Oak Plantation in the Nakina Forest (Jaclyn Bandy)

Broadleaf Plantations, Assisted Tree Regeneration and Fodder Nurseries for Sustainable Forest Management (India)

Trees: Banj Oak (Quercus leucotricophora/glauca), Phalat (Quercus lanata), Fodder: Napier grasses, Bhimal (Grewia optiva), Khadik (Celtis australis)

DESCRIPTION

Natural assisted regeneration of broadleaved species, a small oak plantation and a fodder nursery have been established in the Nakina community forest (intervention area: 10 ha), supporting fodder tree species such as Banj Oak and Falyaat, as well as various subtropical temperate fodder grass species. This has improved the livelihood of the land-users by supporting the health and productivity of the forest, increasing the availability of fuel wood, fodder and groundwater for spring restoration.

1. The technology is applied in a natural environment and is located about 1km away from the settlement and the agriculture land of Nakina Village. The village has access to its own forest, which covers a geographical area of 114 hectare. Of this, 94 hectares come under the Village Forest Council, locally referred to as the Van Panchayat.

2. Characteristics of Technology:

a. Broadleaf species have been established over 7 hectares through natural assisted tree regeneration methods. These include Banj Oak (Quercus leucotrichophora), Falyaat (Quercus glauca), Koeraal (Bauhinia verigata), Bhimal (Grewia optiva), Padam Paaya (Prunus cerasoides), Haradh (Terminalia chebula), Reetha (Sapindus Mukorossi), Utees (Alnus napalensis), Ainyar (Lyonia ovalifolia), Khadik (Celtis australis).

b. Nakina Van Panchayat has made an oak plantation site of 2 hectares in collaboration with G.B. Pant Research Institute.

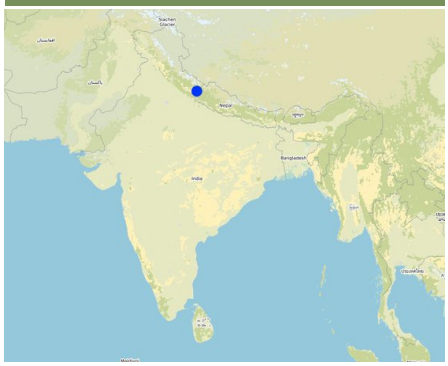
c. A fodder nursery covering 1 hectare hosts a variety of subtropical (Napier: Pennisetum purpureum, Aus, Ginni) and temperate grasses (Guchhi, Dolni, Italian rye: Lolium multiflorum). It was established with the assistance of the NGOs Swati Gramodyog Sansthan and the Himalayan Sewa Samiti. Extraction of fodder leaves and timber are restricted and regulations managed by the Van Panchayat (community forest council).

Purposes/functions:
-Increase trees and grasses to improve availability of fuel and fodder for community, as well as enrich biodiversity.
-Plantation is on a mountain slope (+25% slope), so it will help in preventing soil erosion and landslides.
-Improve soil and water conservation, prevention of surface run-off, support groundwater recharge and spring rejuvenation.

Major activities/Inputs needed to establish and maintain technology:
1. Activities for Assisted Natural Regeneration: protect and facilitate the growth of parent trees inherently present in the area and their regenerations, rather than establishment of entire plantation

2.Activities for the oak plantation: Selection and seed provision of appropriate tree species, clearing of vegetation and preparation of forest top soil, leveling of soil, digging of plantation pits, sowing weeding, watering, occasional pruning, propagation of trees from cuttings, dead sapling replacement, establishment of barrier/fencing for protection from fire.

LOCATION



Location: Nakina Village, Pithoragarh Bloc, Uttarakhand, India

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 80.17454, 29.62579
- 80.17538, 29.62581
- 80.17344, 29.62684
- 80.17383, 29.62789
- 80.16921, 29.62928

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: Yes

Date of implementation: 10-50 years ago

Type of introduction
- ☑ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

3. Activities for fodder nursery:- Selection and seed provision of appropriate grass species and polypot materials, preparation of seedbeds; clearing of vegetation, removal of stones/large roots, ploughing/hoeing, mixing sand and compost on areas with poor soil, sowing seeds pre-monsoon, weeding and watering seedlings, propagation from seed or root cuttings, dead sapling replacement, establishment of barrier/fencing protection from fire.

