Restoration Initiatives and Dependency Reduction on Mangrove Wetlands: A Case Study of Ashirawandh Village, Kachchh, Gujarat, India

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Abstract

Mangrove wetlands in tropical countries provide enormous ecological and economic services to coastal communities. In the semiarid district of Kachchh, northwestern state of Gujarat, India, dependency of coastal communities on mangrove resources for fodder is considerable. Kachchh has the largest (789 km^2) mangrove formation in the Indian west coast composed mainly of *Avicennia marina* though two other species were reported sporadically. Mangrove stand near human settlements in this coastal district is the main source of fodder since fodder from terrestrial sources is sparse due to pronounced aridity of the region. With a livestock population of 1,021,454 during 2011 in coastal blocks that predominantly depends on mangrove biomass for fodder, mangroves face severe threats in the district. This chapter presents the attempts made to create a model for mangrove regeneration with participation of a selected coastal community in order to reduce dependency on natural mangroves. One coastal village with total dependency on mangroves was involved to regenerate 251 ha of mangroves and to manage the created resource to ensure sustainable fodder security. This totally mangrove-dependent village, whose 274 livestock fully depend on the mangroves for fodder, was enabled to raise mangrove plantation and to sustainably manage it. Through village participation, 251 ha of mangroves were regenerated, which besides ensuring their long-term fodder security also generated employment to the villagers to the tune of 17,375 man-days over a 5-year period. The resource management capacity of the target community was simultaneously enhanced through 62 programs on ecological and economic significance of mangroves and training on organizational and technical aspects of mangrove plantation. The gender equated village committee formed was trained in collective

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decision making on different issues of mangrove regeneration and means of rendering the present dependency sustainable. Dependency on mangrove resources was also reduced by creation of 47 ha grassplots, which served as an alternative to meet fodder requirements of the target community. It is expected that the raised resource will meet the entire mangrove fodder requirement after a period of 7 years when the planted trees reach harvestable size.

Keywords
Dependency • Fodder • Mangrove plantation • *Avicennia marina* • Stakeholders

19.1 Introduction

Mangrove wetlands at the interface of land and sea are hugely valuable to coastal communities as its tangible and intangible ecosystem services were estimated to cost around US$14 trillion annually worldwide. Mangrove wetlands are an important coastal ecological entity identified by the Ramsar Convention. Numerous resources of mangrove wetlands such as fish, fodder, construction material, traditional medicine, and honey have been, by tradition, the source of income and livelihood for coastal communities. Hence, degradation of this wetland ecosystem and the concomitant loss of services affect the coastal communities in numerous ways. This problem is a serious concern in many tropical countries where dependency of coastal mass on mangrove wetlands is huge. The role of mangrove wetlands in the livelihood of coastal communities is particularly important in India. For example, nearly 90% of the east Godavari delta population in Andhra Pradesh, India, depends completely on mangrove wetland for sustaining their livelihood (Dahdouh-Guebas et al. 2006). Similarly, in Mahakam delta of Indonesia, 40% of the households depend on mangrove wetlands (Bosma et al. 2012). Indian mangroves are no exception to this worldwide trend in supporting local coastal communities in their livelihood. This high level of dependency calls for initiatives to render it sustainable. The present chapter narrates an attempt wherein a model was created in order to utilize the mangrove resources sustainably.

Kachchh district in the northwestern part of India in the state of Gujarat has the largest arid zone mangrove stand in the Indian west coast comprising 118 km^2 dense and 671 km^2 sparse patches (FSI 2013) constituting 17% of the country's and 71.5% of the state's mangrove extent. The entire mangrove stand is constituted mostly by the species *Avicennia marina (Forsk.)* Vierh though sporadic occurrence of two other true mangrove species *Rizhophora mucronata* and *Ceriops tagal* has been reported (Sawale and Thivakaran 2012). Dependency of coastal communities in Kachchh on mangrove wetlands in terms of fodder is enormous, exerting pressure on the mangrove resources (Singh 2000). This is especially true in mangrove

