Joint forest management in India and its ecological impacts

K.S. Murali
French Institute, Pondicherry, India, and
Indu K. Murthy and N.H. Ravindranath
Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India

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Abstract *Ecological impact of joint forest management (JFM) in India was assessed using the studies undertaken at national, state and forest division levels. It was found that there are very few studies that have specifically addressed the ecological aspects under JFM. The study noted that there are significant strides made in promoting JFM, but the program still needs to address a lot of inadequacies. Though it is estimated that little over 14 million ha of forests are brought under JFM, covering nearly 50 per cent of the open forests in India, how much of it has developed into good forests is not really known. It also needs to be noted that there are many lacunae in implementation of the program and there are also gaps in policies to promote JFM. The study noted that in four states, i.e. Andhra Pradesh, Madhya Pradesh, Orissa and West Bengal, the recruitment was significant, amounting to 17 per cent of the regenerating individuals. In Karnataka, over 10 per cent of open forest has been brought under JFM, while a lot of wasteland could still be brought under JFM. The JFM plantations are dominated with exotic firewood species and low in timber and non-timber species, resulting in lower biodiversity. Biomass growth rate was comparatively higher in JFM forests as compared to the national average. Other support activities to JFM indicated that various biomass conservation programs were initiated, installing a substantial number of energy saving and alternate energy devices. However, the study also notes that effectiveness of such support programs is not clearly known in terms of its functioning and biomass saved.*

1. Introduction

Several approaches initiated to conserve forests without involving the local communities have not met with reasonable success. Thus, it is increasingly recognized that involvement of people in forest management, apart from contributing to regeneration of degraded forest, and helping in cost-effective conservation, also meets community's subsistence needs. To push such efforts, a decentralized and participatory forest management program called joint forest management (JFM) is being promoted in India since 1990. The JFM provisions, under the JFM guidelines of 1990, are expected to promote peoples' involvement, collective decision-making, social fencing, empowerment of the village community, sharing of authority, focus on non timber forest products

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(NTFP) and sustained harvest of usufructs. It is estimated that nearly 200,000 villages are found around the forests (Forest Survey of India, 1999). Efforts at involving local people in management of forest resource have produced encouraging results with respect to conservation and regeneration in states such as West Bengal and Haryana. As of now, 27 states in India have adopted JFM and over 62,800 forest protection committees (FPCs) are protecting about 14.4 million ha (Mha) of forest in the country. Further, it is targeted that in the next five years, i.e. in the tenth five-year plan, nearly 200,000 villages will be involved under JFM, covering 32Mha of forests. The JFM approach has placed new challenges and demands on various sectors. A review of JFM is needed to generate information to assess the impact of policies and identify issues that are to be addressed in the future. An attempt is made here to understand the impact of protection on biodiversity, woody biomass, forest cover and biomass growth rates of forests under JFM.

At the outset, it must be confessed that there have been no systematic ecological studies undertaken at the national or state level to understand the impact of JFM on the forests with respect to regeneration, biodiversity and biomass growth rates. In most states and villages, there were no baseline data collected prior to initiation of JFM to facilitate assessing the impact later. However, there are isolated reports such as case studies that have been compiled and synthesized. One of the major criticisms of such an approach is that case studies illustrate only the better managed village systems and no comparisons are possible with other village systems that have not managed their forests properly. Unfortunately, we have no estimates either at the national or state level about the extent FPC that are performing. Therefore, assessment at the national level becomes extremely difficult. However, ecological implications derived from several case studies indicate trends that may help us to design future studies of JFM assessment and to plan strategies for JFM implementation as well.

2. Vegetation status under JFM: baseline and changed scenario

As said earlier, over 14.4 million ha has been brought under JFM to regenerate degraded land. One of the immediate positive impacts of this program is that if these degraded lands are improved, then the overall improvement is nearly 4 per cent of the total forest area. Ecological impacts that attract the local populace in order for them to continue their biomass-based livelihoods requires that regeneration should continue, additional afforestation measure be undertaken, forest cover be enhanced, biomass growth rates be improved and biodiversity be enhanced or maintained. In the following sections, we describe the impact of JFM on all the above aspects and the recorded changes over a period of time though several studies.

2.1 Natural regeneration status and patterns

Although promoting natural regeneration has traditionally been an integral part of Indian forestry policy, adequate data are lacking with respect to pattern

of regeneration of different degraded ecosystems. Further, insufficient information is available on aspects such as growth, performance and patterns of regenerating species, changes in biomass and yields, total volume of produce, and successional trends, once protection is in place. A study by Tata Energy Research Institute (1999) in ten JFM sites each in the states of Andhra Pradesh (AP), Madhya Pradesh (MP), Orissa and West Bengal (WB) indicate positive trends in regeneration in most of the sites. The individuals regenerating in the JFM sites are relatively high, except in Orissa (Table I) though variations between sites are very high. High regenerating individuals were observed in West Bengal JFM sites though the proportion that were recruited as adults were least among all sites. Typically, in a natural forest, the distribution of individuals in different size classes are leptokurtic i.e. a higher proportion of individuals in lower size classes and a lower proportion in higher size classes. The overall regeneration pattern revealed that vegetation is changing gradually, improving the density of stems.