Benefits/Impacts:
•Restores productivity and fodder/fuelwood availability
•Ecosystem stability
•Enhancement of biological diversity to degraded lands.
•Control landslide and soil erosion
•Control forest fire.
•Maintain wildlife habitat
•Increase livelihood of local people, decrease time spent collecting fodder
•Storage carbon on the forest help to reduce the CO_2 in the atmosphere.

Likes:
This technology is properly functioning in the implementation area and local people have received many benefits from sustainable managing their natural resources rather than receiving incentives for institutional support, local people of the Nakina village are strongly active to protect the forest with their own coordination.

Dislikes:
1.Improve wildlife habitat, which may increase human wildlife conflicts as it is near to agriculture land and settlements.
2.Require regular maintenance activities, which require organization within the community and can increase periodic workload depending on level of participation


Afforested Oak in Nakina Van Panchayat (Jaclyn Bandy)


Fodder Nursery Site (Jaclyn Bandy)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- create beneficial social impact

Land use
Land use mixed within the same land unit: Yes

Grazing land
- Cut-and-carry/ zero grazing

Animal type: cattle - dairy, goats
Is integrated crop-livestock management practiced? Yes
Products and services: meat, milk

Forest/ woodlands
- (Semi-)natural forests/ woodlands: subtropical dry forest natural vegetation. Management: Selective felling
- Tree plantation, afforestation: subtropical dry forest plantation - Broadleaf. Varieties: Mixed varieties

Tree types (deciduous): n.a.
Products and services: Timber, Fuelwood, Other forest products, Grazing/ browsing, Nature conservation/ protection

Water supply
- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Purpose related to land degradation

- ☐ prevent land degradation
- ☑ reduce land degradation
- ☑ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wm: mass movements/ landslides, Wo: offsite degradation effects

chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion), Ca: acidification

physical soil deterioration - Pc: compaction, Pk: slaking and crusting, Pi: soil sealing, Pu: loss of bio-productive function due to other activities

biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bf: detrimental effects of fires, Bs: quality and species composition/ diversity decline, Bl: loss of soil life, Bp: increase of pests/ diseases, loss of predators

water degradation - Ha: aridification, Hs: change in quantity of surface water, Hg: change in groundwater/aquifer level, Hp: decline of surface water quality, Hq: decline of groundwater quality

SLM group

- natural and semi-natural forest management
- forest plantation management
- improved ground/ vegetation cover

SLM measures

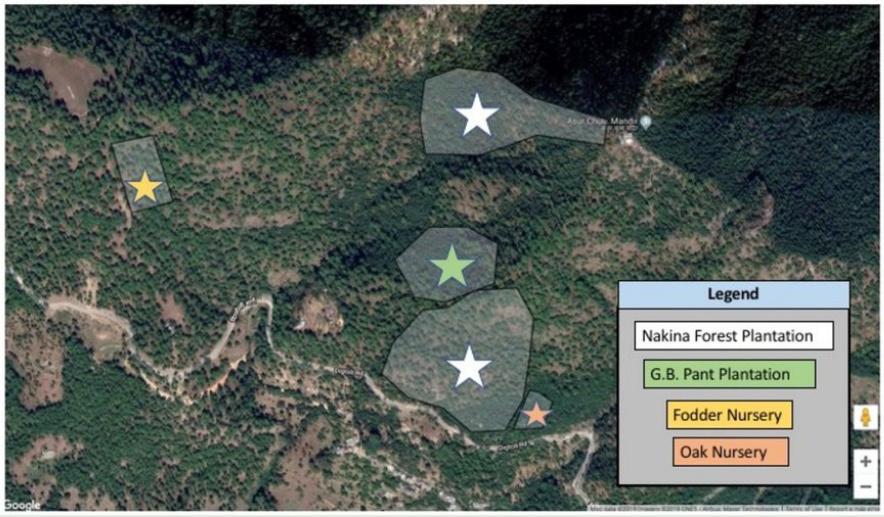
vegetative measures - V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants, V3: Clearing of vegetation, V4: Replacement or removal of alien/ invasive species, V5: Others

management measures - M1: Change of land use type, M2: Change of management/ intensity level, M3: Layout according to natural and human environment, M5: Control/ change of species composition