peripheral areas where villages are clustered. By far, the single dominant factor contributing to the unabated mangrove resource utilization is the presence of huge livestock population, which often exceeds human population, in the coastal villages. Tending livestock and selling milk is the major income-generating activity in most of the Kachchh coastal villages that demands enormous fodder supply. High aridity coupled with poor fodder availability from sparse terrestrial vegetation further renders mangroves as the only biomass for grazing. The presence of a nomadic community called *Maldhari* whose sole profession is rearing camel that feeds mostly on the mangroves accentuates the level of dependency on mangroves. In the light of this extensive resource utilization that often leads to resource degradation, community-participated mangrove regeneration is perceived as a viable alternative. Though the state forest department regularly undertakes mangrove plantation, it has no stakeholder participation with total ban on resource utilization that is often considered economically inefficient besides undermining sustainability (Glaser et al. 2003). Hence, community resource management is suggested as a viable option that, besides stemming the process of resource depletion, renders the local resource users as responsible stewards of forest (Conklin and Graham 1995; Eghenter 2000).

This chapter presents the extent of people's dependency on this wetland resource and the process and outcome of an attempt made to enable a mangrove-dependent coastal community to raise, maintain, and sustainably manage mangrove resources that will ensure long-term livelihood security besides reducing their dependence on natural mangroves.

19.2 The Mangrove-Dependent Community

The target community Ashirawandh is a hamlet of 35 families located in the northwestern coast of Kachchh district. The nearest township is Naliya, the headquarter of Abdasa block (a minor administrative unit). The dependent community at Ashirawandh is highly marginalized with low literacy rate and is lacking in basic civic amenities. Milk selling through tending livestock and fishing are the mainstay of the villagers practiced simultaneously with both having strong reliance on mangroves. To begin with, the level and extent of dependency on mangrove resource was quantified which provided a strong impetus to take up this village for restoration activities through mangrove plantation. The total population of the village is about 210. Though they belong to a cattle-tending nomadic *Maldhari* community, their nomadic lifestyle was given up long back with the permanent settlement in the present hamlet due to its proximity to mangroves that offer good fodder to the livestock and rich fishery resource in the mangrove-lined creeks. Out of 35 families, 28 (80%) practice livestock tending and milk selling as their primary occupation, while fishing in the near shore and mangrove creek waters supports seven families (20%) who also own few livestock, which sustain them during lean fishing period. Hence, quantifying resource utilization and involving them in a mangrove restoration program through plantation was attempted.

19.3 Approach

The level of dependency of the village on mangrove resource was ascertained by gathering primary information on livestock population in the village and their fodder source, mangrove fodder collection schedule, daily consumption rate for a drought, and normal rainfall year through a household survey. The data strongly suggested the extent of dependency on mangrove resource as fodder and provided an impetus for involving the villagers in participatory mangrove plantation and its sustained management. In order to institutionalize the plantation initiative, several basic activities such as formation of a gender equated village level committee with elected office bearers and its legal registration and identification of crusaders who constituted the executives of the plantation activities were put in place. While the ecological and economic importance of mangroves was imbibed through series of intensive awareness programs and exposure visits, technical and management capacity to selected female and male members was imparted through indoor and *in situ* demonstration of site selection, mangrove nursery preparation, and plantation activity. Sustained efforts for enhancing the villagers' capacity were undertaken through gender equity workshops and account keeping training utilizing the services of other nongovernmental organizations (NGOs). Throughout the implementation, female members of the village were encouraged to participate actively since they are the sole collectors of mangrove fodder. Once the villagers strongly imbibed the ecological and economic importance of mangroves through awareness programs, mangrove plantation in an area of 251 ha was taken up in the chosen intertidal belt near the village after obtaining required legal permission. The created village committee with a sustained technical input from the facilitating team solely orchestrated this plantation effort. Simultaneously, with the aim to reduce dependency on mangroves, 47 ha grass plots were created within the village boundary in a suitable site with the grass species *Cenchrus ciliaris* and *Cenchrus setigerus*. Fodder from this newly created ranch was harvested in a period of 4 months. Appropriate benefit sharing mechanism in tune with the livestock owned by each family to share the harvest was ensured. The village committee formed to execute mangrove plantation decided to save 10% of the daily wage of all labors to create a corpus fund in order to support future maintenance and sustainable management of the newly developed resources. The corpus thus created amounted to INR 0.347 million after 3 years. Since village dependency on the mangrove resources was significant, villagers' response for these activities was quite positive and all resource creation and maintenance activities were coordinated by the village committee.