Unregulated grazing and extraction of forest products have led to degradation and loss of vegetation affecting regeneration. A national level study involving eight states indicates that the degraded forests in the majority of locations are under protection for periods varying between three to 100 years (Ravindranath *et al.*, 2000). Protection and management practices include regulations on grazing and extraction of forest products, selective retention of tree species and silvicultural operations. The impact of protection on vegetation has been assessed by comparing protected areas with unprotected forests in the vicinity. The studies indicate that a longer period of protection enhances regeneration and greater tree species diversity. In Western Ghats of Karnataka, the forest protected by Kugwe village community for over a 100 years has 91 per cent of its trees in the >10cm DBH category (establishment class). In some localities in Orissa, such as Gadabanikilo, with over 50 years of protection, 74 per cent of the trees are in the establishment category. Western Ghats of Karnataka, Hunasur, with more than 100 years of protection history, has the maximum number of 62 tree species, while Gadabanikilo in Orissa has 56 species. Comparison between protected and unprotected patches of some of the study villages showed there was no regeneration of trees in the unprotected patches, due to unrestricted grazing. Presence of coppice shoots ensures

Table I. Regeneration and recruitment status (number per hectare) in the sampled VFCs in Andhra Pradesh, Madhya Pradesh, Orissa and West Bengal

	Regeneration density (Mean ± SD)	Recruitment density (Mean ± SD)	Recruitment (%)	Number of sample villages
Andhra Pradesh	3,127.56 ± 2,645.85	642.56 ± 478.88	20.54	9
Madhya Pradesh	5,002.11 ± 2,834.74	843.89 ± 579.50	16.87	10
Orissa	601.22 ± 1,058.10	349.71 ± 250.97	45.24	9
West Bengal	8,914.67 ± 9,419.38	1,380.83 ± 1,163.37	15.49	14
Overall	5,054.71 ± 6,702.22	913.50 ± 886.41	17.21	42

Source: Values are computed using data from Tata Energy Research Institute (1999)

quicker germination, leading to domination of a species. This was observed in the Sal forests of Midnapore, West Bengal, the teak-dominated forests of Baluji Na Muvada and Asundariya in Gujarat and in *Terminalia* sp. regeneration of Alalli and Hunasur of Karnataka.

It is important to ensure long-term sustainability of economically and ecologically important tree species through adequate regeneration. If a large number of individuals of a species are present in the lower DBH classes, it indicates the potential sustainability of regeneration of that species. Gadabanikilo (Orissa), Bhagawatichowk and Kapasgaria (West Bengal) have good representation of tree species in the lower DBH classes, which signifies good regeneration. Further, in these locations, the extraction of firewood is less than 50 per cent of the annual biomass productivity. The presence of a large percentage of trees in the <10cm DBH class in most locations is an indicator of the positive impact of protection arrangements. However, in Bada Bhilwara of Rajasthan, the percentage of trees in the >10cm regeneration is 56 per cent and 44 per cent of trees are in the <10cm class, and further, only 6 per cent of trees are in 5-10cm regenerating class, implying that regeneration may have been affected in the recent past.

2.2 Afforestation through plantations

Raising plantations on degraded forest areas (<25 per cent canopy) and regeneration of less degraded forests is a dominant activity under JFM in many states. In Uttara Kannada district of Karnataka, where JFM was implemented between 1993-2000, 12,050ha of plantations have been raised on degraded forests till 1998-1999 and this accounts for 1.5 per cent of the total forest and 28 per cent of the open forest in the district (Bhat *et al.*, 2000). The area brought under plantation was the highest in 1998-1999 and it constitutes 31 per cent of the total plantation raised since its inception. Among the five forest divisions of the district, nearly 24 per cent of the total plantation area raised was in Sirsi division. In each of the other four divisions, the area brought under plantation was between 15 and 20 per cent each. The total area afforested under the Western Ghats Environment and Forestry Project during 1993-1994 and 1998-1999 was 44,227ha. Of this, non-JFM activity accounted for 32,177ha and JFM activity for 12,050ha, constituting 73 per cent and 27 per cent of the total plantation raised in the Kanara circle respectively. Thus, afforestation under JFM was not a major component of activities under the project. A comparison of the total area afforested in the pre-JFM with the JFM period (Table II) shows

Type of plantation	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Non-JFM	1,620	1,559	1,384	2,261	1,543	3,683
JFM	6,102	6,571	8,106	7,095	2,059	2,244
Grand total	7,722	8,130	9,490	9,356	3,602	5,927

Source: Bhat *et al.* (2000)

Table II.
Plantation raised under WGEFP project – JFM vs non-JFM

that there is no significant difference, indicating that introduction of JFM has not led to any additional large-scale afforestation in the district. In fact, the total area afforested in the district during 1997-1998 and 1998-1999 has declined considerably compared to the pre-JFM, as well as the initial years of JFM phase. Thus JFM means only furtherance of the social forestry program.