TECHNICAL DRAWING

Technical specifications

Google Map of Plantations and Fodder Nursery locations



Author: Jaclyn Bandy

Project Budget with Nakina Village and NGO Himalayan Sewa Samiti: Fodder Nursery, 1 hectare and Assisted Natural Regeneration 97 Hectares)

(Citation: Detailed Project Report: Natural Resource Based Livelihood Project in the Gorang Ghati Cluster, NGO Himalayan Sewa Samiti, Submitted to: Sir Ratan Tata Trust (SRTT) Forest Works Manual, 2015 Forest Research Institute, Dehradun, Uttarakhand)

Project Budget with Nakina Village and NGO Himalayan Sewa Samiti: Fodder Nursery (1 hectare) and Assisted Natural Regeneration (7 hectares)

No.	Task	Unit of Work	Work days	Rate INR	Rate USD	Total Rate INR	Total Rate USD
Fodder Nursery							
1	Clearance of site	ha	4	300	4	1200	16
2	Clearance of lantana infected areas	ha	14	1000	13	14000	186
3	Digging of soil 25 cm to 30 cm deep two times (nursery)	ha	7	500	7	3500	47
4	Digging of soil second time, dressing and leveling (nursery)	ha	18	1300	17	23400	312
5	Earth work for leveling	Cum	0.2	200	3	40	0.5
6	Digging, collection and transport of soil, sand and manure ratio 4:2:1	100 poly bags (15 cm x 10 cm)	0.5	200	3	100	1.3
8	Preparation of nursery beds (3 m x 1 m)	Bed	0.2	100	1.3	20	0.3
9	Sowing of seed and covering of beds	Bed	0.2	100	1.3	20	0.3
10	Sieving of soil, sand, removing twigs and green leaves etc. and rubbing the manure with hands for filling in polythene bags	100 bags	0.3	150	2	45	0.6
11	Filling of polythene bags with potting mixture and placing them in beds	100 bags	0.3	150	2	45	0.6
12	Sowing of seed on polythene bags	100 bags	0.1	100	1	10	0.13
14	Transplanting of seedlings taken from nursery beds in bags/seeds	100 seedlings	0.5	200	3	100	1.3
15	Maintenance of nursery including watering, weeding, shifting of plants and replacement of mortality	10,000 plants	180	100	1.3	18000	240
Fodder Nursery Total (INR)						60480	806.03
Assisted Natural Regeneration in Nakina Community Forest							
1	Assisted Natural Regeneration Activities in Planted Plots @ 10,000 INR per hectare X 7 hectares X 2 years	ha	-	-	-	140,000	1,864
2	Protection and Maintenance @ 3,150 per ha X 7 hectare X 3 years	ha	-	-	-	66,150	881
3	Soil and water conservation and soil fertility measures @ 5,500 INR X 7 hectares X 1 year	ha	-	-	-	38,500	513
Assisted Natural Regeneration Total (INR)						244650	3258
Total Cost: Fodder Nursery + Assisted Natural Regeneration						305,130	4,064
	NGO Himalayan Sewa Samiti (Sir Ratan Tata Trust Contribution (USD)					244,104	3,251
	Nakina Village Contribution (USD)					61026	813

Author: J Bandy

Project Budget for Afforestation of Nakina Community Forest a Broadleaf Plantation (2 hectares)

(Citation: Forest Works Manual, 2015 Forest Research Institute, Dehradun, Uttarakhand)

