the anticipated maximum water level to prevent side scour being formed by the falling water.

5.1.3 Crate wire or wire mesh check dams

When a dry stone check dam is held down with woven wire netting, the life and strength of the structure is enhanced many fold. The mesh of wire is generally 0.15 m x 0.15 m and care should be taken that stones used are larger than the mesh size so that stones do not pass through the mesh. The wire netting is spread below the stone foundation and in the sides before stone work and after completion of stone work the wire netting is tied, covering the masonry tightly so that the whole structure becomes one piece. The stability is secured by careful masonry work, setting and wedging. Wire mesh stone check dams have proved very useful and more lasting than ordinary stone check dams (Fig. 5.2).

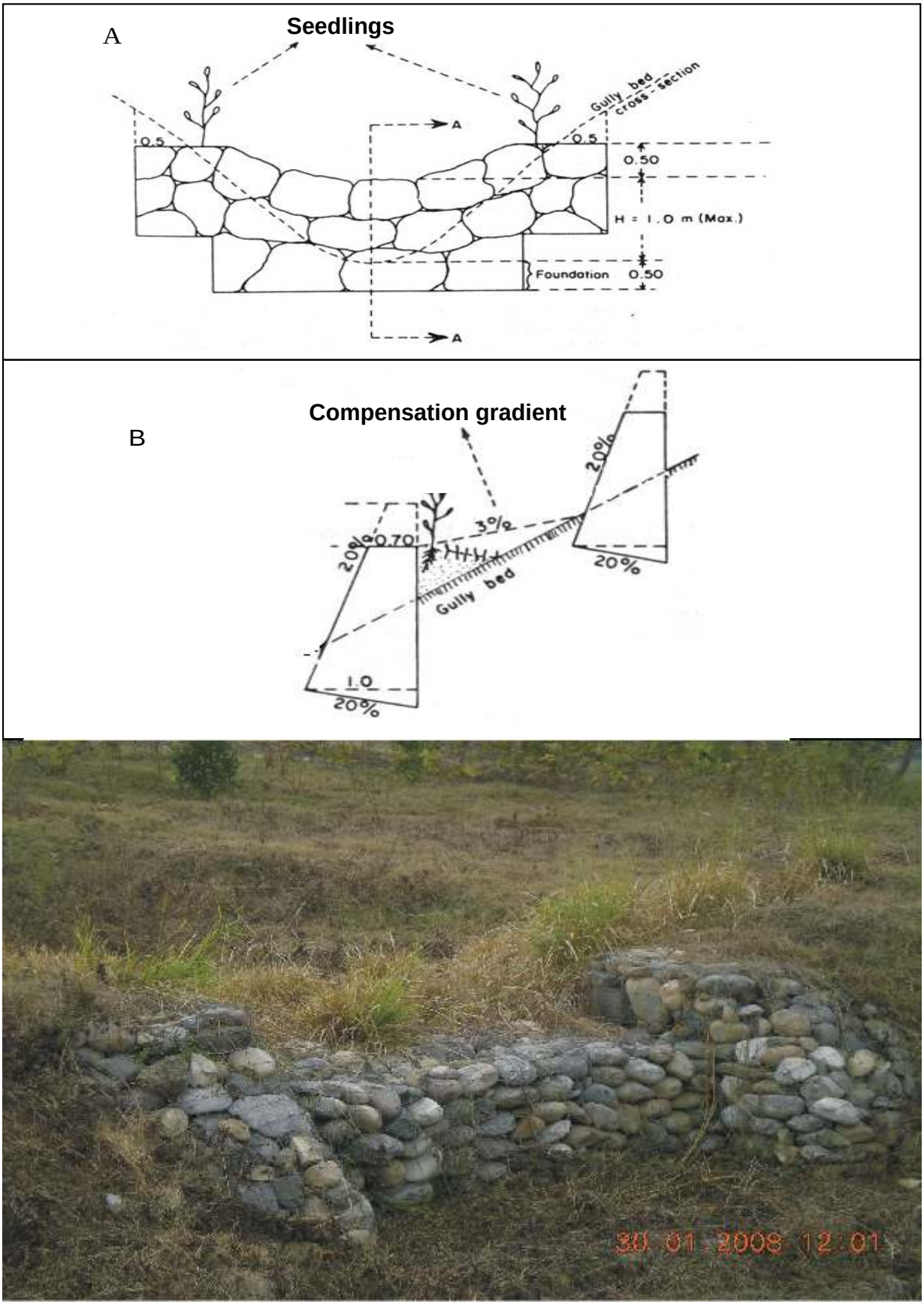


Fig.5.2: A dry stone check dam
(A: Front view; B: 'A'-'A' cross section, C: Live structure)

5.2 DIVERSION DRAINS

Diversion drains intercept the storm water which could otherwise flow down from higher ground on to the arable land which it protects. It is the first line of defense and vital for protection systems and structures below down as it effectively controls the run off from outside the arable land and conducts it safely to natural outlet. The diversion drains should be aligned on non erosive and non silting grades. It must also be protected from silting. A narrow and deep ditch does not get silted up as rapidly as a broad and shallow ditch of the same cross sectional area and is therefore, self maintaining. The soil excavated from the diversion drain shall be deposited on lower side of the drain, leaving a berm of 0.30 m and sectioned in a trapezoidal shape with side slopes not steeper than 1:1. The outlet end of the diversion drain should be taken to the existing or stabilized safe natural drainage lines or outlets so as to conduct the run off properly without causing erosion. Suitable spreading type of grasses must be planted. Panicum repens has been found the best for the alluvial soil of Dehradun followed by *Brachiaria multica, Cynodon plectostachys, C. dactylon* and *Paspalum rotatum* (Sharda *et al.*, 2006). The maintenance operations include periodical removal of weeds, filling of the patches with grass and proper cutting of grass.

5.3 LEVELLING /BENCH TERRACING OF SLOPING CULTIVATION FIELDS

Bench terracing is one of the most popular mechanical soil conservation practices adopted by the farmers in India and other countries. In the hills, intensive farming can only be adopted with bench terracing. It consists of construction of step like fields along contours by half cutting and half filling. Original slope is converted into level fields. Thus hazards of erosion are eliminated and manure and fertilizer applied are retained in the field.

However, in hill areas, most of the cultivation fields are sloping and improperly terraced. These sloping fields need to be bench terraced by cutting and filling with filling supported by retaining stone wall (Fig. 5.3 and Fig 5.4). Terraces may be designed to collect runoff expected from storm of 4 years recurrence interval and 6-hour rainfall. For planning contour trenches, their horizontal and vertical spacing have to be decided. The trench cross section of trapezoidal, rectangular and triangular shape is usually constructed for runoff impoundment. The relationship between the spacing of the trenches, area of cross section and expected runoff can be expressed as follows (Sharda *et al.*, 2006)

$$\text{Spacing (in meters)} = \frac{\text{Cross section area of the trench } (cm^2)}{100 \times \text{Expected runoff (cm)}} = \frac{Q}{A}$$

For continuous trenches, the following formula may be used for working out the horizontal spacing, assuming the trench to be rectangular

$$\text{HI (in meters)} = \frac{A\ (cm^2)}{100 \times Q}$$

Where,

Q	=	Depth of the expected runoff from the area (cm)
W	=	Width of the trench (cm)
d	=	Depth of the trench (cm), and
HI	=	Horizontal Interval (m)

For staggered trenches, with the in-between gap not equal to the length of trench

$$HI = \frac{W \times d}{100\ Q\ (1+X/L)}$$

Where,

X = Gap between the trenches and
L = Length of the trench

The vertical spacing between the trenches is determined by the equation

$$VI = \frac{S}{100} \times HI$$

Where,

VI = Vertical Interval (m),
S = Land slope (%) and
HI = Horizontal Interval (m).

Trench specifications designed to store 25 mm runoff produced by 4 years 6 hours storm of 80 mm on different land slopes is given in Table 5.1 and Fig. 5.3 .

Table 5.1: Trench specifications to store 25 mm runoff

Slope (%)	Trench + spoil bank width (m)	HI(m)	VI(m)
10	1.65	5.50	0.55
20	1.85	5.50	1.10
30	2.10	5.50	1.10

(After Sharda *et al.*, 2006)

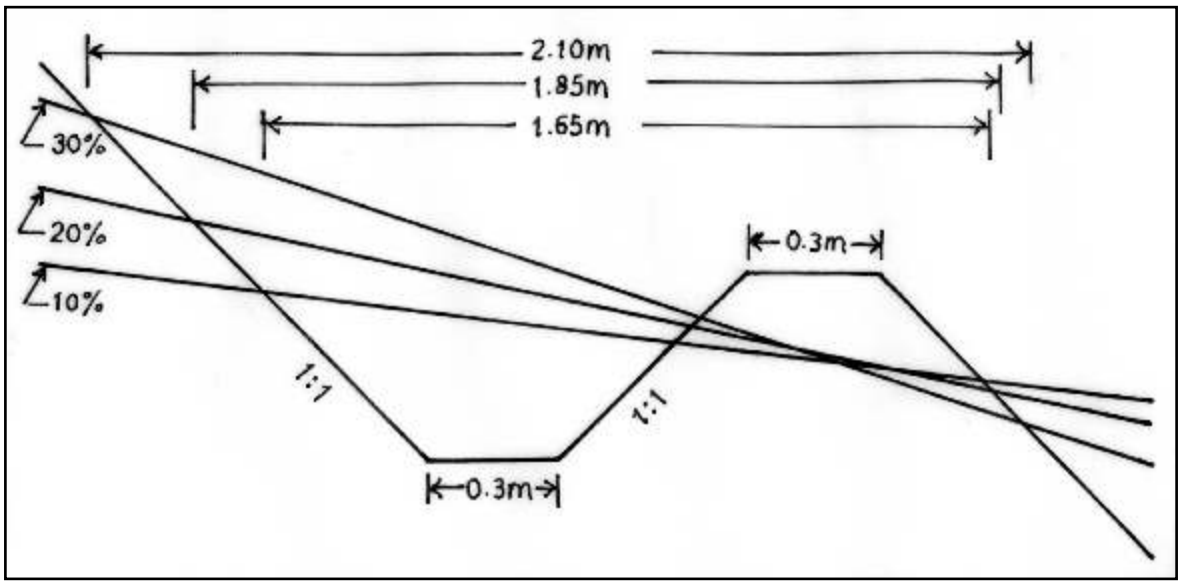


Fig. 5.3 : Trench specifications to store 25 mm runoff on different land slopes

Farmers are generally interested in the construction of irrigated (levelled) bench terraces for reason of higher productivity. The specifications of such terraces are mentioned in Table 5.2, which shows that by constructing a steep stone riser, the area lost due to bench terracing is reduced considerably (Fig. 5. 4). The shoulder bund may also be put under leguminous crops like beans or peas.

