Ind. Jn. of Agri. Econ.
Vol.61, No.3, July-Sept. 2006

SUBJECT I
AGRICULTURAL DEVELOPMENT IN THE NORTH-EAST: STATUS, ASSESSMENT AND PROSPECTS

Conservation Farming as an Alternative to Shifting Cultivation in Meghalaya: An Economic Evaluation

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I

INTRODUCTION

The slow growth of agricultural development in Meghalaya is attributed mainly to the predominance of shifting cultivation. Shifting cultivation (also locally known as *jhum* cultivation) and biotic interference in combination with high rainfall are causing large scale soil erosion. According to an estimation, nearly 18.6 million tonnes of soil, 0.6 million tonnes of organic carbon, 9.7 tonnes of phosphorus and 5,690 tonnes of potassium are lost annually due to shifting cultivation in the North Eastern Hill region of India (Singh and Singh, 1981). The extent of cumulative area affected by shifting cultivation during the 1987 to 1997 period was found to be 1.73 million hectares in the North Eastern Region. It was 0.18 million hectares in Meghalaya accounting for 10.40 per cent of total shifting cultivation area in the North Eastern region during the same period (Government of India, 1999). The loss of topsoil due to shifting cultivation has brought drastic reduction in the productivity per unit area. It has been estimated that for every inch of topsoil lost, yield of crops falls by 6 per cent (Dey, 1996). Similarly, a study in Meghalaya reported that the per hectare yield of paddy under 30 year, 10 year and 5 year *jhum* cycles were 1161 kg, 370 kg and 66 kg, respectively (Toky and Ramakrishnan, 1982). Therefore, it showed that the productivity of paddy decreased subsequently as the *jhum* cycle declined. The significance of this system of farming in the present day is more because of the adverse effects associated with it. The *jhum* cycle in the same land which extended upto thirty years in the olden days has now been shortened to 3-6 years because of increased population pressure on land and decrease in productivity leading to utilisation of more area under shifting cultivation (Borthakur *et al.*, 1978).

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The authors are grateful to S. Selvarajan, Principal Scientist (Retired), National Centre for Agricultural Economics and Policy Research, New Delhi and A. Singh, Principal Scientist, Water Technology Centre, Indian Agricultural Research Institute, New Delhi, for their valuable suggestions. Further, the authors are thankful to R.P.Awasthi and N.D.Verma, former Directors, ICAR Research Complex for North Eastern Hill Region, Meghalaya, for their help and encouragement.

Therefore, it is necessary to evaluate alternative farming systems which incorporate the indigenous and modern resource conservation technologies that can be introduced in areas where the cycle of rotation has been greatly reduced. The present study, therefore, is directed towards the evaluation of different conservation or watershed based farming systems, as an alternative to replace the shifting cultivation.

II

DATA AND METHODOLOGY

The study was conducted in the farming system research block at ICAR Research Complex for North Eastern Region situated at Umiam, Meghalaya State. The various watershed based farming systems selected for the study were livestock-based, forestry, silvi-pasture, agro-pastoral, agro-horti-silvi-pasture, horticulture, and timber forestry. Treatments were imposed in the year 1984. Contour bunds, bench terraces, half moon terraces, contour trenches and grassed waterways are the major items of the mechanical soil and water conservation measures adopted in the various micro-watersheds. Bench terraces, contour trenches and contour bunds were planned in such a way that the vertical interval did not exceed 1.5 m and all the terraces drained their excess run-off into a common grassed water way. Contour bunds in silvi-pastoral and horticultural systems were planned at 5 meters vertical intervals with a view to cut off the path of surface water flow and divert the same to grassed waterways. Small water storage pools were created with the use of gully plugs in the main watercourses so as to act as silting basin. The details of watershed based farming systems and conservation measures adopted are shown in Table 1 and Table 2 presents the details of watershed characteristics under different farming systems.

A pond was constructed at the foot hills to harvest the water. The agro-horti-silvi-pasture, horticulture and natural fallow farming systems (not considered in this analysis) contributed water to the pond. The total catchment area is 5.74 hectares. The average slope of the catchment area is 35 per cent. The capacity of the pond is one hectare meter. On an average 8.7 per cent, 41.3 per cent and 50 per cent of direct rainfall, surface run-off and base flow, respectively contributed to the inflow into the pond. Water is available from June to mid-week of November for 177 days and used for fish production.