Project Budget for Afforesation of Nakina Community Forest and G.B. Pant Institute of Himalayan Environment and Development: Broadleaf Plantation (2 hectares)						
Rate No.	Task	Unit of Work	Work days	Rate INR	Total Rate INR	Total Rate USD
1	Survey and demarcation	ha	3	200	600	8
2	Clearance of site and cutting of shrubs and bushes	-				
	a) Normal shrubs and bushes	ha	5	300	1500	20
	b) Lantana and heavy bushes	ha	15	1000	15000	200
3	Digging pits (30cm x 30cm x 45cm)	pit	10	200	2000	27
4	Filling pits (30cm x 30cm x 45cm)	pit	5	100	500	7
5	Fencing	-		2500	2500	33
	a)Cost of barbed wire	ha	1	2000	2000	26
	b) Labour	ha	5	1000	5000	67
	c) Cost of fence posts	ha	1	500	500	7
6	Cutting and fashioning fence posts 1.5m to 3.05m long, 15 cm to 30cm diameter	posts	7	100	700	9
7	Sealing fence post ends	posts	2	300	600	8
8	Digging holes	no	5	150	750	10
9	Fixing of posts	no	5	100	500	7
10	Transport of fence posts by workers (max distance 3km)	post	2	400	800	11
11	Marking and digging of trenches (30cm x 30cm x 45cm)	ha	10	400	4000	53
12	Sowing seed in contour trenches	ha	10	400	4000	53
13	Sowing seed in pits	pits	10	400	4000	53
14	Planting of saplings (Total: 2000)	per plant	20	100	2000	27
15	Weeding (3 years)	per plant	20	100	2000	27
16	Cleaning of fire lanes along fencing	ha	10	200	2000	27
17	Wages of Chowkidar (forest guard)	ha	70	400	28000	37
18	Maintenance: 5 years, 1000 plants/hectare: 2000 total	ha	1500	20	30000	400
Total Cost of Afforestation in Nakina Community Forest: Broadleaf Plantation (2 hectares)					*108950*	*1450*
	G.B. Pant Institute of Himalayan Environment and Development Contribution (USD)				87160	1160
	Nakina Village Contribution (USD)				21790	290

Author: J Bandy

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **Afforested Community Forest: 7 hectares, G.B. Pant Plantation: 2 hectares, Fodder Nursery: 1 hectare**)
- Currency used for cost calculation: **INR**
- Exchange rate (to USD): 1 USD = 70.0 INR
- Average wage cost of hired labour per day: 400 INR

Most important factors affecting the costs

-Length and amount of available funding, as plantation projects require substantial investment and long term care. -Damage or survival rate of the saplings/trees/fodder species can be severely affected by climatic, anthropogenic, or wildlife disturbances. The success and cost of a plantation and nursery project can vary widely depending on size, topographic characteristics, access, labor availability and overall appropriateness of site selection.

Establishment activities

1. Plantations: Survey, demarcation, clearance of shrubs, bushes, Lantana (invasive species) (Timing/ frequency: Pre-monsoon)
2. Earth work for leveling, Digging pits (30 cm X 30cm X 45cm) along contour lines, spacing of pits no less that 2x2 m, filling of pits with soil/manure mixture (Timing/ frequency: Early June)
3. Planting of saplings: roots of the plants kept straight and the plant put straight in vertical position; done by digging with the help of a stick or small crow bar (Timing/ frequency: Early July)
4. Note: Species like Akhrot, Angu, Maple, Pangar, Poplar, Salix, Utis etc. are planted in winter months (Timing/ frequency: January/February)
5. Dead, dying or dry plants are replaced within 15 days of completion of planting work (Timing/ frequency: Mid June)
6. Thanwalas (semicircular pit) about 15 cm deep, 25-30 cm apart from the plant were dug for rainwater retention/infiltration (Timing/ frequency: Mid June)
7. Weeding after first significant rains (Timing/ frequency: Monsoon)
8. Fodder Nursery: Survey, demarcation, clearance of shrubs, bushes, Lantana (invasive species) (Timing/ frequency: Pre-monsoon)
9. Plowing/hoeing land, collection and soil, sand, manure preparation (4:2:1 ratio) and seedbed preparation (Timing/ frequency: Pre-monsoon)
10. Planting of each cane/rootsplit in holes 15-30 cm deep, with a spacing of 0.5m x 0.5m (Timing/ frequency: Pre-monsoon)
11. Cutting and Harvesting (Timing/ frequency: None)

Establishment inputs and costs (per Afforested Community Forest: 7 hectares, G.B. Pant Plantation: 2 hectares, Fodder Nursery: 1 hectare)

