Jour. Agric. Physics, Vol. 3, No. 1 & 2, pp. 140-145 (2003)

Micro-watershed Development Using Integrated Farming Systems Approach in Degraded Tillalands of Tripura

B.K. BHATTACHARYA*, M. DATTA AND K.R. DHIMAN
ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, West Tripura 799 210

ABSTRACT

Attempts were made during 1998-2000 to convert a cultivable tilla wasteland covering nearly 1ha into a productive micro-watershed under NWDPRA collaborative research programme. The productivity constraints identified over tillaland watershed agriculture system as a whole were (a) fragmented topographical situations, (b) low soil fertility due to low organic matter, low nutrient content and high soil acidity, (c) high rainfall erosivity, (d) erratic distribution of rainfall and (e) poor water holding capacity of soil, high infiltration rate and seepage losses. The adoption strategies were mainly based on integration of different farming systems in order to achieve (a) sustainability in production by optimal use of existing technologies and (b) improvement in productivity replacing with advanced technologies. the different farming systems which were adopted are broadly divided as (1) land suitability based cropping system, (2) fuel-folder system and (3) inland fisheries in water harvesting pond. Arable rice based cropping system was adopted in upland having 3-5% slope. Cropping on slopes more than 15% consisted of pineapple-lemon land use with cassava, hybrid napier, pigeon pea, sweet potato and turmeric as soil conservative biological barriers. In valley land, multiple cropping was adopted. Agri-horti-silvi system was also adopted in sloppy land. Horticulture land use with profitable banana and vegetable production was one of the components in watershed project. Water harvesting pond (61ft x 37ft x 7ft) over a catchment area of 0.723 ha was dug using 'tarfel' as lining material which could reduce seepage loss from 21 to 8 mm/day and increase the water storage life for about three months for irrigating crops during the lean period. Nutrient recycling was achieved by the application of dried silt collected in a tank from runoff and erosion of top soil and compost prepared from crop residues. The integration of pisiculture was done by utilizing water harvesting pond for short growing fishes during rainy season.

Background

Nature presents Tripura an extremely fragile land formation which cannot be exploited ruthlessly for the need of man without the risk of inviting ecological catastrophe in the long-run (Bhattacharjee, 1993). Three distinct physiographic zones are discernible. These are (1) north-south oriented hill ranges (2) undulating plateau lands (3) lowlying alluvial plains. the second zone is disected by medium and narrow valleys, steams and gullys and severely eroded lands. These are interspersed with hillocks locally called *tillas*. The narrow valleys are called *lungas*. The net sown area in these tilla-lunga combination constitutes 21% but cultivable wasteland constitutes 9% of the total areas. So scope for extensive cultivation of field crops is limited and intensive cultivation through integrated farming systems is the only way to increase production.

Although Tripura is blessed with monsoon, but the sharp year-to-year, and month-to-month fluctuations in the distribution of rainfall pose a serious threat of early or late season drought even within the rainy season. The studies on water balance showed that Tripura uplands undergo severe water deficit during November to April (Bhattacharya *et al.*, 1997).

Tripura occupies an area of 217 thousand hectares under rainfed cultivation and this area covers nearly 88% of the net sown area. Moreover, the presence of only 7.6% net sown area possesing assured irrigation unequivocally indicates the

*Present Address : Scientist - SD, CMD/ARG/RESA Space Applications Centre (ISRO), Ahmedabad 380015
e-mail : bkbbhatt@yahoo.com

necessity of watershed management. The upland and sloppy land soils of Tripura are very low in available N, P, K with high soil acidity (pH 5.5). Besides monocropped land use, exceedingly low crop productivity in rainfed areas would pose a threat to sustainable agriculture in the years to come. The development of the rainfed areas on watershed basis has been bestowed the highest priority by the Govt. of India.

The present paper discusses on the development of integrated farming systems through watershed approach in a micro-watershed with the following research mandates:

i) Control of soil erosion through vegetative and engineering measures

ii) *In-situ* moisture conservation

iii) Development of operational land use system for different topographic conditions

iv) Rainwater harvesting and recycling

v) Integrated nutrient management

Study area and basic activities

A project to develop a model watershed in *tillalands* of Tripura through integrated farming systems was initiated during February 1998. The funding of Rs. 4 lakhs for three years was provided by the Deptt. of Horticultrue and Soil Conservation, Tripura under the National Watershed Development Project for Rainfed Agriculture (NWDPRA) scheme.