19.4 Degree of Dependency on Mangrove Resource

Ashirawandh has a livestock population of 274, which is equivalent to total adult cattle unit (ACU) of 368.3 (Table 19.1). With a requirement of 7.5 kg/ACU, Ashirawandh requires 4.62 tons of fodder per day (Table 19.1). If camel population numbering 50 is excluded due to their free grazing in mangroves and on other

Table 19.1 Livestock population in the village and their fodder needs

Livestock category	Number	Cattle units—ACU[a]	Per day fodder demand (tons)[b]	Annual fodder demand (tons)
Cows	8	8	0.06	21.9
Bull	6	6	0.045	16.425
Buffalo	210	294	2.205	804.825
Camel	50	70	2.205	843.15
Total	274	368.3	4.62	1686.3

[a]Adult cattle unit (ACU): numbers of different types of livestock are converted into a uniform number (ACU), based on the biomass requirement, which is determined based on the body weight of animal. The conversion units are one adult cattle = one ACU, one buffalo = 1.4 ACU, one sheep or goat = 0.25 ACU, and one camel = 1.4 ACU (Geevan et al. 2003)
[b]Per day fodder demand in Kg at 7.5 kg dry fodder/day

Table 19.2 Monthly mangrove fodder collection by the Ashirawandh villagers

Months	Womenfolk/day	Avg wt/d/women (kg)		Collection/m (kg)	
		Seeds	Leaves	Leaves	Seeds
January	30	–	90	81,000	–
February	35	–	85	89,250	–
March	33	–	75	74,250	–
April	35	–	90	94,500	–
May	35	–	70	73,500	–
June	26	–	75	58,500	–
July	9	11	30	8100	2970
August	8	12	25	6000	2880
September	7	12	20	4200	2520
October	30	7	75	67,500	6300
November	35	–	70	73,500	–
December	33	–	65	64,350	–
Average	26.3	10.5	64.16	694,650	14,670
Annual collection					709,320

terrestrial vegetation, the fodder need for the remaining 224 cattle (308 ACU) is around 2310 kg/day (843.15 tons/year). Out of this annual fodder requirement of 843.15 tons, mangrove leaves and seeds fetch 709.32 tons annually meeting 88.2% of the requirement.

Mangrove fodder collection by the target community is being done in two ways, namely, direct collection from mangroves and free grazing by camels in the mangrove forest. Mangrove fodder, mostly leaves, is collected from both revenue and reserve mangrove forest stands. On a yearly average, 26.3 womenfolk visit mangroves twice in a day and collect around 64.16 kg/head of leaves (Table 19.2). About 9599.5 woman-days in a year is expended for mangrove fodder collection. Besides this, an average of 10.5 kg of seeds was collected during July–October (Table 19.2). Overall, around 615,904 kg of mangrove leaves and 14,670 kg of

seeds by an average of 26.3 womenfolk are being collected in a year that amount to 1687.4 kg/day of biomass removal (Table 19.2). The number of womenfolk increases during the summer months of March–June concomitant with the quantum of fodder requirement for the livestock (Table 19.2). However, during monsoon months the fodder collection reduces drastically to 37.5 kg/women/day, due to the availability of fodder from terrestrial sources. The collected fodder is transported to the village by boat and truck at a cost of INR 25 per head load weighing 25–70 kg. Since the sole collection of leaves is meant to stall feed milking cattle, camels are let loose freely to graze mostly on mangroves. Camels, which are mostly nonproductive, except for their sale value, on an average, consume 10–15 kg/day of mangrove biomass.

Mangrove propagule collection during fruiting season of July–October is done along with mangrove leaves, the requirement for which during the monsoon months is low due to availability of fodder from terrestrial vegetation. Womenfolk interviewed unanimously expressed their preference to mangrove seeds since it is believed to increase milk yield. A woman in a day gathers around 10.5 kg of propagules in 3–4 h of low tide periods. It is estimated that 14,670 kg of seeds, with which cattle are fed as a supplementary fodder, during July–October is collected by the village women (Table 19.2). Collection of seeds is detrimental for the mangroves since it affects their regenerating potential.