Specify input	Unit	Quantity	Costs per Unit (INR)	Total costs per input (INR)	% of costs borne by land users
Labour					
Plantation Community Manual labour	person-days	400.0	400.0	160000.0	50.0
Skilled labour (advisor, experts)	person-days	7.0	2000.0	14000.0	
Fodder Nursery Raising	Total Cost	1.0	25000.0	25000.0	25.0
Equipment					
Axe, Crow bar, Wheel barrow	pieces	10.0	1500.0	15000.0	100.0
Digging forks, Hammers, Hoes, Spade	pieces	10.0	1500.0	15000.0	100.0
Scissors, Pruning knives/shears, Budding and Grafting Knives/Tape	pieces	10.0	700.0	7000.0	50.0
Plant material					
Fodder Grass/20 Quintals of Grassroot slips	Total Cost	1.0	45000.0	45000.0	50.0
Plantation Material, 3.88 INR per Sapling x 1000 Sapling per hectare x 7 hectare	Total Cost	1.0	27160.0	27160.0	50.0
Fertilizers and biocides					
Soil/Water Conservation and Soil Fertility Measures: 5,500 INR per Hectare x 2	Total Cost	1.0	11000.0	11000.0	100.0
Nakina Forest: Assisted Natural Regeneration preparation and composting	Total Cost	1.0	2000.0	2000.0	100.0
Fodder Nursery composting	Total Cost	1.0	1000.0	1000.0	100.0
Other					
Plantation Transportation, Pitting, Planting: 6.9 INR per plant X 1000 sapling x 2 hectare	Total Cost	1.0	13800.0	13800.0	50.0
Fodder Nursery (Rootstock Purchase, Transportation)	Total Cost	1.0	5500.0	5500.0	50.0
Nakina Village: Assisted Natural Regeneration Activities in Planted Plots, 10,000 INR per hectare X 7 hectares x 3 years	Total Cost	1.0	30000.0	30000.0	100.0
Total costs for establishment of the Technology				**371'460.0**	
Total costs for establishment of the Technology in USD				*5'306.57*	

Maintenance activities

1. Second weeding done in September, followed by a third weeding after the winter rains. (Timing/ frequency: Post-monsoon)
2. A Chowkidar (forest watch guard) is deputed for five years in the plantation area to look after it (Timing/ frequency: Post-planting)
3. Periodical weeding and removal of grasses suppressing the plants, maintenance and repair of inspection paths (Timing/ frequency: Year round)
4. Fire Control: Keeping regular watch over the plantation area during the fire season, cleaning of the outer periphery of the plantation area in two meter width (Timing/ frequency: Dry season)
5. Collective help and co-operation with the villagers in the protection of the plantation; checks on fodder extraction/allowance, prevention of trespassers (human/wildlife) (Timing/ frequency: Year round)
6. During the second year, dead plants are replaced by planting fresh saplings (ca. 20%) (Timing/ frequency: Onset of monsoon)
7. Fodder grasses: propagation from cuttings or from root slips (Timing/ frequency: None)
8. Fodder Grasses: Harvesting of grasses every 6-8 weeks, maintaining a stubble height of 5-10 cm from the ground level at each harvest to avoids weakening of root system (Timing/ frequency: None)

Maintenance inputs and costs (per Afforested Community Forest: 7 hectares, G.B. Pant Plantation: 2 hectares, Fodder Nursery: 1 hectare)

Specify input	Unit	Quantity	Costs per Unit (INR)	Total costs per input (INR)	% of costs borne by land users
Labour					
Maintenance of nursery	Total Cost/Year	1.0	3000.0	3000.0	25.0
Maintenance of plantations	Total Cost/Year	1.0	4000.0	4000.0	25.0
Total costs for maintenance of the Technology				**7'000.0**	
Total costs for maintenance of the Technology in USD				*100.0*	

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone

- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

Average annual rainfall in mm: 1500.0
Monsoon- mid-June to mid-September; July and August are the rainiest months and the temperature is warm and moist; between 70-85% of the annual precipitation occurs in the monsoon season

Seasons
a. Winter or Cold weather (mid Dec. - mid March)
b. Summer or hot weather (mid March - mid June)
c. Season of general rains (South - West monsoon season)
d. Season of retreating monsoon (mid September to mid November)
Name of the meteorological station: India Meteorological Department, Meteorological Centre Dehradun
The overall climatic condition in the Pithoragarh district is

governed by the southwest monsoon. It has a sub-tropical to temperate climate, with three pronounced seasons; summer, winter, and monsoon. The hilly terrain of the Himalayan region has snow cover and is cold during winter with snowfall normally occurring during the months of December to March.

