

Impact of Crop Composition and Stand Structure on Natural Regeneration of *Shorea Robusta* Gaertn. f. (Sal) - Case Study

O.P Chaubey¹, Archana Sharma¹ and S. S. Dhuria²

¹Stare Forest Research Institute, Jabalpur (M.P.) India

²Guru Ghasidas University, Bilaspur (C.G.) India

E-mail: chaubey.dr@gmail.com¹, archanasharma.sharma6@gmail.com¹

Abstract

Shorea robusta is threatened these days due to poor regeneration potential. No systematic attempts were made in India, to understand dynamism of its natural regeneration and to suggest management inputs to encourage its regeneration. The present study deals with the natural regeneration with particular reference to crop composition and community structure in East Mandla Forest Division in Madhya Pradesh, India. The results indicated that the regeneration of *Shorea robusta* (seedlings per ha) varied from 916 to 21847. Besides this adequate regeneration of *Shorea robusta*, the distribution pattern of individuals of *Shorea robusta* trees in different girth classes was also seemed to be uninterrupted in most of the stands studied. This trend of uninterrupted distribution of *Shorea robusta* in different growth phases with plenty of established regeneration is the healthy sign of establishment and growth of *Shorea robusta* crop in the past in this area.

Keywords: Natural regeneration, stand structure, crop composition, distribution, phyto-sociology

1. Introduction

Shorea robusta is the most important timber species and has high production potential in the forests of Central India. It is threatened these days due to poor regeneration potential. A great deal of work has been done in the past on the ecology of *Shorea robusta*, however, an exact status of natural regeneration in various *Shorea robusta* communities has not been clearly defined and complete data base is not available. *Shorea robusta* in Madhya Pradesh (M.P.), India, is confined mainly in forests of East Mandla, West Mandla, South Balaghat, North Balaghat, Dindori, South Shahdol, North Shahdol, Anooppur, Umaria, East Sidhi, West Sidhi, West Chhindwara, Hoshangabad, Harda, Katni, Pachmarhi forest divisions.

Scattered information is available in literature on status of *Shorea robusta* regeneration in relation to soil pH (Gupta, 1953), accumulation of leaf litter in moist forests (Champion and Seth, 1968) damage by wild animals (Sirkar, 1954), effect of grazing closure (Chaubey and Jamaluddin, 1989), Shrubby growth and ground flora richness (Khan and Gupta, 1960). Srivastava (1963) studied phyto-sociological studies of *Shorea robusta* forests in U.P. with special reference to regeneration. Dabral *et.al.* (1980) studied micro-climatic variations in naturally regenerating *Shorea robusta* forest in West Dehradun. They advocated that temperature and moisture regimes of the surface soil are related with mortality of *Shorea robusta* seedlings. Jha and Pandey (1980) studied the comparative loss of soil moisture during decomposition of leaf litter in Popalar, *Eucalyptus*, Chir, Teak and *Shorea robusta* and suggested that moisture loss is least in *Shorea robusta* as compared to other species. No systematic attempts were made in India, to understand dynamism of natural regeneration of *Shorea robusta* and to suggest management inputs to encourage its regeneration, particularly in M.P. The natural regeneration aspect received very little attention with particular reference to crop composition and community type.

Ecology of natural regeneration of *Shorea robusta* with special reference to crop composition and community types was attempted by Khan and Gupta (1960) in Dehradun Valley. The present paper deals with studies on natural regeneration *Shorea robusta* with respect to crop composition and stand structure in Mandla Forest division of Madhya Pradesh (India). According to Champion and Seth classification of forest types, *Shorea robusta* forests in this area are falling under following two categories –

1. Moist peninsular low level *Shorea robusta* (3C/C₂e (ii)
2. Moist peninsular valley *Shorea robusta* (3C/C₂e (iii)

Topographically, most of the *Shorea robusta* forest of this area is found in undulating plains, foot hills and plain habitats.

