

## Impact of Sal (*Shorea robusta*) ANR (Assisted Natural Regeneration) in Shivalik Forests of Uttarakhand

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Received 18 May 2023, Accepted 10 July 2023, Published on 20 September 2023

### ABSTRACT

Along with other valuable tree species, Sal is the predominant forested crop in the Shivalik Circle of the Doon valley. It has been observed that the stock of Sal forests is quickly running out. The influence of Sal ANR (Assisted Natural Regeneration) was investigated in 10 forest ranges of the Shivalik Circle of the Uttarakhand forest department, India, keeping in mind the importance of this tree species. For the purpose of gathering field data that spanned the entirety of the compartment, random sampling was used. For comparison, data from two compartments, Sal ANR and non-ANR (next to ANR), were gathered. Various conclusions were drawn according to the study.

**Keywords** Sal, Regeneration, Compartments, Forest circle, Tree species.

### INTRODUCTION

Sal (*Shorea robusta*) is regarded as an important timber resource of India. Sal is distributed in Tropical Moist Deciduous and Tropical Dry Deciduous forests in the Shivalik hills and valley areas of Uttarakhand as a climax species (Champion and Seth 1968). Scientific management of natural Sal forests helps in creating better conditions for the growth of species which in turn leads to an increase in the growth rate. The main silvicultural systems that have been adopted to manage the Sal forests include Irregular Shelterwood, Selection and Coppice with Standards and Coppice with Reserves. Clear felling followed by seed sowing of Sal under 'Taungya' was also tried in some states. The natural regeneration of Sal has been causing much difficulty since last various decades and in recent years the problem has assumed serious magnitudes. In a few localities the problem has become so acute that the normal felling in Sal forests had to be curtailed or suspended either for lack of natural regeneration or due to heavy mortality in the standing mature crop by drought or borer attack. The problem of natural regeneration involves two major aspects—one is recruitment and the other is establishment of Sal seedlings under natural conditions. Plantation with Sal is difficult as raising plants in nursery is quite difficult as mortality of seedlings is very heavy. Studies made on this aspect of natural regeneration of Sal in the past, have been reviewed from time to time by Chakravarti (1948), Davis (1948), Gupta and Premnath (1963), Seth (1961), Pande (1956, 1961), Bhatnagar (1959, 1961), Seth and Khan (1960), Seth and Bhatnagar (1960), Srivastava (1965), Champion

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and Seth (1968), Samra *et al.* (1985), Maithani *et al.* (1989), and Mishra (1981).

Shiwalik Circle of Doon valley has Sal as the dominant forest crop besides other valuable tree species. It has been experienced that Sal forests are fast depleting in stock for various reasons like Hoplo (*Hoplocerambyx spinicornis*) attack, fire and biotic pressure and in turn, once known to be very rich Sal forest are being replaced by other less valuable trees like Rohini (*Mallotus philippensis*) and other associates of Sal including the invasive weeds like *Lantana camera*, *Ageratum coenizoides*, *Clerodendron*, *Ardicia solanacea*. Therefore need was felt to replenish and rejuvenate the area with new Sal crop. The Assisted Natural Regeneration (ANR) project was started in Shiwalik Circle of Uttarakhand in two forest divisions i.e. Dehradun and Kalsi in the year of

2005 to 2007-08 to assist the Sal regeneration. The silvicultural system applied in Doon valley of Sal forest was Irregular Shelterwood system with floating periodic blocks considering irregular regeneration. Canopy was opened in PB I irregularly considering regeneration. ANR methods were applied in the ANR compartments. Uttarakhand Forest Department entrusted Sal-ANR impact study to Forest Research Institute in Dehradun and Kalsi Forest Divisions of Shiwalik Circle after 10-12 years of operations.

## MATERIALS AND METHODS

### Study sites

The study on impact of Sal ANR was carried out in the following forest ranges of Shiwalik Circle of Uttarakhand forest department (Table 1).

