Oak Plantation in the Nakina Forest (Jaclyn Bandy)

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

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

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.

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.

: Nakina Village, Pithoragarh Bloc, Uttarakhand,

: 2-10

- 80.17454, 29.62579
- 80.17538, 29.62581
- 80.17344, 29.62684
- 80.17383, 29.62789
- 80.16921, 29.62928

:
/

?:
/

: 10-50

✓

(> 50)

✓ /

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 CO2 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)

☑ , ,
☑ /
☑ /
☑
☑ /
☐
☑
☐

/

• /
: - ,

? /
: ,

/

• ( ) / :
.

• :
- .

Tree types ( ):
: , , ,
, /

☑
☐
☐

☐
☑
☑ /
☐
☐

- Wt:
, Wg:
, Wm: , Wo:

- Cn:
(
), Ca:

- Pc: , Pk: , Pi: , Pu:

- Bc: , Bh: , Bq: / , Bf: , Bs: / , Bl: , Bp:

- Ha: , Hs: , Hg: , Hp: , Hq:

SLM

-
-
- /

SLM

- V1: , V2: 2 , V3: , V4: / , V5:

- M1: , M2: / , M3: , M5: /

G.B. Pant Plantation: 2 Hectare, pits of (30 cm X 30cm X 45cm) were dug along contour lines, spacing of pits is not less than 2x2 m, about 2,000 Quercus saplings were planted.

Nakina Broadleaf Plantation: 7 Hectare, pits of (30 cm X 30cm X 45cm) were dug along contour lines, spacing of pits is no less that 2x2 m, about 15,000 trees have been planted and the forest is being continually managed in the area.

Species: 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)

Fuelwood cutting (lopping), fodder collection, and selective clear cutting for Quercus leucotrichophora and other broadleaved species is done between Nov- April.

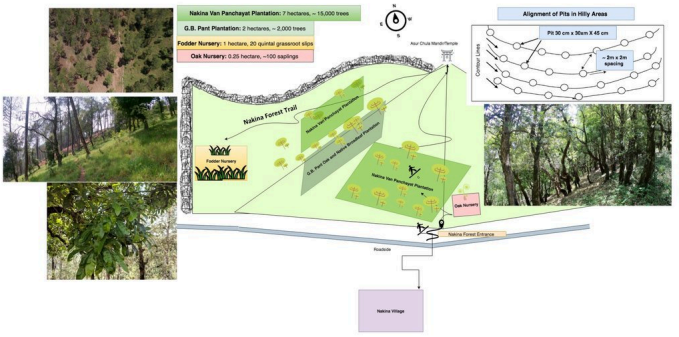
Fodder Nursery: 20 Quintals (20,000 kg) of various grassroot slips over 1 Hectare. This provides +175 tonnes/year. (Subtropicals species: napier, aus, ginni, Temperate species: guchhi, dolni, italian rye)

Planting: Grasses are planted during the months of June-July at the advent of rainy season, about 10 cm deep vertically and at a spacing of 45 x 30 cm apart.

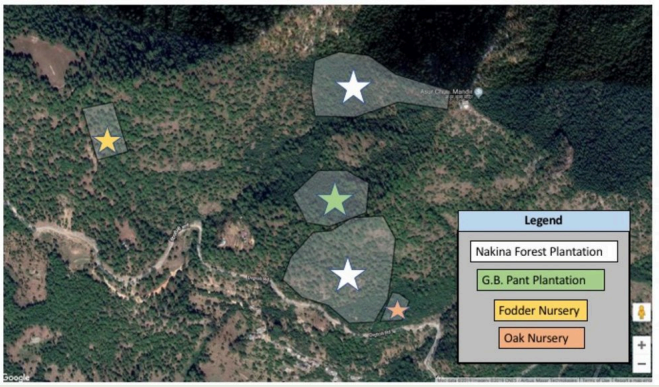
Propagation: grasses forms clumps during its growth period. The clump when broken gives a number of small units known as slips, which are the units of propagation and on planting, they establish as individual plants. While preparing the slips for planting, fibrous roots and leaves are be trimmed off. Cuttings with 2 nodes from the middle portion of moderately matured stems (3 – 4 months old) were planted in a slanting position at one side of the ridges with one node buried in the soil. The underground node develops roots and shoots while the upper node shoots only. The soil around the stem is pressed tightly. Farm yard manure is applied after harvest (application rate varies; estimation is 5-8 tonnes). Annually about 6 to 8 cuts are possible.