2. Methodology

2.1. Survey, Demarcation and Layout of Sample Plots

Before starting the survey, management maps and stock maps were collected from the forest division for borer affected *Shorea robusta* areas. Sample plots of suitable size were laid in various compartments of identified divisions. In all, 10% of the total compartments were selected randomly from borer-affected areas particularly from East Mandla division. The regeneration status of *Shorea robusta* and other associates was studied using quadrats method laid in each sample plot (Mishra, 1989, Philips, 1959). The size and number of quadrats to be laid was decided taking care of statistical norms and ecological standards. Number of seedlings of seed and coppice origin were recorded separately in each sample plot laid in different compartments.

2.2. Study the Community Structure and Regeneration Status of *Shorea robusta* and other Associates

The phyto-sociology of tree vegetation was studied in each sample plots for determining the crop composition, stand structure and dominance of tree species in the community. Attempts were made to determine the regeneration of *Shorea robusta* and other miscellaneous species with the crop composition and community structure. Regeneration of *Shorea robusta* seedlings was categorized into two classes *i.e.*, adequate and un-adequate as per recent norms adopted in forest working plans. In order to determine the recruitment pattern of tree species particularly *Shorea robusta* trees, following GBH classes was established to get the percent density (Ralhan *et. al.*, 1982) for each species in different girth classes.

Class	Range in gbh/cbh (cm)
A	0-10 (Seedlings)
B	>10-20 (Saplings)
C	>20-40
D	>40-60
E	>60-80
F	>80-100
G	>100-120
H	>120-140
I	>140-160
J	>160

The total number of individuals belonging to above girth classes was computed for each species. The number of individuals in each girth class was divided by total number of individuals of all girth classes of that species. The resultant value was multiplied by 100 to get percent density for each girth class of each species. Plots will be laid in

different edapho-climatic areas having variations in soil properties, crop composition and rainfall pattern.

3. Results

3.1. Status of Standing Crop and Regeneration *Shorea robusta* and its Associates

The status of standing crop and regeneration of *Shorea robusta* and its associates, pertaining to crop composition, density of standing trees ha⁻¹, established regeneration ha⁻¹, population structure in terms of density of *Shorea robusta* and its associates in different girth classes, health status of crop, biotic pressure, current status of borer infestation etc. in the selected compartments studied in Mawai range of East Mandla division of Madhya Pradesh is described below:-

1. Compartment No. 1150

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is mostly plain with sandy loam soil and semi hard strata. The crop is pure *Shorea robusta* forest with inadequate humus. The site quality is M.P. III & IV A. The associates of *Shorea robusta* in top canopy are *Terminalia tomentosa*, *Anogeissus latifolia*, *Terminalia chebula*, *Terminalia bellerica* and *Syzygium cumini*. In middle canopy, the tree associates are mainly *Buchanania latifolia*, *Diospyros melanoxylon* and *Lagerstroemia parviflora*. The ground flora has *Embelia ribes* as an important shrub. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. The density of *Shorea robusta* and miscellaneous species was found to be 290 trees ha⁻¹ and 230 trees ha⁻¹ respectively. The established regeneration of *Shorea robusta* was computed to be 12403 ha⁻¹. Besides *Shorea robusta*, the regeneration of *Terminalia chebula*, *Milliusa tomentosa*, *Buchanania lanzan*, *Lagerstroemia parviflora* and *Terminalia tomentosa* was also noticed. Of the total regeneration (21847 seedlings ha⁻¹.) recorded, the *Shorea robusta* contributed to 57%, and rest of the 43% was rendered by other miscellaneous species. The growth phase of *Shorea robusta* showed uninterrupted trend of regeneration from seedling to sapling stage and onwards. This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