A community land near Lembucherra Gaon Panchayat is brought under the purview of NWDPRA Areas. Slope variation of the project area is stated below:

Slope (%) group	Area (ha)
0-3	0.265
3-5	0.180
5-10	0.125
10-15 and above	0.412
Total area	0.982 ~ 1.0 ha

Plot no.	Topography
1.	Table top upland
2.	Slopy land
3.	Valley land
4.	Slopy land
5.	Undulating eroded land
6.	Plain table land

The topography map showing slope conditions and contour map of the study region were presented in Plates 1 and 2 respectively.

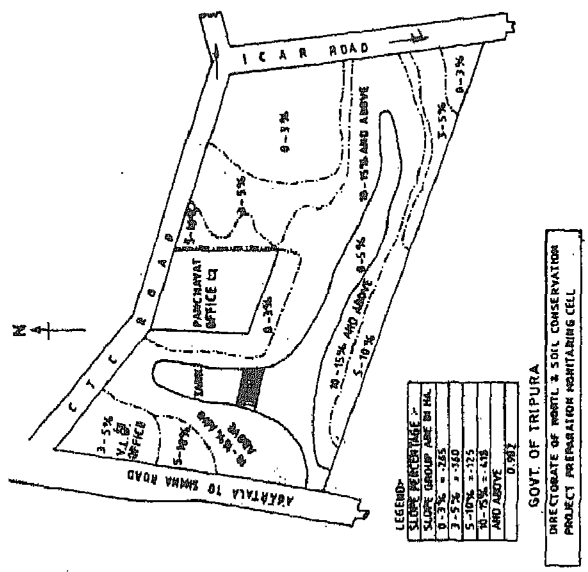

Plate 1. Slope conditions in the study region near Lembucherra Gaon Panchayat

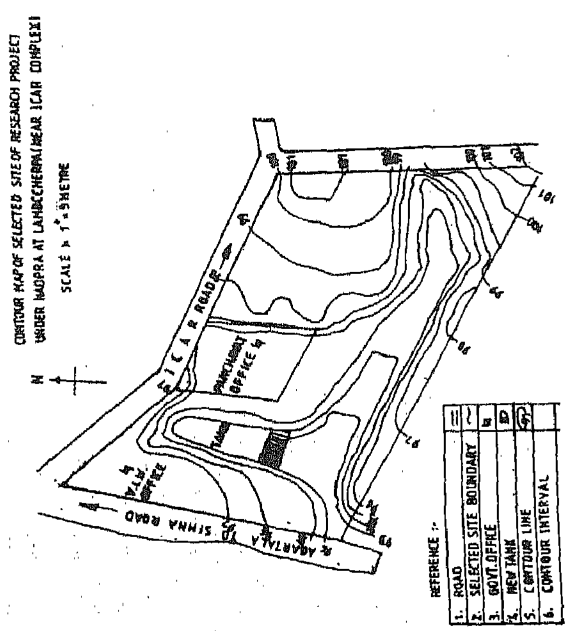

Plate 2. Contour map of the study area at Lembucherra Gaon Panchayat

The milestones occurred during different phases of project implementation (February 1998 to March 2000) are:

i) Burning and clearing of bushes and jungles in the study area and bamboo fencing

ii) Survey of the area for slope delineation and preparation of contour maps

iii) Preparation of water harvesting structure with lining measures for seepage control

iv) Preparation of compost pit from green leaves and crop residues and silt collection tank for nutrient recycling

v) Construction of bunds with vegetative barriers were made on sloppy land to control erosion

vi) Preparation of drainage network

The different measures taken to fulfil the research mandates are listed below with respect to different plot numbers.

Land use systems

Plot 1

Arable cropping system and contour farming

i) Upland rice-pulse cropping system where studies on integrated nutrient management practices were carried out using locally made compost and recycling of collected dried silt.

ii) Intercropping of arhar and ginger (1:2) along the contour lines in areas having 10-15% slope.

iii) Local pigeon pea as perennial crop (2-3 years) cultivation on bunds for its stabilization.

iv) Planting of *Erythrina*/blackpepper, subabool, *Glyricidia* to utilize the available area along fencing. The leaves of subabul and *Gliricidia* were utilized for compost making.

Plot 2

Soil erosion control and sloppy area utilization

i) Cassava in the ridges and hybrid napier in the furrow (2:1) for soil conservation.

ii) Pineapple-Assam lemon land use system across the slope to utilize the sloppy area.

Plot 3

Valley land cropping

i) Growing of paddy, groundnut, sugarcane, Colocasia, bitter gourd, cucumber for maximum land utilization.

ii) Cassava in bunds for stabilization of drainage channels.

Plot 4

Agri-horti-silvi culture system

i) Silviculture with planting of mango (var. Amrapalli) and gamahar (*Gmelina arbora*).

ii) Strip cropping with hybrid napier and turmeric in close spacing for the control of soil erosion through vegetative measures.

iii) Growing of cowpea, maize and moong.

