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Enhancing the Productivity of Degraded Lands in Coastal Ecosystem

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The management of agricultural land to improve farm income in coastal degraded (waterlogged saline soil) areas is quite challenging due natural calamities. Under such fragile environment sustaining the livelihoods of these resources poor farmers become a real challenge both for technology developers as well as policy makers. In the coastal area the land shaping technique, particularly farm pond and paddy-cum fish models, are unique technology for addressing the key challenges like land degradation (salinity), drainage congestion and scarcity of fresh water for irrigation and in turn have the potential to enhancing production, productivity, income and employment. These techniques particularly farm pond, paddy-cum-fish, salt tolerant variety and agronomic practice are a financially viable and attractive proposition for the degraded lands of coastal ecosystem.

Introduction

The coastal ecosystem is one of the most fragile ecosystems of the globe and the problem is acute in India, which has a long coastline of 8129 km spread over as many as 9 States, 2 Union Territories and 2 Island ecosystems. Natural calamities like, cyclones, storms, tsunami, seawater ingress, tornado are the frequent visitors in this area causing monumental losses to the lives and properties of the people living in the coastal regions. The farming operation often becomes risky due to natural calamities that increases the risk of farming or restricted the farm operation and ultimately increases the instability of farm income. The management of agricultural land to improve the farm income in coastal ecosystem is quite challenging because, firstly, most of the agricultural area is characterized by mono-cropping with low yielding rice varieties during *kharif* season. Due to the problem of water logging, tall rice varieties are cultivated which have low yield potential as compared to high yielding short varieties. Secondly, after rainy season, as the fields gradually dries up salinity building-up occurs and during *rabi* season it becomes difficult to grow any crop due to severe scarcity of freshwater which is essential for management of degraded land in respect to soil salinity and water logging. Therefore, the management of rainwater for agricultural use becomes extremely important for increasing the crop productivity particularly during *rabi* season. Under such fragile environment sustaining the livelihoods of these resources poor farmers become a real challenge both for technology developers as well as for the policy makers. To increase the farm income under the degraded lands of coastal ecosystem, strategies have been discussed to increase the income and livelihood for farmers by adopting the salt resistant crop varieties and land shaping technologies.

Land Shaping Technologies

Land shaping is nothing but articulation of land arrangement so as to overcome certain hydrologic problems in agricultural area for potential crop cultivation. Some of the land shaping techniques, which can be used by farmers, are given below and discussed one by one.

Raised crop beds with coconut husks (RCBCH)

A mound sized 1 m wide and 0.3 m high is prepared, and compost is mixed with soil for fertilization. Coconut husks cover the ridge to guard vegetables against continuous and heavy rains (Fig.1) as well as for salinity management. The advantages of the RCBCH method are increasing microbial content in the soil and the improvement of acidic soil by increasing soil pH. The coconut husks also serve as a rich source of potash.

Broad Bed and Furrow System (BBF)

Inhibited growth of vegetables and the dilution of fodder are caused by excess rainfall during the rainy season (June–December). In contrast, during the dry season vegetable production is significantly damaged by snails, bacterial wilt and a shortage of water. The BBF system for soil and water management is a kind of integrated farming system to grow vegetables, enhance fodder and to rear fish (grass carp) in rice fields using water harvested in furrows throughout the dry season. As shown in Fig.2, the BBF system has a central broad bed (4 m wide and 1 m in height) and furrows (6 m wide and 1 m deep). Vegetables crops are planted in the broad bed. Grass carps are rearing in the furrows and harvested water is used for irrigation. The resulting net returns for the first year were 62,000 Rs. per ha, from the combined sales of the vegetables, rice and fish. In the second year, income nearly doubled (117,000 Rs. per ha). The small return in the first year was due to the construct costs associated with the BBF system.

Fig.1: Raised beds with coconut husk application

Fig.2: BBF system for soil and water management

Pond based integrated farming system (IFS*)*

Farm ponds, as one of the suitable options of land shaping, form the centre of integrated farming system (Fig.3). It may store *in situ* rainfall or harvest surface runoff from surrounding areas depending upon the available rainfall in a region. In high rainfall areas, like A&N Islands where average annual rainfall is about 3100 mm, even *in-situ* rainwater storage in farm pond serves the purpose. However, in areas where surface runoff is the main source of water, the contributing drainage area or watershed should be large enough to maintain desired water level in the farm pond. The requirement of expensive overflow structures may be avoided by optimizing the catchment vs. storage area. The required catchment area depends on soil type, land use and land slope. Following steps should be made while planning, designing and constructing a farm pond: (i) rainwater availability, (ii) crop water requirements, (iii) design dimension of farm pond, (iv) location of the farm pond and (v) lining requirement for seepage control. A comprehensive work on rainwater management in Sundarban delta, West Bengal (Ambast *et al.*, 1998) suggested to convert 20% of the farm/watershed area into on farm reservoir (OFR) to harvest excess rainwater. Further, simulation of surface drainage improvement by rainwater harvesting with and without OFR indicated surface drainage improvement up to 75%, which provides scope for cultivation of high yielding rice varieties in rainfed humid rice lowlands. Optimal land and water allocation using linear programming model indicated benefit-cost ratio of 2:1 (excluding income from fishery and horticulture), and thus justified the investment in OFR. For A&N Islands, Gupta *et al.*, (2006) suggested that excess rainwater available during May to December should be stored *in situ* in the dugout farm ponds to provide supplemental irrigation during dry spells in wet season and life saving irrigation for crop cultivation during dry season. Further, on the basis of crop evapotranspiration and water requirement of different crops the size of the pond was optimized as 15% of the land holding to irrigate the remaining 85% area for summer crops.