Temperature- The temperature ranges from 0°C to 10°C in winter and from 8°C to 33°C in summer season. However, there is no meteorological observatory in the district. The account of the climate is based mainly on the records of the observations in the neighboring districts where similar meteorological conditions prevail. Variations in temperature are considerable from place to place and depend upon elevation as well as aspect. As the insolation is intense at high altitudes, in summer temperatures are considerably higher in the open than in the shade.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [x] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [x] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [x] concave situations
- [ ] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: ground water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [x] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [x] elderly

Area used per household
- [x] < 0.5 ha
- [x] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [x] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure
health

poor ✓ good

Comments

The situation of infrastructure is difficult and inconsistent in the

education	poor		✓	good
technical assistance	poor	✓		good
employment (e.g. off-farm)	poor	✓		good
markets	poor		✓	good
energy	poor		✓	good
roads and transport	poor		✓	good
drinking water and sanitation	poor	✓		good
financial services	poor	✓		good

hill regions because of the terrain. The major infrastructural issues are drinking water and irrigation facilities, electricity, transportation and communication facilities and social infrastructure (housing and education). As for financial services, only the State Bank of India (SBI) is active in the hill regions where it is trying to achieve the objective of 100% financial inclusion. Some villages mentioned buying into into agricultural insurance in the past, however this was a temporary enterprise and they were never compensated after extreme climatic events that occurred and damaged over 70% of their crop. Though infrastructure and education has generally improved over the years, institutional and marketing networks in the region aimed at supporting hill-farmers are lacking.

IMPACTS

Socio-economic impacts

fodder production	decreased						✓	increased
fodder quality	decreased						✓	increased
animal production	decreased						✓	increased
wood production	decreased						✓	increased
forest/ woodland quality	decreased						✓	increased
production area (new land under cultivation/ use)	decreased						✓	increased
land management	hindered						✓	simplified
expenses on agricultural inputs	increased						✓	decreased
workload	increased						✓	decreased

Quantity before SLM: 2 ton/ha
Quantity after SLM: 30 ton/hectare

Tree lopping for fodder was decreased by 15%

Decreased the amount of supplementary fodder required for livestock. The amount of grasses, fodder, and fuelwood has increased significantly.

Less time spent collecting forest resources, as the area where the technology is near the village and supports fodder/fuelwood growth (broadleaf forest/oak nursery area)

Socio-cultural impacts

food security/ self-sufficiency	reduced						✓	improved
health situation	worsened					✓		improved
land use/ water rights	worsened						✓	improved
cultural opportunities (eg spiritual, aesthetic, others)	reduced						✓	improved
recreational opportunities	reduced						✓	improved
community institutions	weakened						✓	strengthened
SLM/ land degradation knowledge	reduced						✓	improved
conflict mitigation	worsened						✓	improved

Improved self sufficiency of village, as the technology has helped increase animal productivity (more fodder, better quality) and increased water availability.

Water condition has improved and people spend less time spent collecting fodder in the forest.

There is less friction between the villages of Bhurimuni and Nakina. Nakina did not have to go ask for permission to access the Bhurimuni Naula for water during the dry season.

The improvements of forest resource security and resilience to disasters/climatic extremes have allowed the villagers have more free time to build up a communal gathering area for ceremonial events and festivals around the Vaishnavi Temple.

Recreation opportunities for villagers have increased. Particularly women, (some of whom are involved in a self help group and active Van Panchayat members), expressed that they saved approximately 1-2 hours/day in fodder collection time.

The partnerships formed between land-users, the Nakina Van Panchayat, the Forest Department and external institutions are leading examples of necessary cooperation between all levels of governance for project harmonization.