2. Compartment No. 1161

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is mostly undulating with black soil and hard strata. The crop is mixed *Shorea robusta* forest with inadequate to adequate humus. The site quality is M.P IVa & IVb. The associates of *Shorea robusta* in top canopy are *Terminalia tomentosa*, *Anogeissus latifolia*, *Ougeinia dalbergioides*, *Syzygium cumini*. In middle canopy, the tree associates are mainly *Lagerstroemia parviflora*, *Abrus precatorius*, *Cassia fistula*, *Lagerstroemia parviflora*, *Emblia officinalis*, *Buchanania latifolia*, *Semecarpus anacardium*, *Casearia graveolens*, *Madhuca latifolia*, *Diospyros melanoxylon* etc. The ground flora has *Embelia ribes*, *Hemedesmus anacardium* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, was found well, however, trees showed malformed growth. The biotic pressure was found to be heavy. The density of the crop was 0.4 and below. The density of *Shorea robusta* and miscellaneous species was found to be 900 trees ha⁻¹ and 860 trees ha⁻¹ respectively. The established regeneration of *Shorea robusta* was computed to be 13111 ha⁻¹. Besides *Shorea robusta*, the regeneration of *Buchanania latifolia*, *Pterocarpus marsupium*,

Diospyros melanoxylon, *Terminalia chebula*, and *Randia dumetorum* was also noticed. Of the total regeneration (13874 seedlings ha⁻¹) recorded, the *Shorea robusta* contributed to 99% and rest of the 01% was rendered by other miscellaneous species. The growth phase of *Shorea robusta* showed uninterrupted trend of regeneration from seedling to sapling and onwards. This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

3. Compartment No. 1184

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was not under borer infestation during 1997-98. The configuration is mostly undulating with black soil and hard strata. The crop is mixed *Shorea robusta* forest with inadequate to adequate humus. The site quality is M.P IV b. The associates of *Shorea robusta* in top canopy are *Terminalia tomentosa*, *Anogeissus latifolia* (Roxb.ex DC.) Wall.ex Bedd., *Madhuca latifolia* In middle canopy, the tree associates are mainly *Lagerstroemia parviflora*, *Abrus precatorius* Linn, *Cassia fistula*, aonla, *Buchanania latifolia*, *Semecarpus anacardium* L.f., *Casearia graveolens*. Dalz, *Madhuca latifolia*, *Diospyros melanoxylon* Roxb. etc. The ground flora was found scanty with *Embelia ribes*, *Hemedesmus anacardium*, *Sida cordifolia* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, was found well, however, trees showed malformed growth. The human pressure was found to be heavy. The density of the crop was 0.4 and below. The density of *Shorea robusta* and miscellaneous species was found to be 160 trees ha⁻¹ and 140 trees ha⁻¹ respectively. The established regeneration of *Shorea robusta* was computed to be 916 ha⁻¹. The regeneration was found poor due to the heavy biotic pressure.

4. Compartment No. 1195

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is mostly plain with sandy soil and semi-hard strata. The crop is pure *Shorea robusta* forest with inadequate humus. The site quality is M.P II and III. The associates of *Shorea robusta* in top canopy are *Terminalia tomentosa*, *Anogeissus latifolia* (Roxb.ex DC.) Wall.ex Bedd., *Pterocarpus marsupium* Roxb., *Adina cordifolia* (Roxb.) Hook.f.ex Brandis, *Lagerstroemia parviflora* etc. In middle canopy, the tree associates are mainly *Lagerstroemia parviflora*, *Ougeinia dalbergioides* Benth, *Syzygium cumini* (L) skeels, *Cassia fistula*, aonla, *Buchanania latifolia*, *Semecarpus anacardium* L.f. , *Casearia graveolens*. Dalz, *Madhuca latifolia*, *Diospyros melanoxylon* Roxb., *Stereospermum suaveolens*, *Randia dumetorum* etc. The ground flora was found dense with invasion of chhind and *Flemingia semialata*. Other herbaceous species were *Embelia ribes*, *Hemedesmus anacardium*, *Elephantopus scaber*, *Sida cordifolia* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. The density of the crop was 0.4 and above. The density of *Shorea robusta* was found to be 240 trees ha⁻¹. This was followed by *Lagerstroemia parviflora* with density of 80 trees ha⁻¹. The established regeneration of *Shorea robusta* was computed to be 12666 ha⁻¹. The regeneration was found to be profuse. Besides *Shorea robusta*, the regeneration of *Buchanania lanzan*, *Pterocarpus marsupium*, *Terminalia chebula*, *Terminalia tomentosa*, *Lagerstroemia speciosa*, *Stereospermum suaveolens* and *Randia dumetorum* was also noticed. Of the total regeneration (14426 seedlings ha⁻¹) recorded, the *Shorea robusta* contributed to 88%, and rest of the 12% was rendered by other miscellaneous species. The growth phase of *Shorea robusta* showed uninterrupted trend of regeneration from seedling to sapling and onwards.