**Table 1.** Sal ANR study sites in Shiwalik Circle of Uttarakhand.

Sl. No.	Forest ranges/compartments	Geo-reference	Altitude (m)	Area	General vegetation	Prevailing conditions of ANR compartments
1	Golatappar, 7-B Chhiddarwala, Barkot range, Dehradun Division	N 30°04'7.5" S 78°12'32.0"  N 30°04'14.4" E 78°12'32.0"	376	30	<i>Diospyros malabarica</i> , <i>Pterospermum acerifolium</i> , <i>acerifolium</i> , <i>Mallotus philippinensis</i> , <i>Puranjiva roxburghii</i> , <i>Adina cordifolia</i> , <i>Shorea robusta</i> .	Thick undergrowth of Kala tendu and Kanak champa. Very rare Sal regeneration. Not suitable for ANR. Protection was given by digging trench around ANR comp.
2	Golatappar, 4-B, Chhiddarwala, Barkot range, Dehradun div (Part-I)	N 30°05'32.2" E 78°11'43.0"	398	30	<i>Shorea robusta</i> , <i>Adhatoda vasica</i> , <i>Lantana camara</i> .	Very heavy anthropological pressure. Area not suitable for ANR. Protection was given by digging trench around ANR comp.
3	Golatappar, 4-B, Chhiddarwala, Barkot range, Dehradun \ div (Part-II)	N 30°06'08.4" E 78°11'34.4"	443	30	<i>Syzygium cuminii</i> , <i>Clerodendron viscosum</i> , <i>Adina cordifolia</i> , <i>Toona ciliata</i> , <i>Shorea robusta</i> , <i>Lantana camara</i> , <i>Ageratum conezoides</i> .	Some regeneration of <i>Shorea robusta</i> is observed but most of the saplings were found browsed due to Nilgai. Protection was given by digging trench around ANR comp.
4	Ghamandpur- 8 B Golatappar, Barkot range, Dehradun div	N 30°06'47.8" E 78°11'35.2"	444	35	<i>Shorea robusta</i> , <i>Syzygium cuminii</i> , <i>Chamor</i> , <i>Terminalia tomentosa</i> , <i>Mallotus</i> , <i>philippinensis</i> , <i>Eupatorium glandulosum</i> .	Area is suitable for Sal regeneration. Protection was given by digging trench around ANR comp.

Table 1. Continued.

Sl. No.	Forest ranges/compartments	Geo-reference	Altitude (m)	Area	General vegetation	Prevailing conditions of ANR compartments
5	Bhogpur-1-A, Thano range, Dehradun div	N 30°12'10.1" E 78°14'14.4"	708	35	<i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>Lantana camara</i> , <i>Mallotus philippinensis</i> , <i>Eupatorium glandulosum</i> .	Area is suitable for Sal regeneration. Protection was given by stone wall fencing. Terrain is hilly.
6.	Bhogpur-2, Thano range, Dehradun div	N 30°12'49.5" E 78°14'08.5"	757	65	-Do-	-Do-
7	Maidan-1, Thano range Dehradun Div.	N 30°12'50.2" E 78°12'20.7"	845	25	<i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>Lantana camara</i> , <i>Mallotus philippinensis</i> , <i>Eupatorium glandulosum</i> , <i>Carissa opaca</i> , <i>Dendrocalmus strictus</i> .	Area is not much found suitable for ANR due to Bamboo clumps were observed.
8	Lacchiwala-3 A, Lacchiwala range, Dehradun div.	N 30°11'07.9" E 78°06'28.4"	445	20	<i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>Lantana camara</i> , <i>Mallotus philippinensis</i> , <i>Flemingia chappar</i> , <i>Syzygium cumini</i> , <i>Clerodendron viscosum</i> , <i>Carissa opaca</i> , <i>Murraya</i> .	Sal saplings are not established. Only current year seedlings were observed. Protection was given by digging trench around ANR comp.
9	Lacchiwala-6 AB Lacchiwala range, Dehradun div	N 30°11'57.6" E 78°06'50.9"	524	25	-Do-	-Do-
10	Lacchiwala-14 B, Lacchiwala range, Dehradun div	N 30°13'06.3" E 78°07'23.8"	574	30	<i>Shorea robusta</i> <i>Terminalia tomentosa</i> , <i>Lantana camara</i> <i>Mallotus philippinensis</i> <i>Anogeissus latifolia</i> , <i>Lagerstroemia parviflora</i> , <i>Carissa opaca</i> , <i>Murraya</i> .	About 60-70% of the Sal ANR area is replaced by road widening. Protection was given by digging trench around ANR comp.
11	Navada-9, Lacchiwala range, Dehradun div.	N 30°13'36.1" E 78°03'40.5"	675	30	<i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>Lantana camara</i> , <i>Mallotus philippinensis</i> , <i>Carissa opaca</i> , <i>Murraya</i> .	Heavy anthropological pressure. Regeneration was not observed.