Table 5.2 : Specifications for irrigated benches in N-W Himalayas[1]

Slope (%)	VI (m)	Bench width (m)	Terrace width (HI)	Depth of cut (m)	Depth of soil required (m)	Bench length (m)	Area lost (%)
7	0.6	8.5	8.6	0.3	0.6	1163	1.4
10	0.75	7.5	7.6	0.4	0.7	1307	2.0
20	1.0	5.0	5.2	0.5	0.8	1923	3.8
30	1.2	4.0	4.2	0.6	0.9	2358	5.6
40	1.5	3.8	4.0	0.8	1.0	2469	7.4
50	1.8	3.5	3.9	0.9	1.2	2590	9.3

1 = (After Sharda *et al*., 2006)

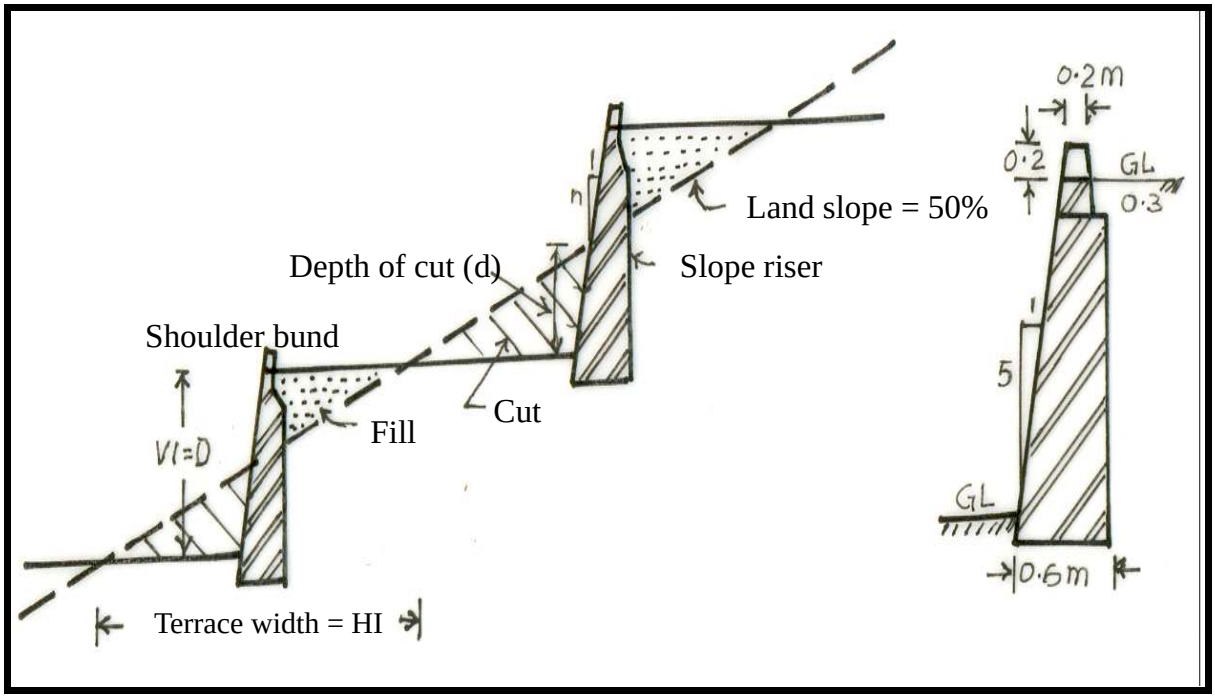


Fig. 5.4: Bench terrace constructed by cutting and filling

5.4 CONTOUR TRENCHING

Contour trenches are widely used for moisture conservation in plantation areas. It is a practice of excavating trenches along a uniform level across the slope of land. Bunds are formed along the trenches on the downstream side with material taken out of them. The expected service life of a trench is about 3 to 4 years, after which, the vegetation is supposed to perform the conservation function.

Contour trench break the velocity of run off and store whole or part of runoff. If contour trenches are constructed on the slope at the interval, just before runoff water attains erosive velocity, their life will be much more. Trenches should be designed to store 60-70 per cent of runoff from 6 hours storm with 4 years return period in coarse textured soil (Sharda *et al.*, 2006). The intercepted runoff percolates through the soil slowly and is made available to the plants. The structural details of a contour trench have been mentioned in Fig. 5.5.

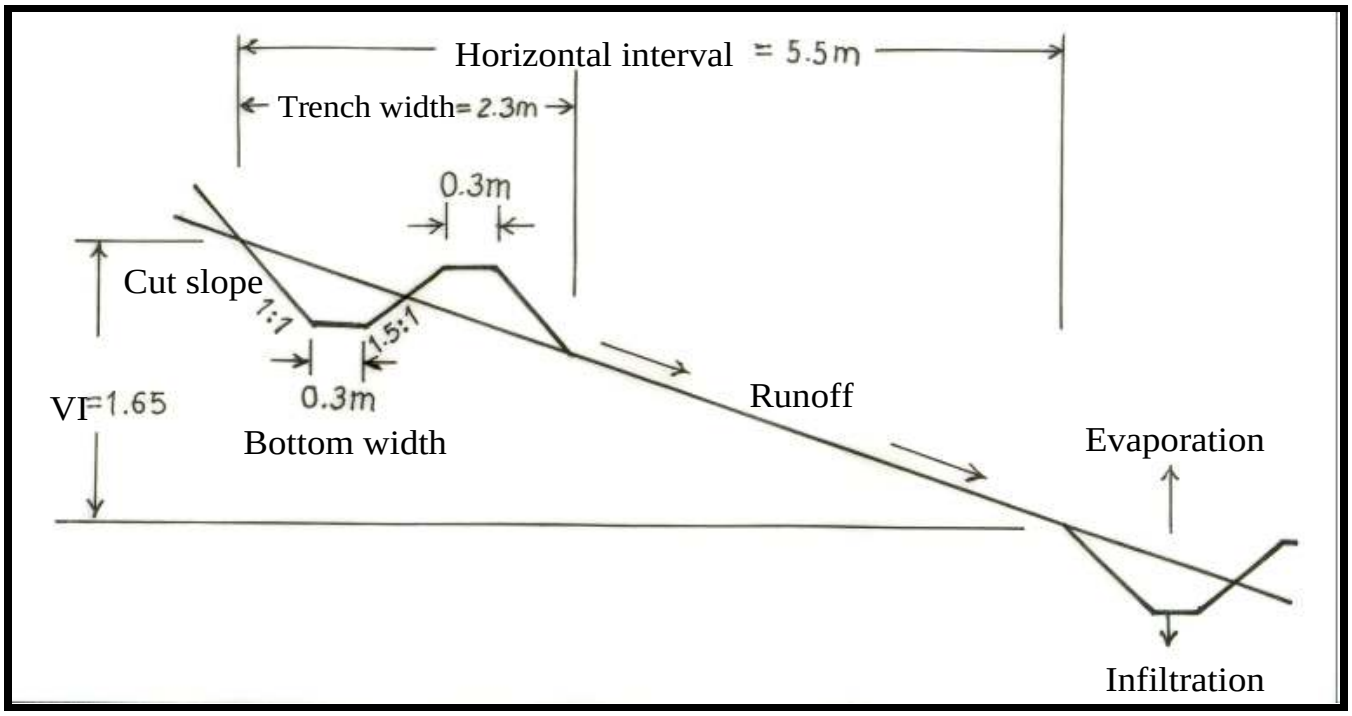


Fig. 5.5: Sketch of a contour trench showing various details

They are normally used in the upper portion of watershed for the plantation of forestry/horticultural plants. Fodder grasses should be planted on the bund and trees may be planted just downstream of the trench or in the trench itself in gravelly soil. Contour trenches are of two types:

5.4.1 Continuous trenches

The trenches are called continuous when there is no break in length and can be 10-20 m long across the slope depending upon the width of the field. Trenches are generally used in low-rainfall areas and dug with a cross section varying from 30 cm to 45 cm x 45 cm (Fig. 5.6).

5.4.2 Staggered trenches

These are generally made in high rain fall areas as there is a danger of overflow and breach in case of continuous trenches in such areas. In staggered trenching, the trenches are located directly below one another in alternate rows and in a staggered fashion. These may be 2 m to 3 m long and the spacing between the rows may vary from 3 m to 5 m (Fig. 5.7).

