Extension brochure

Fodder and firewood production from a managed silvipastoral system raised on old river bed lands in the North-West Himalayas

View of well managed *Grewia optiva* trees and *Panicum maximum* grass in a silvipastoral system

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Published by
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218 - Kaulagarh Road,
Dehradun - 248 195 (Uttarakhand)
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Printed at:
Allied Printers, Dehradun
Ph.: 2654505, 3290845

FOREWORD

Availability of green biomass for meeting requirements of animals and woody biomass for meeting energy requirements of rural communities is a major concern for land use planners in the ecologically sensitive Himalayan region. 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. Degradation of forests due to illicit biomass collection for fodder and firewood has increased the vulnerability of the region to ecological sustainability and there is an urgent need for developing sustainable low cost technologies of producing renewable biomass from wastelands.

Silvipastoral systems rose on marginal lands and community owned wastelands can be an effective low cost technology for the production of biomass that can directly benefit rural farm families who need energy and fodder resources on a daily basis. In this brochure, technology for the production of firewood and small quantities of fodder developed by ICAR-Indian Institute of Soil and Water Conservation, Dehradun has 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. This low cost land use system can provide substantial amount of green fodder (6.5 q^{-1} ha^{-1} yr^{-1}) and woody biomass (6.5 q^{-1} ha^{-1} yr^{-1}) in close vicinity of rural settlements and can be easily managed by farm women, leading to substantial savings of time which can be better utilized elsewhere.

I congratulate the authors for bringing out this useful publication.

(P.K. Mishra)
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Fodder and firewood production from a managed silvipastoral system raised on old river bed lands in the North-West Himalayas

Erosion in the upper Himalayan regions leads to frequent flooding and over flowing of 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 and these lands remain completely unutilized.

About the technology

Firewood and fodder requirements are high in most villages in the lower Western Himalayan region but areas to produce them in close vicinity of villages are non-existent. This technology involves of growing trees and fodder grasses together in the same unit area of land and managing the tree canopy and harvesting of grasses at periodic intervals. Village wastelands can be utilized for the sustainable production of fodder and firewood which will help small and marginal farmers who rely on animal husbandry as a secondary source of income.

Technology Development

Trees and grasses for firewood and fodder production are established on marginal lands. Tree species selected for planting should be hardy, stress tolerant amenable to lopping and produce non-toxic wood which is easy to burn; while fodder grasses must tolerate hot dry summers and frequent harvesting. Fodder quality must be satisfactory with low crude fibre, easy digestibility and high crude protein content. Tree and grasses should remain disease free all through the year. This tree-grass combination can be raised on old river bed lands (Photo 1), community

Photo 1: *Grewia optiva* trees on old river bed land

owned wastelands, shallow soils not fit for either agriculture or fruit cultivation.

Selection of tree species for woody biomass

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

- Species should be capable of growing in moisture stressed conditions for longer duration
- Species should be deep rooted
- Species should be frost tolerant.
- Species should be easy to establish after planting out.
- Species should be medium to fast growing.
- Foliage should be palatable and non-toxic.
- Stem should be thorn less and gum free.
- Species should be able to withstand frequent lopping *Grewia optiva*, *Bauhinia variegata, Celtis australis* are some of the suitable tree Species for fodder & fuel wood production.

Selection of grass species for fodder production

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

- Species selected should be perennial, easy to establish from rooted slips with rapid growth.
- Species should be stress tolerant and be able to withstand frost and low temperatures.
- Species should be able to tolerate both shade and bright sunshine.
- Fodder quality should have good digestibility with crude protein content of 6-8% and less of fibre at the time of maturity.
- The species should be able to withstand frequent harvesting and produce new tillers quickly. *Panicum maximum, Chrysopogon fulvus* are some of the suitable grass spices for fodder production in lower hills (Photo 2).

Criteria for site selection

- Community owned sites lying barren, situated in close vicinity to settlements should be preferred. Even privately owned sites with

constraints may be identified for fodder and woody biomass production.

- Sites with shallow soil depth (<40 cm), mildly sloping or flat can be selected.
- Sites should be well drained and have no water logging in the monsoons.
- Sites should be free from fire hazards and protected from free grazing cattle.