Paddy cum fish system

Integrating aquaculture with agriculture assures higher productivity and year round employment opportunities for farmers. The plots utilized for rice cum fish system is mainly based on organic fertilization with a varieties of animals excreta such as poultry dropping, pig excreta, cow dung and wastes of plants such as rice husks and ashes from household burnt and remains of burnt straws after the harvest is over. Compost fertilizer like decomposed straws, weeds and stalks. The rice field can be utilized for fish culture in the following two ways. Fishes can be reared from the month of May to September when the paddy crops grow in the field. The fish culture can also be taken up from the month of November to February after harvesting of paddy crops is completed and transplantation for the next season begins. The culture of fishes in paddy fields, which remain flooded even after the paddy is harvested, may also serves as an occupation for the unemployed youths. Paddy field is suitable for fish culture because of having strong bund in order to prevent leakage of water, to retain up to desired depth and also to prevent the escape of cultivated fishes during floods. The bunds built strong enough to make up the height due to geographical and topographic location of the paddy field. Bamboo mating was done at the base of the bunds for its support.

Three tier land farming system

It is another form of land shaping option so as to introduce crop diversification in the low-lying mono-cropped paddy area. In this, one third part of the land is dugged to a depth of 2 m or more depending upon the site specific condition and the dugged soil can be spread to the other extreme of the field so as to raise this part by at least 1 m whereas some soil can be used for making bunds around the pond. The middle part of the field remains at the original ground level. In the raised part, vegetables can be grown whereas in the middle part rice is grown. The rainwater can be harvested in the dugged part and fish can be integrated. This enhances the net return of the farms.

Ridge and furrow system

In low lying areas, the paddy land is converted into ridges and furrows (Fig.4). This system is semi-permanent type, which could be lasted for 3-5 years. Regular maintenance is required for proper shaping of ridges. The paddy land is converted into ridges by cutting the soil and making the ridge. The width of the ridge and furrows are 1.0-1.5 m and height of up to 0.5 m. The earth cutting and filling operation could be accomplished manually by spade in the summer. At the time of filling the soil should be compacted. It will prevent the soil erosion. The ridges are used for plating of coconut, arecanut and banana. If possible vegetable crops could also be grown on the ridges.

	
Fig.3.Pond based integrated farming system	Fig.4. Ridges and furrows system in converted paddy land

Agronomic Strategies and Salt Tolerant Paddy Varieties

Table 1. Recommended rice varieties for different land situations

HYV for unaffected areas	Salt tolerant cultivars
For mono-cropping: IET 9188, IET 7991, IET 8021 *For double cropping:* IET 11754, IR 18350-229-3, Vytilla 3, IR 31851-6-3-3-2-2 (Short duration); Quing Livan 1, Taichung Sen Yu, Milyang 55, Nanjing 47161 (Medium duration)	CSR 10, CSR 23, CSR 30, CSR 36, Canning 7 (CSSRI) Vytilla 4, and Vytilla 5 (KAU) CO 43, TRY 1, Pokkali (TNAU); PSBRc 50, PSBRc 88, PSBRc 90 (IRRI); BTS 24, BRRI dhan40, BRRI dhan41 (BRRI)

Table 2. Vegetables and fruit crops with their salinity tolerance for coastal areas

Vegetable crops	Varieties	Salinity levels (dS/m)
Brinjal	Pusa Hybrid 6 and Pusa Uphar	8
Tomato	Pusa Ruby, Pusa 120 and Pusa Rohini	8
Chilli	CA 960, Suryamukhi and Pusa Jwala	7
Watermelon	Sugar sweet and Sugar Baby	6
Sapota	Badami, Cricket Ball and Kalipatti	10
Guava	KG, Kashi and L-49	6

In the degraded low-lying waterlogged fields, farmers grow tall, extremely long duration traditional Burmese paddy cultivar, C 14-8. It covers about 60-70% of the rice cultivated area. The farmers used to transplant the rice and revisit the farm only for harvest with virtually no management inputs in terms of nutrient application or pest/disease management. A yield of 1.8-2.2 t/ha provides livelihood in subsistence mode. On the other hand, modern long duration high yielding paddy varieties could produce about 4-5 t/ha, of course with management at semi-intensive scale. Based on evaluation of different varieties, CIARI recommends Ranjeet and Varshadhan as the alternate high yielding long duration paddy varieties.

In some areas after tsunami, rice cultivation became an uphill task owing to high salinity and associated nutritional problems. Moreover, there is a need to increase the cropping intensity, diversify from rice cropping and shift to some vegetable crops. In areas where soil salinity is between 4-8 dS/m, CSR-23 and CSR 36 have shown better performance and can be used for obtaining high yield. Some other salt tolerant rice cultivars are given in Table 1. Salt tolerances of some other common crops are given in Table 2.

Conclusion

In coastal areas the land shaping technique is a unique technology for addressing the key challenges like land degradation (salinity), drainage congestion and scarcity of fresh water for irrigation and in turn have the potential to enhancing production, productivity, income and employment. These techniques particularly farm pond and paddy-cum-fish are financially viable and attractive proposition for the coastal region. In addition to that, agronomic strategies and salt tolerant varieties of crops under soil salinity is between 4-8 dS/m, have shown better performance and can be used for obtaining high yield. The techno-economic evaluations of these systems were evaluated. Therefore, these techniques may be adopted by the farmers of the coastal ecosystem depending upon the specific farmer field location.

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