Regeneration of teak forests under joint forest management in Gujarat

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Abstract: In order to understand the impact of JFM in Gujarat, a study was conducted in three divisions viz., Baria, Rajpipala and Sabarkantha covering 24 villages. Vegetation parameters such as species richness, density of trees, basal areas, Shanon Weiner's diversity index, woody biomass and MAI were observed and compared with control plots in a non-JFM village. Stem density, species richness, species diversity, basal area, biomass and mean annual biomass increment were higher in JFM forests as compared to controls. This study also indicates that JFM forests are meeting substantial biomass needs of the community and contributes towards achieving sustainable forestry.

Keywords: Gujarat; joint forest management; community forestry; sustainable forestry.

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1 Introduction

The Government of Gujarat officially floated JFM on 13th March, 1991. The aim is to seek participation of village communities through Joint Forest Management Committees (JFMCs) in regeneration, conservation, development and maintenance of degraded forests, to meet village community requirements such as grass, firewood, small timber and to promote sustainable forestry.

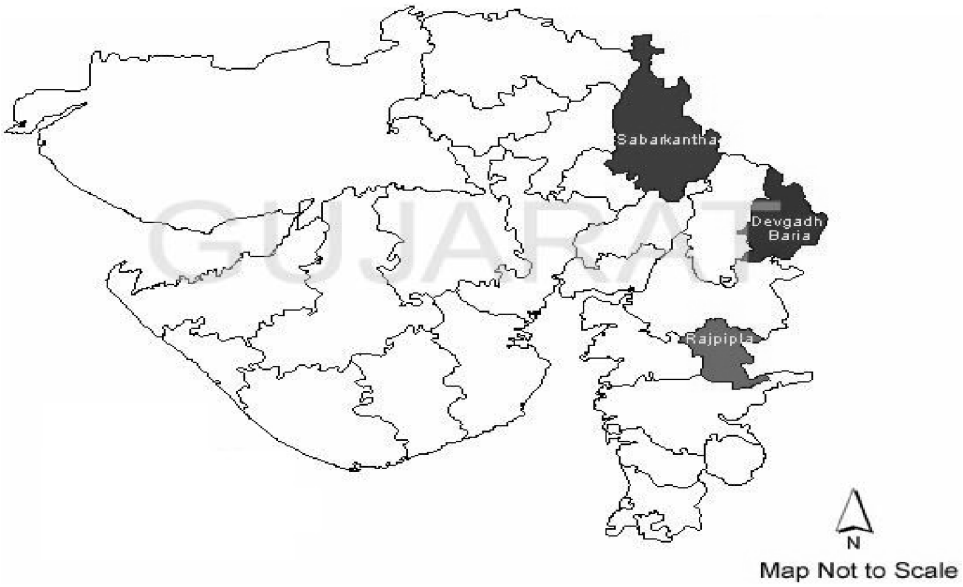
Natural regeneration is considered as the least cost option to recover degraded forests through joint forest management (JFM). Normal practice under JFM is through regulated grazing and controlling fire. These are generally operationalised by erecting cattle proof trenches, fencing and fire lines. In addition, such activities are supported with suitable water conservation measures such as developing contour bunds and check dams, planting species that control soil erosion and other soil-moisture enhancement measures. Plantation activities in such areas are generally less intensive and species of local importance are given the first choice. Under assisted natural regeneration, species like *Teak*, *Bamboo*, *Acacia*, *etc*., are planted. Usually during micro-plan preparation, such activities are included as entry-point activities and communities assist in its implementation. Once the forest is sufficiently regenerated, harvest schedules are decided and singling operations are also carried out for economically important species such as Teak and Terminalia and other timber species.

Natural regeneration is important as it addresses mainstream biodiversity concerns of JFM. In many areas where protection measures are strictly employed, successful regeneration of natural forests is observed. Such areas, apart from satisfying biodiversity related goals, provide community requirements such as Non-Timber Forest Products (NTFPs), green leaves, fodder and other benefits. A study was conducted to understand the impacts of JFM on vegetation status of forests.

2 Methodology

The JFM areas of Gujarat were categorised into Northern, Eastern and Southern regions, and one forest division was selected from each of the three regions. These divisions, viz., Rajpipla (East), Sabarkantha (South) and Baria were selected primarily owing to the varied physio-geographical characteristics and social conditions (Figure 1). This has resulted in selection of three ecologically distinct zones having different rainfall and vegetation pattern for the detailed ecological study.