A clear pattern of enhanced mangrove fodder collection during summer and winter, which becomes low during monsoon, could be gleaned from the data. Maximum number of households, the percentage ranging from 95 to 100, uses mangroves during summer and winter. The data presented in Table 19.2 relate to a normal monsoon year with an annual average rainfall of 350 mm. Often, rainfall in Kachchh is erratic. During 3 out of 10 years in Kachchh, the rainfall is lesser than 120 mm and rainfall totally fails in every 2 years in a 5-year cycle (Thivakaran 2011). The grazing and fodder collection pressure during years of low rainfall or drought could be manifold higher than the one recorded presently. Exploitation of mangrove resource in Kachchh is confined to fodder collection, and exploitation of timber, honey, and firewood is totally absent here although high rate of firewood collection from mangroves of neighboring Jamnagar district was reported earlier (Singh 2000). In Kachchh mangroves, firewood is seldom collected since *Prosopis juliflora*, a terrestrial woody plant, meets all the firewood requirements.

19.5 Ashirawandh Mangrove Committee

The gender equated and legally registered village committee, *Ashirawandh Cheriya Vikas Samithi* (ACVS), with its general and executive committee was instrumental for implementing the participatory mangrove regeneration endeavor. The committee's confidence and commitment was enhanced through financially empowering the committee members who handled project accounts, prompt labor wage

distribution and daily plantation activities, and development activities like building community hall, check dam, and water tank in the village. Regular monthly meetings with majority of the villagers' participation would prepare the monthly work schedule detailing the assigned works for all core members of the committee. With regular monthly meetings, the whole community was instilled with adequate organizational capacity and team spirit. With clearly set responsibility with regard to mangrove plantation, grass plot creation and yearly equitable grass sharing based on cattle holding per household, and transparent financial dealings, total transparency was ensured with monthly expenditure statements placed before the committee followed by discussions. With the committee well in place and functioning, the implementers' role was restricted to facilitation and assistance.

19.6 Capacity Building

In the initial years of the project, much attention was paid to build the perceptional, technical, and managerial capacity of the villagers in view of their strong dependence on the mangrove resources. In a span of 5 years, 27 awareness programs, 25 capacity-building workshops, and 10 exposure visits were conducted (Table 19.3). This enhanced villagers' managerial and perceptional ability considerably, which was ascertained through a survey that reported substantial increment in their technical and managerial skills. While awareness programs generally dealt with ecological, economic, and livelihood importance of mangrove resources, managerial capacity was built through proper record keeping, bank transactions, and account maintenance. Likewise, exposure visits to similar community-based organizations and mangrove hotspots (Sundarbans West Bengal, Bhitarkanika Orissa) enabled them to gain insights into conservation significance of mangroves in particular and coastal resources in general.

Table 19.3 Details of capacity building in Ashirawandh

S. No	Nature of program	No	Subject covered
1	Awareness programs	27	Coastal ecology and its importance; ecological, economic, and livelihood importance of mangroves; sustainable approach; legal aspects of coastal zone; impacts of indiscriminate resource exploitation
2	Capacity building	25	Gender equity, technical aspects of mangrove regeneration, financial handling, income generation, record keeping, grass plot management, sustainable resource exploitation
3	Exposure visits	10	Visit to similar communities; important mangrove hotspots; JFM sites of Sundarbans, Tamil Nadu; sites of traditional fodder conservation

19.7 Fodder Plot and Mangrove Dependency Reduction

In order to ensure greater sustainability and reduce the target community's degree of dependence on mangrove resources, the village committee was encouraged to raise a grass fodder plot of 47 ha with terrestrial grass species such as *C. ciliaris* and *C. setigerus* in the village vicinity during the monsoon of 2002 with required technical input from the facilitators. Though the grass yield was low during the first year (2002), in subsequent years, it rose to 550 kg/ha per annum with a total yield of around 26 tons during 2006 monsoon. A robust benefit sharing mechanism by dividing the grass yield with total cattle population and distributing it in tune with cattle holding of each household was worked out by the committee, which ensured equated distribution of gross production. Though the annual grass yield of 26 tons met only a fraction of the annual fodder requirement during intense fodder collection period of summer, during monsoon months, grass yield met a higher portion of requirement, while the rest of the fodder requirement was met from other terrestrial sources. However, it amply demonstrated how an alternative fodder resource could be raised to supplement instead of totally relying on a single resource.

