5. Improving water productivity through land shaping activity

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5.1 Introduction

Land is very essential to achieve the twin goals of national food security and livelihood security through the introduction of improved varieties, increased use of inputs, and expansion of irrigation. A significant gain in food production through increased land productivity was the main outcome. Though, India still has one of the lowest land productivities among the major food-producing countries (1.7 t/ha versus 4.0 t/ha in China, and 5.8 t/ha in USA) doubling of the land productivity in five decades from now could help India to meet most of its increasing food demand. But over the years water has become a scare resource and hence the water productivity should be enhanced through determined efforts and technology. Crop water productivity is the amount of water required per unit of yield and a vital parameter to assess the performance of irrigated and rainfed agriculture. Crop water productivity will vary greatly according to the specific conditions under which the crop is grown. The great challenge for the coming decades will be the task of increasing food production with less water, particularly in countries with limited water and land resources. Conservation of available water resources for agricultural and other water use is the overall aim. Crop water management is a key area to optimize crop production with limited and dwindling water supplies.

5.2 Rationale

Andaman and Nicobar islands receive an average annual rainfall of about 3100 mm. Nearly 95% of annual rainfall is received during May to December (2300 mm in May- September during Southwest monsoon and 650 mm in October-December during Northeast monsoon) and remaining 4 months from January to April is dry period when the numbers of rainy days in each month hardly exceed three. Agriculture badly suffers during this period due to moisture stress which necessitates the need to improve the water productivity through various suitable methods.

After tsunami, in A&N islands the sea water intrusion changed the soil conditions and turned it to be unfavorable for immediate crop cultivation. The EC of Tsunami affected soils varied between 6.7 dS/ m and 23.7dS/m and over the years it decreased however, the problem of water logging remains. In few areas there was unique impact of stagnation of sea sediments, debris and sea water. The thick slushy black deposits on the soil surface causing heavy damage to the soil structure and standing crop. Due to the land subduction and elevation as a consequence of earthquake and tsunami, the following four situations arise in Andaman islands (table 5.1).

Table 5.1 Different land conditions after tsunami

Situation	Feature
I	Low lying coastal areas where there is permanent stagnation of sea water and the depth of impounding of sea water increases with high tide.
II	Low lying coastal areas where sea water reaches with every high tide and recedes with low tide (areas affected with fluctuating sea water table).
III	Low lying coastal areas where sea water has intruded only during Tsunami and then receded permanently
IV	Upheaval of land in North Andaman. The earth mass was raised by 0.5 to 1.5 m resulting in withdrawal of high tide line towards the sea.

The area under degraded land and water are increased after Tsunami. Degraded land and water can be grouped in to Permanent submergence of land by sea water, Occasional flooding of sea water in coastal paddy fields, Saline soil, Acid soil and Acid sulphate soil.

5.3 Technology for degraded land and water

Diversification of the traditional farming in the coastal areas has a tremendous scope. The present system of mono-cropping with rice offers only sub optimal resource utilization and instead of rice in Kharif, paddy cum fish culture may be introduced in many areas for higher profitability, food security, employment generation and for reducing the risk factor. The integration of agriculture, livestock, poultry, fishery, apiculture, horticultural crops, agro-forestry etc. through farming system approach will have tremendous scope in the coastal areas for enhancing employment opportunities, productivity, supplemental income to marginal/women farmers, livelihood security and food and nutritional security on a sustainable base. The following technological intervention in the coastal affected land and other suitable location may results in the increased water productivity and livelihood security.

- Farm pond
- Three tire system
- Broad Bed and Furrow System
- Ridges and Furrow system
- Paddy cum fish system

5.3.1 Farm Pond: Farm ponds, as one of the suitable options of land manipulation, form the centre of integrated farming system. Farm ponds 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 (Fig. 5.1). The requirement of expensive overflow structures may be avoided by optimising the catchments vs. storage area. The required catchments area depends on soil type, land use and land slope. Following steps should be followed 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.