This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

5. Compartment No. 1205

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The compartment has been fenced during 2003 –04 to rehabilitate the crop. The configuration is mostly plain with sandy soil and porous strata. The crop is pure *Shorea robusta* forest with adequate humus. The site quality is M.P III. The associates of *Shorea robusta* in top canopy are *Terminalia tomentosa*, *Anogeissus latifolia*, *Pterocarpus marsupium*, *Lagerstroemia parviflora* etc. In middle canopy, the tree associates are mainly *Lagerstroemia parviflora*, *Ougeinia dalbergioides*, *Butea monosperma*, *Embluca officinalis*, *Buchanania lanzan*, *Semecarpus anacardium*, *Casearia graveolens*, *Madhuca latifolia*, *Diospyros melanoxylon*, *Stereospermum suaveolens*, *Randia dumetorum* etc. The ground flora was found dense with invasion of *Flemingia semialata*. Other herbaceous species were *Embelia ribes*, *Hemedesmus anacardium*, *Elephantopus scaber*, *Sida cordifolia*, *Ventilago calyculata*, *Smilax macrophylla* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. *Shorea robusta* trees were straight, cylindrical and tall. The density of the crop was moderate (0.5-0.7). The density of *Shorea robusta* and miscellaneous species was found to be 540 trees ha⁻¹ and 170 trees ha⁻¹ respectively. The established regeneration of *Shorea robusta* was computed to be 12625 ha⁻¹. The regeneration was found to be quite profuse. The growth phase of *Shorea robusta* showed uninterrupted trend of regeneration from seedling to sapling and onwards. This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

6. Compartment No. 1215

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is between plain and undulating, with alluvial soil and hard strata. The crop is pure *Shorea robusta* forest with inadequate humus. The site quality is M.P III. In middle canopy, the tree associates are mainly *Lagerstroemia parviflora*, *Ziziphus xylopyrus*, *Madhuca latifolia* etc. The ground flora was found invaded with *Flemingia semialata*. Other herbaceous species were negligible. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. *Shorea robusta* trees were straight, cylindrical and tall. The density of the crop was 0.4 and below. The density of *Shorea robusta* was found to be 120 trees ha⁻¹. This was followed by *Lagerstroemia parviflora* (40 trees ha⁻¹), *Ziziphus xylopyrus* (Retz.) Willd (20 trees ha⁻¹) and *Madhuca latifolia* (10 trees ha⁻¹). On perushorea robusta of *Shorea robusta* density in different girth classes, it reveals that out of 120 trees ha⁻¹, 30 plants ha⁻¹ recorded in sapling stage (GBH between 10 –20cm). This is the good indication of establishment of recruits occurred during the last 10 years. The established regeneration of *Shorea robusta* was computed to be 20055 ha⁻¹. The regeneration was found to be quite profuse. Besides *Shorea robusta*, the regeneration of *Butea monosperma* (Lam.) Taub. and *Terminalia chebula* was also noticed. Of the total regeneration (20193 seedlings ha⁻¹) recorded, the *Shorea robusta* contributed to 99%, and rest of the 01% was rendered by other miscellaneous species.

7. Compartment No. 1225

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different

tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is plain with sandy loam soil and semi hard strata. The crop is pure *Shorea robusta* forest with inadequate humus. The site quality is M.P IVa. In top and middle canopy, the tree associates are mainly *Lagerstroemia parviflora*, *Buchanania lanzan*, *Terminalia tomentosa* etc. The ground flora was found scanty with invasion of *Flemingia semialata*. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. The density of the crop was 0.4 and below. The density of *Shorea robusta* was found to be 210 trees ha⁻¹. This was followed by *Terminalia tomentosa* (40 trees ha⁻¹), *Buchanania lanzan* (20 trees ha⁻¹) and *Lagerstroemia parviflora* (10 trees ha⁻¹). The established regeneration of *Shorea robusta* was computed to be 1166 ha⁻¹.