Oak Nursery: 0.25 ha. The nursery bed is rectangular and measures about 100m x 25 m. The seedlings are uprooted by hand from a seedbed and transplanted (bare-root transplanting). The nursery is on a gently sloping land (23%). Seedlings with poor lateral root development are culled out.

Oak Plantation Alternative:
Acorns are collected and put in water for 24 hours. Acorns that sink are immediately sown in a well tilled seedbed 2-5 cm deep, 15 cm from each other and covered with a thin layer of firm soil. Beds are mulched with straw or leaves. However, not every acorn will germinate and animal predation of acorns can be an issue. In general, probability of success is lower than with seedlings.
Google Map of Plantations and Fodder Nursery locations



Author: Jaclyn Bandy



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 and G.B. Pant Institute of Himalayan Environment and Development: Broadleaf Plantation (2 hectares)

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

Project Budget for Afforestation 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

- (**Afforested Community Forest: 7 hectares, G.B. Pant Plantation: 2 hectares, Fodder Nursery: 1 hectare**)
- **INR**
- ( ) 1 USD = 70.0 INR
- 400 INR

-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.

1. Plantations: Survey, demarcation, clearance of shrubs, bushes, Lantana (invasive species) (/ : 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 (/ : 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 (/ : Early July)
4. Note: Species like Akhrot, Angu, Maple, Pangar, Poplar, Salix, Utis etc. are planted in winter months (/ : January/February)
5. Dead, dying or dry plants are replaced within 15 days of completion of planting work (/ : Mid June)
6. Thanwalas (semicircular pit) about 15 cm deep, 25-30 cm apart from the plant were dug for rainwater retention/infiltration (/ : Mid June)
7. Weeding after first significant rains (/ : Monsoon)
8. Fodder Nursery: Survey, demarcation, clearance of shrubs, bushes, Lantana (invasive species) (/ : Pre-monsoon)
9. Plowing/hoeing land, collection and soil, sand, manure preparation (4:2:1 ratio) and seedbed preparation (/ : Pre-monsoon)
10. Planting of each cane/rootsplit in holes 15-30 cm deep, with a spacing of 0.5m x 0.5m (/ : Pre-monsoon)
11. Cutting and Harvesting (/ : None)

			(INR)	(INR)	%
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
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

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
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
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
				371'460.0	
				5'306.57	

1. Second weeding done in September, followed by a third weeding after the winter rains. (/ : Post-monsoon)
2. A Chowkidar (forest watch guard) is deputed for five years in the plantation area to look after it (/ : Post-planting)
3. Periodical weeding and removal of grasses suppressing the plants, maintenance and repair of inspection paths (/ : 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 (/ : 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) (/ : Year round)
6. During the second year, dead plants are replaced by planting fresh saplings (ca. 20%) (/ : Onset of monsoon)
7. Fodder grasses: propagation from cuttings or from root slips (/ : 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 (/ : None)

			(INR)	(INR)	%
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
				7'000.0	
				100.0	

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

- [ ]
- [x]
- [ ]
- [ ]

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)
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.