Plot 5 and 6

Horticulture

Planting papaya, banana, guava for utilization of undulating eroded land near pond area and growing *bhindi* and brinjal for land utilization through vegetable cultivation.

Results and Discussion

Water harvesting and seepage control

A water harvesting pond (61ft x 37ft x 7ft) covering a catchment area of 0.717 ha was excavated and water storage behaviour was recorded from July to October 1998. The daily storage is plotted in the Fig. 1. The water harvesting pond had having brick blast floor in order to check water percolation loss but the side wall of the pond was exposed to seepage water loss. The seasonal water balance (Table 1) during the said period showed that water storage underwent a high decrease from 1600 mm in the month of July to 200 mm in the month of October. The highest proportion of run-off is lost due to seepage which was in the order of 21 mm/day. The life of water storage was 91 days. Water harvesting pond receiving 94.1% of rainfall in the month of July

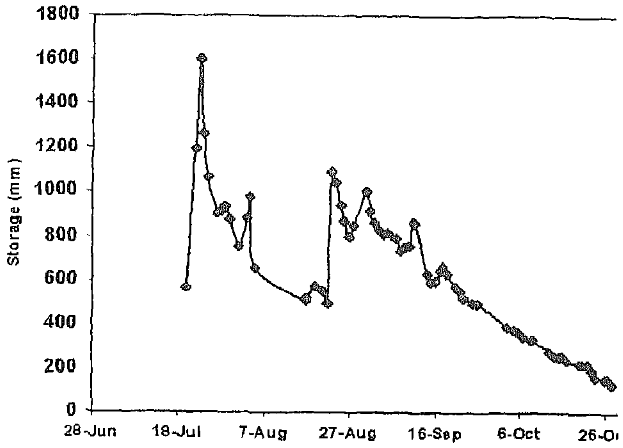

Fig. 1. Water yield behaviour of water harvesting pond in NWDPRA site in Tripura during 1998 without lining

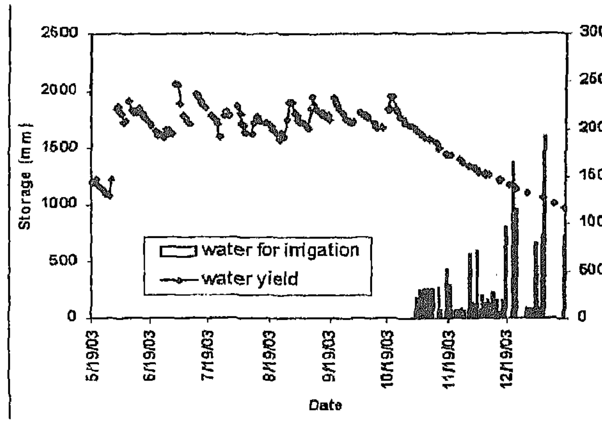

Fig. 2. Water yield behaviour of 'tarfel' lined water harvesting pond during 1999-2000 and availability of water for irrigation during *rabi* 1999-2000 season

Table 1. Seasonal water balance in the water harvesting pond before and after 'tarfel' lining

Components	Before lining (1998) (June-Oct.)	After lining (1999) (May-December)
A. Inflow (ha-m)		
i) Precipitation	1.208	9.34
ii) Run-off	0.81	20.79
iii) Base flow / Interflow	1.931	0.481
Sub-total	3.949	30.611
B. Outflow		
iv) Evaporation	0.557	2.81
v) Overflow	0.0	26.39
vi) Seepage	1.23	1.071
Sub-total	1.787	30.371
Change in storage	2.162	0.240

Table 2. Effect of compost on upland rice

Treatments	Yield (q/ha)		WUE (kg/ha-mm)	
	TRC-1-67	Bandana	TRC-1-67	Bandana
NPK + Compost	27.2	14.30	2.74	1.69
NPK	23.29	12.01	2.33	1.41
Compost	19.63	4.30	1.90	0.49
Control	12.39	3.77	1.21	0.45

was observed to contain water above the monthly rainfall almost in the entire duration as recorded.

The storage behaviour of 'tarfel' (bitumen sheet with impregnated mica and sand generally used for covering roof in the village) lined pond during 1999 was plotted in Fig. 2. The storage life was found to be 240 days. The seasonal water balance (Table 2) showed that the average seepage loss in the 'tarfel' was found to be 8.0 mm/day. Figure 2 also showed the amount and frequencies of application of irrigation water during *rabi* 1999-2000. The total amount of irrigation water applied was 16,511 litres from mid October 1999 to mid January 2000 for growing vegetables such as, pea, cabbage, cauliflower in plot 5 and 6. The pond was utilized for short growing fish culture during rainy season between July to August 1999.