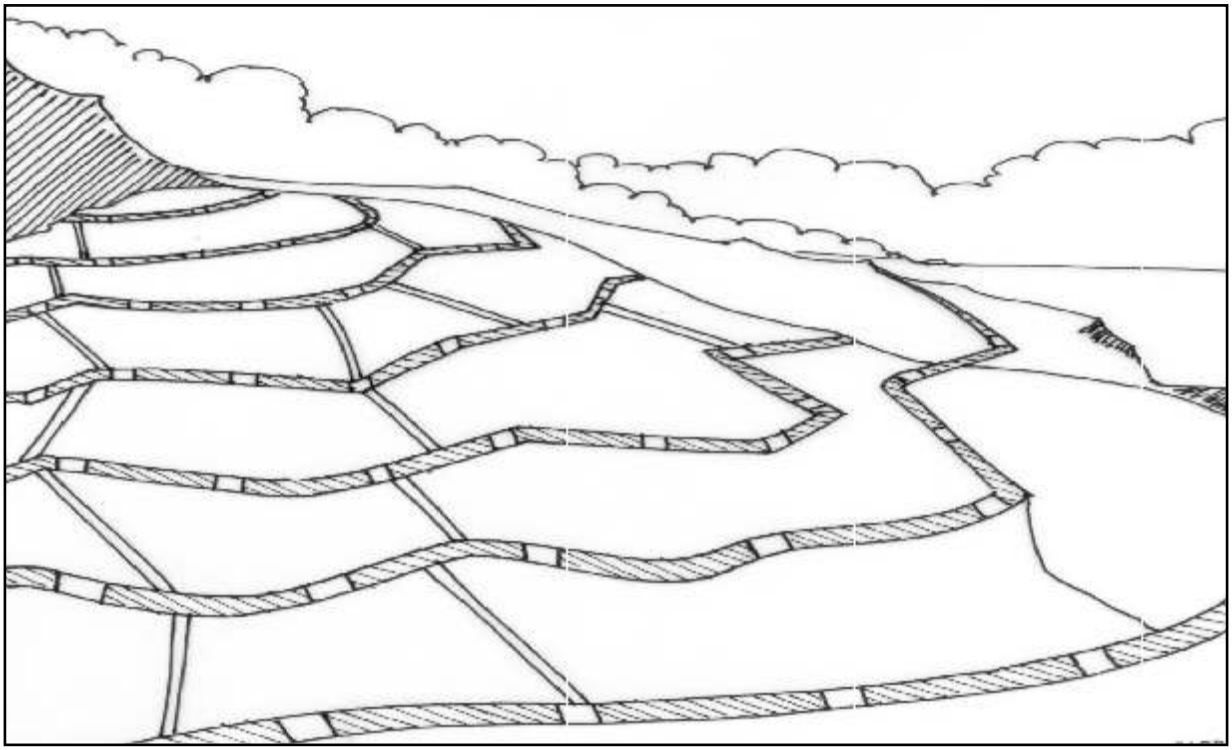


Fig. 5.6: Continuous trenching in hilly agricultural fields

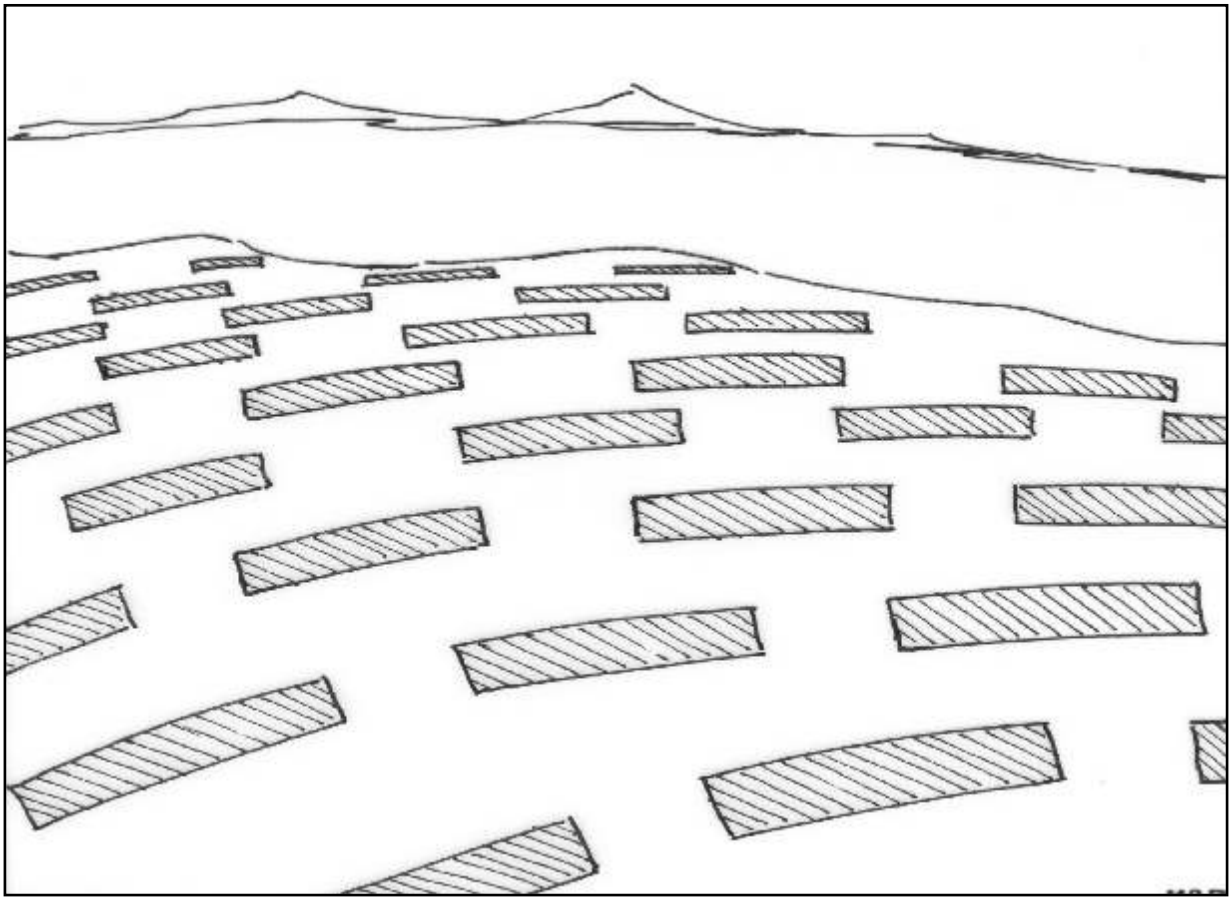


Fig. 5.7: Staggered trenching

5.5 STABILIZATION OF LANDSLIDES

5.5.1 Stream bank protection

One of the main reasons for the frequent occurrence of land slides in the hill areas is toe cutting by streams and rivers. In order to confine the flow and protect the bank, construction of spur walls/retards is desirable to deflect water of torrents from toe cutting of banks particularly at the curves. As a matter of fact R.C.C. block spur wall involves large scale work with heavy cost. Therefore, wire mesh boulder or stone spur walls must be constructed as there is no dearth of boulders or stones in the hills.

A method for locating the spur wall or retard is shown in Fig. 5.8. The first major retard at A is located by the intersection of the projected centre line of flow with the concave bank. In locating the second major retard C, a line HB is drawn parallel to the above projected centre-line and through the end of retard A. The intersection of this line with the concave bank locates point B. AC is then made equal to twice AB. Additional retards are located by intersection of a line connecting end points of two previous retards with concave bank (see D). An auxiliary retard at K is located at a distance AB upstream from A and is extended into the stream about one half the lengths of other retards.

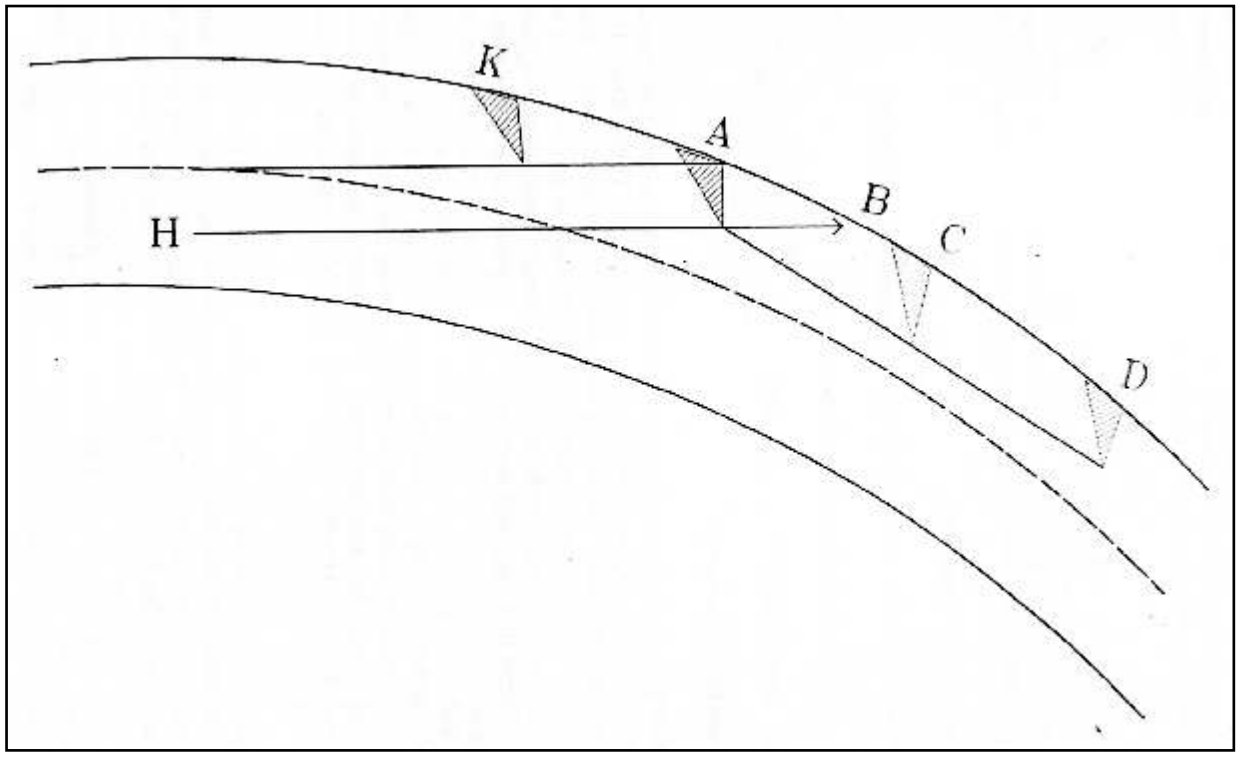


Fig. 5.8: Design and location of retards

The retard of spur walls should extend into the stream at an angle of 45 degree for a distance of about 30 per cent of the channel width. On small streams the spacing of retards may be made equal to stream width and length 0.25 times the spacing. In the silt setting between parallel lines of spur walls, species which grow well near stream beds should be planted e.g. *Alnus nepalensis*, *Ipomoea carnea*, *Populus ciliata, Salix, Vitex negundo* and local grasses etc.

5.6 STABILIZATION OF LAND SLIPPED SLOPES

Following measures are suggested for stabilization of land slipped slopes:

(i) **Protective measures against biotic pressure :**

Four strand barbed wire fencing should be erected around the affected area to prevent cattle, sheep, goats and other animals grazing in the area.