The area afforested under the JFM program is 40ha/VFC at 0.44ha/household in the district. The average area per VFC is in the range of 34-52ha in different forest divisions. The availability of plantation per household and per VFC is not uniform; for instance, Haliyal forest division enjoys the maximum benefit of 52ha/VFC and 1.08ha/household and Honnavar division has the lowest area, with 34ha/VFC and 0.22ha/household (Bhat *et al.*, 2000). In the majority of JFM sites, productivity of plantations has met with reasonable success. It remains to be seen, on an average, whether the productivity under natural forests is satisfactory.

Nearly 10 per cent of the open forest in the state is brought under the JFM program. The potential area available for afforestation is 4 per cent of the geographical area under open forest and 10 per cent under wasteland category. So far a total of 3 per cent of open forest and wasteland and less than 1 per cent of geographical area has been covered under JFM (Rao *et al.*, 2002). The area covered is therefore not so significant. The contribution of the state to national level is 6.5 per cent of FPCs formed and less than 1 per cent of the area brought under JFM.

Species composition. More importance is given for timber as well as firewood species in JFM plantations as compared to non-JFM plantations (Table III). During the year 1993-1999, assessment of JFM and non-JFM plantation shows that nearly 66 per cent of the stems in non-JFM plantations are firewood species, whereas in JFM plantations it was 47 per cent. However, importance was also given to timber and non-timber species in JFM plantations, with nearly 42 per cent of stems belonging to mixed species in enrichment plantations. In addition, nearly 10 per cent of the stems belonged to species important to artisans in JFM plantations.

3. Biodiversity conservation

One of the important concerns of JFM implementation is that there has been not enough consultation with local people in decisions regarding the choice of

JFM			Non-JFM		
Species	Area (ha)	% area	Species	Area (ha)	% area
Mixed species-enrichment plantation	28,768	42.53	Firewood and miscellaneous species	968,869	66.10
Bamboo and cane	6,678	9.87	Other plantations	269,569	18.39
Multipurpose-local needs	31,811.5	47.03	Eucalyptus	138,163	9.42
Herbs and shrubs	150	0.22	Cashew	40,428	2.75
Silivipasture	220	0.32	Teak	25,140	1.71
			Softwood	9,171	0.62
Total	67,627.5	100.00	Total	1,465,778	100.00

Source: Rao *et al.* (2002)

Table III. Afforestation strategies under JFM and non-JFM programs in Karnataka

species while plantations were raised. Studies have shown that the species dominating the plantations in the social forestry program in India are exotics such as Eucalyptus, *Acacia auriculiformis* and *Casuarina equisetifolia* (Ravindranath and Hall, 1995). In yet another study in Uttara Kannada district (Bhat *et al.*, 2000), the species composition in four villages under the social forestry project and five villages under the JFM project indicates that species planted were not the choice of the community and there was little or no community participation in the decisions on species to be planted. Firewood species dominated both social forestry and JFM plantations, accounting for 63 per cent and 61 per cent of the trees respectively (Table IV). *Acacia auriculiformis* forms a major proportion (over 40 per cent) in both the plantations (Bhat *et al.*, 2000). A higher proportion of timber species was planted under the JFM program (23 per cent) compared to social forestry plantations (10 per cent). It was understood from interviews with local communities that they preferred timber species to non-timber species, primarily due to value appreciation of timber over time. Teak (*Tectona grandis*) was planted only in one of the five JFM plantations raised, while none of the social forestry plantations had this species. Social forestry plantations gave relatively more emphasis to NTFP species, in order to meet subsistence requirements. *Emblica officinalis* was included in three out of five JFM plantations but was included in all social forestry plantations. The non-timber species include *Mangifera indica, Sapindus emarginatus* and *Syzygium cuminii.*

In view of the greater demand, more firewood species were planted in these plantations, resulting in reduced biodiversity. Other studies, however, indicate that in many plantations under JFM, biodiversity has improved, due to protection offered to the plantations in initial years (Bhat *et al.*, 2001). Thus, there is tremendous scope for improving biodiversity, as secondary growth improves in plantations. This could even be increased, if species rich plantations are adopted, giving utmost importance to local needs.

In many community forestry systems, that are not initiated through the forest department, higher species diversity was found (Ravindranath *et al.*, 2000). This high diversity is primarily due to local people adopting various management and silvicultural practices that promote biodiversity. Though these villages have had the advantage of more years of protection, they had regulated their extraction to suit the enhancing biodiversity. For instance, in Gadabanikilo (Orissa), the entire forest area was demarcated to patches for

Species	JFM plantations	Social forestry plantations
Firewood species	61.35	62.87
Timber species	23.02	10.04
NTFP species	15.62	26.67
Total	100.00	100.00

Source: Bhat *et al.* (2000)

Table IV.
Species composition (%) in JFM and social forestry plantations

extraction of Madhuca flowers, firewood and so on, with only one patch allocated completely to enhance biodiversity and regeneration (Rai *et al.*, 2000). Such examples could be taken to JFM areas to indicate the importance of enhancing biodiversity and regeneration to enhance the future forest resource.