Site preparation

- The planting area should be demarcated by either stone walling the perimeter or planting of thorny bushes at 1m spacing as live hedge.
- 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 45 cm^3 in April-May at spacing of 4 m x 4 m (625 pits for tree seedlings per ha).
- Remove stones and gravel from the dugout pit, add 2 kg farm yard manure (FYM) to the soil, mix well and fill back the pit with this filling mixture. Add 10 gm of insecticide (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.
- Protect the area by placing thorny bushes or by planting *Agave* (Rambans) suckers at 1m spacing as a live hedge all around the area.

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.

Planting of grass slips

- Obtain healthy rooted slips from a nursery or from clumps already growing in the vicinity during the beginning of the monsoon season.
- Separate rooted slips and carefully remove long tillers by cutting them neatly.
- Each slip should have 3-4 healthy tillers and well developed roots.
- Plant each slip at a spacing of 0.75 x 0.75 m in holes 10-12 cm deep and pack the soil back by hand, keeping the slip straight.
- Water immediately if there are dry spells and carry out minor weeding activities every fortnight for the next 2 months till new tillers sprout and the slips are fully established.
- After one month, broadcast 25 kg DAP per hectare for improving vegetative growth of the grasses.

Cost of Establishment

Activity		Unit cost (₹)	Total cost (₹ ha^{-1})
A)	Cost of scrub clearing (per ha)	₹ 5600	₹ 5600
B)	Cost of tree planting @ 625 trees (per ha)		
	a. Pitting (45 cm^3)	₹ 5 each	3125
	b. Seedling cost	₹ 3 each	1875
	c. Basin making	₹ 4 each	2500
	Total (a to c)		**7500**
C)	Cost of grass planting @17800 slips (per ha)		
	a. Cost of slip	0.50 each	8900
	b. Planting cost (per slip)	0.50 each	8900
	Total (a to b)		**17800**
D)	Weeding 2 times in the first year (per ha)	3000/-	6000
	Grand total		**36,900**

Photo 2: Established *G. optiva* trees with *P. maximum* (left) and C. *fulvus (*right) raised on old river bed lands

Maintenance and Management of Area

Site prepared for the silvipastoral system required protection and after care for the first 2-3 years, during which annual weeding and protection from fire, illicit grazing and biomass harvesting is necessary. The important steps that are required to be followed for effective establishment and biomass production are:

- After planting of grasses and basin making of seedlings, complete weeding by the end of September is necessary to improve growth of seedlings.
- Tending of tree seedlings by pruning out all unwanted branches and removal of dead and dying tillers in the grasses must be done at the same time.
- Second weeding and tending of seedlings must be carried out by February next year; green fodder is not to be harvested for allowing biomass accretion to take place.
- Replace all tree and grass mortalities in the 2nd year by the onset of the rainy season so that establishment can be completed by the end of the rainy season.
- Harvest all shoots from both the grass species using sharp sickles and remove all dead material from the clumps at the end of the rainy season.
- Depending on growth, a second and third harvest of grass may be carried out in November and again in February of the next year.
- After five years, pollarding is to be carried out on the trees. This requires harvesting the stem and all above ground material at a height of 1.5 m from the ground level. Using a sharp saw, the stem is carefully removed in the month of June-July, so that new shoots appear from the cut end during the rainy season and grow rapidly.
- Apply a coat of lime on the cut end to prevent damage by borers and other insects, just after cutting the stem. Continue to tend trees by removing unwanted side shoots regularly.
- Harvest the new shoots growing from the cut end during December or January when tree fodder and firewood is in demand. Dry the woody portions for a week before burning them.
- Perennial grasses begin to die after 7-8 years and need to be replaced before the arrival of the monsoons.

Precautions to be taken

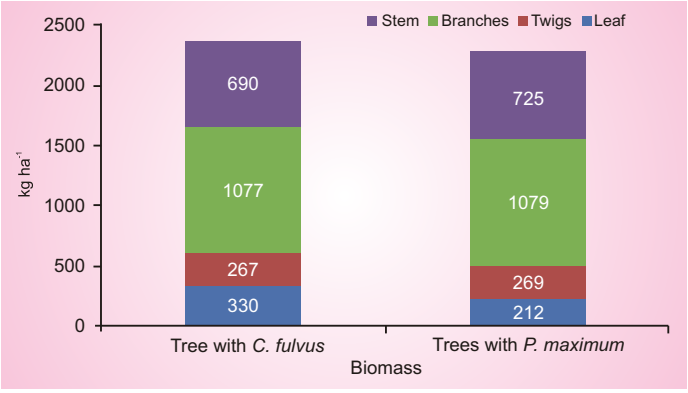
- Setting up the system requires careful planning and adequate knowledge about the site condition (prone to water logging, fire, other disturbances).
- The whole system takes 2 years to stabilize completely and fodder from grasses become available after the cessation of the monsoons from the 2nd year.
- Fodder from trees is available from the 5th year after pollarding the trees (Photo 3), so provision of green fodder during the winters must be made in advance.
- Since the silvipastoral system is established on poor site conditions, grass mortality begins from the 7-8th year and they have to be replaced by uprooting the dead and dying clumps and planting new slips just before the arrival of the monsoons.
- The developed area has to be kept protected at all times from free grazing cattle and fire during the dry periods ranging from March to June.