**Table 1.** Continued.

Sl. No.	Forest ranges/compartments	Geo-reference	Altitude (m)	Area	General vegetation	Prevailing conditions of ANR compartments
12	Jhajra-2, Jhajra range, Dehradun div	N 30°21'18.9" E 77°55'08.5"	629	65	<i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>Lantana camara</i> <i>Mallotus philippinensis</i> , <i>Carissa opaca</i> , <i>Murraya</i> , <i>Ardicea solanacea</i>	Thick undergrowth of Gurbheli/bhalukhaja Area is suitable for Sal-ANR.
13	Chorpur, Charva-1, Chorpur range, Kalsi soil Conservation division, Dehradun.	N 30°24'53.1" E 77°48'02.4"	510	30	<i>Shorea robusta</i> <i>Lantana camara</i> , <i>Mallotus philippinensis</i> , <i>Carissa opaca</i> <i>Murraya</i>	Heavy regeneration of Sal in pole stage Required thinning.
14	Chorpur, Chandpur-1A, Chorpur range, Kalsi soil Conservation division, Dehradun.	N 30°25'28.5" E 77°51'15.2"	600	33	<i>Shorea robusta</i> , <i>Lantana camara</i> , <i>Mallotus philippinensis</i> , <i>Carissa opaca</i> , <i>Murraya</i>	Heavy regeneration of Sal in pole stage. Required thinning.
15	Chorpur, Rudrapur-1, Chorpur range, Kalsi soil Conservation division, Dehradun.	N 30°26'27.2" E 77°49'59.7"	520	40	-Do-	-Do-
16	Chorpur, Dumet-2A, Langa range, Kalsi soil Conservation division, Dehradun.	N 30°29'19.7" E 77°50'45.8"	570	30	-Do-	-Do-
17	Chorpur, Dumet-1B, Langa range, Kalsi soil Conservation division, Dehradun.	N 30°30'08.4" E 77°51'06.5"	557	40	-Do-	-Do-
18	Kalayanpur 2A, Timli range	N 30° 24' 34.08 E 77 22' 54.5"	493	30	<i>Mallotus philippinensis</i> , <i>Anogeissus latifolia</i> , <i>Murraya</i> , <i>Carissa opaca</i> , <i>Jasminum pubescence</i>	-Do-

### Methodology for data collection

**Sampling :** The study was carried out in a total of 10 forest ranges of 2 forest divisions under Shiwalik Circle of Uttarakhand namely, Dehradun and Kalsi. The random sampling was adopted for field data collection which covered whole area of the compartment. The data was collected from two compartments i.e. Sal ANR and non-ANR (adjacent to ANR) for comparison. Sample plots of 10 m x 10 m were laid for tree enumeration, regeneration counts and vegetation survey. The sampling intensity was 50% of the com-

partment area. The sample plot was marked by GPS to record the coordinates and way points.

**Data collection :** The DBH of all the plants and trees in 10 m x 10 m sample plots (ANR and non-ANR) was recorded. The data on regeneration was recorded from sample plots to observe regeneration status. Regeneration status is based on the established population of seedlings, saplings and poles of Sal. Whippy regeneration was also recorded. Top broken and Whippy seedlings are those which were browsed and grazed by wild animals.

**Table 2.** Regeneration status (ha) in ANR and Non ANR compartments in different forest ranges of Shivalik Circle, Uttarakhand.