8. Compartment No. 1237

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is undulating with sandy soil and hard strata. The crop is pure *Shorea robusta* forest. The soil devoid of humus. The site quality is M.P IVa and IVb. The compartment has many blanks. In top and middle canopy, the tree associates are mainly *Terminalia tomentosa*, *Adina cordifolia*, *Lagerstroemia parviflora*, *Embllica officinalis*, *Buchanania lanzan* etc. The ground flora was found scanty with invasion of *Phoenix* species, *Carrisa opaca* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, were found good. The biotic pressure was found to be heavy. The density of the crop was 0.4 and below. The density of *Shorea robusta* was found to be 330 trees ha⁻¹. This was followed by *Adina cordifolia* (40 trees ha⁻¹), *Terminalia chebula* (20 trees ha⁻¹) and *Casearia graveolens*. *Dalz* (10 trees ha⁻¹), *Buchanania lanzan* (10 trees ha⁻¹) and *Lagerstroemia parviflora*. The established regeneration of *Shorea robusta* was computed to be 1639 ha⁻¹, followed by *Diospyros melanoxylon* (972 seedlings ha⁻¹), *Lagerstroemia parviflora* (833 seedlings ha⁻¹) and *Terminalia tomentosa* (208 seedlings ha⁻¹). The growth phase of *Shorea robusta* showed uninterrupted trend of regeneration from seedling to sapling and onwards. This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

9. Compartment No. 1250

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is plain with sandy soil and semi hard strata. The crop is pure *Shorea robusta* forest with inadequate of humus. The site quality is M.P IVA and IVB. The compartment has many blanks. In top and middle canopy, the tree associates are mainly *Terminalia tomentosa*, *Madhuca latifolia*, *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Embllica officinalis*, *Terminalia chebula*, *Terminalia belerica*, *Pterocarpus marsupium* etc. The ground flora has abundant density of *Phoenix* species, *Carrisa opaca*, *Elephantopus scaber* etc. Other important herbaceous species were *Hemedesmus anacardium*, *Asparagus racemosus*, *Celastrus paniculatus* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. The density of the crop was 0.2 –0.4. The density of *Shorea robusta* was found to be 340 trees ha⁻¹. This was followed by *Lagerstroemia parviflora* (70 trees ha⁻¹), *Madhuca latifolia* (30 trees ha⁻¹), *Buchanania lanzan* (20 trees ha⁻¹) and *Terminalia tomentosa* (10 trees ha⁻¹). The established regeneration of *Shorea robusta* was computed to be 6375 ha⁻¹. The growth phase of *Shorea robusta* showed uninterrupted

trend of regeneration from seedling to sapling and onwards. This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

10. Compartment No. 1261

Table 1, 2 and 3 indicated the density of established regeneration, density of tree species above 20 cm girth at breast height (GBH) and population structure of different tree species in various girth classes, respectively. The crop of this compartment was under borer infestation during 1997-98. The configuration is plain with sandy soil and porous strata. The crop is pure *Shorea robusta* forest with inadequate humus. The site quality is M.P IVa. The compartment has many blanks. In top and middle canopy, the tree associates are mainly *Terminalia tomentosa*, *Syzygium cumini*, *Madhuca latifolia*, *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Embllica officinalis*, *Terminalia chebula*, *Terminalia belerica*, *Pterocarpus marsupium* etc. The ground flora was found scanty with invasion of *Phoenix species*, *Carrisa opaca* etc. The general health status of *Shorea robusta* trees in particular and their associates in general, was found good. The density of the crop was moderate (0.5 –0.7). The density of *Shorea robusta* was found to be 810 trees ha⁻¹. This was followed by *Terminalia tomentosa* (50 trees ha⁻¹), *Butea monosperma*. (30 trees ha⁻¹), *Syzygium cumini* (30 trees ha⁻¹) etc. The established regeneration of *Shorea robusta* was computed to be 10736 ha⁻¹, followed by *Syzygium cumini* with 5333 seedlings ha⁻¹, *Terminalia tomentosa* with 278 seedlings ha⁻¹, etc. The growth phase of *Shorea robusta* showed uninterrupted trend of regeneration from seedling to sapling and onwards. This is the good indication of establishment and development of *Shorea robusta* crop in this stand.