4. Biomass production and utilization

High biomass growth rate is essential to meet the biomass demands of communities. Adequate biomass production from the regenerating forests will motivate communities to strengthen their efforts to protect and manage degraded forestlands. If forest protection is effective, wood stock of the forests will increase with duration of protection. The rate of regeneration, however, depends on the vegetation type (dominant species), soil, rainfall and other factors.

4.1 Growth rates of biomass in regenerating forests

The growth rates of regenerating forests under protection are detailed in Ravindranath *et al.*, (2000). The extent of standing biomass in relation to the age of the forest in these examples gives a fair estimate of the impact of protection. High growing stock is recorded in the protected forests that are managed by self-initiated forest protection groups with longer history of protection. The standing stock is about 343 and 266t/ha in Gujarat and Karnataka respectively. The mean annual increment (MAI) of woody biomass in protected forests ranged from 2.18t/ha/year in West Bengal to 9.75t/ha/year in Gujarat. The average MAI in the study areas is about 4.35t/ha/year, which is higher than the national average of 0.91t/ha/year for natural forests (Forest Survey of India, 1995). The MAI of the plantations is in the range of 1.64t/ha/year (in Jammu and Kashmir) to 9.75t/ha/year (Gujarat) in contrast to the national MAI of 3.6t/ha/year for plantations (Seebauer, 1992). Thus, it is seen that the overall MAI of protected and regenerating forests is comparable to, or higher than, the national MAI of plantations under social forestry. It has been observed that protection, and regulation of firewood harvesting has contributed to moderate to high growing stock in all locations under JFM and self-initiated community protection groups. However, it must be noted that these productivity estimates are primarily from isolated patches, perhaps the ones that are functioning well, and not aggregated over several patches of protected forests.

The growing stock status and tree densities per hectare in the sampled JFM sites reveal a positive impact of the JFM strategies on growing stock. While maximum augmentation of volume and tree densities per hectare in the lowest girth class in Behrangooda, Marikamma and Durgaprasad village committees in Andhra Pradesh is likely to be the outcome of effective protection efforts, low tree density and volume per hectare in this class in Kilagada may be attributed to poor management practices. Most of the increment in tree densities per hectare was observed in the 20-40cm basal girth class in Behrangooda, Muddanpalli, Marikamma, Ramavaram and Jambinagoma committees. The volume per hectare was highest in forests protected by Marikamma,

Ramavaram, Durgaparasad, Behrangooda and Muddanpalli committees (Tata Energy Research Institute, 1999).

The observation of growing stock data in MP revealed that the maximum influx of timber volume and tree densities per hectare in the lowest diameter class (less than 20cm basal girth) is highest in Bilaspur Circle and Talpiparia Committee of Chindwara Forest Division. It has emerged from field observations that the most important reason for augmentation of tree densities and volume per hectare in the lowest class is the consequence of sound management practices and effective protection efforts. The low accession of timber volume per hectare in the lowest diameter class in Khajri and Kewri in Madhya Pradesh may be attributed to poor management practices (Tata Energy Research Institute, 1999).

Similarly, a substantial increment in the lower girth class reflects the positive impact of the protection activities in the state of Orissa. While maximum accretion of timber volume per hectare in the lowest class was seen in Dudakasuria, Gujamaria and Karlapita committees, the tree densities per hectare in this class were highest in Gangutia, Karlapita and Sinkhaman. The increment in timber volume and densities per hectare in the lowest basal girth class can be attributed to effective JFM strategies at these sites. Contrary to the above, poor volume and tree densities per hectare in the lowest girth class at sites, namely Amalphata, Gumma and Kotlapita, are the result of poor management strategies adopted in the wake of JFM activities (Tata Energy Research Institute, 1999).

The comparison of volume and densities per hectare in the surveyed JFM areas in WB revealed that growing stock as well as density of establishment class in the control site compares poorly with the corresponding JFM sites. The maximum augmentation of volume in the lowest girth class in Kantaberi, Jhataboni, and Hurhuria committees of WB is the result of better protection strategies. The growing stock inventory by the Forest Survey of India (1996) in Bankura, Midnapore and Purulia districts of West Bengal also revealed similar results.