Figure 1 Location of study divisions: Sabarkantha, Devgadh Baria and Rajpipla in Gujarat



Eight villages in each division were selected in consultation with the Forest Department officials. Quadrat method was used to obtain data on ecological aspects. The details of sampling are provided in the Table 1. The plots were laid on good, medium and poor vegetation areas. The size of the quadrat was same for both the heterogeneous and the homogeneous vegetation areas. However, quadrat size differed for growth forms viz., trees, shrubs and herbs (regenerating class). Four quadrats (50 m× 50 m) were selected for each village to sample tree population (>10 cm GBH), while in one corner of this plot a shrub (>3 but <10 cm GBH) plot (10 m× 10 m) was laid. In the centre of every tree plot, herb plot (1 cm× 1 cm) was laid to study herbaceous species or regeneration status of plants. Control plots were laid in adjacent non-JFM villages. For tree quadrats, data on species name, girth at breast height (GBH) and approximate height of the trees in meters were recorded, while for shrub species, name and number of individuals were recorded. For herbs, species identity and number of individuals were recorded.

Table 1 Details of quadrats in different study divisions

Name of the forest division	*Number of villages*	*Number of tree plots* (50 m× 50 m)	*Number of shrub plots* (10 m× 10 m)	*Number of herb plots* (1 m× 1 m)	*Area sampled* (m^2)
Baria	8	4	4	4	83,296
Rajpipla (E)	8	4	4	4	83,296
Sabarkantha (S)	8	4	4	4	83,296

Parameters such as species richness, density of trees, basal areas, Shannon Weiner's diversity index, woody biomass and mean annual increment were calculated for each division of JFM and control plots to understand the ecological impact of JFM. Jaccard's Index of Similarity (as given by Macgurran (1988)) was calculated to examine similarity

between three sampled divisions in terms of species composition. Biomass was calculated based on the product of height and basal area for each tree, and whenever possible we used species-specific biomass equations as given by Forest Survey of India (1996). In addition to ecological study, household survey and group discussion were conducted to assess the impact of JFM on fuelwood availability and NTFPs.

3 Results

3.1 Species richness and diversity

In the three forest divisions of Gujarat, 174 species were recorded, with Rajpipla being most diverse with 104 species followed by Baria with 102 species and Sabarkantha with 73 species. Though the species richness in JFM area was high, dominance of few species was observed. About 80 species were represented by single individual and 19 species were represented by two individuals. Overall, more than 76% of the species were present in less than five sampled quadrates.

At the village level, in the JFM area, the species richness ranged from 17 to 20. In control plots, the species richness varied from 11 to 13. The Shannon Weiner diversity index for JFM areas showed that Baria had the maximum diversity index (1.59) followed by Rajpipla (1.54) and Sabarkantha. In control plots, the diversity index ranged from 0.98 to 1.21. In all the forest divisions, JFM forests have exhibited higher species diversity compared to control plots (Table 2).

Table 2 Average species richness and diversity index

Name of the division	*JFM forest*		*Control plots*	
	Average species richness	*Diversity index*	*Average species richness*	*Diversity index*
Baria	20.00	1.59	11.50	1.13
Rajpipla	17.63	1.54	12.50	1.21
Sabarkantha	16.75	1.16	13.25	0.98
Average	18.13	1.43	12.42	1.11

3.1.1 Species similarity among three divisions

It was observed that Baria and Sabarkantha had maximum similarity of 35.94%, Baria and Rajpipla had 32.47% similarity and Sabarkantha and Rajpipla had least similarity of $J = 27.54\%$. It can be noted that Rajpipla was not only most diverse among the three areas but also has highest number of unique species. In other words, 50 species unique to Rajpipla division was recorded, 46 species to Baria division, while only 20 species were unique to Sabarkantha division.

3.2 Density of trees and basal area

Mean tree density of JFM area was 1482 with highest in Sabarkantha and lowest in Rajpipla forest division (Table 3). In comparison with the control plot, the increase in tree density of JFM area was 74%, with maximum in Baria followed by Sabarkantha forest

division (Table 3). Tree basal area of JFM forests was high in Baria (11.30) followed by Sabarkantha (8.58) division. In comparison to control plots, percentage increase in basal area was the highest in Sabarkantha and Baria forest division and the average increment across all the three divisions was 62%.