Table 1. Established Regeneration of Different Tree Species (Plants ha⁻¹) in Different Compartments

S.No	SPECIES NAME	Compartment numbers of Mawai Range									
		1150	1161	1184	1195	1205	1215	1225	1235	1250	1261
1	<i>Shorea robusta</i> Gaertn. f.	12403	900	13111	12666	12625	20055	1166	1639	6375	10736
2	<i>Terminalia chebula</i> Retz.	8611	10	69	69	-	69	-	-	-	69
3	<i>Miliusa tomentosa</i> (Roxb.) J. Sinclair	347	-	-	-	-	-	-	-	-	-
4	<i>Terminalia tomentosa</i> W. & A.	69	210	-	69	69	-	-	208	-	278
5	<i>Buchanania lanzan</i> Spreng	139	30	278	69	-	-	-	-	-	69
6	<i>Lagerstroemia parviflora</i> Roxb.	278	-	-	625	-	-	-	833	-	-
7	<i>Randia dumetorum</i> (Retz.)Poir.	-	-	69	430	-	-	-	-	-	55
8	<i>Pterocarpus marsupium</i> Roxb.	-	30	278	430	-	-	-	-	-	-
9	<i>Diospyros melanoxylon</i> Roxb.	-	70	69	-	-	-	-	970	-	-
10	<i>Stereospermum suaveolens</i> DC.	-	-	-	69	-	-	-	-	-	-
11	<i>Syzygium cumini</i> (L) skeels	-	-	-	-	97	-	-	-	-	5333
12	<i>Butea monosperma</i> (Lam.)	-	-	-	-	-	278	69	-	-	-
13	<i>Adina cordifolia</i> (Roxb.) Hook.f.ex Brandis	-	-	-	-	-	-	-	-	-	278
14	<i>Terminalia bellirica</i> (Gaertner) Roxb.	-	20	-	-	-	-	-	-	-	-

15	<i>Anogeissus latifolia</i> (Roxb.ex DC.) Wall.ex Bedd.	-	50	-	-	-	-	-	-	-	-
16	<i>Emblica officinalis</i> Gaertner	-	10	-	-	-	-	-	-	-	-
17	<i>Semecarpus anacardium</i> L.f.	-	10	-	-	-	-	-	-	-	-
18	<i>Casearia graveolens</i> Dalz	-	10	-	-	-	-	-	-	-	-
19	<i>Ougeinia dalbergioides</i> Benth.	-	10	-	-	-	-	-	-	-	-
20	<i>Madhuca latifolia</i> Roxb.	-	10	-	-	-	-	-	-	-	-
Total		21847	13870	916	14427	13069	20193	1166	3652	6375	16818

Table 2. Density of Tree Species ha⁻¹ (above 20 cm GBH) in Different Compartments