Sl. No.	Forest ranges	CTR Regeneration Compartments		Established		Top broken		Whippy		New recruits Non-ANR
		ANR	Non-ANR	Non-ANR	ANR	Non-ANR	ANR	Non-ANR	ANR	
1	Barkot	Golatappar 4 B	0	60	0	0	1080	6000	2580	3120
		Golatappar 7 B	0	350	300	0	8400	2940	2030	1260
2	Navada	Ghamandpur 8 B	240	180	660	2240	3060	600	900	780
		Navada 9	0	60	0	0	2950	200	1300	1920
3	Thano	Bhohpur 2	6500	910	4290	0	16600	19160	2350	3640
		Maidan	400	100	0	0	2950	2000	1250	2050
4	Malhan	Malhan 8B	0	0	0	0	700	1550	0	16
		Kalyanpur-Timli	500	0	900	0	4400	1400	2300	700
5	Timli	Timli- Majri	400	600	450	200	1050	1750	1150	2300
		Darariet 6	180	240	900	480	2460	1800	1560	2340
6	Asarori	Asarori-Laldang-5	0	0	1	0	56	52	28	68
7	Jhajhra	Jhajhra	0	0	0	0	0	0	0	0
		Charva	180	240	900	480	2460	1800	1560	2340
8	Chorpur	Chandpur-1 A	340	123	740	340	3405	1600	3400	1230
		Rudrapur -1	160	0	480	0	4240	2480	2720	2480
9	Langa	Dumet -2 A	435	120	560	220	780	530	3547	1203
		Dumet-1 B	300	240	800	1200	2960	3280	3280	2080
10	Lacchiwala	Lacchiwala 6AB	550	300	100	300	6900	850	1250	1050

## RESULTS AND DISCUSSION

The regeneration status of different compartments of 10 forest ranges under ANR is presented in Table 2. Range wise regeneration status is given in below paragraphs.

**Barkot range:** Data were collected from 3 compartments namely, Golatappar 4 B, Golatappar 7 B and Gamandpur 8 B. The compartments of Golatappar were highly disturbed due to intense biotic interventions of human population and plant communities. There was heavy mortality of newly recruited seedlings due to heavy competition of Kala tendu (*Diospyros malabarica*) and Kanak champa (*Pterospermum acrifolium*) in Goaltappar 7 B compartment.

The regeneration status has been observed in ANR and non ANR compartments. It is revealed from the Table 2 that Ghamandpur 8 B compartment has established regeneration in which 240 established plants of Sal were found in a hectare with more than 3 m of height while non -ANR compartments have established regeneration in range of 60-350 plants per ha. It is noticed that although regeneration has reached sufficient upto whippy stage but after that due to heavy shade effect of Kanak champa and Kala

tendu in Golatappar 7 B and Lantana and Chamror in Golatappar 4 B, regeneration could fail to reach at established stage. The heavy canopy density and heavy litter weight of Kala tendu and Kanak champa in Golatappar 7 B have badly affected Sal regeneration. The Golatappar 4 B compartment has high species diversity in shrub layer of Rohini, Lantana, Chamror which are responsible for inhibition of regeneration of Sal.

**Navada range:** There was only Sal trees in Non ANR compartment as compared to ANR compartment where "sain" is associated with Sal. Lantana and *Ardisia solanacea* (Gurbheli) have 100% frequency in the ANR compartment. Due to heavy density and frequency of these species, regeneration in ANR compartment was absent. The regeneration in this range is badly affected due to not carrying further operations of weeding and cleaning of ground flora. Although regeneration is obtained every year as new recruits but it could not establish due to undergrowth competition of weeds and biotic interference of wild animals and cattle of nearby population.