Photo 3: Pollarded *G. optiva* trees and Fully established *P. maximum* with pollarded trees (right)

Benefits of the system

- A well established silvipastoral system mimics a natural forest and helps to conserve soil and water on sloping lands, builds up soil organic matter, sequesters soil carbon and provides multiple benefits to the user.
- The system is climate resilient and can withstand frequent dry spells and recover quickly during the rainy season.
- On sloping lands, with minor land surface modification, the system can reduce runoff and allow for rapid infiltration of water.
- Investment is made only once in 10-12 years depending on site conditions. Routine cleaning and weeding is to be done by the farmers or the community who are the beneficiaries.

- Production of fodder from grasses becomes available from the 2nd year and from trees from the 5th year onwards.
- At the time of pollarding of trees, nearly 1 t ha^{-1} of woody biomass can be obtained from the trees growing alone and about 7 q ha^{-1} from trees growing with grasses. Nearly 3.0 q. of green leaf fodder can also be obtained (Fig. 1).
- Controlled biomass collection by manually harvesting grasses and tree fodder and keeping the trees disease free can improve productivity.



Biomass available form different tree components at the time of pollarding *G. optiva* trees grown with two fodder grass species

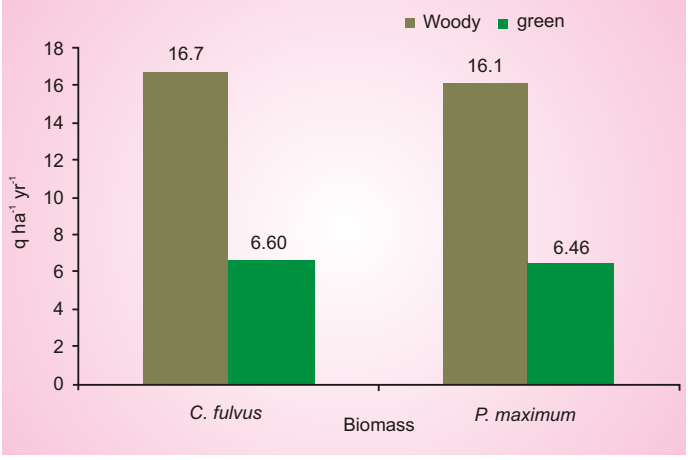


Fig. 1: Comparison of woody material and green leaf fodder production from the silvipastoral system (average of 9 years) using two fodder grasses and pollarded *G. optiva* trees.

Economics of the system

In general a silvipastoral system is economical due to the low cost of establishment and the products (fodder, firewood) regularly available over several years. This system using pollarded *G. optiva* trees with *Chrysopogon fulvus* and *Panicum maximum* is economically viable, with a B:C ratio of more than three and a positive NPV, as given below. The investment made in setting up the silvipastoral system can be recovered within 4 years and replanting of grasses will need to be taken up after 9-10 years after yields begin to decline. If the trees are well looked after, mortality may begin after 12-14 years after which the trees will have to be replaced.

	Pollarded trees with *C. fulvus*	Pollarded trees with *P. maximum*
Payback period (years)	3	4
NPV (₹)	128,179	112,602
B:C ratio	3.48	3.18
IRR (%)	69.12	54.20

Cost of firewood@ ₹ 300 q^{-1}; Cost of fodder @ ₹ 250 q^{-1}; Cost of establishment ₹ 36,900 ; Discount rate 8%)

Scope of Technology

Silvipastoral systems raised on marginal lands offer opportunities for the production of fodder and firewood in the valleys lower Western Himalayas. Nearly 3.0 million hectares are characterized as old river bed lands in the states of Jammu & Kashmir, Himachal Pradesh, lower parts of Punjab Shivaliks and Uttarakhand. Both the fodder grass species and tree species can be raised and managed for maximizing biomass production that will provide much needed fodder for animals and firewood for cooking purposes.

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