People are taking forest management seriously and making innovative plans for further SLM interventions, whether it be community-initiated or with the help of external institutions/agencies.

Conflict has decreased in the village do to increased availability of resources. The overall morale of the village is better and less frantic due to an improvement in dodder, fuel and water provision. This has further enhanced cooperation for interventions that require participation and effort in the community

forest.

Ecological impacts

water quantity	decreased	✓	increased
harvesting/ collection of water (runoff, dew, snow, etc)	reduced	✓	improved
surface runoff	increased	✓	decreased
groundwater table/ aquifer	lowered	✓	recharge
evaporation	increased	✓	decreased
soil moisture	decreased	✓	increased
soil cover	reduced	✓	improved
soil loss	increased	✓	decreased
soil accumulation	decreased	✓	increased
soil crusting/ sealing	increased	✓	reduced
soil compaction	increased	✓	reduced
nutrient cycling/ recharge	decreased	✓	increased
soil organic matter/ below ground C	decreased	✓	increased
acidity	increased	✓	reduced
vegetation cover	decreased	✓	increased
biomass/ above ground C	decreased	✓	increased
plant diversity	decreased	✓	increased
invasive alien species	increased	✓	reduced
animal diversity	decreased	✓	increased
beneficial species (predators, earthworms, pollinators)	decreased	✓	increased
habitat diversity	decreased	✓	increased
landslides/ debris flows	increased	✓	decreased
drought impacts	increased	✓	decreased
impacts of cyclones, rain storms	increased	✓	decreased
emission of carbon and greenhouse gases	increased	✓	decreased
fire risk	increased	✓	decreased
micro-climate	worsened	✓	improved

The technologies improve water holding capacity of the soil by decreasing runoff velocity and improve overall water storage.

Soil moisture of common land was increased by about 15%

Trees and other vegetation has helped mitigate displacement of soil from upstream areas to the lowlands

Vegetation growth and cover has improved due to more shade and water availability

Increased species diversity due to improved moisture availability, soil conditions and microclimate.

Provide more water and habitat for small animals/birds.

Healthy afforested areas provide more water, habitat, and protection for microorganisms and insect species. They support native grasses and vegetation.

Incidents of landslides decreased due to less surface flow velocity and soil destabilisation. Villagers also noted that there were that less displaced soil and sediment accumulation in the ravine that normally incurs damage from upstream debris flow in the monsoon season.

Drought impacts decreased due improved surface and subsurface hydrological functioning in the upper watershed catchment areas. This increased microwatershed/ springshed groundwater stores and enhanced stream and spring flows in the dry season.

Erosion impacts from extreme rain storms is reduced by decreasing flow velocity

Carbon storage is increased by the plantation. It has been previously studied that Uttarakhand Van Panchayat forests sequester carbon at the average rate of 3.5 t ha -1 yr-1. This varies depending on forest distribution, species and land management.
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The forest intervention area is protected by the villagers from anthropogenic and wild fires, therefore the forest has rehabilitated more quickly and has a lower risk of burning due to improved green vegetation cover and less flammable pine needle accumulation. In the case of pine forests, pine needles are a major source of fuel for fire and the removal of buildup remains a major challenge for the land users.

Because of the interventions, vegetation/biomass, soil cover and water availability has improved and created a more suitable microclimate for microorganisms, plants, animals and people. The microclimate has

improved due to decreased surface temperatures from exposed, bare soil or ground that is covered with pine needles. This improved microclimate is visible, as it has additionally allowed a wider range of species (grasses, shrubs, wildflowers, insects, birds) to inhabit the intervention site.