**Thano range :** The data on Sal ANR was collected from Bhogpur 2 and Maidan 1 compartments. Total area of the compartment is 187.3 ha. Out of which

65 ha area was taken under Sal ANR. The Maidan compartment 1 is about 3 km far from the Thano range office and Bhogpur 2 compartment is about 4 km far from the range office. The ANR of Maidan 1 was undertaken in 25 ha. Both the compartments are situated on the hill slopes. It has been observed that Bhogpur 2 has shown an excellent regeneration of Sal than Maidan. The Sal was predominant in Bhogpur 1 with basal area of 741.82 m<sup>2</sup> and 420 trees density per ha in ANR compartment as compared to Maidan where the density of trees was less but basal area was found more (849.64 m<sup>2</sup>). There were four species of trees found in Maidan ANR compartment. There were 11 species of shrub layer in ANR Bhogpur 1 and 5 species in non ANR compartments. There were 8 species of shrub layer in ANR compartment and 2 species in non-ANR of Maidan 1 compartment. It has been observed that due to low accumulation of leaf litter on the slopes and less competition of weeds, regeneration was found establish in Thano range .

**Malhan range:** The compartment area of 50 ha was taken up under ANR operations upto 10 years of duration. This range has problem of Sal regeneration due to intense biotic pressures of nearby population (Bhatnagar 1963). The configuration of the area is plain with some nallahs flow through the compartment. There were 3 species of trees in ANR compartment and 7 species of shrubs and 5 species in non-ANR compartment. In Malhan range, Sal ANR was not found successful.

**Timli range:** The data were collected from Kalyanpur, Darariet and Timli- Majri compartments. The operations of Sal ANR were carried out in 2004-05. The vegetation of Kalayanpur revealed that there are 8 tree species in ANR compartment while non-ANR has 4 tree species. The density, frequency and basal cover of Lantana and other weeds are high in both the compartments. It is revealed from the Table 2 that established regeneration is found in ANR compartment of Kalayanpur but it was nil in non- ANR. It was observed that ground litter and canopy density of trees has affected Sal regeneration as heavy leaf litter was found in non-ANR compartment. The numbers of species are almost same in both the compartments. Table 2 revealed that regeneration is found normal in Timli-Majri compartment. In Darariet compartment,

the density and basal area of Sal in ANR compartment is higher than non-ANR compartment but number of species in both compartments is equal. In case of shrub layer, the ANR compartment had 15 species and non ANR had 12 species. Non ANR compartment performed better than ANR in Darariet as shown in the table.

**Asarori range:** ANR was carried out in Laldang compartment 5 in Asarori range of Dehradun forest division. The forest of Laldang is tropical mixed Moist Deciduous type in which Jamun has contributed a good density. It has been observed that post operations under ANR could not have been undertaken in the compartment as per plan resulting heavy density of *Ardisia solanacea*, *Lantana*, *Murraya*, *Clerodendron* was observed in ANR compartment. Seedlings were not able to reach to establish stage due to the dense undergrowth of these plants.

**Jhajhra range:** The Jhajhra compartment was undertaken in ANR operation in the year 2004-05. There was 4 species in tree layer in ANR compartment as compared to 2 in non ANR. Density of *Ardisia solanacea* on the forest ground is so high that it is not allowed Sal seedlings to grow. It is therefore, Sal regeneration is totally absent in Jhajhra. Sal is found in mature stage. Soil is moist due to heavy undergrowth of *Ardisia* and *Murraya* which becomes favorable to moist species like Jamun. Canopy density in Sal ANR compartment is more (80.8%) as compared to non-ANR (71.8%). *Lantana* and *Parthenium* are found in the open space.

**Chorpur range:** Number of species in ANR compartment increased due to opening of canopy. Almost all age group of Sal is found in this compartment. It shows that the Sal regeneration in Chorpur range is found to be normal. It is also observed that only 8% whippy seedlings reached to the pole stage. It has been found that Sal regeneration has reached to more than 10 cm of diameter and formed congestion among plants due to intense density. Thinning is therefore required to minimize competition and to obtain uniform growth. Continue removal of leaf litter and soil working has improved Sal regeneration but thinning is required in advance crop for removal of inferior trees to provide light and space to superior grown trees.

