WASTELAND UTILIZATION FOR FODDER AND FIREWOOD PRODUCTION FROM HIGH DENSITY PLANTATIONS IN THE NORTH WEST HIMALAYAN REGION

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FOREWORD

Availability of biomass to fulfil energy requirements of rural communities is a major concern for land use planners and conservationists. Increasing cost of energy and deficit in fodder availability have led to severe hardships of small and marginal farmers who are forced to burn available biomass for cooking food and leave their animals for open access grazing in forest areas leading to more damage. Extensive degradation of forests all over the country by illicit biomass collection has already occurred and there is an urgent need for developing technologies of producing renewable biomass at low cost from wastelands.

Short rotation forestry practices implemented on wastelands can be an effective low cost technology for the production of biomass that can directly benefit hundreds of farm families who depend on subsidized energy provided by the state or collect them from various sources. This system provides green leaf fodder of about 0.84 t/ha on an annual basis for a period of 12 years after which large quantities of woody biomass (ranging from 42 to 131 t/ha) becomes available consequent to thinning of trees at seven and twelve years. This practice can be adopted by rural communities and even state forest departments to produce firewood at low cost in close vicinity to settlements.

In this brochure, technology for the production of firewood and small quantities of fodder developed by Central Soil and Water Conservation Research and Training Institute, Dehradun have been described for the benefit of small and marginal farmers in the foothills of Western Himalayas. This technology can be used for the productive utilization of old river bed lands presently lying unutilized. I congratulate the authors for bringing out this useful publication.

(P. K. Mishra)
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INTRODUCTION

Shortage of firewood occurs all over India and rural populations either collect dry twigs and branches from forest areas or use alternate sources of energy like cow dung for meeting their energy requirements. Utilization of wastelands for production of firewood and fodder is a viable option to partially meet energy and fodder demands from sites situated in close vicinity to habitation. Illicit collection of biomass from notified forest areas causes serious disturbances to the ecosystem which is difficult to restore.

Erosion in the upper Himalayan regions leads to frequent flooding and over flow in rivers in the valley portions and consequent deposition of slope forming material along river banks which consists chiefly of coarse sand, gravel and stones of various sizes. Nearly 2.73 m ha is affected by these deposits in the Himalayan foothills where most of these lands remain unutilized.

About the technology

The practise of growing trees at close spacing and harvesting them mechanically at a fixed time interval is called as high density forestry. Nutrient recycling by trees through litterfall enriches the soil surface and builds up organic carbon. Firewood requirements are high in most villages in the lower Western Himalayan region. Village wastelands can be utilized for the production of firewood at periodic intervals and also small quantities of green leaves and woody biomass from annual tending of the stands.

TECHNOLOGY DEVELOPED

Trees for firewood production are established on marginal lands which are not fit for crop or fruit cultivation. Species selected for planting should be hardy, stress tolerant and produce non-toxic wood which is easy to burn. These plantations could be raised on old river bed lands, community owned wastelands, shallow soils not fit for agriculture or fruit cultivation.

Selection of tree species for planting

The species selected for this production system should have the following characteristics-

- Species should be capable of growing in moisture stressed conditions for nearly eight months in a year

- They should be frost tolerant
- Species should be easy to establish after planting out
- Species should be medium to fast growing with long clean stems and minimum of branching
- Foliage should be palatable and non-toxic
- Stem should be thorn less and gum free
- Suitable species are *Ailanthus excelsa, Bauhinia variegata, Dalbergia sissoo, Gmelina arborea, Grewia optiva, Grewellia robusta,Morus alba.*
- *Dalbergia sissoo* prefers to grow in riverine sites and is popular for high quality timber at long rotations of 60-70 years (Photo 1), but it can also be grown on similar sites as high density plantations exclusively for firewood production with high calorific value.

Photo:1 View of *Dalbergia sissoo* stand on an old river bed

Criteria for Site Selection

- Community owned sites lying barren, situated in close vicinity to settlements should be preferred. Even privately owned sites may be chosen for biomass production.
- Sites with shallow soil depth (<40 cm), mildly sloping or flat can be selected.
- Sites should not have water logging in the monsoons.
- Sites should be kept free from fire and protected from free grazing cattle.
- The planting area should be demarcated by either stone walling the perimeter or planting of thorny bushes for protection.