(ii) **Structural measures :**

Stone retaining walls along contour should be constructed to withhold and help in stabilizing the land slip.

(iii) **Vegetative measures :**

Slip area should be planted and well covered with quick establishing species of trees and shrubs e.g. *Agave, Alnus nepalensis, Ipomoea, Populus ciliata, Salix, Vitex, Woodlandia,* etc.

(iv) **Covering with netting :**

Wherever possible land slipped slopes should be provided with cover of wire netting, rope netting or sack (coarse jute fabric) etc. including wattling and mulching. Several types of netting can be used woven with wire, jute yarns or cannabis ropes etc. To use these nettings, slopes should be smoothened, seeded and fertilized and layer of mulch is spread and the netting unrolled over the mulch and anchored by wire staples.

(v) **Diversion channel :**

Diversion channel well above the landslide can check rain water coming to fragile site and divert it to safe natural course nearby.

5.7 DEVELOPMENT OF NATURAL PONDS, LAKES AND SPRINGS

Ponds and springs in the hills are of small size while lakes are quite large. Development of ponds and springs in the forest areas should be done according to the local conditions after consulting the villagers. If during consultation with the villagers technical shortcomings come to light, solutions should be decided again in consultation with the villagers for which a plan should be worked out keeping the following in mind:

(i) Topographic survey of ponds and springs falling in the area

(ii) Identification of problems such as premature silting, diversion of rain water, soil erosion etc. in the area.

(iii) Consultation with the local people and users.

(iv) Knowing the object of ponds, springs and lakes such as drinking water for cattle, irrigation and drinking water, seasoning of branches of 'Bhimal' and 'Bhang' for extracting fibre or any other purpose.

(v) Feasibility of action plan as per advice of villagers and technical problems.

Plate-5

Few Soil Conservation Measures Structures

Crate wire with loose boulders

Drain line treatment with stone wall

Stream bank protection

CONVERGENCE BETWEEN NREGA AND NAP

Convergence is an evolving process and while broad principles can be laid out at the Centre, the actual contours of convergence will be determined by the resources at the district and the field context. Also to fully identify the possibilities of convergence it may be necessary to make a beginning with select programmes so that the experience of implementation may further inform and refine strategies for convergence.

With this perspective a Task force on convergence with NREGA was set up with representative from different Ministries and Departments implementing programmes with complementarities with NREGA. The Task Force recommended beginning with select programmes of select Ministries. The Ministry of Forest and Environment which was represented on the Task force was identified as an important partner to NREGA, as afforestation and plantation are permissible activities under NREGA. Possibilities of convergence between NREGA and the programmes of MoEF were discussed between the two Ministries and based on these discussions, convergence areas and modalities were identified and the following guidelines for convergence of afforestation/plantation works taken up under NREGA and under the programmes of the MoEF.

6.1 CONVERGENCE BETWEEN NREGA AND NAP

6.1.1 Convergence between NREGA and NAP is mutually beneficial. Ministry of Environment and Forests has the task of achieving one third of the land area under forest and tree plantation as envisaged in the National Forest Policy, 1988. This cannot be accomplished by the MoEF alone due to enormity of the task. Convergence with NREGAS will provide additional resources. Operational guidelines of NAP also Suggest co-ordination with rural development programmes so that the forest fringe areas and community/privately owned forests can be developed on watershed approach in a holistic manner. The integrated area development approach with ecological concerns will benefit NREGA leading to better quality planning and selection of works capable of generating sustainable employment.

6.2 NATIONAL AFFORESTATION PROGRAMME (NAP)

6.2.1 NAP is being operated as a 100% Central Sector Scheme. The overall objective of the scheme is to develop the forest resources with people's participation, with focus on improvement in livelihoods of the forest –fringe communities, especially the poor. NAP scheme aims to support and accelerate the ongoing process of devolving Joint Forest Management Committee (JFMC) at the village level and Forest Development Agency (FDA) at the forest division level. Financial support under NAP Scheme is meant for afforestation. For its success, ancillary activities are supported as well. The financial support is available for:

(a) Afforestation – following models:
- Aided Natural Regeneration
- Artificial Regeneration
- Bamboo Plantation
- Cane Plantation
- Mixed Plantation of tree having MFP and medicinal value.
- Regeneration of perennial herbs and shrubs of medicine value.
- Pasture Development/Silvipasture

(b) Mobilization of village JFMC and Micro-planning in project villages.

(c) Soil and Moisture Conservation

(d) Entry Point Activity (for village development; average assistance Rs.4000 per ha of afforestation)

(e) Fencing, Monitoring and Evaluation, Training, Awareness raising

6.2.2 NAP is implemented through a 2-tier structure of Forest Development Agency (FDA) at the forest division level and Joint Forest Management Committee (JFMC) at the village level.

6.2.3 The decentralized, participatory management and the nature of works of NAP are both complementary to NREGA. NREGA is implemented by the PRIs with about 50% to be executed by *Gram Panchayats*. Line departments like the forest departments are also included among the implementing agencies and the norms are followed as of forest department. The project area under NAP are forest area and adjoining land areas including village common lands, community lands, revenue waste lands, Jhum lands and private lands, which are also covered under NREGA.

6.3 PARAMETERS OF CONVERGENCE

6.3.1 Works identified under NREGA for convergence will be planned and executed with the parameters of NREGA i.e.

a) The cost of material component of projects including the wages of the skilled and semi-skilled workers taken up under the scheme shall not exceed forty per cent of the total project costs.

b) As far as practicable, a task funded under the scheme shall be performed by using manual labour and not machines.

c) No Contractors

6.4 MODALITIES FOR CONVERGENCE BETWEEN NREGA WITH NAP

In operational terms, convergence of activities under NREGA and NAP will require coordination between these two programmes at the levels of

(i) Management

(ii) Planning

(iii) Works

6.4.1 Management

1. The DPC NREGA (Collector/CEO) will constitute a District Resource Group (DRG) at the district level with representative from the Forest Department (FDA CEO) and the department of Rural Development (NREGA and SGSY) and Panchayati Raj and a similar resource group at the Block level (BRG)

2. The group will facilitate

(a) **Knowledge sharing :** Familiarization of all the members of the group on guidelines of NAP and NREGA. This will clarify the programme parameters for what can be converged and what cannot.

(b) **Planning :** Since under both programmes, there are ongoing activities as well as that have to be planned afresh the group will have to determine the nature of interventions in the ongoing works and lay down a planning process that have to be planned a new.

(c) **Communication :** Since both programmes aim at participatory processes effective IEC with the local community, user groups, workers, forest dwellers, will have to be planned and implemented.

(d) **Training :** Training of personnel/agencies responsible for NREGS and NAP implementation must be planned and implemented.

(e) **Technical Support :** Techno-feasible norms for works selection, technical designs and appropriate technologies for afforestation and plantation projects will have to be formulated by technical expertise available for NAP. NAP should provide technical support for the supervision and evaluation of NREGA works so that they conform to appropriate designs and technologies.

(f) **Resource Pooling:**

(**i**) **Human:** Under NREGA dedicated personnel is to be deployed. In intensive afforestation/plantation works districts, some of the personnel could come on deputation from the forest department or some personnel with suitable qualifications for afforestation/plantation could be taken on contract.

(**ii**) **Financial:** Sharing of information on financial resources available and expected to be made available in the ensuing years. This will determine the quantum of works/activities that can be taken up and indicate where activity convergence will enable gap-filling or augmentation in scale/value and which activity is to be funded under which programme.

(**iii**) **Informational:** Data management could be converged through the use of NREGA MIS which provides work wise/beneficiary wise details. Any additional feature required by the NAP may be incorporated in the NREGA MIS after discussion with the Ministry of RD.

(g) **Monitoring and Evaluation :** Joint monitoring and supervision of activities should be planned. Baseline assessment, concurrent appraisal and documentation and evaluation of impact of NAP and NREGA on a set of indicators for eco-restoration as well as for local community needs could be initiated. Quantification of benefits of works undertaken could also be taken up.

6.5 PROCESSES FOR CONVERGENCE IN PLANNING AND THROUGH WORKS

6.5.1 Planning

6.5.1.1 Convergence of NAP will have to be both for preparing perspective plans and annual plans. Guidelines of NREGS stipulate the formulation of perspective plan to facilitate advance planning and to provide a development perspective for the district. The aim is to identify the types of NREGA works that should be encouraged in the district and the potential linkages between these works and long term employment generation and sustained development. The NREGA perspective plans identify the needs and gaps in the district in all sectors, not just related to works permissible under NREGA. Thus, afforestation/planning needs are to be factored in the NREGA perspective plan. Multi year planning of afforestation would be dovetailed in the NREGA perspective plan.

6.5.1.2 The Annual Work Plan (AWP) of NREGA lists the shelf of projects recommended by the Gram Sabha and finalized by the Gram Panchayat/IP/ZP. If the perspective plan has been made than the AWP will be broadly based on the perspective plan but must be endorsed by the Gram Sabha/PRLs as per the Act. The NREGA plan will be based on the permissible works under schedule one NREGA.

6.5.1.3 Micro plans would be prepared by the JFMC/EDCs as per NAP guidelines for NAP assistance and consolidated/vetted through FDAs for NAP founding.

6.5.1.4 A list of project activities to be planned for under NAP includes inter alia

i) *In situ* soil and moisture conservation measures,
ii) Soil and moisture conservation by constructing small scale engineering structures.
iii) Planting and sowing of multi-purpose trees, shrubs, grasses and legumes, as well as non-timber species.
iv) Fuel wood and fodder plantation including pasture development for meeting biomass needs of the rural communities.
v) Conservation *in situ* of medicinal plant species and augmenting their plant population by undertaking plantation in the watershed.
vi) Raising of Bamboo, cane plantation and medicinal plants.
vii) Raising of coastal shelterbelts in the problem areas.
viii) Cultural operations.
ix) Promotion of agro-forestry and sericulture etc. as appropriate.
x) Wood substitution and fuel wood conservation measures such as distribution of fuel efficient stoves.
xi) Measures needed to disseminate new technology.