Table 3 Tree density and basal area of forest divisions

Forest division	*Mean tree density* (Number/ha)			*Mean basal area* (m^2/ha)		
	JFM forest	*Control plots*	*Percentage of difference*	*JFM Forest*	*Control plots*	*Percentage of difference*
Baria	1356	677	100	11.30	6.17	83
Rajpipla	730	476	53	6.51	5.60	16
Sabarkantha	2360	1414	67	8.58	4.53	89
Average	1482	856	73	8.80	5.43	62

3.3 Standing biomass in the JFM area

Average standing biomass across all the divisions was 58.39 t/ha (Table 4). Standing biomass was highest in Baria (89.46 t/ha) followed by Sabarkantha (48.8 t/ha). The biomass in Baria is high because of the presence of *Madhuca indica* (Mahuda) species. Mean annual increment was also high in case of Baria 8.95 t/yr/ha followed by Sabarkantha 4.51 t/yr/ha division, and the average annual increment across all the divisions was 5.61 t/yr/ha.

Table 4 Standing biomass and mean annual increment of forest divisions

Name of division	*Standing biomass* (t/ha)		*Mean annual increment* (t/ha) *of JFM forest*
	JFM forest	*Control plot*	
Baria	89.46	49.78	8.95
Rajpipla	33.74	33.63	3.37
Sabarkantha	48.8	21.79	4.51
Average	58.39	35.07	5.61

3.4 Cut stems

Average cut stems in JFM areas of three divisions ranged from 3.63 to 11.5 stems/ha (Table 5) with an average of 7 cut stems/ha. In control plots, the range was between 20.75 and 24.25 with an average of 22.25.

Table 5 Number of cut stems/ha in JFM and control forests in different divisions

Division	*JFM forest*	*Control plots*
Baria	5.87	21.75
Rajpipla	11.5	24.25
Sabarkantha	3.63	20.75
Average	7	22.25

3.5 Firewood supply and demand

JFMCs survey has shown substantial dependence on JFM areas for firewood. Additional firewood demand is being met from agricultural lands, forests on non-JFM areas and plantation areas. Even the village common lands contribute to fuelwood needs of the local communities, though to a much limited extent. Firewood collection from JFM area is prevalent where the areas are opened for cut back, clearing, thinning or for collection of dried twigs/ branches, etc.

Table 6 provides general scenario of fuelwood dependence of the survey conducted by JFMCs. It can be noted that most of the JFM areas are reaching a stage, where yield is continuous and enough to satisfy all local needs. After JFM, areas for firewood were reduced to some extent initially because of the restriction imposed on collection of firewood. Therefore, there was reduction in the quantities of fuelwood collection after JFM in comparison with fuelwood collection before JFM. Now that the JFM areas are opening up for fodder and fuelwood collections, the needs of the local communities will be increasingly satisfied from the JFM areas alone. For the Sabarkantha (S) division, all the JFMCs are benefiting from the fuelwood obtained from the JFM area.

Table 6 Source of fuelwood before and after JFM (% JFMC in parenthesis)

Source of fuelwood	*Extent of dependence*	
	Before JFM	*After JFM*
Natural forest (JFM area)	22(92)	18(75)
JFM plantation	1(4)	4(17)
No collection (JFM)	1(4)	2(8)
Natural forest (Non-JFM)	6(25)	5(21)
Agricultural lands	23(96)	23(96)
Village commons	4(17)	3(12)
Other area	1(4)	1(4)
Kerosene	8(33)	17(71)
Biogas	1(4)	3(12)
Dung	17(71)	17(71)
LPG	0	3(12)
Purchase of wood	1(4)	3(12)

It was observed that the dependence of all socio-economic groups has substantial dependence on JFM areas on different sources of firewood (Table 7). Though the extent of the dependence on alternate sources of fuel is marginal, large numbers of households across various socio-economic strata have started accessing them.

Table 7 Fuelwood dependence of different socio-economic groups (number of JFMCs)

Landholding of farmers	*Total households*	*Source of biomass*				*Fuelwood quantity kg/week/household*
		JFM area	*Non-JFM area*	*Non-forests*	*Alternatives**	
Large and Medium	542	507	173	542	542	59.47
Small and marginal	3769	3434	1838	3769	3769	57.91
Landless	83	49	34	0	83	57.50

*Kerosene, LPG, biogas and dung contribute to alternative sources of fuel.

3.6 NTFP availability potential

In Gujarat, 13 nationalised and 19 non-nationalised NTFPs are collected across the state. Apart from this, there are many NTFPs that are available through Forest Department-run Dhanvantari project. The major NTFPs collected in the state are *Diospyros melanoxylon* (timru) leaves, Mahua flowers and seeds, Gum and Honey (Mudrakartha et al., 2003). The collection of NTFPs shows an increasing trend in the State. The expenditure towards the collection for the year 1997 alone was Rs. 19,845,000 while a total of 341,242 person-days were spent in collection of the NTFPs.