(0-2%)
(3-5%)
(6-10%)
(11-15%)
✓ (16-30%)
✓ (31-60%)
(>60%)

✓
✓

0-100
101-500
501-1,000
✓ 1,001-1,500
✓ 1,501-2,000
2,001-2,500
2,501-3,000
3,001-4,000
> 4,000

✓

✓ (0-20)
✓ (21-50)
(51-80)
(81-120)
(> 120)

(
)
✓ /
✓ (,)
/ ( )

(> 20
)
/ ( )
(,)
/ ( )

(>3%)
✓ (1-3%)
✓ (<1%)

< 5
✓ 5-50
> 50

✓
/

(
)
✓
✓
( )
( )
✓

?
/
✓
/
✓

✓

✓

SLM

✓ ( )
✓ (/)
/

10%
✓ 10-50%
✓ 50%

✓

✓
/

✓

✓ /
✓ /
(,
)

✓
✓

✓
✓
✓

✓ < 0.5
✓ 0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
> 10,000

✓

✓

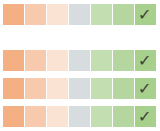
(
)
✓ ( )

✓ (
)
✓ ( )

(.)

The situation of infrastructure is difficult and inconsistent in the 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.

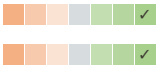


SLM: 2 ton/ha
SLM: 30 ton/hectare

/

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)

/

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.

SLM /

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,

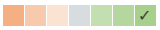
fuel and water provision. This has further enhanced cooperation for interventions that require participation and effort in the community forest.

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

(
)

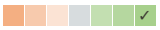
/

Soil moisture of common land was increased by about 15%

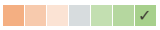


Trees and other vegetation has helped mitigate displacement of soil from upstream areas to the lowlands

/

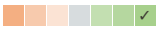


/



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.
.

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.

(-springs)

Improved spring discharge in the peak dry season

( )

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.

Helped slow down sediment and runoff

( )

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)

Less damage from runoff

/

Decreased intensity of runoff on the roadside and settlement below

Irregular rainfall patterns/ delayed monsoon

( )

:

/

- 1-10%
- ✓ 11-50%
- > 50%

?

- ✓ 0-10%
- 11-50%
- 51-90%
- 91-100%

?

/

✓

?

/

( )

:

- 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)

:

- Aligned with landuser
- Improved microclimate, overall ecosystem health, and increased carbon sequestration.

/ / :

- 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).

/ / :

- 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.

Editors

Jaclyn Bandy

Hanspeter Liniger

: 3 2019 : 27 2021

Jagdamba Prashad Joshi -
Basant Ballabh Pandey -

https://qcat.wocat.net/km/wocat/technologies/view/technologies_5243/

SLM

Approaches: Naula Management and Conservation https://qcat.wocat.net/km/wocat/approaches/view/approaches_5202/
Approaches: Community Forest Management in the Nakina Van Panchayat https://qcat.wocat.net/km/wocat/approaches/view/approaches_5199/
Approaches: Community Forest Management in the Nakina Van Panchayat https://qcat.wocat.net/km/wocat/approaches/view/approaches_5199/
Approaches: Naula Management and Conservation https://qcat.wocat.net/km/wocat/approaches/view/approaches_5202/
Approaches: Community Forest Management in the Nakina Van Panchayat https://qcat.wocat.net/km/wocat/approaches/view/approaches_5199/
Approaches: Community Forest Management in the Nakina Van Panchayat https://qcat.wocat.net/km/wocat/approaches/view/approaches_5199/
Approaches: Gestion participative du boisement communal de Bugarama https://qcat.wocat.net/km/wocat/approaches/view/approaches_6224/

- G.B. Pant Institute of Himalayan Einvironment & Development (G.B. Pant Institute of Himalayan Einvironment & Development) -
- ICIMOD International Centre for Integrated Mountain Development (ICIMOD) -
- Onsite and Offsite Benefits of SLM

- 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
- 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
- Policy Brief: Spring Revival through Sustainable Land Management (SLM) in the Himalayan Foothills: Uttarakhand, North India. Author: Liniger HP, Bandy J, Year: 2020: https://www.wocat.net/en/projects-and-countries/projects/onsite-and-offsite-benefits-sustainable-land-management/india
- Video: SLM for Himalayan Spring Revival. Author: Liniger HP, Bandy J, Year: 2020: https://vimeo.com/429988881