All the activities / works listed above at serial number (i) to (ix) are also allowed/covered under NREGA. Therefore, a project covering forest area and adjoining land areas including village common lands, community lands, revenue waste lands, Jhum lands and private lands with watershed approach, will be prepared. Work required and covered under NREGA will be selected under NREGS. Works not allowed under NREGA but permissible under NAP will be selected under NAP.

6.5.1.5 The micro planning of NAP by the JFMs can be coordinated with the AWP planning of NREGA, so that selection of works under the NAP plan and under the NREGA AWP complement with each other.

6.5.1.6 For this purpose, block level resource persons may be trained on the programmes and the methodology of convergence between NAP and NREGA. They will guide the Gram Sabha in preparing the village plan. So that the micro plans of NAP and the AWP of NREGA complement each other and the selection of works and their sequence is dovetailed into a well-linked programme.

6.5.1.7 The institutional platform for such dovetailing will be the Gram Sabha at the village level and then the Gram Panchayat. The programme Officer and the BRG at the Block level and the DPC and the DRG at the district level will ensure that the selection of works under NREGS and NAP are in mutual coordination. The DRG will ensure that in converging the plans of both the programmes, the technical quality of the plan is maintained as per the norms of NAP as for example in the selection of tree/plant species, area of plantation/afforestation, (work location) technology and season of work. The Department of forest database of forest resource mapping for that district will be shared with the group to enable the formulation of feasible afforestation/plantation plans as the result of NREGA and NAP planning process.

6.6 WORKS

6.6.1 Works under NREGA may be at three levels: (i) Works approved in current shelf but not yet started (ii) ongoing works and (iii) Works completed (iv) Works yet to be selected for the next financial year (as part of the annual planning process). Therefore, convergence would need to be planned, keeping these varying stages of works.

6.6.2 The operation may be undertaken at three levels. In case of the first scenario, where works have been included in the shelf of projects, but not started yet, the shelf of projects formulated under NREGA may be re-scrutinized to assess the feasibility of works selected. The forest department may share their database on natural resources in that area/district especially on forest covers and so that it may be assessed that the selection of works is appropriate. If any correction is required it may be done. In case of the second and third scenarios, the expertise of the forest department should be marshaled for quality supervision and in planning the next set of activities. In case, land development has been undertaken (on individual /community land) plantation agroforestry projects may be taken up. The technical advice of the forest department may be considered for planning the next set of activities. The list of works completed/taken up will be shared with Department of Forest which will indicate appropriate activities/technologies for each work for value addition.

6.6.3 Convergence through works may be affected in some of the following ways:

a. Gap filling through NREGS for similar work under NAP
b. Dovetailing inputs into a common project
c. Area Approach

d. Value addition through NREGA to NAP works

e. Technical support for ensuring quality in planning, selection and execution of NREGA works.

(A) Gap Filling/ Enhancing scale

Under this permissible works may be converged for Gap Filling/Enhancing scale, mutually supplementing resources for common needs and inputs.

(i) Afforestation and tree plantation

The activities which can be covered under afforestation and tree plantation under NAP are,

a). Afforestation:

To cover degraded forest and barren land under afforestation.

b). Reforestation and Tree plantation:

- Eco -restoration,
- Avenue plantation,
- Road, Rail, Canal and Boundary plantation,
- Shelter belt plantation,
- Block plantation,
- Agroforestry.

c). Grassland Development and Silvipasture

Root stock regeneration, new plantation and Silvipasture can be executed on common/ panchayat/ revenue/ forest land under NREGS. Some forms of fencing like dry stone, ditch, organic fencing can also be taken up under NREGA. Activities relating to cut back, coppice, singling, requires semi-skilled or skilled labour. Skilled labour can be used for these activities and can be funded under NREGA provided that the 60:40 ratio (wage –material) is maintained since skilled labour is coated under material head. Boundary plantation and agroforestry on the land of SC, ST, BPL and beneficiary of LR and IAY can be taken under NREGS and on individual land other than these categories, these activities can be taken up under NAP.

(ii) Water conservation/ harvesting

Creation/rejuvenation of traditional water harvesting structures under NREGA should be taken up near plantation under taken by NAP for additional watering of plantations/afforestation in the arid and semi arid areas. This will help in creating vegetation that conserve water/act as sponge in medium to long term. Similar, contour trenches, check dams in the degraded forest lands in the vicinity of the habitations would help the biomass regeneration and part recharge water bodies.

Works on water conservation/harvesting which can be taken up under NREGA and also under NAP are:

a) Catchment area treatment,

b) Check dam,

c) Ponds,

d) Any other water conservation/ harvesting structure as per local requirement.

a) Catchment area treatment: The project area should be confined to recorded forest and adjoining land areas including village common lands, community lands, revenue waste lands, Jhum lands and private lands. To conserve rain water *in situ* and check soil erosion, treatment of catchment area falling in forest and surrounding area, be taken up on watershed approach by constructing contour furrows, continuous contour trenches, bunding, bench terracing and vegetative barriers etc. as per site requirement. Under this activity, the work on forest/ village common/ community/revenue waste lands and on the individual land of SC/ ST/ BPL/ Beneficiary of land reform and IAY can be carried out under NREGS and in addition supplement these works in FDA project area under NAP.

b) Check dam : Different types of temporary and permanent check dams in the drainage lines, falling in the area may be taken up on a watershed approach i.e. starting from ridge to valley. On forest/village common/ community/ revenue waste lands and on the individual land of SC/ ST/ BPL/Beneficiary of land reform and IAY these can be constructed under NREGS and in addition, supplement these works in FDA project area under NAP.

c) Ponds: Similarly the construction of different type of ponds i.e. Dugout ponds, Sunken ponds, Farm ponds and Village ponds etc. for storage of rain water and recharge ground water in the catchment area as per requirement and feasibility on forest/village common/community/revenue waste lands and on the individual land of SC/ST/BPL/Beneficiary of land reform and IAY be carried out under NREGS and in addition, supplement these works in FDA project area under NAP.

(iii) Land Development

Land development activities may be taken up under NREGA to rehabilitate degraded forest and wasteland. The entire activity of land development should be conceived of as a project, with a clearly laid out plan for land use after land development. If plantation/afforestation is planned, then the kind of plantation species to be used, the source of irrigation, protection can be taken up under NREGS and afforestation and plantation can be under NAP.

(iv) Roads

Maintenance of forest roads may be taken up under NREGA.

(B). Dovetailing inputs into a common Project

Under this, certain basic activities of a project may be through activities under NREGA. The activities that can be done under NREGS are:

(i) Closure by Dry stone wall, Ditch cum bund fencing,
(ii) Constructing Soil and water conservation structures,
(iii) Soil work for Contour trenches, V ditches, Digging of pits,
(iv) Seeding through NREGS labour,

(v) Weeding and Hoeing can be done through NREGS labour.
Following works may be carried out under NAP
(i) Raising Nursery
(ii) Transportation of plants to the planting site,
(vi) Application of Manure/ Insecticides
(vii) Protection from
- Frost
- Hot winds
- Grazing

(viii) Barbed wire fencing where other fencing not possible
ix) Watch and Ward

C) Area Approach

Certain activities required for integrated development of area (but permitted under NREGA) may also be taken up in the fringe area, through Forest Department as it will ensure uniformity and quality of approach guided ecological concerns. These include activities like irrigation facilities, land development, renovation of traditional water bodies, drainage and water logged areas.

(D) Value Addition

Through back-forward linkages for sustainable development NREGA can provide the primary input into natural resource generation. For it to become the basis of sustainable development back-forward linkages have to be worked out and the entire work be conceptualized as a project. The project approach must have a two fold objective: (i) ensuring that the work under NREGA is made durable through appropriate inputs (such as technologies not permitted under NREGA). This may normally imply moving form kuccha to pukka, (ii) Using the physical asset created under NREGA for economic activities in a way that the labour that has worked on that asset is able to earn an income from it.

Examples of this approach are :

- Land development (individual land of eligible categories under NREGA) and Agro-forestry on that land under NAP.
- Plantation.
- Minor Forest Produce (MFP) based activities- for MFP primary collectors- skill up graduation for primary processing of MFP, micro financing through SHGs, ware housing/cold storage facility of MFPs, common facility hubs-lathe machine/bamboo splitting machine etc.

6.7. IMPLEMENTATION AGENCIES

Beside the Forest Department and the Gram Panchayat, Joint Forest Management Committees may also be the implementation agencies.

6.8. NON –NEGOTIABLE IN WORK EXECUTION

(a) Only Job Card holders to be employed for NREGA component.
(b) Muster rolls to be maintained on work site with copies in the Gram Panchayat and to be electronically maintained on nrega.nic.in
(c) Social audits to be done through Gram Sabhas.
(d) Wage payment will be through no frills account in banks/post office.
(e) Financial assistance under NAP for ancillary activity can be provided only when afforestation under NAP is carried out.

6.9. PILOTS FOR CONVERGENCE OF PROGRAMMES

In selected districts representing Bio-Geographic zones, lot of projects on convergence may be taken up. These will be operationalised in accordance with the process suggested above. The pilots will be like action research and will be concurrently evaluated for identifying further possibilities and up scaling.