In three NTFP collection centres in Gujarat, revenue to the tune of Rs. 773,802.90 was generated in a single year (Table 8). The sale value of Minor Forest Products for the year 2000–2001 alone was in the tune of Rs. 34,162,000 (Gujarat Forest Statistics, 2002).

Table 8 Revenue generated (Rupees) from sale of NTFPs (From April 1996 to March 1997)

Sale centre	*Sale through JFMCs* (Rs.)	*Sale through Dhanvantari scheme* (Rs.)	*Sale through agents* (Rs.)	*Total sale* (Rs.)
Gandhinagar	172,013.00	79,335.00	101,654.00	353,002.00
Ambaji	169,922.00	19,648.00	155,374.00	345,304.00
Himmatnagar	27,715.10	9,431.80	38,350.00	75,496.90
Total	368,650.10	108,414.80	295,478.00	773,802.90

It was observed that the Timru leaves, Mahua flowers, *Annona squamosa* (Sitafal) fruits and *Terminalia belerica* (Baheda) are the major NTFPs. The details in terms of the average quantities of these NTFPs collected per households and number of households engaged in collection and sale of these items are provided in Table 9. There are many other NTFPs such as *Chlorophytum borivilianum* (Safed musli), *Anogeissus latifolia* (Dhavda) gum, Khakra leaves (*Butea monosperma*) that are collected and sold. Some communities are engaged even in cultivation of Safed musli, though larger part of both the cultivated and the collected material is sold to the local farmers as a planting material. Among the NTFPs that are strictly collected from the JFM area, Timru leaves (beedi leaves) contribute the most and have shown increasing trends.

Table 9 Source and collection of major five NTFPs (number and percentage of JFMC%)

Area	*Percentage of JFMC collecting*	*Average quantity/household/year*	*Number of households collecting*
JFM area	Timru- 4 (17)	1201.63 Bundles	305
	Mahua- 1 (4)	160 kg	35
	Sitafal- 3 (12)	525.86 kg	145
	Baheda- 1 (4)	150 kg	5
JFM and non-JFM	Timru- 7 (29)	2390 Bundles	1093
	Mahua- 2 (8)	155 kg	200
	Dhav- 3 (12)	21.47 kg	353
	Musli- 1 (4)	10 kg	10

It can be noted that for many villages, there is no formal boundary between JFM and non-JFM areas and hence values expressed here may include collection from both these areas. In 11 committees, members are not involved in collection of NTFP and obviously no monetary gains from the sale of NTFPs. However, collection of *Butea monosperma* leaves for mulching of ginger crop is practised by few members. When the dependence of different socio-economic group on NTFPs was examined, it was observed that small and marginal farmers have greater dependence on NTFPs in terms of diversity (Table 10).

Table 10 NTFP dependence of socio-economic groups for major five NTFPs (number and percentage of JFMC)

Socio-economic groups	*Major NTFPs*	*Average households*	*Average quantity/year/household*
Large and medium farmers	Timru	105	2130 Bundles
	Mahua	20	155.74 kg
	Sitafal	10	525.86 kg
	Dhav	70	21.47 kg
Small and marginal farmers	Timru	1293	2130 Bundles
	Mahua	215	155.74 kg
	Sitafal	135	525.86 kg
	Baheda	5	150 kg
	Dhav	283	21.47 kg
	Musli	10	10 kg
Landless	Timru	10	156 Bundles

4 Discussion

Gujarat has experienced over a decade of community forestry. Thus, it is important to understand the impact the JFM programme has made to the State in terms of ecological assets built, social capital accrued and economic improvements achieved. The impact of JFM on ecological status of selected villages in Gujarat, particularly in three divisions is discussed.

4.1 Conservation and promotion of biodiversity under JFM

Communities are expecting that JFM would fulfil their diverse biomass needs and at the same time, despite inherent pressures, JFM areas contribute to vegetation cover and biodiversity enhancement. In the above context, it would be very interesting to view the extent of the needs that are satisfied by the JFM today, and expectations that are remained to be fulfilled. It is a foregone conclusion that in JFM areas, vegetation cover and tree density have improved over the years. In some cases, JFM areas are now comparable with nearby natural forest areas in terms of species composition and diversity (Murthy et al., 2004). The floristic diversity of the JFM areas is remarkable and is evident from the current study, wherein 174 species were recorded across three forest divisions studied. The number of species reported is significant, given the fact that, only 24 JFM villages were sampled. It can also be noted that, for certain JFM areas, local communities have promoted fodder species (mostly grass) by selective removal of tree species. In such JFM areas, the diversity of tree species as well as cover may not show improvement. Such models need to be studied further to draw lessons for need-based JFM area management.