Off-site impacts

water availability (groundwater, springs)	decreased	✓ increased	Improved spring discharge in the peak dry season
reliable and stable stream flows in dry season (incl. low flows)	reduced	✓ increased	Bhind and Vaishnavi Naulas (springs) have improved discharge in the peak dry season. According to villagers, there was little to no water available in May/June, and since 10 years the flow has returned due to the plantation efforts combination with structural technologies.
downstream siltation	increased	✓ decreased	Helped slow down sediment and runoff
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	✓ improved	No direct evidence, but statements from the locals indicate that there are less sediments in the spring water (due to improved soil infiltration and buffering capacity)
damage on neighbours' fields	increased	✓ reduced	Less damage from runoff
damage on public/ private infrastructure	increased	✓ reduced	Decreased intensity of runoff on the roadside and settlement below

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	✓ very positive
Long-term returns	very negative	✓ very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓ very positive
Long-term returns	very negative	✓ very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	✓ very well	
seasonal rainfall decrease	not well at all	✓ very well	Season: dry season
Irregular rainfall patterns/ delayed monsoon increase	not well at all	✓ very well	

Climate-related extremes (disasters)

local rainstorm	not well at all	✓ very well
local thunderstorm	not well at all	✓ very well
local hailstorm	not well at all	✓ very well
drought	not well at all	✓ very well
forest fire	not well at all	✓ very well
landslide	not well at all	✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- ✓ 11-50%
- > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ✓ 0-10%
- 11-50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Yes
- ✓ No

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Improves livelihood of villagers by addressing and significantly improving the fodder, fuel, water nexus. Increased fodder availability and decreased time spent collecting fodder/fuel in the forest has greatly benefited the village, and women in particular. Animal health and productivity has also increased.
- Reduces erosion, improves catchment of runoff, increases groundwater availability and aids in spring recharge.
- Supports soil quality and existing broadleaf forest; increased filtration, improved soil moisture and water availability.
- Reduces impact of landslides and further downstream damage to settlements (water erosion, siltation)

Strengths: compiler's or other key resource person's view
- Aligned with landuser
- Improved microclimate, overall ecosystem health, and increased carbon sequestration.

Weaknesses/ disadvantages/ risks: land user's view → how to overcome
- Risk of damage to plantation and nursery from fires → Maintain protective barrier (wall and fire lane); more prominent live-fencing could be established around the fodder nursery, as it is under greater susceptibility to fire damage due to its location near the stone wall border and pine-dominant forest.
- Moisture stress from weed competition reduces the growth of broadleaves → Consistent monitoring of weed and invasive species control (lantana) and eupatorium (Ageratina adenophora).

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome
- There can be poor survival and slow growth of newly planted trees from damage while handling; e.g. the oak nursery has the potential to support many more plants, but it seems there is a need for more care when handling young broadleaved species. → Careful attention to plant handling, avoiding root damage, and appropriate timing of transplanting (e.g. avoid heat exposure)
- Young oaks appeared somewhat nutrient deficient and are exposed in the forest; there were signs of animal intrusion or possibly damage by human crossing as the oak nursery is next to a small dirt trail. → The survivability of the young oaks could be improved through mulching and establishing an enclosure or live fencing around the nursery.

  In the future, contour trenching and ponding can be also done before the plantations to improve the soil moisture.

REFERENCES

Compiler
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Reviewer

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Resource persons
Jagdamba Prashad Joshi - land user
Basant Ballabh Pandey - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5243/

Linked SLM data
Approaches: Naula Management and Conservation https://qcat.wocat.net/en/wocat/approaches/view/approaches_5202/
Approaches: Community Forest Management in the Nakina Van Panchayat
https://qcat.wocat.net/en/wocat/approaches/view/approaches_5199/

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Project
- Book project: where the land is greener - Case Studies and Analysis of Soil and Water Conservation Initiatives Worldwide (where the land is greener)

Key references

- Plant Nursery Management: Principles and Practices, P. Ratha Krishnan Rajwant K. Kalia J.C. Tewari M.M. Roy, 2014, ISO 9001 : 2008: http://www.cazri.res.in/publications/PRathaKrishnan.pdf
- Forest Works Manual and schedule of rates for Forestry Related Works, Uttarakhand, 2005, Forestry Research Institute, Dehradun: https://nrega.nic.in/1ForestWorksManual-FRI.pdf

Links to relevant information which is available online
- Nursery Manual for Native Plants: A guide for tribal nurseries: https://www.fs.fed.us/rm/pubs_series/wo/wo_ah730.pdf
- Fodder and Forage Production: http://www.fao.org/3/T0706E/T0706E07.htm
- Nursery Technology: http://agritech.tnau.ac.in/forestry/nursery_major_activities.html