6.10. FUNDING WILL BE THROUGH NREGA AND NAP.

6.11. THESE GUIDELINES WOULD BE SUBJECTED TO EXISTING FORESTRY LEGISLATIONS /REGULATIONS.

SCHEDULE OF RATES FOR FORESTRY WORKS

7.1 SCHEDULE OF RATES FOR NURSERY RAISING

S. No.	Items of works	Unit of work	Zone A		Zone B		Zone C	
			Mandays	Rates (Rs.)	Mandays	Rates (Rs.)	Mandays	Rates (Rs.)
1.	Clearance of site	ha	4.11	300	4.11	300	4.11	300
2.	Clearance of *Lantana* infected areas	ha	13.70	1000	13.70	1000	-	-
3.	Digging of soil 25 cm to 30 cm deep two times (New Nursery)	ha	6.85	500	8.22	600	9.59	700
4.	Digging of soil second time, dressing and leveling (New Nursery)	ha	17.81	1300	18.49	1350	19.18	1400
5.	Earth work for levelling	Cum	0.21	15	0.22	16	0.27	20
6.	Digging, collection and cartage of soil, sand and manure in a ratio of 4:2:1	100 poly bags. (15cmx10 cm)	0.34	25	0.41	30	0.48	35
7.	Stone walling for making 'Pushta' in sloping land	Cum	1.23	90	1.30	95	1.37	100
8.	Preparation of nursery beds (3m x 1m)	Bed	0.16	12	0.18	13	0.19	14
9.	Sowing of seed and covering of beds.	Bed	0.02	1.25	0.02	1.5	0.03	2
10.	Sieving of soil, sand, removing twigs and green leaves etc. and rubbing the manure with hands for filling in polythene bags	100 bags	0.27	20	0.34	25	0.41	30
11.	Filling of polythene bags with potting mixture and placing them in beds	100 bags	0.34	25	0.41	30	0.48	35
12.	Sowing of seeds in polythene bags	100 bags	0.04	3	0.04	3	0.04	3
13.	Irrigation of nursery beds	ha	28.77	2100	31.51	2300	34.25	2500
14.	Transplanting of seedlings taken from nursery beds in bags/beds	100 seedlings	0.62	45	0.62	45	0.68	50
15.	Maintenance of nursery including watering, weeding, shifting of plants and replacement of mortality.	20,000 plants minimum	6 months	73/day	12 months	73/day	18 months	73/day

16.	Annual ploughing / digging of nursery beds 25 cm - 30 cm deep (old nursery)	ha	41.10	3000	45.21	3300	49.32	3600
17.	Preparing germination beds (3 m x 1m) by putting in soil, sand and manure, 7.50 cm thick including cost of manure for ball plants	Bed	0.14	10	0.16	12	0.19	14
18.	Shifting of ball plants							
a)	After 6 months	100 plants	1.03	75	1.03	75	1.03	75
b)	After 12 months	100 plants	1.64	120	1.64	120	1.64	120
19.	Cost of insecticides	100 plants	0.45	33	0.48	35	0.52	38
20.	Spraying of insecticides, when required (Labour)	20,000 plants	0.50	36.5	0.50	36.5	0.5	36.5
21.	Grading and shifting of seedlings (3 times)	100 plants	1.32	96	1.32	96	1.32	96
22.	Preparing root/shoot cuttings of teak, semal, shisham etc. including digging of plants, making ball plants (complete work)	100 plants	0.41	30	0.41	30	0.41	30
23.	Fixing root / shoot cuttings	100 plants	0.41	30	0.41	30	0.41	30
24.	Preparing branch cuttings of poplar, mulberry, pipal, bargad, gular, *salix* etc. and planting in beds	100 plants	0.41	30	0.44	32	0.48	35
25.	Planting of root / shoot cuttings	100 plants	0.07	5	0.07	5	0.07	5
26.	Making thatch covers for protection of plants from heat/ frost including cost and cartage of thatch grass and labour	bed 3mx1m	0.14	10	0.15	11	0.16	12
27.	Cost per Plant	Rupees	-	3.028	-	3.475	-	3.9904
	Or Say	Rupees	-	3.00 per plant	-	3.50 per plant	-	4.00 per plant

7.2 SCHEDULE OF RATES FOR PLANTATION WORK

S. No.	Items of work	Units	Zone A		Zone B		Zone C	
			Mandays	Rates (Rs.)	Mandays	Rates (Rs.)	Mandays	Rates (Rs.)
1.	Survey and demarcation	ha	0.48	35	0.49	36	0.51	37
2.	Clearance of site and cutting of shrubs and bushes							
a)	Normal shrubs and bushes	ha	4.79	350	5.14	375	5.48	400
b)	*Lantana* and heavy bushes	ha	13.70	1000	10.27	750	6.85	500
3.	Digging pits (Size 30 cm x 30 cm x 45 cm)	pit	0.03	2	0.03	2	0.04	3
4.	Filling pits (Size 30 cm x 30 cm x 45 cm)	pit	0.01	0.45	0.01	0.5	0.01	0.55
5.	Fencing		0.00		0.00		0.00	
a)	Cost of barbed wire	ha	33.56	2450	36.99	2700	41.10	3000
b)	Labour	ha	4.67	341	4.73	345	4.79	350
c)	Cost of fence posts	ha	13.70	1000	13.70	1000	13.70	1000
6.	Cutting and fashioning of fence posts 1.5 m to 3.05 m long, 15 cm to 30 cm diameter	100 posts	7.19	525	7.53	550	7.88	575
7.	Coaltaring both ends (labour only)	100 posts	0.89	65	0.89	65	0.89	65
8.	Digging holes (45 cm x 20 cm)	100 nos.	2.12	155	2.19	160	2.26	165
9.	Fixing of posts	100 nos.	1.85	135	1.92	140	1.99	145
10.	Stretching barbed wire	RM	0.68	50	0.75	55	0.82	60
11.	Cartage of fence posts including loading and unloading (by truck)							
a)	distance up to 10 km		0.08	6	0.10	7	0.10	7
b)	11 km to 15 km	Post	0.12	9	0.14	10	0.14	10
c)	16 km to 30 km	Post	0.14	10	0.15	11	0.15	11
d)	31 km to 45 km	Post	0.15	11	0.16	12	0.16	12
e)	over 45 km for every 10 km add 10%	Post	-	-	-	-	-	-
12.	Cartage of fence posts by mazdoors (maximum distance 3 km - 4 km)	Post	0.05	4	0.05	4	0.07	5
13.	Cartage of barbed wire (One roll – 50 kg)		0.00		0.00		0.00	
a)	By truck		As per Tpt. Rates		As per Tpt. Rates		As per Tpt. Rates	
b)	By pony	km	0.20	14.5	0.21	15	0.22	16
14.	Repair and up keep of barbed wire fencing	100 RM	0.22	16	0.23	17	0.25	18

15.	Putting thorny bushes along side fence	100 RM	0.96	70	0.96	70	0.96	70
16.	Digging of contour trenches							
a)	(a) Marking of trenches	10 RM	0.04	3	0.04	3	0.04	3
b)	(b) Digging of trench (30 cm x 30 cm x 45 cm)	10 RM	0.38	28	0.41	30	0.45	33
17.	Sowing seed in contour trenches	RM	0.00	0.25	0.00	0.25	0.00	0.25
18.	Sowing seed in pits	100 pits	0.11	8	0.11	8	0.11	8
19.	Cartage of polythene bag plants by truck. (15 cm x 10 cm bags)							
a)	Up to 10 km	plant	0.04	3.25	0.05	3.5	0.05	3.5
b)	11 km - 25 km	plant	0.03	2.55	0.04	2.7	0.04	2.7
c)	26 km - 50 km	plant	0.02	1.65	0.03	1.9	0.03	1.9
20.	Cartage of polybags plants by head load	100 bags/km	0.48	35	0.55	40	0.62	45
21.	Cartage of naked plants by head load	100 bags/km	0.06	4.5	0.07	5	0.08	5.5
22.	Planting of saplings	plant	0.01	0.75	0.01	0.8	0.01	0.85
23.	Weeding							
a)	1st (Including making Thanwala)	per plant	0.02	1.2	0.02	1.2	0.02	1.2
b)	2nd Weeding	per plant	0.01	0.4	0.01	0.4	0.01	0.4
24.	Weeding in second year and third year	per plant	0.01	0.4	0.01	0.4	0.01	0.4
25.	Cleaning of fire lines along the fencing	ha	0.70	51	0.75	55	0.82	60
26.	Wages of chowkidar	ha	10.34	755	10.34	755	10.34	755
27.	Second year maintenance	10 ha	36.30	2650	36.30	2650	36.30	2650
28.	Third year maintenance	10 ha	-do-	-do-	-do-	-do-	-do-	-do-
29.	Fourth year maintenance	10 ha	-do-	-do-	-do-	-do-	-do-	-do-
30.	Fifth year maintenance	10 ha	-do-	-do-	-do-	-do-	-do-	-do-
31.	Collection of Agave bulbs, cartage and planting	100 bulbs/km	0.68	50	0.82	60	-	-
	Total	400 plants/ha	280.82	20500	294.86	21525	308.22	22500
		800 plants/ha	332.88	24300	349.52	25515	366.16	26730
		1000 plants/ha	342.47	25000	359.59	26250	376.71	27500
		1600 plants/ha	413.70	30200	434.38	31710	455.07	33220

7.3 SCHEDULE OF RATES FOR SOIL AND WATER CONSERVATION WORKS

S. No.	Item of Work	Units	Zone A		Zone B		Zone C	
			Mandays	Rates (Rs.)	Mandays	Rates (Rs.)	Mandays	Rates (Rs.)
1.	Earth cutting							
a)	Earth mixed with boulders	m^3	0.27	20	0.30	22	0.34	25
b)	Hard rock	m^3	0.58	42	0.62	45	0.68	50
c)	Very hard rock	m^3	0.99	72	1.03	75	1.10	80
2.	Stone walling (including cartage of stones up to 33 m)	m^3	1.99	145	2.19	160	2.40	175
3.	RR Stone masonry (dry)	m^3	3.29	240	3.63	265	3.97	290
4.	Gabion structure (stones, cartage and cost of wire not included)	m^3	1.64	120	1.71	125	1.78	130
5.	Excavation of soil	m^3	0.36	26	0.41	30	0.48	35
6.	Cutting of wire mesh and bending	m^2	3.15	230	3.29	240	3.42	250
7.	Weaving of wire							
a)	4”x4”	metric ton	64.38	4700	65.89	4810	67.12	4900
b)	6”x6”	metric ton	63.01	4600	64.52	4710	65.75	4800
8.	RR stone masonry inside wire mesh (1.20+0.75) in sections 2 including cartage of stone up to 100 m	m^3	2.19	160	2.45	179	2.60	190
9.	Cartage of stones by							
a)	Head loads beyond 100 m	quintal/km	0.27	20	0.34	25	0.37	27
b)	By ponies	quintal/km	0.15	11	0.16	12	0.18	13
10.	Digging of protection ditch 1.20 m upper end, 0.80 m bottom, 1 m deep, digging and taking the dug earth out	m^3	0.53	39	0.62	45	0.68	50
11.	Making dumps of dug up soil and dressing (1.5 0 m+0.75 m)/2 m x 0.9 m	m^3	0.19	14	0.21	15	0.22	16
12.	Planting agave bulbs on above	RM	0.07	5	0.07	5	-	-
13.	Digging contour trenches (1m x 0.30 m x 0.20 m)	Trench	0.10	7	0.10	7	0.12	8.5
14.	Sowing of seed in dug soil	Trench	1.03	75	1.12	82	1.16	85