Site Preparation

- Prior to planting of seedlings, the area should be made free from all weeds, old stumps and unwanted vegetation
- Make pits with a crow bar of size 60 cm^3 in April-May at spacings of 2x2 m (2500 seedlings/ha), 3x2 m (1666 seedlings/ha), 4x2 m (1250 seedlings/ha).
- Remove stones and gravel from the dug out pit, add 2 kg manure to the soil, mix well and fill back the pit with this filling mixture. Add 5 gm of Chloropyriphos to the mixture if the site has termite infestation problem.
- For clayey soils, add 1 kg coarse sand to make the pit filling mixture porous so that water may percolate into the pit.

Planting of Tree Seedlings

- Obtain healthy desired seedlings from a recognized nursery.
- Seedlings should be 1 year old and about 1 m tall (3 feet high). Plant seedlings in the prepared pits in the 1st week of July. Keep seedlings straight and press soil firmly around the base, when planting.
- After planting of the seedling, make a small basin around the base to collect rain water which will help in seedling establishment.
- After 2 weeks of planting, remove all unwanted side branches in all seedlings leaving straight clean stems to grow into the pole stage.

Cost of Establishment

- Cost will vary with location and condition of site selected for planting

Activity	Cost (₹)
A. Cost of cleaning the area (per ha) including removal/ burning of unwanted vegetation	3000/-
B. Cost of seedling planting	
Pitting with crow bar	3/- each
Seedling cost	5/- each
Planting cost of seedling	2/- each
Basin making around each seedling	3/- each
C. Total cost per seedling planted	13/- each
D. Total cost per ha for 2x2 m spacing (2500 plants)	27,500/-
E. Total cost per ha for 3x2 m spacing (1666 plants)	18,326/-
F. Total cost per ha for 4x2 m spacing (1250 plants)	13,750/-

Calculated for 2011 prices

- If the community is involved in the establishment of the plantation, then cost will be reduced.

Maintenance and Management of Area

Site prepared for the establishment of plantation requires regular cleaning for the first four years in order to remove weeds and climbers. Tending of seedlings for obtaining straight stems and removal of unwanted side branches is carried out from the fourth year till the time the trees attain the pole stage and no side branches are developed. The important steps to be followed are-

- After planting of seedlings is completed by the 2nd week of July, careful weeding should be carried out by the 2nd week of September. All unwanted branching in the seedlings should be removed by a pair of secateurs.
- Second weeding should be completed by the end of February and all dead and dying vegetation should be removed. Dead seedlings should also be removed and pits re-dug for planting next year in July.
- Repeat annual tending and weeding exercises twice a year for the next 4 years
- Begin pruning of all side branches upto a height of 1.5m in all stems from the 4th year after the monsoon, using a sharp saw or axe.
- Separate leaves to be used as fodder and woody biomass to be dried and then used as firewood.
- Repeat this step every year after the monsoons till the 11-12th year or till the time when the side branches stop appearing and growing on the stems at different spacings.

Thinning of Stands

- The first mechanical thinning is done when the plantation is seven years old followed by another thinning when the plantation is 12 years old.
- During the first thinning of stands, every alternate tree in each row is harvested irrespective of its growth, while in the 2nd thinning the remaining trees are harvested.
- Trees are harvested by clear felling 10 cm from the ground level, making a clean cut using a sharp axe or saw.
- After felling, the small and large woody components are separated for drying and use as firewood (Photo 2) while the green foliage is used immediately as fodder.
- The same steps of cleaning and weeding are repeated every year till the 12th year when the next felling cycle of the remaining trees is carried out in the same fashion.
- Under suitable site conditions, species like *Grewia optiva* and *Dalbergia sissoo*, may produce coppice from the stumps. These shoots can again be allowed to grow to a height of 2 m after which they can be thinned and only healthy shoot retained for the next 5-6 years for harvest at a later date.

Photo: 2 View of harvested fire wood from *Grewia optiva* trees

TECHNOLOGY IMPACTS AND BENEFITS

- Utilization of non-arable lands for biomass production using fast growing short rotation tree species which can provide fodder from annual prunings and firewood from clear felling at fixed intervals.
- The quantity of fodder from annual prunings is shown in Table 1 while woody biomass obtained from felling is shown in Fig. 1.
- Depending upon area available large amounts of firewood and fodder can be produced which can be utilized by user groups and local communities
- The system is completely rainfed and does not require expensive inputs except annual tending and cleaning
- Large investment is made only once in 12 years and annual maintenance can be done by user groups formed in the village.