4.2 Biomass production and demand

While JFM is contributing substantially to vegetation cover, it is yet to be seen to what extent it is fulfilling the local community demands. The sustainable management of vegetation depends upon the ability of JFM to meet demands of the local community. As evident from this study, there are indications of JFM areas meeting the demands of the community. For example, many JFM villages have increasingly benefited by fodder, apart from meeting local demands. Local communities are able to generate revenue from the sale of fodder. An independent investigation by VIKSAT has shown that communities have responded to the improved fodder situation by purchasing improved breeds of cattle. Surely, all these would go a long way in sustaining JFM.

4.3 Reduced fuelwood consumption through promotion of fuel-efficient devices

As explained, substantial proportion of the communities is utilising alternative fuel devices such as those using kerosene, LPG, biogas, etc. However, there is vast scope for enhancing the extent of use of such alternatives. Currently, only limited number of families have realised this potential. In this case, there is need to spread awareness through demonstrations of such devices for wider replication. Fuel-efficient chulha can also be another viable preposition as most of the JFM areas are tribal and the people are unaware of latest technological interventions. Such devices would help to ease out pressure on JFM areas for fuelwood. VIKSAT has initiated steps in this direction for the project villages of Sabarkantha and Mahesana districts.

4.4 Non-timber forest produce

In the absence of yield estimates, the harvest is mostly controlled by external/market demands, leading to overexploitation of species, e.g., the NTFP – *Anogeissus latifolia* (Dhavda) gum is almost wiped out from most of the Sabarkantha division owing to overexploitation. Also, indiscriminate harvest has altered the ecology of many species

resulting in permanent loss or irreparable damage to other species. Regeneration of *Madhuca indica* is severely hampered owing to rampant collection of all the reproductive stages of the plants. For some species, destructive harvesting, leading to irreparable damage to the populations e.g., *Chlorophytum borivllianum* (Safed Musli), is almost eliminated from the Sabarkantha as a consequence of uprooting for the extraction of tubers/roots. The situation is deteriorating further for species that are exploited but no efforts done towards its cultivation. There is lack of cultivation know-how and cultivation is not lucrative as tree species take long time to establish. For many species, sound ecological practices on collection, harvesting and post-harvest (especially storage) technologies are yet to be developed. Additionally, lack of marketing skills and linkages, and value addition has compounded the problem. For example, wastage resulting from improper collection and storage is leading to loss in quality and quantities. This is resulting in additional pressure on species in terms of more collection. Most of the marketing is done locally wherein agents make profit at the cost of collectors and situation remains grim with unavailability of market linkages. This calls for an urgent action towards NTFP-based enterprise development.

4.5 Promotion of agro-forestry, homestead gardens and agriculture development

Enhancing forest resources on private lands, homestead gardens and developing sustainable agriculture also holds prime importance in the context of tribal JFM villages because of poor quality of land, lack of irrigation facilities, uncertainty rainfall and persistent drought condition has severely hampered viability of the agriculture. The problem is further compounded with absence of technical inputs and reduced access to the latest farming technologies. Furthermore, the expanding area on crop monoculture has wiped out traditional diversity of crop species that were evolved to suit to the local climatic conditions. Special attempts must be made to systematic revival of traditional crop diversity for sustainable agriculture and also for sustainable forestry. Considering the extent of spread of JFM (31 million ha), there is enormous scope to manage the vegetation scientifically to meet increasing demands of the local communities (Sengupta and Kumar, 2002).

Overall, the key of sustainable vegetation management is to provide the forest-dependent communities with a secure livelihood. In case of Malekpur, JFM experiences were very encouraging wherein lower soil-runoff and higher water availability had improved the annual agricultural production by Rs. 2,00,000–3,00,000 (Sengupta and Kumar, 2002). This leads to management practices that need to be followed under sustainable forestry. Differences exist between conventional and community forest management practices in terms of management objectives, options, planning and implementation, methods and plans adopted in management, harvesting prescriptions and cost effectiveness (Nagaraja et al., 2002). However, location-specific silvicultural practices and thumb rules for harvesting to meet the needs of the community are far from developed (Ravindranath et al., 2004). This once again emphasises the need for resorting to adaptive management strategies.

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