19.8 Mangrove Regeneration

Mangrove regeneration and rehabilitation in an area of 251 ha has been completed by the village *samithi* in a span of 5 years from 2002 to 2006 (Table 19.4). Three different plantation techniques, namely, planting nursery-raised saplings, direct seed sowing (dibbling), and planting wild seedlings, were adopted though the latter was given up due to poor results. During 2002, germination and subsequent survival rate in the 35 ha plantation was only 35% in spite of more than normal rainfall of

Table 19.4 Year-wise plantation details, technique, species, and targets

Year	Plantation area (ha)	Species	Plantation method	Survival rate (%)
2002	20	*Avicennia marina*	Nursery saplings	35
2003	35	*A. marina*	Nursery saplings	65
	20	*A. marina*	Direct dibbling	55
	10	*R. mucronata*	Direct dibbling	10
	10	*Ceriops tagal*	Direct dibbling	8
2004	35	*A. marina*	Nursery saplings	71
	10	*A. marina*	Direct dibbling	38
	3	*R. mucronata*	Direct dibbling	10
	2	*Ceriops tagal*	Direct dibbling	65
2005	20	*A. marina*	Nursery saplings	73
	6	*Ceriops tagal*	Direct dibbling	55
2006	55	*A. marina*	Direct dibbling	69
	25	*Ceriops tagal*	Direct dibbling	71

550 mm during that year. Reasons identified were poor quality propagules and proximity of the intertidal site to lower tidal mark, which resulted in large number of saplings being carried away in tidal currents. Besides, the use of mangrove propagules sourced from Jamnagar mangroves acclimatized to lesser salinity regime, in contrast to the more than normal salinity range of 38–44 ppt prevailing in Kachchh creek waters, also resulted in poor survival rate during that year. However, these shortcomings were rectified in the subsequent years through better technical input to villagers. Identifying better site, the use of locally available propagules that could withstand higher salinity and proper treatment of propagules yielded better results (Table 19.4). Throughout the plantation exercise, a consistent spacing of 1×1.5 m was followed for all the three candidate species, namely, *A. marina*, *R. mucronata*, and *C. tagal*. However, *A. marina* was predominantly used in both direct dibbling and nursery development in view of its local prevalence and endemicity besides high tolerance to drought and seawater and soil salinity. Of the three candidate species, *R. mucronata* showed the poorest survivability not exceeding 10% in all the 5 years, whereas *C. tagal* showed a better survivability with 20–25% in later years though it was poor in initial years of 2002–2003. Due to high survival rate of *A. marina*, it was the preferred candidate species and planted in large scale in subsequent years.

The whole plantation exercise was conceived and carried out by the villagers with the implementing organization confining its role to technical inputs like site selection and nursery preparation that became least toward the latter years of implementation. All through the 5 years of plantation work, a total employment of 17,375 human-days was generated with each household getting around 500 human-days in a span of 5 years with womenfolk constituting the bulk of labor force. A corpus fund of INR 0.347 million was generated out of labor wages (20% of the daily labor wage), which would form the core fund for future maintenance and management of the created resources. Control of the corpus fund was solely entrusted to the three-member village committee with appropriate governing norms such as wages for maintenance and gap filling, fencing, and physical protection of the plantation. The core committee would decide its mode of utilization within the larger objective of mangrove resource maintenance and its long-term sustainability.