Table 1: Green fodder production (t/ha) from annual prunings at three spacings

Species	Spacing (mxm)	Green Fodder Production (t/ha) at the Age (years)								
		4	5	6	7	8	9	10	11	12
G.optiva	2x2	0.412	0.575	0.353	0.562	1.000	1.420	1.350	2.200	0.630
	3x2	0.286	0.643	1.630	1.240	0.890	1.070	1.020	1.000	0.870
	4x2	0.250	0.562	0.300	0.520	1.010	0.800	0.860	0.370	0.265
B.variegata	2x2	0.332	0.612	0.240	0.680	1.070	2.660	1.270	2.420	0.036

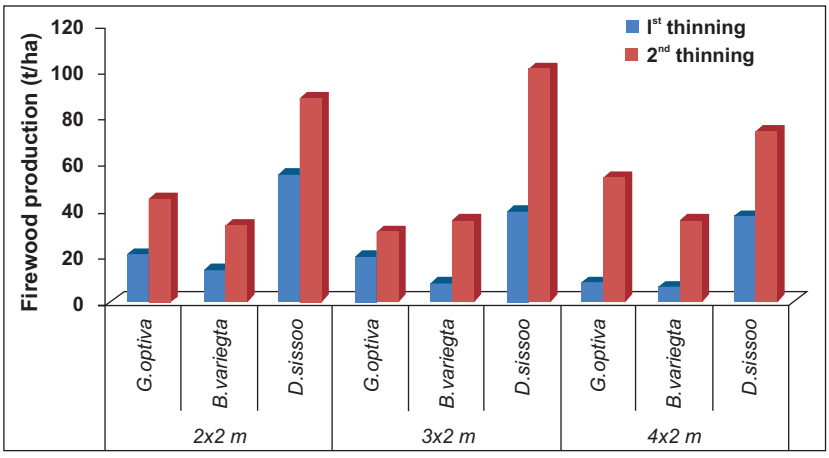

Fig.1: Total firewood production from three species raised on old river bed lands at three different spacings during two thinning intervals

(1st thinning at 7 years, 2nd thinning at 12 years, tree densities per ha are 2500, 1666 and 1250 at 2 x 2, 3x2 and 4x2 m spacing, respectively. Tree densities per hectare are 1250, 833 and 625 at the time of 2nd thinning. Cost of firewood is @₹1,200 t^{-1}).

IMPACT ON SOIL PROPERTIES

The plantations had a positive impact on soil organic carbon status in the 0-45 cm soil depth. The annual rate of increase of soil organic carbon (SOC) content ranged from 502 kg C ha^{-1} in *G. optiva* at wide spacing to 1410 kg C ha^{-1} in *D. sissoo* at wide spacing. The highest carbon sequestration rate was observed in *D. sissoo* followed by *B. variegata* and *G. optiva* at wide spacings to the tune of 1.32, 1.20 and 0.55 t ha^{-1} yr^{-1}, respectively. Water holding capacity increased by 6% in the 0-7.5 cm soil layer, while organic carbon content (%) increased to 1.35-3.10% in the 0-7.5 cm layer in comparison to no tree cover (0.64%). Increase in soil water infiltration (I) and saturated hydraulic conductivity (cm hr^{-1}) rates were also observed which were highest in *D. sisssoo* stands.

ECONOMICS

Economic analysis of the technology carried out by standard methods, indicated that *D. sissoo* was the most profitable species with the highest rate of return being obtained from stands at 3x2 m spacing (Table 2). *G. optiva* had the highest returns at wide spacing while *B.variegata* was economically

Table 2: Economic analysis of high density plantations raised on old river bed lands

Species	Spacing	Density per ha	Income (₹ lakhs/ha)	Investment (₹ lakhs/ha)	B:C ratio*
D. sissoo	2x2	2500	8.75	2.36	4.06
	3x2	1666	11.00	2.49	4.41
	4x2	1250	11.30	2.78	3.70
G. optiva	2x2	2500	4.83	2.78	1.74
	3x2	1666	3.64	2.49	1.46
	4x2	1250	5.48	2.36	2.32
B. variegata	2x2	2500	3.34	2.78	1.20
	3x2	1666	2.69	2.49	1.08
	4x2	1250	2.15	2.36	0.91

*Calculated for two harvesting cycles at the age of 7 and 12 years, wood price @₹ 1,200 t^{-1} and 8% discount rate.

viable only at close spacings. *Grewia optiva* is preferred with the green leaves obtained as 'top feed' available during the winters when all other top feed species have turned leafless.

SCOPE OF TECHNOLOGY

This technology offers immense potential for the utilization of non-arable lands for biomass production in the valley portions of the lower western Himalayas. The species described in this brochure occur extensively over the sub-tropical regions in the states of Jammu & Kashmir, lower Himachal Pradesh, parts of Punjab Shiwaliks and Uttarakhand. The formation of user groups within the community, who are also the end users, will ensure protection and maintenance of the plantation.

हर कदम, हर डगर
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