GREWIA OPTIVA + HYBRID NAPIER BASED SILVIPASTORAL SYSTEM FOR DEGRADED LANDS IN NORTH-WEST HIMALAYAS

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FOREWORD

India with 2.3% share of global geographical area supports nearly 20% of the world's livestock population which is an integral part of economy especially in rural areas. It is necessary to maintain our livestock resources with optimum productivity level and sound health which requires sufficient management of forage. The traditional sources of forage to maintain this huge livestock population in the country are insufficient and dwindling due to various causes. Therefore, urgent and necessary steps are required to investigate and scan the new sources of animal fodder. The limited cultivated land area of the country presently is under increasing pressure of human and cattle population. Therefore, degraded land must be put forth for forage production. The Himalayan region, which is about 16.4% to the total geographical area of the country, has plenty of degraded bouldery wastelands due to seasonal torrents originating in higher reaches. The CSWCRTI, Dehradun is developing technologies for effective utilization of such degraded lands since 1955.

Grewia optiva (Bhimal) is an important multipurpose tree of Himalayan region and also highly rated among fodder trees by local inhabitants. Hybrid Napier is one of the widely cultivated hardy perennial fodder grass suitable for cultivation in degraded land was introduced in India in the year 1912-15. The institute has developed the technology *Grewia optiva* (Bhimal) + Hybrid Napier based silvipastoral system suitable for degraded lands. This system has been found to be very useful for proper utilization of degraded lands in Himalayan region.

To make the farmers of Himalayan Region aware about the benefits of adoption of this technology for proper utilization of degraded lands of the region, the research work conducted at CSWCRTI, Dehradun has been presented in this brochure. I am quite hopeful that this shall be beneficial to the farmers and user agencies engaged in the development of Himalayan Region.

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INTRODUCTION

India has 20% of the world's animal population that needs to be supported with only 2.3% of the world's total land area. It has been estimated that about 10 crore animals graze openly in forests, while fodder is available for only 2.8 crore animals. By 2025 the supply of green and dry fodder would be 411.3 and 488 million tons, while the demand would be 1170 and 650 million tones, leaving a net deficit of 65 and 25%, respectively. It is therefore, necessary to identify areas where fodder and firewood sources can be grown for their subsequent utilization by rural communities. In the foothills of the Western Himalayas, large areas are categorized as bouldery riverbed lands which is about 2.73 m ha in the Himalayan foothills and 0.3 m ha occurs in Doon Valley alone.

Grewia optiva (Bhimal) is most liked multipurpose tree species (MPTs) of the north-western Himalayas. It provide a crude protein (15-20%) rich green fodder, firewood and bark is used as cordage, due to its superior strength. Hybrid Napier (*Pennisetum purpureum*) is a robust perennial grass well adapted to warm humid to sub-humid climate. It grows successfully all over the Himalayan region up to an elevation of 1400 m amsl including valleys and can withstand frequent harvesting. Its fodder quality is best when young shoots are harvested and green leaves contain 7.0, 16.3, 0.17 and 3.16% of crude protein, mineral matter, phosphorous and potash, respectively.

ABOUT THE TECHNOLOGY

Silvipastoral system (cover photo) is the most promising alternate land use system which integrates multipurpose tree, and grass on degraded lands for optimising land productivity. This silvipastoral system (*Grewia optiva* + hybrid napier) utilized gravelly flood plains under two management practices to maximize tree and grass productivity for obtaining fodder and firewood. Silvipastoral practices help in conservation of natural resources and provide forage, timber and fuel wood on a sustainable basis. Small and marginal farmers who are engaged in raising livestock can benefit a lot by adopting this system.

METHODOLOGY

- The study was conducted in the subtropical climate on degraded bouldery riverbed land containing 74% of boulders (Photo 1). The soil is poor and low in chemical composition.
- One year old healthy seedlings of Bhimal are planted in pits size of 45 cm^3 during July at a spacing of 4 m x 4 m (625 trees ha^{-1}).
- Rooted slips of Hybrid Napier grass were planted at a spacing of 0.75 m x 0.75 m to allow rapid root proliferation and growth of tillers. The trees and grasses were maintained under rainfed conditions.
- After five years, lopping (75%) and pollarding (1.5 m) treatments (Photo 2) were imposed on the trees.
- Tree biomass and grass were harvested during October-November every year and manual harvesting of grass was permissible from the second year of planting, depending on growth of tillers.