4.2 Current extraction of firewood vs annual biomass production

Degradation of forests, particularly growing stock, occurs when woody biomass extraction exceeds annual biomass production. It is not possible to state exactly what percentage of current annual woody biomass production can be sustainably removed. But, if the current rate of extraction is higher than the current rate of annual biomass production, perhaps that is a sure indicator of degradation. In several study locations in India (Ravindranath *et al*., 2000), the range of extraction of firewood from the protected forest varied from no extraction to quantities higher than the annual biomass increment. In Alalli (Karnataka), the current extraction is insignificant. In most other locations (Kapasgaria, Kunbar, Bada Bhilwara, Baluji-Na-Muvada, Asundariya, Garda and Kugwe) the extraction rate is less than 25 per cent of MAI of biomass. In Hunasur, Bhagawatichowk and Rampur, it is 25-50 per cent; in Dabbar and

Kharikamathani the extraction is greater than 50 per cent. In Nabra, Kutling and Halakar it is higher than the mean annual biomass production. But in Nabra and Kutling, the leaf biomass has also been included, leading to higher biomass extraction rates. In some villages (Vondrujola, Chandrayyapalem, Juttadapalem of Andhra Pradesh), the current extraction rates are zero or insignificant as the forest is young and the forests have been under protection and regeneration for less than three years. Thus, in a majority of locations under self-initiated forest protection groups and JFM systems, the current rates of extraction are not unsustainable. This is largely due to the successful enforcement of firewood extraction regulations.

5. Forest cover

Forest cover change has been documented through satellite images only in Andhra Pradesh. There are two studies indicating the change of forest cover in the state. One indicates the changes at the micro (local) level, the other at the district level. The remote sensing data indicate an improvement in the forest cover of the three villages ranging from 3-6 per cent over the two-year period 1996-1998. The satellite based data indicate a substantial decrease in the forest areas devoid of trees, called "blanks", ranging from 25-40 per cent. The increase in the area covered by dense forest has ranged from about 4 per cent in Borigam and Yapalguda to 8 per cent in Kishtapur (D'Silva, 2001). The data also show some decrease in scrub land and a small increase in open forest. The initiation of forest protection by these villages has made some difference to ecological conditions of the forests.

An overall improvement of 4.25 per cent of forest cover is observed in AP between 1996 and 1998. Medak district achieved highest improvement in forest cover (38.6 per cent) followed by Nalgonda (35.8 per cent). East Godavari, Krishna, Mehboobnagar and west Godavari districts did not achieve any change with respect to forest cover. However, Nizamabad and Kurnool districts indicated forest degradation during the assessment years. An improvement of 4.25 per cent in forest cover in two years is a remarkable change brought in through JFM. However, it is not clear if the change is only through JFM activity or is a result of various afforestation programs in the districts (Andhra Pradesh Forest department, 2000). Similar studies in Orissa also indicate that there is some improvement in forest cover over a short period of time (Ostwald, 2000).

6. Alternative developmental programs for success of JFM

JFM, being a social movement, cannot solely focus on the development of forests. Thus, developing the NTFP market, adding value to various forest products, agricultural development watershed development and such programs related to natural resource development need to be promoted along with forest regeneration and development. Thus, several related developmental departments need to work together in a given village or a cluster of villages for overall development. Also, it is necessary to work towards an integrated development approach rather than isolated efforts.

Non-timber forest products

in community forest managed areas where the major interest of the community is in NTFPs for meeting subsistence needs, revenue generated from timber in the future holds little meaning or value in the beginning. In order to sustain community interest, it would be essential to promote and enhance the yield of NTFPs on a long-term basis, possibly through silvicultural interventions. The time gap, in other words the pay back period, between current protection and future yield is too large to sustain the interest of communities. The review of AP JFM program revealed that efforts are being made to plant grafted varieties of NTFP species in blocks, forest blanks and along trenches, homesteads and agriculture bunds. The strategy is to hasten economic returns in the earliest possible time and thereby sustain the interest of the beneficiaries.

About 450 hectare of forest land in patches of 5-10 hectare each, was brought under plantations of *Emblica officinalis, Terminalia bellerica, Annona squamosa, Bambusa* species etc. over the last three years in the JFM areas of Bankura (south) division of WB. In Madhya Pradesh, the major thrust is on plantating *Emblica officinalis, Bambusa* species and *Jatropha* species in homesteads and along agriculture bunds. Most of these species have been planted because of their products/fruit yielding potential that commences from the fourth year onwards. In Gujarat, the focus is to manipulate silviculture systems in such a way that productivity of locally desirable species are enhanced at first stage. As many as 21 NTFP species having multipurpose uses have been part of plantations (Guhathakurta, 1992; Pathan, 1994).

In arid and semi-arid regions of India, the major focus of the JFM program is on grass production rather than tree regeneration. According to the MP Forest Department, in Jhabua, local communities benefited from 7,800,00 grass *pulas* (bundles) worth Rs.1.17 million in 1997. These *pulas* were produced from community managed forests. A study by Bahuguna (1993) points out that Forest Department increased its revenue up to 12 lakh during 1993 by utilising land for fodder production with community participation in Indore forest circle of MP. Ramanathan and Sharma (1998) mention that Amakatra, Denka and Gorakhal committees in Harda forest division of MP harvested 81 tons of grasses in 1993, 114 in 1995, 600 in 1997 and 800 tons in 1998. Similarly, WB Forest Department has also introduced fodder cultivation in specified plantations as an inter-crop. For instance, in Midnapore (East) division about 460ha has been covered with forest grasses during the last five years.