S.No	SPECIES NAME	Compartment numbers of Mawai Range									
		1150	1161	1184	1195	1205	1215	1225	1237	1250	1261
1	<i>Shorea robusta</i> Gaertn. f.	290	900	160	240	540	120	210	330	340	810
2	<i>Terminalia chebula</i> Retz.	10	10	10	-	-	-	-	20	-	-
3	<i>Milusa tomentosa</i> (Roxb.) J. Sinclair	-	-	-	-	10	-	-	-	-	-
4	<i>Terminalia tomentosa</i> W. & A.	30	210	10	-	10	-	40	-	10	50
5	<i>Buchanania lanzan</i> Spreng	40	30	50	-	-	-	20	10	20	90
6	<i>Lagerstroemia parviflora</i> Roxb.	90	-	-	80	-	40	10	10	70	10
7	<i>Randia dumetorum</i> (Retz.)Poir.	-	-	-	-	-	-	-	-	-	-
8	<i>Pterocarpus marsupium</i> Roxb.	-	30	-	-	-	-	-	-	-	-
9	<i>Diospyros melanoxylon</i> Roxb.	10	70	-	-	40	-	-	-	-	-
10	<i>Stereospermum suaveolens</i> DC.	-	-	-	-	-	-	-	-	-	-
11	<i>Syzygium cumini</i> (L) skeels	10	-	-	-	-	-	-	-	-	30
12	<i>Butea monosperma</i> (Lam.)	-	-	-	-	10	-	-	-	-	30
13	<i>Adina cordifolia</i> (Roxb.) Hook.f.ex Brandis	-	-	-	-	10	-	-	40	-	10
14	<i>Terminalia bellirica</i> (Gaertner) Roxb.	20	20	-	-	-	-	-	-	-	-
15	<i>Anogeissus latifolia</i> (Roxb.ex DC.) Wall.ex Bedd.	20	50	10	-	-	-	-	-	-	-
16	<i>Emblica officinalis</i> Gaertner	-	10	-	-	-	-	-	-	-	10
17	<i>Semecarpus anacardium</i> L.f.	-	10	-	-	-	-	-	-	-	-
18	<i>Casearia graveolens</i> Dalz	-	10	10	-	-	-	-	10	-	-
19	<i>Ougeinia dalbergioides</i> Benth.	-	10	-	-	-	-	-	-	-	-
20	<i>Madhuca latifolia</i>	-	10	30	-	10	10	-	-	30	20

	Roxb.										
21	<i>Abrus precatorius</i> Linn	-		20	-	-	-	-	-	-	-
22	<i>Ziziphus xylopyrus</i> (Retz.) Willd	-		-	-	-	20	-	-	-	20
23	<i>Cassia fistula</i> L.	-		-	-	10	-	-	-	-	10
24	<i>Ziziphus xylopyrus</i> (Retz.) Willd.	-		-	-	30	-	-	-	-	-
25	<i>Lannea coromandelica</i> (Houtt.) Merr.	-		-	-	10	-	-	-	-	-
26	<i>Albizia amara</i> Boivin.	-		-	-	20	-	-	-	-	-
Total		520	1370	300	320	710	190	280	420	470	1090

Table 3. Population Structure in Terms of Plant Density of *Shorea robusta* Crop in Different Girth Classes Showing Different Growth Phases

S . N o .	Com ptt. No	Plant density ha ⁻¹ in different girth classes (cm)										
		Establish ed regenera tion ha ⁻¹	10-20 (saplin gs)	>20 -40	>40 -60	>60 -80	>80 -100	>100 -120	>120 -140	>140 -160	>160 -180	>180 - 200 and above
1.	1150	12403	140	20	10	10	10	20	30	10	20	20
2.	1161	13111	290	330	100	30	100	-	30	-	-	20
3.	1184	916	50	30	20	10	30	20	-	-	-	-
4.	1195	12666	60	10	10	40	40	60	20	-	-	-
5.	1205	12625	330	90	10	20	30	30	20	10	-	-
6.	1215	20055	30	-	-	-	-	10	10	50	-	20
7.	1225	1166	10	100	50	20	20	-	10	-	-	-
8.	1237	1639	40	30	20	30	70	70	10	30	10	20
9.	1250	6375	-	50	40	20	50	70	50	40	20	-
10	1261	10736	220	450	80	20	10	10	-	10	10	-
Average		9169.2	-	-	-	-	-	-	-	-	-	-

4. Discussion

Besides the adequate regeneration of *Shorea robusta*, the distribution pattern of individuals of *Shorea robusta* trees in different girth classes was also seemed to be uninterrupted in most of the stands studied. This trend of uninterrupted distribution of *Shorea robusta* in different growth phases with plenty of established regeneration is the healthy sign of establishment and growth of *Shorea robusta* crop in the past in this area. Though in some cases interrupted of the gap phase of regeneration also occurred which may indicate that one are more climatic and/or bio-edaphic sectors inhibited the regeneration completely for certain periods of time and with the return of favorable conditions, the species was able to regenerate again. No indication of any disease/ borer infestation was found in the study area. The presence of healthy *Shorea robusta* trees in all age groups suggests that the *Shorea robusta* seed collection would not hamper the sustainable development of the *Shorea robusta* crop and its associates in this area.