Photo 1 : Excellent growth of 'Bhimal' on degraded bouldery riverbed lands

Photo 2 : Pollarded (1.5 m) Bhimal trees on degraded bouldery riverbed lands

COST OF ESTABLISHMENT

Activity	Cost* (₹)
Cost of scrub cleaning per hectare	4000
Cost of tree planting @ 625 trees per hectare	
a. Pitting (45 cm^3) @ ₹ 10 per pit	6250
b. Tree seedlings @ ₹ 3 per seedling	1875
c. Transportation of seedlings @ ₹ 1 per seedling	625
d. Basin making @ ₹ 4 per basin	2500
Cost of grass planting @ 17800 slips per hectare	
a. Grass slips (₹ 0.50 each)	8900
b. Planting of each slip at suitable site (₹ 0.50 each)	8900
Total cost per hectare	**33050**

*Cost is based on minimum rates prevailing in the market.

GROWTH AND BIOMASS PRODUCTION

Successful establishment of trees and grass together (Photo 3) depends on balanced access to solar energy, water and nutrients. Biomass production of grass under trees is affected by tree density, shade tolerance, light interception and moisture availability. Growth and yield from the understorey component begins to be affected only when tree crowns are fully developed. Therefore, tree canopy management in a silvipastoral system is necessary to maximize system productivity.

Photo 3 : Pollarded Bhimal + Hybrid Napier (NB_5) based silvipastoral system on degraded lands

Survival and Growth of Napier

- Highest survival (78.6%) of Napier was found under pollarding management practice followed by grass without tree (72.5%). However, in pollarding treatment the clump survival was higher over the entire study period.
- Bhimal (*Grewia optiva*) did not affect the survival of Napier in silvipastoral system because under pollarding survival was higher than pure stand of grass.
- Maximum clump height (327.5 cm) was recorded under pure stand of Napier (control) followed by pollarding (324.5 cm).
- Maximum clump diameter (31.8 cm) was recorded under lopping followed by grass alone (31.0 cm) which shows that there is no adverse effect of trees on clump diameter.
- Number of tillers $clumps^{-1}$, did not shown any difference between grass alone and in association of tree. Highest number of tillers (30.3) was recorded with pollarding followed by grass alone.
- Hybrid Napier is a fairly hardy grass and has the capacity to regenerate naturally. However, it needs to be replaced by the 10^{th} year and therefore, fresh slips are planted.

Napier Yield

- Pollarding management practice has favourable effects in producing highest green biomass from Napier grass (260 q ha^{-1}) followed by grass alone (221 q ha^{-1}).
- Under pollarding management, grass yield was always higher while it was lower under lopping which could be attributed to the shade effect.
- The trend of growth traits under pollarding was effectively beneficial for grass biomass yield which may be attributed to increased light availability in comparison of other canopy management practices.

Tree Growth

- The diameter at breast height (DBH) increased progressively with age, due to increase in volume and reduction in density. The maximum DBH recorded was 5.5 cm without grass and 4.5 cm along with grass.

- The diameter of Bhimal was higher under lopping than pollarding whereas, it decreased when Napier grass was inter cropped with trees.
- The interaction between tree and grass was also recorded to be significant for effect of grass on tree performance.

Tree Biomass Production

- Green leaf biomass was highest (15.8 q ha^{-1}) under pollarding management than lopping. Similarly, the fibrous branches, fuel wood, and total biomass production was also higher under pollarding alone followed by pollarding with grass, except in case of bast fibre which is followed by lopping + grass (Table 1).

Table 1 : Biomass production (q ha^{-1}) from *Grewia optiva* under different management practices in a silvipastoral system

Treatments	Green leaf fodder	Bast fibre branches	Bast fibre	Fuel wood	Total tree Biomass
Lopping + grass	4.2	7.4	0.38	15.8	27.8
Pollarding + grass	6.2	8.4	0.29	21.1	36.0
Lopping only	5.7	8.3	0.12	16.3	30.4
Pollarding only	15.8	17.9	0.46	54.9	89.0

- The total biomass yield from trees was also recorded highest with pollarding alone (89 q ha^{-1}) without grass followed by pollarding + grass (36 q ha^{-1}), which is about 53 per cent lower with Napier association.