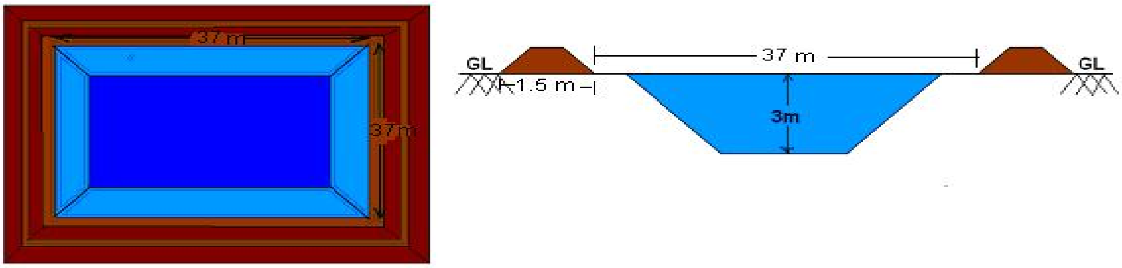

Fig. 5.1 Farm pond

5.3.2 Three tier system: This system involves the shaping of land into pond. One third land area to pond, one third as original or mid land (2nd portion) and one third as raised land (3rd portion) is the low lying areas (Fig. 5.2). One third area of land can be made as pond on downward side of slope. The dug out soil should be taken to 3rd position for raising the land. It can be used water harvesting, fish cultivation and supplemental irrigation during wet season (dry spell). In dry season, the sunken areas can be used for rice cultivation. The rain water stored in the furrow is sufficient to keep the root zone soil of the bunds and mid land moist for the few initial months of the dry season and for life saving irrigation. Because of stored fresh water in the furrow, the field remains relatively salt free. The sunken area can create better drainage in the field and prevent the huge damages of the standing upland crops on bunds/ mid lands following occasionally heavy rains in rabi/ summer due to climatic disturbance in the coastal areas. During wet season, paddy can be grown in the mid land along with vegetables on the raised bed. But in dry season, vegetables can be cultivated on both the land and water harvested in the furrow can be used for irrigation purpose of vegetables.

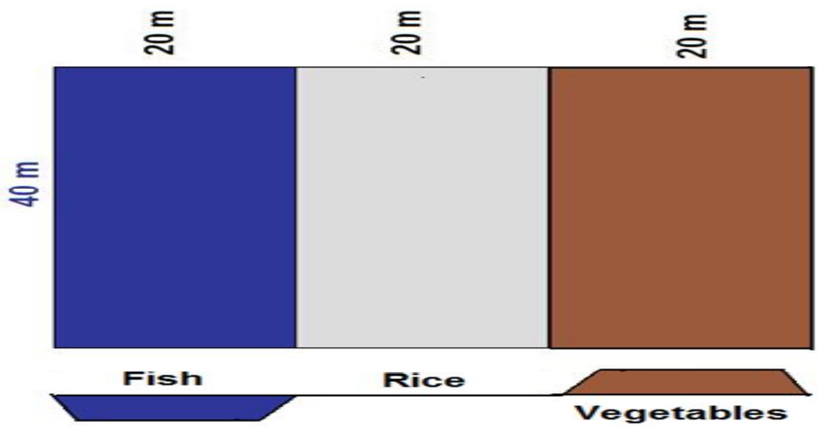

Fig. 5.2 Three tier system

5.3.3 Broad Bed and Furrow system: Paddy is cultivated mostly in low lying valley during monsoon season. The site for BBF should be in low lying area. The purpose of this land manipulation technique is to bring the water logged area under cultivation during monsoon season. The advantages of this system are as follows.

- It helps in draining off excess water in the field and soil
- Also provides more soil aeration for plant's growth
- Greater ***in situ*** moisture conservation and easier for weeding and mechanical harvesting