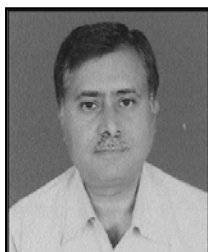
5. Conclusion

Keeping the status of standing crop and regeneration of *Shorea robusta* in particular and its associates in general, it is concluded that crop condition is quite good and regeneration is adequate, yet, biotic influences, fire and other hazards should be strictly controlled for the sustainable development of the forest structure.

References

- [1] H. G. Champion and S. K. Seth, "General silviculture for India", Manager of Publication, Delhi-6, (1968).
- [2] O. P. Chaubey and Jamaluddin, "Impact of grazing closure on some ecological aspects of Shorea robusta natural forests with special reference to its regeneration in Madhya Pradesh", Biome, vol. 4, no. I, (1989), pp. 29-33.
- [3] B. G. Dabral, S. P. Pant and S. C. Pharasi, "Micro-climate of a regenerating Shorea robusta forest in West Dehradun", Proc. of second forestry conf., Dehradun, (1980), pp. 1-13.
- [4] R. S. Gupta, "Studies in soils", Proc. of All India Shorea robusta Study Tour and Symp., FRI, Dehradun, (1953), pp. 28-29.
- [5] M. N. Jha and P. Pandey, "Loss of soil moisture as affected by decomposing leaf litter of different forest species", Indian Forester, vol. 106, no. 5, (1980), pp. 352-358.
- [6] M. A. W. Khan and A. C. Gupta, "Plant communities associated with Shorea robusta regeneration in Dehradun Valley", Indian Forester, vol. 86, no. 7, (1960), pp. 417-422.
- [7] K. C. Mishra, "Manual of plant ecology", 3rd Oxford (IB) publishing Pvt. Ltd. New Delhi, (1989).
- [8] E. A. Philips, "Methods of vegetation study", A Holt Dry Dem it enry Holt and Co. Inc., pp. 107, (1959).
- [9] R. K. Ralhan, A. K. Saxena and J. S. Singh, "Analysis of forest vegetation at and around Nainital in Kumaun Himalaya", Proc. Natn. Sci. Acad., no. 1, (1982), pp. 121-137.
- [10] M. M. Sirkar, "Letter to the Editor", Indian Forester, vol. 80, no. 1, (1954), pp. 62.
- [11] P. B. L. Srivastava, "Phyto-sociological studies of Shorea robusta forests of U.P. with special reference to regeneration", Ph.D. thesis, Agra University, Agra, (1963).
- [12] V. P. S. Verma and B. K. Sharma, "Studies on production and collection on Shorea robusta (Shorea robusta) seeds", Indian Forester, vol. 104, no. 6, (1978), pp. 414- 420.

Authors



O. P. Chaubey is working as Head of Forest Botany Branch in M.P. State Forest Research Institute, Jabalpur (M.P.) India. He was awarded in Ph.D. degree in Forest Ecology in 1986 from Dr. H.S. Gaur University, Sagar, (Madhya Pradesh, India). He has to his credit two books, 13 monograph of various forestry species and more than 75 research papers published in both National and International journals. He has 30 years of research experience in field of forestry. He has completed more than 22 externally funded research projects in the capacity of Principal Investigator. He has organized a number of symposia/ workshops at National and State levels. He has imparted trainings to field foresters, University scholars, NGOs and Rural Communities engaged in conservation and management of biological diversity.



Dr. Archana Sharma is working as Head of Seed Technology Branch in M.P. State Forest Research Institute, Jabalpur. She was awarded in Ph.D. degree in Seed Science in 1993 from Dr. H.S. Gaur University, Sagar, (Madhya Pradesh, India). She has to her credit more than 50 research paper published in both National and International journals, three bulletins and fourteen brochures. She has 20 years of research experience in seed technology. She has completed more than 15 externally funded research projects in the capacity of Principal Investigator. She has organized a number of trainings and workshops at National and State levels. She has imparted trainings to field foresters, University scholars, NGOs and Rural Communities engaged in seed technology, sustainable management and harvesting of bio resources.