Total Biomass Production

- The total biomass from the silvipastoral system as a whole was highest with pollarding + grass (296 q ha^{-1}) followed by lopping + grass (229 q ha^{-1}) (Table 2).

Table 2 : Biomass production (q ha^{-1}) under two canopy management practices from silvipastoral system

Treatments	Green grass fodder	Total tree biomass	Total biomass from silvipastoral system
Lopping + grass	201	28	229
Pollarding + grass	260	36	296
Lopping only	-	30	30
Pollarding only	-	89	89
Grass only	221	-	221

- Pollarding + grass (management) was the best technique to obtain grass biomass from degraded lands followed by lopping + grass. Secondly, tree pollarding alone (Photo 4) was the best technique for biomass production as compared with the canopy management practice with grass combinations.

Photo 4 : Pollarded Bhimal with profuse sprouting in silvipastoral system

BENEFITS OF SILVIPASTORAL SYSTEM (SPS)

- Silvopastoral system (Photo 5) provides multiple benefits like fuelwood, leaf fodder, grass fodder, bast fibre and improves soil fertility by adding leaf litter.

Photo 5 : Bhimal + Hybrid Napier based silvipastoral system

- Rehabilitation of degraded lands through silvipastoralism and tree canopy management improves in soil fertility through addition of organic matter and nutrients.

- Growing of forage grasses and trees along village roads, Panchayat lands, terrace risers/bunds etc. is a non competitive landuse system.
- It is an important farming system which promotes the livestock husbandry.
- Best alternate land use system in adverse edaphic and climatic conditions for biomass production.
- This sustainable production system provides different forest produces which serve as raw material for cottage industries.
- It is a kind of creation of new forests which for a long time reduce dependence on traditional forests for different forest produces/commodities.
- Arrests erosion by reducing runoff and increases infiltration.
- Growing forage crops, grasses and trees requires less water which reduce the need for fuel and energy driven irrigation systems.

ECONOMICS OF THE SYSTEM

Grewia optiva (tree) + Hybrid Napier (grass) based silvipastoral system on degraded bouldery riverbed lands (Photo 5) is an economically viable system for utilization of degraded wastelands for biomass production. Highest B:C ratio of 1.8 was observed in case of the recommended technology (tree pollarding + napier grass) with a payback period of 8 years, when calculated for a 12 years cycle at 10% discount rate (Table 3).

Table 3 : Economics of the silvipastoral system on degraded lands

Treatments	Green grass fodder		Total tree biomass		Total biomass from silvipastoral system		B:C ratio
	(kg ha^{-1})	Cost* (₹)	(kg ha^{-1})	Cost* (₹)	(kg ha^{-1})	Cost* (₹)	
Lopping + grass	20100	40,200	2800	5,600	22900	45,800	1.4
Pollarding + grass	26000	52,000	3600	7,200	29600	59,200	1.8
Lopping only	-	-	3000	6,000	3000	6,000	-
Pollarding only	-	-	8900	17,800	8900	17,800	1.2
Grass only	22100	44,200	-	-	22100	44,200	1.4

*₹ 2 per kg is the minimum rate prevailing in the market.

This silvipastoral system is economical due to the production of different forest products as leaf fodder, fire wood, bark fibre and timber (on age rotation basis) form degraded lands. Once the silvipastoral system is established will continue to provide green biomass in different forms by annual lopping and pollarding of the tree.

SCOPE OF THE TECHNOLOGY

Viable silvipastoral systems have been designed for better utilisation of degraded lands which are not suitable for crop production. These lands can be put to use for producing multiple benefits that shall benefit rural communities. The technology described here has potential for productive utilization of wastelands in Uttarakhand, Jammu & Kashmir, Himachal Pradesh and in regions with similar conditions. Lands lying unutilized can be made to produce fodder, fibre, fuel and timber wood. Besides environmental stability, the restoration of wastelands provides employment opportunities and creates alternate sources of income for farmers.