Reduction in firewood consumption

Traditionally, rural people have been collecting firewood from the forests without much restriction. It is estimated that about 40Mt of firewood is produced in India against an estimated current demand of 296Mt (APFD, 1995), thus leaving a wide gap of 256Mt. Of the total firewood being used in the country, only 23 per cent is from private homesteads, while the rest comes from forests or other areas. Despite the fact that firewood collected from the forest has low calorific value, rural people continue to collect the same (APFD, 1995).

In view of the already emerging firewood shortages and to enhance the production, several alternatives to firewood need to be adopted. Further, to reduce firewood consumption, energy efficient devices need to be promoted. Restrictions imposed on firewood collection and/or adoption of energy efficient devices, therefore, can be viewed as an indicator of reduced forest dependency. In this section we take a look at such programs that reduce firewood consumption and that use energy efficient devices.

The mainstay of the JFM program in Andhra Pradesh is to reduce firewood reliance of the forest fringe communities through popularising energy efficient devices in these areas. The review of the JFM program revealed that about 189,393 stoves and 2,146 biogas units have been supplied to FPC areas so far (APFD, 2000). According to a Tata Energy Research Institute (1999) study, the average household firewood consumption per day has declined between 22 and 50 per cent with a mean value of 28 per cent due to increased usage of fuel-efficient devices in AP. Moreover, an increase in average family income due to increased wage employment under JFM resulted in cessation of commercial firewood head loading, thereby reducing the pressure on forests. Although such arrangements may be temporary, the point that needs to be highlighted is that if compensated for the losses they incur as a result of protection, people's co-operation in forest protection can be assured. In WB, fuel-efficient cooking devices have been adopted in forest fringe areas (Tata Energy Research Institute, 1999). A study revealed that about 2,000 Banjyoti Chullahs was distributed in 24 FPCs of south Bankura. Similarly, 2,000 each Shambhu and Deepak Chullahs was supplied to local communities by Midnapore east forest division under the JFM program. It has been estimated that the Banjyoti chullah is capable of reducing the firewood consumption by 40 per cent.

In Madhya Pradesh, 169 and 245 smokeless stoves were distributed to Kanhai-Khondra and Paraswara committees of Bilaspur forest division. Similarly, nine biogas plants, 50 smokeless stoves, 28 kerosene stoves and 26 kisan sigries were supplied to committee members of Talpiparia. Likewise, two biogas plants were introduced besides distribution of smokeless chullahs in Jameri committee of Jhabua forest division (Tata Energy Research Institute, 1999).

Thus, in states where the JFM program is being implemented on a large scale, efforts are being made to reduce the pressure on forests for firewood through introduction of fuel saving devices such as smokeless stoves, biogas plants etc. It is, however, not very clear as to what proportion of firewood is being saved using these devices. One of the estimates in the Western Ghats Environment and Development project in Karnataka shows that 2,006 biogas plants, 18,884 smokeless stoves, and 362 arecanut processing stoves (Rao *et al.*, 2002) have been installed. One of the important aspects of the program is effective functioning of the devices. Though these studies noted the number of installed devices, no study mentions the level of functioning of these devices. If the programs are to be effective, then enough care should also be given to technical aspects of such devices and their maintenance in future.

Promotion of agroforestry and plantations in homesteads

Agroforestry can be used as one of the important sources of productivity to reduce forest dependency. In this section, we have made an attempt to document strategies of agroforestry promotion in JFM areas. Successful JFM experiences have suggested that in most cases alternative sources of firewood were available to locals. For instance, community participation became easier in southwest West Bengal because of the large-scale agroforestry activities in the region. In Midnapore and Puralia districts, the plantations of *Acacia auriculiformis* and eucalyptus have led to a reduction of up to 50 per cent in firewood dependency on the forest. Similarly, Prosopis plantations in and around villages led to the success of JFM in Eklingpura (Udaipur, Rajasthan) at zero opportunity cost. Similarly, Tropical Forest Research Institute (1997) reported that agroforestry promotion in JFM areas of Sambalpur district of Orissa are finding favour with farmers. Agroforestry practice is commonly found in the Western Ghats region of Karnataka and Kerala states in southern India. Apart from maintaining higher local species diversity, agroforestry practices also aid in meeting various biomass needs of the community and reducing the reliance on forests (Shastri *et al.*, 2002).

Agriculture development

Under the transformed village resource development philosophy of JFM, the thrust is on judicious use of presently available land resources and adoption of new production systems for sustained and optimum returns (Bahuguna, 1993, 1994). While providing stakeholders with forest usufructs is the first step in the process, the ultimate aim is to provide alternatives to usufructs being used to reduce reliance on forest resources. For instance, an increase in food grain production not only adds to local economy, but also helps in producing adequate fodder as a result of increased straw production. This consequently helps in reducing reliance on forests for fodder. This expanded version of JFM is observed in AP, MP and Haryana where agriculture land development is an integral component of the JFM program. This, however, requires increased irrigation infrastructure, in addition to the use of high yielding varieties and fertilizers, bringing changes in cropping patterns and developing unproductive agriculture fields through soil and moisture conservation approach. Marginal and medium farmers are being encouraged to adopt mixed farming and multi-crop systems for stability and sustainability of the farming unit.