Nutrient recycling

The effect of locally made compost on yield and water use efficiency (WUE) of locally screened rice variety (TRC-1-97) and a high yieding variety (Bandana) for upland rice obtained from CRRI, Cuttack, was studied (Table 2). Bandana was found to record lower yield than its reported yield (4 t/ha) due to its lodging behaviour at soft dough stage. But TRC-1-67 was found to have higher yield and WUE (1.24-2.72 t/ha & 1.21-2.74 kg/ha-mm) than Bandana (0.38-1.43 t/ha & 0.45-1.69 kg/ha-mm). It was found that the yield and WUE were highest in NPK+compost followed by only NPK and only compost. Similar results were also obtained in bhindi also. This suggests to produce nutritionally enriched compost.

In situ moisture conservation

Different locally available biomulches such as *Glyricidia, Acacia,* Chan (*Saccharum* sp.), maize stalk, straw were used to study their efficacy on *in situ* moisture conservation and yield of groundnut as compared to synthetic polythene mulch (Table 3). Here, ground-nut was sown during mid-August after maize crop on 0-5% slope in the interspaces of mango. *Acacia* was found to record highest yield (5.0 q/ha) and WUE (0.9 kg/ha-mm) followed by maize stalk (4.06 q/ha & 0.73 kg/ha-mm) and chan (3.55 q/ha & 0.64 kg/ha-mm).

Table 3. *In situ* moisture conservation on groundnut

Treatment	Yield (q/ha)	WUE (kg/ha-mm)
Mulches		
Glyricidia sp.	0.19	0.035
Polythene	2.95	0.54
Acacia sp	5.0	0.90
Chan (*Saccharum* sp.)	3.55	0.64
Maize stalk	4.06	0.73
Straw	1.20	0.22
Control	3.85	0.69

Weed control

Weed is a major problem to obtain desired agricultural output. A large amount of expenditure is required to remove weeds either manually or by spraying herbicides. The weed cleaning is much more difficult in pineapple planted area on steep slopes (>15%). The effect of locally available biomulch called 'chan' (*Saccharum* sp.) on yield attributes of pineapple in pineapple+Assam lemon cropping (Table 4) was studied. It was found that the number of fruits, average fruit size of pinapple, water use were higher in case of mulching than no-mulch conditions.

Table 4. Weed control and its effect on pineapple - Assam lemon land use on steep slope

Treat-ment	Water use (mm)		Yield attributes	
	Between pineapple rows	Between pinapple and lemon	No. of pinapple fruits /100 m^2	Av. fruit weight (gm)
Leafy Mulch	356	333	109	900
No-mulch	345	324	62	750

Cost evaluation

The two years' expenditure details are given in Table 5. The expenditure was drastically reduced from Rs.1,10,607 in 1998 to Rs.63,800 in 1999. It was found that 80% of yearly expenditure was required for meeting cost of hired labourers. The cost of lining for seepage control was found to be Rs.10 per sq.ft.

Table 5. Expenditure statement

Heads	Amount (Rs.)	
	Feb 98-Dec 98	Jan 99-Dec 99
1. Engagement of contractual labourers	51,807	40,000
2. Planting material & seed	9657	7000
3. Manure	1200	500
4. Water harvesting structure & seepage control	34,702	7000 (lining)
5. Farm implement	1821	300
6. Miscellaneous	11,020	8000
Total (Rs.)	1,10,407	63,800

Conclusions

This paper highlighted the different components of watershed managemnet such as land use systems, soil and water conservation, nutrient recycling etc. and their integration to develop a viable production system. This sort of model watershed development can be applicable for converting typical *tilla* wasteland of Tripura into productive unit.

References

Bhattacharya, B.K., Mitra, S. and Datta, M. 1997. Identification of water deficit and surplus periods and prediction of profile water content from surface soil water status in uplands of Tripura. *J. of Indian Soc. Soil Sci.* 45(4) : 698-701.

Bhattacharjee, P.R. 1993. Self-sufficiency in food-grains vs. optimal resource-use: An exercise in choice of agricultural strategy in Tripura. In : Agricultural Development in North-East India. Ed. A.K. Alam and P. Datta Ray, pp 293-300.

Bhattacharjee, P.R. 1989. In Quest of Growth Boosters in the Rural Economy of Tripura". In : Seminar on "Rural Development in N.E. region" organised by the NEICSSR, Shillong.

Senchoudhury, S. 1990. "The utilization of Bio-resources in Agricultural Production in Tripura". In : Symposium on "Bio-Resources of Tripura", Deptt. of Life Sciewnce, Tripura University, March, 1990.