15.	Making wooden obstacle bunds							
a)	Digging of pits 30 cm x 45 cm x 90 cm for fixing live posts	Pit	0.05	4	0.06	4.5	0.07	5
b)	Fixing of live posts	100 posts	0.14	10	0.16	12	0.21	15
16.	Live hedge							
a)	Cutting, debarking, fashioning 1-8.3 m to 2.44 m long posts	100 posts	6.16	450	6.51	475	7.12	520
b)	Coaltaring both ends (labour)	100 posts	0.68	50	0.82	60	0.92	67
c)	Cartage of posts up to 3 km	km	1.92	140	2.19	160	2.44	178
d)	Digging holes 30 cm x 45 cm	100 hole	1.64	120	1.85	135	2.04	149
e)	Fixing of posts	100 posts	1.16	85	1.23	90	1.42	104
f)	Stretching barbed wire, fixing staples and cartage of barbed wire inside work site	100 m	0.96	70	1.10	80	1.22	89
g)	Cartage of barbed wire (50 kg bundles by head load)	km	0.25	18	0.32	23	0.37	27
17.	Digging holes for fixing live posts (75 cmdeep x 25 cm diameter)	100 holes	2.74	200	2.78	203	3.42	250
18.	Cartage of live posts by truck							
a)	Up to 10 km	post	0.05	4	0.07	5.2	0.08	6
b)	11 km -15 km	post	0.08	6	0.10	7.4	0.12	8.5
c)	16 km -30 km	post	0.10	7	0.12	8.9	0.14	10
d)	31 km - 45 km	post	0.11	8	0.14	10	0.16	12
e)	Over 45 km per 10 km	post	10% rise/10 km.		10% rise/10 km		10% rise /10 km	
19.	Collection of stones (breaking, digging and collecting)	m^3	0.21	15	0.25	18	0.27	20
20.	Excavation of foundation		0.00		0.00		0.00	
a)	Up to 15% bajri mixed soil	m^3	0.25	18	0.31	22.3	0.34	25
b)	16 to 50 % bajri mixed soil	m^3	0.34	25	0.41	30	0.48	35
c)	Over 50% bajri mixed soil	m^3	0.44	32	0.49	36	0.55	40
21.	Vegetative obstacles and Wattling works							
a)	Digging pits for fixing posts (30cm x 45 cm x 90 cm)	post	0.03	2.5	0.04	2.6	0.04	2.65
b)	Fixing posts and Wattling works	post	0.08	5.5	0.08	5.7	0.08	5.75
22.	Digging pits for fixing brush wood and planting live hedge	100 pits	1.34	98	1.34	98	1.34	98

7.4 SCHEDULE OF RATES FOR FIRE PROTECTION WORK

S. No.	Item of Work	Units	Zone A		Zone B		Zone C	
			Mandays	Rates (Rs.)	Mandays	Rates (Rs.)	Mandays	Rates (Rs.)
1.	Plantation Areas							
A.	Cutting and burning of fire lines							
a)	15 m wide	km	9.14	667	9.86	720	10.96	800
b)	10 m wide	km	8.62	629	9.45	690	10.27	750
c)	7.5 m wide	km	7.07	516	7.67	560	8.22	600
d)	6 m wide	km	6.04	441	6.58	480	6.85	500
e)	3 m wide	km	5.08	371	5.48	400	5.89	430
2.	Other areas							
a)	30 m wide	km	6.55	478	5.34	390	5.14	375
b)	15 m wide	km	5.52	403	4.36	318	4.18	305
c)	10 m wide	km	4.58	334	4.36	318	4.36	318
d)	7.5 m wide	km	4.05	296	3.40	248	2.99	218
e)	6 m wide	km	3.10	226	3.04	222	3.04	222
f)	4.5 m wide	km	2.95	215	2.95	215	2.95	215
g)	3 m wide	km	2.49	182	2.55	186	2.55	186
h)	2.4 m wide	km	1.93	141	2.04	149	2.04	149
i)	1.4 m wide	km	1.74	127	1.74	127	1.74	127
B.	Cutting and burning of Compact lines							
a)	3 m wide	km	1.74	127	1.64	120	1.59	116

7.5 SCHEDULE OF RATES FOR HABITAT IMPROVEMENT/ PASTURE LAND DEVELOPMENT

S. No.	Item of Work	Units	Zone A		Zone B		Zone C	
			Mandays	Rates (Rs.)	Mandays	Rates (Rs.)	Mandays	Rates (Rs.)
A.	*Lantana* eradication							
1.	Areas covered by Lantana up to 50%							
a)	1st year	ha	41.10	3000	41.10	3000	-	-
b)	2nd year	ha	8.22	600	8.22	600	-	-
c)	3rd year	ha	4.11	300	4.11	300	-	-
d)	4th year	ha	2.05	150	2.05	150	-	-
e)	5th year	ha	2.05	150	2.05	150	-	-
2.	Areas covered more than 50% by *Lantana*							
a)	1st year	ha	68.49	5000	68.49	5000	-	-
b)	2nd year	ha	13.70	1000	13.70	1000	-	-
c)	3rd year	ha	6.85	500	6.85	500	-	-
d)	4th year	ha	3.42	250	3.42	250	-	-
e)	5th year	ha	3.42	250	3.42	250	-	-
B.	Cutting, collecting in heaps and burning of bushes							
1.	*Lantana* infected areas	ha	11.64	850	8.22	600	-	-
2.	Other areas	ha	5.32	388	2.40	175	2.74	200
C.	Digging of grass for planting and cartage to the planting site	100 bunch	0.34	25	0.34	25	0.34	25
D.	Planting of grass	100 bunch	0.22	16	0.27	20	0.27	20
E.	Watcher (area per month, Rs. 800/- minimum)	Month	10.96	800 (5ha)	10.96	800 (3 ha)	10.96	800 (3 ha)

7.6 SCHEDULE OF RATES FOR COLLECTION OF SEEDS FOR NURSERY RAISING

S. No.	Species	Rate (Rs. Per kg.)	S. No.	Species	Rate (Rs. Per kg.)
1.	Aam (Deshi)	13.00	42.	Parkinsonia	52.00
2.	Arjun	10.00	43.	Jangal jalebi	55.00
3.	Amaltas	19.00	44.	Jhingan	21.00
4.	Ashoka	13.00	45.	Jarul	103.00
5.	Amla	60.00	46.	*Jacarenda*	110.00
6.	*Ailanthus*	21.00	47.	Jamnoi	13.00
7.	Akhrot (Deshi)	55.00	48.	Kachnar	46.00
8.	Angu	87.00	49.	Kharpat	30.00
9.	Aaru	26.00	50.	Kath Sagaun	38.00
10.	Arandi	30.00	51.	Kadam	103.00
11.	Bahera	40.00	52.	Kanju	15.00
12.	Bakain	8.00	53.	Kharik	116.00
13.	Baurang	38.00	54.	Kala Seris	23.00
14.	Bamboo	256.00	55.	Kanchula	82.00
15.	Bhojpatra	125.00	56.	Kingora	400.00
16.	Bhotia Badam	78.00	57.	Kaner	38.00
17.	Burans	45.00	58.	Kwiral	60.00
18.	Banj	72.00	59.	Kaphal	38.00
19.	Bhimal	112.00	60.	Madar	118.00
20.	Bedu	82.00	61.	Morpankhi	80.00
21.	Bakli	24.00	62.	Maljhan	32.00
22.	Bel	117.00	63.	Mehal	5.00
23.	Chandan	30.00	64.	Neem	13.00
24.	Chir	275.00	65.	Nimbu	24.00
25.	Cheura	53.00	66.	Phaldu	38.00
26.	Cham Kharik	188.00	67.	Poola	40.00
27.	Darli (Cleaned)	300.00	68.	Putli	50.00
28.	Dhauri	26.00	69.	Padam	72.00
29.	Deodar	250.00	70.	Pangar	13.00
30.	Dudhiya tushar	47.00	71.	Papri	88.00
31.	*Eucalyptus*	105.00	72.	Ringal	38.00
32.	Fur and spruce	302 37.00	73.	Ritha	65.00
33.	Gamhar	21.00	74.	Robinia	38.00
34.	Gulmohar	30.00	75.	Sal	10.00
35.	Genthi	195.00	76.	Safed siris	21.00
36.	Ghingaru	44.00	77.	Sandan	40.00
37.	Gutel	7.00	78.	Shisham	13.00
38.	Haldu	38.00	79.	Shahtoot	82.00
39.	Harar	60.00	80.	Semal	43.00
40.	Jamun	15.00	81.	Silver Oak	103.00
41.	Utis	120.00			

GLOSSARY OF THE TECHNICAL TERMS

Afforestation : Establishment of ground cover of trees, shrubs and grasses on a barren land where no forest existed until fifty years ago or earlier- reforestation.

Agri-shade net: Netting made of synthetic material which comes with different shading factors i.e. allowing different percentages of sunlight to pass through. A 60% shade net, for example, will block only 40% of the sunlight. It is used in high value crops and nurseries where strong sun is likely to damage the crop or the plants.

Agroforestry: The practices of planting trees on agricultural farms, especially on peripheral bunds of fields, for simultaneous production of food crops and trees. As a production system, agroforestry is superior to pure cropping. Trees, apart from bringing up nutrients from the deeper layers of soil, provide shelter, maintain temperature moderation and humidity in the atmosphere, improve the organic content of the topsoil and promote fertility enhancing soil-fungi such as the root associative mycorrhizae and the nitrogen fixing rhizobia.

Air-layering: A technique of plant propagation wherein a branch of an adult tree is debarked and tied with moist cloth and moss, leading to development of shoots and roots which are then carefully removed as an independent plant.

Bare root plants: Plant not transplanted with ball of soil around the roots (and probably not raised in containers). Such plants are uprooted from the ground where they grow and are then planted with roots naked i.e. cleared of earth. Only certain species can tolerate naked root handling in arid climate.