A study by Tata Energy Research Institute (1999) concluded that adoption of modern agriculture technologies under the JFM program have resulted in increased agriculture production leading to social well-being of farmers. Various strategies have been adopted in different committees to this effect. For instance, members of Talpiparia committee of Chindwara forest division undertook soil conservation activities amounting to 186.5m^3, worth Rs.40,000, in 10ha of their agriculture lands. Additionally, 271m^3 of productive soil was added onto 8ha of agriculture field in 1996. Further, the committee also distributed low interest credits to marginal and medium farmers for dry season

crops. This resulted in a substantial increase in agriculture productivity besides changes in cropping patterns. Cultivation of cash crops such as soyabean, wheat and vegetables has increased, while traditional crops such as maize, sorghum and rice has declined. Further, farmers have started cultivating a third crop in their agriculture fields.

In Bilaspur forest division of MP, Kalidongri committee members have purchased eight diesel pump sets by accessing low interest credits. Construction of a diversion channel in 1997 resulted in increased irrigation land of 122 acres. This has resulted in a change in the cropping pattern. Traditional crops with poor nutrient quality and yield such as Kodu/Kutki (minor millets) have been replaced by high yielding varieties of wheat, pigeon pea and yellow mustard. Further, villagers have started growing vegetables in summer.

In Paraswara committee of Bilaspur circle, construction of a stop dam in 1996 has brought about 32ha dry agriculture land under irrigation. Additionally, 75 farmers undertook soil and moisture conservation activities such as laying canals in their agriculture fields in 1997. Thus, an area of about 60ha has further come up under irrigation through gravity. Here too, the minor millets have been replaced by rice, the staple crop of the villagers. Villagers are hopeful of an increase in the next crop due to increased access to irrigation facilities, and their ability to afford seeds of high yielding varieties and fertilizers as a result of employment generated through JFM. In Karra Nara committee of Bilaspur circle, more and more villagers are getting involved in dry season agriculture due to increased access to irrigation facilities.

Bahuguna (1993, 1994) also draws similar conclusions in Harda and Jhabua forest divisions of MP. According to Samarthan and participatory research in Asia (1998), more and more village communities are getting involved in agriculture as a result of increased irrigation facilities during the last three to four years in Kharpawar FPC in Madhya Pradesh. In Haryana, construction of 86 earthfill dams by the Forest Department in 52 JFM villages having 633.64 hectare meter water storage has resulted in better distribution of water from existing dams in about 2,854 hectare of agriculture land (Tata Energy Research Institute, 1999). The agriculture development in JFM areas in AP is through maximising use of fertilizers, shifting from traditionally grown low yielding nutrient deficient crops to high yielding nutrient rich varieties, ploughing agriculture fields before sowing crops and increasing irrigation infrastructure.

7. Recommendations and conclusions

The findings from diverse ecological regions of India have demonstrated that JFM has resulted in a significant increase in plant diversity and biomass production. There is evidence to show that experiences with community forestry in degraded forestlands have been partially successful over the last ten years. Over 14.4Mha of degraded forestland with less than 25 per cent crown cover in India has been brought under JFM. A large proportion of this area has potential for regeneration. These fragile ecosystems can be regenerated to meet economic and ecological needs of local communities, along with an increase in

productivity of timber. Regulating biotic interference and following *in situ* and *ex situ* soil and moisture conservation approaches are the first step to creating favorable conditions for regeneration. Various silvicultural treatments assist germination and hasten growth rates of seedlings. Gap planting of locally desirable species can generate additional forest products. Some of the implications for JFM at the national level are as follows:

Cost effective revegetation of degraded lands through JFM

India has vast areas of degraded land or wastelands, estimates of which vary from 42 to 130Mha, of which, according to one estimate, 82Mha are available for tree planting. The Forest Department has mainly concentrated on afforestation through block plantations (largely under social forestry programs). Annually, about 1 to 1.25Mha of tree plantations are raised at a per ha cost of over Rs.15,000 to 25,000 (Ravindranath and Hall, 1995). These social forestry plantations are dominated by species such as *Eucalyptus* sp., *Acacia auriculiformis, Casuarina equisetifolia, Tectona grandis* and *Pinus* sp. At the current rate of conventional afforestation and budget allocation, vast tracts of degraded lands would continue to get further degraded and biomass shortages are likely to be accentuated. This has adverse implications for biodiversity and watershed functions.