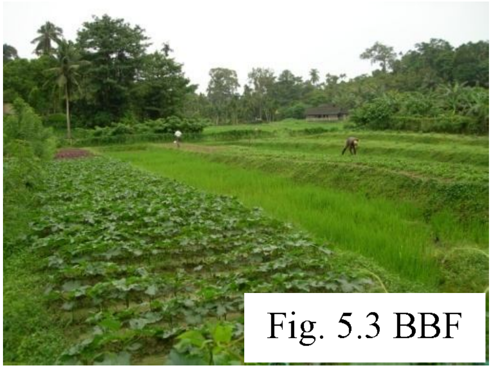

Fig. 5.3 BBF

The design and dimension of BBF system was developed depending upon certain parameters including intensity of rainfall, physical and chemical properties of soil and drainage requirement. This system involves making of broad bed and furrow alternatively in rice fields. Broad beds are made in the shapes of inverted trapezium by digging soil from either sides of the broad bed and putting it in the bed area by cut and fill method (Fig. 5.3). The proper time of starting the earthwork is summer season because in this season the soil can be easily manipulated. It was found that beds of 4-5 m width and furrow of 5-6 m width with minimum 1 m depth are found suitable for the island conditions having high intensity rainfall. The length and breadth of beds and furrows can be adjusted depending on the availability of land. Therefore, in 1 ha of agricultural field, 10 beds of 4 m x 100 m x 1 m and 10 furrows of 6 m x 100 m x 1 m can be made. High value vegetables can be grown on beds during monsoon seasons and paddy cum fish can be practiced in furrows. During monsoon season, the excavated area i.e. furrow can be used for rice and fish cultivation while vegetables/ fodders crop will be cultivated on raised beds. During post monsoon season, vegetables and pulses can be grown on the raised beds. The use of BBF reduces the average annual runoff to one half and the soil loss to one forth as compared to that of the traditional system. By adopting this system, nearly 67 % of the rainfall was used by the crops while 14 % and 19 %

were lost in the form of evaporation and deep percolation respectively. This system is also useful in decreasing runoff and increasing rain infiltration.

5.3.4 Ridge and Furrow: In this technology, the land will be converted to alternate ridge (0.5-1 m width and 0.5 m height) and furrows (0.5-1.0 m width and 0.5 m depth). Upland areas paddy land of can be converted into ridges by cutting the soil. This kind of system will prevent the soil erosion. The ridges are used for planting coconut, arecanut and banana and fruits like papaya. If possible vegetables can be grown on the ridges in dry season; also furrows can be used for growing short duration vegetables (like marsa and poi bhaji, radish etc.) due to the availability of moisture in furrow. This technology will provide scope for round the year cropping activity, higher income and livelihood security. The sowing or planting of crops can be taken on the slope of ridges and furrows to keep away salts from the root zone of crops.

Fig. 5.4 Ridge and furrow

5.3.5 Paddy cum Fish: In this system, trenches of about 3 m width and 1.5 m depth will be dug around the field. The excavated soil can be used for making raised bunds of about 1.5m width at the top around the field to protect the fishes to be grown in this system (Fig. 5.5). Ridges can be used for growing vegetables and other high value crop (cauliflower, capsicum and horticultural crops) cultivation round the year and the rain water harvested in trenches can be used for irrigation purposes. Trenches will serve as shelter for fishes. During wet season, the centre land can be used for paddy cultivation while in dry season, vegetables can be grown on the same land. Due to better drainage condition created by the digging of the trenches, crop damage in the dry season following occasional heavy rains in this season

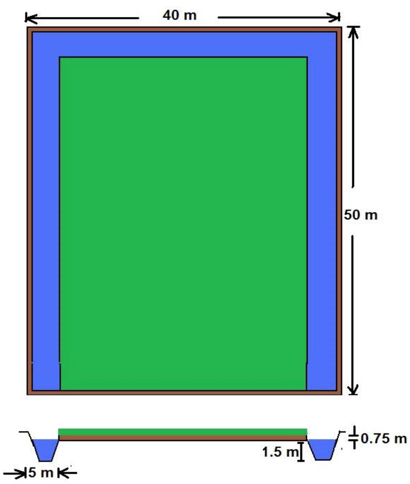

Fig. 5.5 Paddy cum fish

can be minimized. Due to the production of crops like vegetables and fodder on the bed and paddy and fish cultivation in the furrows, it is expected to improve the total net income, besides the regular income from the scale of vegetables to meet the expenditure.

5.4 Conclusion

The various land shaping activities primarily helps to utilize the available land and water more effectively in addition to providing opportunities for leaching of soluble salts. The stored water in the field can be effectively utilized during the dry season and also helps in diversifying the farming system. Thus these measures improve not only the water productivity but also the livelihood security of the farmers.

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