**Langa range:** The data were collected from Rudrapur and Dumet ANR compartments. In Rudrapur compartment, there is no significant difference of species diversity between ANR and non- ANR compartments. Data indicates that Sal is found in all diameter age classes. It is seen from the table that both the compartments had current year regeneration. Due to continue protection and other operations, regeneration is found established in ANR compartment. The density of 160 established plants of Sal per ha were found in regeneration compartment while the Sal regeneration was absent in non-ANR compartment. In Dumet 1 B, there was no significant difference of regeneration of Sal in ANR and non-ANR compartments.

**Lacchiwala range:** Lachhiwala 6AB compartment is located near range office. The ANR was carried

out in 25 ha of area. Trench fencing was done around ANR compartment for protection of wild animals like elephants and deer. Canopy was opened by felling of mature and over mature trees of PB I stage in ANR compartment as the density of Sal trees was found less in non-ANR compartment. It is observed that density of jamun has been increased due to moist conditions of associated species especially *Mallotus* and *Clerodendron*. In the Sal ANR compartment, Sal ANR progressed to 11-20 cm of diameter thereafter biotic pressure and dense ground flora inimical establishment of plants. Therefore, thinning in compartment is required to optimize density of regeneration.

After a period of 10-12 years of Sal ANR operations in Shivalik Circle, it was found that Bhogpur compartment of Thano range had maximum estab-

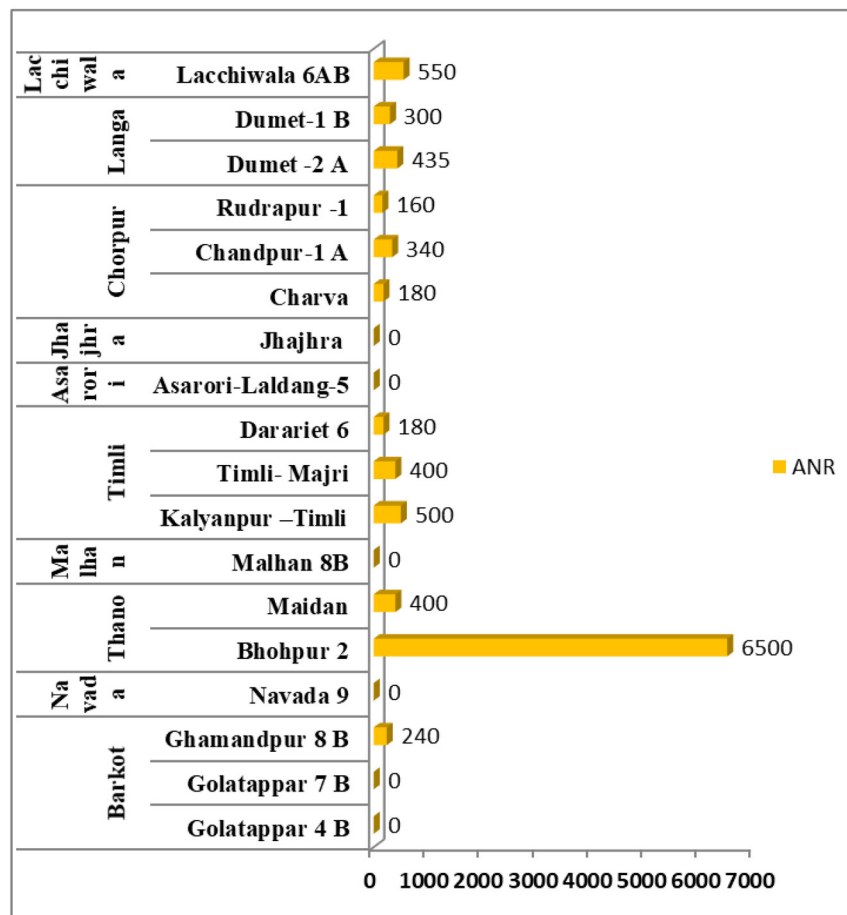


Fig. 1. Range wise established Sal regeneration under ANR in Shivalik Circle of Uttarakhand.

lished density of Sal regeneration.