One of the criticisms of JFM is the lack of involvement of the community in all the activities of forest development and regeneration including planning, implementation and benefit sharing. Many studies reveal that most microplans are prepared without the knowledge of the village community thus not incorporating the choice of species, land area to be regenerated and so on. The government should use this opportunity to generate interest among people to develop their own land apart from using their inputs and services for the same. Our network studies indicate that if the local communities are genuinely involved, expenses often incurred by the Forest Department such as employing a guard, fencing, trench digging and other such physical barriers could be avoided.

Sustainable use of forest products

Study of various reports on JFM indicates that though there are provisions for communities to use forests, there are no regulations or policies for the usage of forest products. Protection from indiscriminate extraction of forest products and regulation of grazing is necessary for promotion of forest regeneration. It is noted that restriction of grazing in the initial years seems to be necessary than a total ban on grazing for long periods. Banning or regulation of grazing, though desirable in disturbed or degraded forest areas, may have adverse implications for livestock-owning families, particularly the landless and marginal farmers, as they may not have any private land to graze their cattle.

In locations such as Uttara Kannada in Karnataka, a combination of barbed wire fences, cattle proof trenches and a paid guard protect plantations raised under JFM, during the first three years. The EERN study showed that many of

the slow growing species, such as *Terminalia paniculata, T. crenulata, T. tomentosa, Emblica officinalis, Syzigium cuminii, Buchanania lanzan* and *Careya arborea,* had regenerated during the initial non-grazing period. These were grazed when the protected plantations were opened for grazing after three years, leaving only the fast growing species such as *Acacia auriculiformis* and *Casuarina equisetifolia*.

Under the JFM situation, as in West Bengal where sal coppice shoots dominate, grazing may not be a major issue except probably during the first year, till coppice shoots grow beyond a height where the cattle can damage them. But in locations such as those in Karnataka, where regenerating forests are dominated by germinating seedlings, a longer period of protection may be necessary. But if the experience of self-initiated forest protection villages is considered, an appropriate participatory arrangement avoiding expensive methods could be evolved for protection of regenerating forests. To reduce adverse implications for livestock-owning households, regenerating forests in villages could be considered for grazing regulations on a block-by-block basis. For example, one-third of the land could be excluded from grazing for three years, followed by the second block for the following three years.

Studies have clearly shown that regulation of firewood extraction is very critical and communities have realized its importance. It is, however, difficult to exactly define or prescribe at what stage of regeneration communities could start extracting firewood, and what mode and rate of extraction is sustainable. Communities could, however, use some "thumb rule" to determine extraction rates, monitor the impact of extraction practice on vegetation, and readjust the extraction practice. For example, using simple field ecological methods, community members could estimate the DBH of trees, basal area, standing biomass and productivity of woody biomass. They could monitor the impact of this extraction on growth and regeneration and, based on the findings, increase or decrease the extraction rates. In situations of severe shortages of firewood, the potential harvestable limit could be up to 50 per cent of the MAI. But the impact needs to be monitored and, accordingly, extraction rate adjusted. Further research and monitoring is necessary to define the specific parameters of extraction for different agro-ecological zones. Experimental trials may also be required to suggest extraction practices in different forest zones.

Participatory forest monitoring and adaptive forest management for JFM

One of the main goals of participatory management of forests is to ensure sustainable flows of woody biomass and NTFPs. Sustainable modes and rates of extraction need to be location, forest type and species specific. The response of vegetation to a given extraction practice will have a long gestation period. Given the large diversity of locations, with socio-economic and ecological variations, the only feasible option is to enable village communities or teachers and students to monitor the status of vegetation, develop and adopt practices, monitor their impact, and accordingly modify them. Such an approach could be termed as adaptive forest management.

Sustainable forest management practices cannot be prescribed. They have to evolve locally, given the diversity and variation in climate and culture. There is a need to promote the adaptive forest management approach in different locations and judge feasibility by experience. Research and monitoring findings by external institutions should feed into the decision-making processes at the village level as well as planning and policy-making at the forest division, state and national levels.

To promote adaptive forest management, there is a need to develop a simple methodology to enable local communities to monitor and assess the impact of protection or extraction practice. A set of indicators and methods has to be developed and communicated to identified members of the local community. Though village community members do observe the changes in vegetation, it is necessary to undertake systematic monitoring and record changes for comparison and assessment. Initially, participatory monitoring could be launched in a few locations on a trial basis and knowledge gained from the experience, later extended to other locations.

Our analysis overall indicates that while the JFM programme has made strides in initiating the local people to be involved in conservation and development of forests, much needs to be done to make an impact on ecology of the villages significantly. Apart from forests alone, there is a need to develop an integrated village ecosystem in the programme involving all types of land use categories involving common and private lands. There is a need to develop site-specific management plans to undertake meaningful participatory forestry, strategy to harvest biomass and maintain growth rates of the forests, develop harvest practices for various forest products that the village community depend on for commercial and subsistence needs, and finally, the development of an adaptive forest management strategy based on the objectives set out by the local community to meet various biomass needs. There is also a need for increased vigil and ownership pride among the community to protect, use and monitor forest products for their own benefit.

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