Beating up: Replacing dead plants during the out planting operation, in order to avoid gaps in the plantation. This operation is a part of the planting operation itself and should be considered separate from replacement of casualties which is carried out in the same season of the next year.

Bed: A plot of ground prepared for growing of stocking plants. A container bed is a strip of dug up ground meant for retaining plant containers in erect position. It is also called a stand out bed. It is called a polypot bed if the predominant type of containers used is polypots. For brevity, it may also be called a polybed. A sunken bed is one that has its bottom level below the ground level. A raised bed has its bottom level higher than the ground level. A germination bed is specially prepared raised bed of 10 to 15 cm height made up of fertile soil meant for sowing of fine seeds. It is also called a seedbed. The plantlets after germination in a seedbed are pricked out and transplanted. A mother bed is a plot of land for growing plants to a larger size, usually of one year or more. It is also called a growing bed or a field.

Bench terraces: Terraces prepared by cut and fill method on steep slopes in order to prevent soil erosion and to improve moisture retention. Bench terraces are prepared along contours (and are also known as contour terraces). The terraces can be made level, or provided with a small reverse slope. In areas with better rainfall, a longitudinal grade may also be provided.

Biotic pressure: The pressure of interference in the natural ecological processes in a place exerted by human and animal agents. Grazing, wood collection and destruction of vegetation are the predominant activities constituting biotic pressure.

Check dam: A structure built on natural water courses, streams or rivulets, to check, obstruct or slow down the flow of water. It is meant to prevent water from building up velocity and thereby carrying heavy charge of silt, thus serving the dual purpose of preventing soil erosion and improving soil moisture. Check dams can be pervious, such as the loose stone check dams, or impervious, such as those over dumped with alternate layers of clay and humus.

Contour bund: An embankment of earth constructed on contour to check flow of water. A contour bund has a definite section. Usually trapezoidal in shape, with sectional area ranging from 0.50 to 2.50 m^2

Contour furrows: Furrows made by ploughing ground on contour line, these can also be made by manually excavating ground where a tractor cannot be used or is not available. Contour furrows are meant to harvest surface runoff and to conserve soil. These are used in areas with a ground slope less than one per cent and where grass or legumes are to be sown on a large scale, such as in silvi-pastoral plantations.

Contour line: A line on a map or drawing representing points of equal elevation on the ground. These lines connect a series of points of equal elevation and are used to illustrate topography or relief, on a map. They show the height of ground amsl in either feet or meters and can be drawn at any desired interval. For example, numerous contour lines that are close together indicate hilly or mountainous terrain; when far apart, they represent a gentler slope.

Contour trench: A trench of square or rectangular cross section excavated on a contour line for the purpose of arresting flow of water in sloping ground. Its section depends upon depth of soil and its excavatability. Usually sectional area ranges from 0.10 to 0.30 m^2. Spacing between two contour lines for c-trench is so designed that the runoff resulting from the average expected precipitation can be effectively intercepted.

Contour vegetative hedge: A linear growth of vegetation consisting of small trees, shrubs legumes or other perennials running on a contour and acting as a barrier to soil erosion. Since a vegetative hedge lasts longer than other barriers like excavated trenches or dikes of stones, these are often created in conjunction with the latter. The bund of a contour trench or a V-ditch is sown with seeds of shrubs and trees, at a close spacing, so that eventually as the soil bund fuses into the ground the vegetative hedge emerges to become a permanent soil and water conservation structure.

Coppice: Re-growth of a plant from its stump after it has been cut. A tree should be cut close to the ground for early and strong coppices. Not all plants will coppice, whereas certain plants will coppice more vigorously than others.

Culling: Removing or rejecting the inferior species of plants. It prevents inferior plant material from reaching the plantation site.

Culm: The individual stem or stalk in a clump, specifically, the monocotyledonous stem of bamboo or grass.

Cuttings: Vegetative pieces of plants meant for propagation in nursery. Propagation from stem cuttings or branch cuttings is by far the most effective method of multiplying a germplasm. Certain species, however, are first raised by the seed and then young seedlings are uprooted and their root-shoot cuttings are grown in containers or field in order to get better girth and stout plants. The practice is commonly used in case of timber species.

Dibbling: Method of seed sowing by making small holes in ground or soil and inserting seeds into them.

Energy plantation: A plantation specifically raised for production of biomass for conversion into energy. The mode of conversion of biomass into energy can range from burning fuel wood in households to using sophisticated gasifier for production of electricity.

Exotic species: Species not native to the place of plantation. These are brought from another place, region or maybe country, because of their certain special advantages, especially, in terms of economic returns. Usually exotic species will not do well to the ecology of the place.

Grading: Sorting or arranging plants in a nursery in order to remove certain fraction of them that are poorest in terms of quality.

Grafting: An asexual method of plant propagation wherein a cutting of desired plant material, the scion, is specified with the rootstock and tied firmly so that the two fuse together and become one plant.

Mortality: The ratio of the number of plants that have died to the total number of plants originally planted in a given plantation. It is expressed as a fraction or in terms of percentage.

Mulch: A protective covering of compost, brushwood, or other material spread or left on the ground to reduce evaporation, maintain even soil temperature, prevent erosion, control weeds and to enrich the soil.

Mulch lines: In sand dune stabilization, the lines of brushwood mulch erected into sand to act as micro-windbreaks and to check movements of sand. Mulch lines can aligned in a parallel pattern running across the prevailing direction of winds, or in a checkerboard pattern of square grids, or in the masonry pattern of staggered squares.

Organic matter: Matter of plant or animal origin, as contrasted against inorganic or mineral matter. Organic matter in a soil determines its structure and fertility. In arid areas the soils are often deficient in organic matter and that is why removal of plant produce from such areas should be carried out carefully.

Out-planting: Planting the nursery raised seedlings into field.

Over-seeding: The practice of sowing seeds, especially of grass, in an area to supplement the natural seed dispersal in the area.

Pesticide: A substance, usually toxic chemical, meant to destroy pests. Pesticides can lead to the serious problem of polluting the environment, especially if these do not break down in short time. Use of pesticides with a very long life, such as Aldrin has been banned in most countries.

Plantation: A large group of trees planted in a tract of land, usually fenced or delineated with a boundary. Planting of nursery raised seedlings is necessary to supplement the natural vegetation growth, especially in arid and semi-arid areas.

Plantation calendar: A schedule prescribing the dates and periods for the different activities involved in raising of a plantation.

Plantation journal: A book that serially records all the events, work done and expenses incurred on a plantation, usually in a pre-set format. The plantation journal of a work is an original record containing the history of that work.

Planting pits: Pits dug in field for planting. Pits benefit plants in many ways, chiefly by providing loose porous soil for easy root penetration and increased water holding.

Plus trees: Trees identified as of superior phenotype and possibly of superior genotype. Such trees are used as a source of plant material, such as seeds and cuttings for propagation purposes.

Polypots: Tubes made of polyethylene, usually LDPE, and sealed at one end to be used as pots in nursery. In nurseries with large scale production of containerized plants, the polypots have proved to be the most economic, versatile and convenient containers.

Potting mix: Mixture of earth and manure with a good level of fertility and drainage to be used as a medium of growth for plants to be grown in pots.

Pricking out: The process of removal of the young seedlings from one seedbed to another, or from a seedbed to containers.

Prickling: A seedling in a seedbed fit to be pricked out.

Propagation losses: Loss in plant material in the process of plant propagation in nursery. Propagation losses can be very high in certain methods whereas these are insignificant in others.

Provenance: The characteristic source or place from where seeds or plants were obtained.

Pruning: The practice of cutting of parts of plant, usually unwanted branches, for better shape and more fruitful growth.

Recalcitrant seed: Seeds having excessive moisture and low viability. Recalcitrant seeds cannot be dried to room temperature e.g. muli bamboo and neem.

Rhizome: An elongate horizontal subterranean plant stem that is often thickened by deposits of

reserve food material, produces shoots above and roots below and is distinguished from true root in possessing buds, nodes and perhaps scale like leaves.

Root pruning: Pruning of roots, especially of the overgrown roots emerging out of the pot, in order to encourage development of a compact fibrous root system.

Root sucker: Shoot rising from the root of a woody plant. Also called sucker.

Rooting hormones: Chemical substances that stimulate growth of root from the vegetative part of plant.

Root shoot ratio: The ratio of the total mass of a plant contained in the roots to that in the shoot. The concept is useful in defining balanced development of a healthy plant in nursery. If growth of roots is constrained and the root mass is small compared to the shoot, the plant roots may not be able to meet the larger shoot's demand of nutrients when it is planted out in field.

Rose can: A can fitted with a spout ending in a circular piece of perforated sheet so that water can be evenly sprayed over plants in nursery to avoid dislodgement of soil particles while watering.

Secateurs: Pruning shears or cutters with narrow blades but powerful leverage to allow cutting of thick branches.

Seed treatment: The operation of softening, scarifying or cracking the seed coat for easy and quick germination. Seeds of many species have very hard seed coat which may not break or whither for a very long time, thus leading to delayed germination. The usual methods prescribed for treatment of such seeds before sowing include soaking of the seeds in boiled water or in sulphuric acid, mechanically scarifying the seeds, burying the seeds in a pit covered with moist soil or slurry and alternate wetting and drying in the open.

Seed viability: The period over which the seed will retain its germination capacity within specified limits.

Seeding time: Time of the year when a particular species of plant bears seeds. Often seeding in plants occurs in a particular season, whereas in case of certain species, seeding may be a continuous process throughout the year.

Seedling : A young plant grown from seed.

Stump cutting: Root shoot cutting

Survival: The ratio of plants living at the end of a specified period from out-planting, to the total number of plants originally planted.

Tall plants: Plants raised specifically over a longer period, usually two years or more in nursery, so that these may survive the harsh conditions of arid climates better.

Transplanting: To lift and reset a plant in another soil or situation.

Vegetative propagation: Propagation by non-sexual processes such as by cuttings or tissue culture.

Wasteland: Barren or uncultivated land not producing anything or producing far below its optimal level.

Watershed approach: An approach of treating a large tract of land by dividing it into watersheds based on drainage lines and proceeding to comprehensively treat one watershed before going to another.

Watershed recharge: Amount of precipitation that percolates into the soils of a watershed and then appears as subsurface water in springs and wells.

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