Based on the observed growth rate of 35 and 21 cm/year during 2003 and 2004 of the mangroves planted in 2002, it is presumed that by seventh year the afforested mangrove area could be harvested for foliage biomass by the villagers. Considering an annual biomass yield of 14 tons/year/ha, with 10% increment in annual fodder demand by the year 2011, the afforested mangrove area of 251 ha is likely to meet the fodder requirement of the village, which will in turn check their natural mangrove exploitation (Table 19.5). However, this assumption is subject to factors like normal growth, less drought years, and not more than 10% increment in village livestock. Even in the event of less growth, the enhanced foliage yield will reduce dependency on natural mangroves rendering it more sustainable.

Table 19.5 Fodder requirement and projected fodder yield from the raised plantation

Year of plantation	Planted area—ha	Foliage yield 14 tons/year[a]	Projected fodder requirement of the village with 10% yearly increment—tons/year	Total biomass budget—tons/year
2009	20	280	1623.394	−1343.39
2010	95	1330	1785.733	−455.733
2011	145	2030	1964.307	65.693
2012	171	2394	2160.738	233.262
2013	251	3514	2376.811	1137.189

[a]A total removable biomass of 14 tons/ha was considered

19.9 Viability of Participatory Mangrove Afforestation

Participatory mangrove afforestation is being attempted in many tropical countries with the well-documented examples from the Philippines and is now presumed to be a widespread phenomenon (Posey and Balee 1989; Anderson 1990; Redford and Padoch 1992). In India, community-based mangrove restoration efforts are yet to be taken up in large scale. One successful attempt, which regenerated mangroves in an area of 293 ha with total community participation, was reported from Pichavaram mangroves of Tamil Nadu (Selvam et al. 2003). The experience gained in Tamil Nadu and in other tropical countries led to a rethinking on the state-controlled ownership and management of forest resources in which the locals, who have more stake to conserve, have no role to play. Initial results obtained in the present effort of community-based mangrove regeneration and management, though encouraging, are yet to be fully evaluated as to how the community is going to manage the resources raised in the absence of the inputs and facilitation provided during implementation. The much-publicized participatory management of Philippine mangroves differs from the present case in one important aspect, i.e., the kind of forest produce utilized. While in the present case only mangrove foliage is exploited (as fodder), in other instances, it is the timber and firewood gathering necessitating removal of whole aboveground biomass rendering it highly unsustainable. Although it is yet to be quantified, there are strong reasons to suggest that the present effort, in due course of time, will serve to reduce pressure on the natural mangrove forests by providing alternative source of fodder. With natural resources very inaccessible, further refinement of participatory resource raising seems to be the only alternative. Current outright ban by the government on state-controlled forest resource utilization is considered to undermine biological sustainability besides being economically inefficient (Glaser et al. 2003). If proved successful, the present attempt will lead to a paradigm shift transforming the local stakeholders as conservers and protectors rather than destructors of natural resources.

Widespread failures of community-based mangrove planting have been reported elsewhere (Calumpong 1994; Pomeroy et al. 1996; Primavera and Agbayani 1997). These failures mostly happened when the planted mangroves failed to yield expected

economic benefits, which consequently led to their neglect and indiscriminate exploitation. In the present case, though adequate sustainability was ensured by means of establishing a maintenance fund, other unforeseen factors like extreme drought and coastal developmental activity may lead to indiscriminate exploitation with the stakeholders losing sight of all sustainability principles. However, it is essential in the present case to keep track of changes in the stakeholder's behavior *vis-a-vis* the raised resources and its maintenance. Several instances during the project period like voluntarily selling off their camels whose maintenance does not give much economic returns suggested the strong willingness of the community to protect and sustainably use the created resources.

19.10 Conclusion

Kachchh coast, of late, is witnessing intensive mangrove plantation initiatives with more than 25,000 ha of mangroves raised by government and nongovernment agencies in the last two decades. Majority of these mangrove restoration efforts are single institutional without community participation, and the widespread failures reported in many plantation initiatives are solely attributable to lack of community participation. Community as an active stakeholder in such ventures has proved to be beneficial as it ensures success and viability of the restoration effort. As a partner, stakeholding community is bound to ensure the physical protection and sustainable resource use since they play a major role in resource creation. The issue of grazing which is a major menace to many natural mangroves in Kachchh is negated since a social fencing is ensured by involving the coastal community. The present effort of mangrove plantation wherein community is the implementer amply demonstrates the sustainability of the venture.

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