Timli, Langa and Chorpur ranges have density from 180 to 500 established plants per ha. In Lacchiwala range, the density of 550 established plants per ha was recorded. While Sal –ANR was not found successful in Navada, Barkot, Malhan, Jhajhra and Asarori forest ranges (Fig. 1). ANR operations in these ranges were not found to be carried out. Although, new recruits were found in the ANR compartments but due to lack of ANR interventions, seedlings could not establish in the ranges. In Chorpur and Langa ranges seedlings have reached to pole stages and their density is very heavy. Silvicultural thinning is required to be carried out so as to remove inferior plants.

## CONCLUSION

All the sites selected for undertaking ANR were not found suitable and few sites were having well-established regeneration of Sal. The impact of ANR on regeneration as observed in ten forest ranges of 2 forest divisions of Shiwalik Circle of Uttarakhand revealed that regeneration has reached upto the diameter range of 8-10 cm. Thano, Timli, Langa, Chorpur and Lacchiwala ranges have established regeneration, wherein ANR operations were quite successful. While ANR was not successful in Barkot, Navada, Jhajhra, Malhan and Asarori. Maximum value of established regeneration was observed in Thano range.

Though these sites were administered with basic silvicultural operations during the inception of ANR, however, to accelerate the regeneration potential, further silvicultural operations are required to be given in future based on the  $-3/2$  power law of self thinning. Ground thinning is therefore required in Langa, Thano and Chaorpur ranges by removal of inferiors and bad shaped poles and saplings from the compartments. Thinning will be made proper and sound development of silviculturally available trees of Sal. It is also advisable to provide 60-70% of shade to the seedlings below 5 cm of diameter. In case where the woody and whippy regeneration have come it is necessary that more light is to be admitted by thinning of understory. In case of woody stage the canopy is to be opened in such a way that domi-

nates left were spaced 12-15m apart. In areas where regeneration has reached the established stage, the top canopy has to be opened further. It is necessary to provide nursing or nurse crop for retention of light crowned miscellaneous species of Sal regeneration. Removal of the mature and over mature trees along with the shrub cutting in the moist Sal will definitely enhance regeneration particularly the seedlings, as they cannot tolerate competition in the early phase of life. So to reduce the competition moderate shrub cutting is advisable.

In case of dry Sal, branch pruning and lopping along with shrub cutting is advisable. Avoid cutting of associated trees (Mallotus, Terminalias, Cassia etc.) to conserve the moisture during peak dry season and to nurse the seedlings and saplings from frost during winter cold. Shrub cutting is essential to check competition for seedlings.

Moisture stress and heavy undergrowth in few areas is responsible for heavy mortality of Sal seedlings after their recruitments. Recruitment of Sal seedlings is not a problem but establishment of seedlings and their conversion to higher diameter class is more important. Reduced moisture and growth of undergrowth (shrubs and weeds) has increased intra-specific competition in the forest ranges of Asarori, Jhajhra and Barkot forest ranges. Heavy anthropological pressure in Malhan and Navada ranges resulting in failure of ANR.

On an average there is a substantial increase in carbon content of soil after the implementation of ANR project. The high soil carbon content is favourable for the system, as it will decompose and mineralized slowly for the uptake of growing stock. However, there are some abnormalities with such carbon content in Non-ANR system which denotes high soil moisture percentage followed by canopy closure or high tree density.

ANR operations have neither resulted into deterioration of microclimatic conditions nor sustainability of forest ecosystems. However, these operations have resulted into reduced levels of carbon sequestration in 41.93 % of sites, which may be attributed to removal of woody and non-woody biomass. However,



regeneration of tree and other species and their subsequent growth is likely to enhance the sequestration levels in near future. If crop is well managed the new sequestration levels may be higher than prior to the felling operations.

ANR operations have resulted into significant increase in income of the local people from forest products and also the availability of forest products such as fuelwood, fodder, small wood and NWFP. The level of employment in forestry sector has also increased as a result of these operations.

Most important mitigation measures are required absolute protection from biotic interference, particularly grazing and fire for another 8-10 years. Other mitigation measures include soil and water conservation works such as check dams, stonewalls and vegetative measures on slopes.

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