For the present study, data regarding crop production, fish production, livestock production, soil loss, run-off, soil nutrient status were collected from the registers and Annual Reports of the ICAR Research Complex for North Eastern Hill Region, Meghalaya. The average of eight years (1988-1995) data had been used for the analysis. To estimate the cost and return for shifting cultivation system, thirty farmers who were practicing shifting cultivation were interviewed during the year 2000 at random with the help of structured questionnaires in the Umiam region. The market prices prevailing during the financial year 2000-01 were used in all the farming systems for the estimation of costs and returns. The discount rate of 12 per cent per annum was assumed to represent the opportunity cost of capital in this study. From the general observation and discussion with the scientists, the economic life of the forestry plantation was

TABLE 1. LAND TREATMENT DETAILS OF VARIOUS WATERSHED BASED FARMING SYSTEMS

Farming systems (1)	Crops (2)	Conservation measures (3)
Livestock	Guinea grass (*Panicum maximum*) and broom grass (*Thysanolaena maxima*), maize *(Zea mays*), field beans (*Dolichos lablab*) and oats (*Avena sativa*) plus milch cows.	Contour trench (Rs.13,400 per hectare)
Forestry	Michelia *oblonga*, *Symangtonia populnea* and *Alnus nepalensis*. It included both timber and fodder treses.	Nil
Silvo-pastoral	*Symangtonia populnea*, *Bauhinia purpurea*, *Thysanolaena maxima* (broom grass) and *Brachiaria ruziensis* (congo-signal)	Nil
Agro-pastoral	Maize (*Zea mays*), paddy (*oryza sativa*), groundnut (*Arachis hypogaea*), soybean *(Glycine max)*, french bean (*Dolichos lablab*), linseed (*Linum usitatissinum*), ginger (*Zingiber officinale*), oats (*Avena sativa*), radish (*Raphanus sativus*), mustard (*Brassica juncea*), broom grass (*Thysanolaena maxima*) and guinea grass (*Panicum maximum*) plus milch cows.	Bench terrace and contour bunds (Rs.15,760 per hectare)
Agro-horti-silvo-pastoral	French bean (*Dolichos lablab*), maize (*Zea mays*), ginger (*Zingiber officinale*), mustard (*Brassica juncea*), radish (*Raphanus sativus*), chilli (*Capsicum frutescens*), sweet potato (*Ipomoea batatas*), Symangtonia populnea, Grevillea robusta, Alnus nepalensis, orange (*Citrus reticulata*), lemon (*Citrus limonia*), pear (*Pyrus communis*), broom grass (*Thysanolaena maxima*) and guinea grasses (*Panicum maximum*)	Contour bunds, bench terraces and small water pools (Rs.7,480 per hectare)
Horticulture	Orange (*Citrus reticulata*), lemon (*Citrus limonia*), guava (*Psidium guajava*), radish (*Raphanus sativus*), chilli (*Capsicum frutescens*), sweet potato (*Ipomoea batatas*) and French bean (*Dolichos lablab*).	Contour bunds, bench terraces and small water pools (Rs.4,320 per hectare)
Timber forestry	Earlier this was the shifting cultivation plot and it was planted with timber tree (*Michelia champaca*) during 1992.	Nil
Shifting cultivation	Mixed cropping of paddy, maize, cotton, tapioca, ginger, etc. were grown. Livestock rearing like cattle, pig, poultry and goat were practiced. Data collected from the 30 shifting cultivators were used for the analysis.	Nil

Source: Annual Report (1983), ICAR Research Complex for North Eastern Hill Region, Umiam, Meghalaya.
Note: Figures in parentheses of the last column indicate investment (2000-01 prices) on conservation structures.

TABLE 2. DETAILS OF VARIOUS FARMING SYSTEMS IN THE STUDY AREA

Particulars (1)	Livestock (2)	Forestry (3)	Silvi-pasture (4)	Agri-pasture (5)	Agri-horti-silvi-pasture (6)	Horticulture (7)	Timber farming (8)
Net cultivated area (ha)	0.803	0.84	0.9	0.74	0.93	0.96	0.50
Average slope (per cent)	32.02	38.6	32.18	32.42	41.77	53.18	41.35
Maximum length (m)	301	320	295	240	260	515	185
Maximum width (m)	65	230	175	65	85	85	48
Treatments imposed	1984	1984	1984	1984	1984	1984	1992

Source: Annual Report (1984), ICAR Research Complex for North Eastern Hill Region, Umiam, Meghalaya.

estimated to be 25 years except pine trees (50 years). The economic life of the fruit plantation was also estimated to be 25 years. The discount rate was employed to reduce the future cash flows and to take into consideration of the benefits and costs to their

present worth. The annuity was estimated for the forestry and timber farming systems to compare costs and returns between the different farming systems.

III

RESULTS AND DISCUSSION

The present study, therefore, is directed towards the evaluation of different conservation based farming systems, as an alternative to replace the shifting cultivation. The results of empirical analysis have been presented and discussed under the different heads.

3.1 Income from the Farm Pond

One of the most important components of watershed is water harvesting structure to store the water drained from the catchments area for further uses. A pond was constructed at the foothills to harvest the water. The farm pond was used for fish production. Fingerlings were released on the last week of June at a stocking density of 8000 per hectare with a stocking ratio of 2.5 (catla): 1 (rohu): 1(mrigal): 2.5 (common carp): 3 (silver carp) and harvested in the mid-week of November. The average recovery was 91 per cent.

The details regarding input used and output obtained for the seasonal pond are presented in Table 3. Human labour recorded the major share (40 per cent) in the total cost followed by manure (21 per cent). The share of mustard oil cake and fingerlings were equal with 11 per cent. The total cost, gross return and net return per pond were Rs. 19,583, Rs. 33,480 and Rs. 13,897, respectively. This suggests that run-off harvesting and its proper use offer ample scope to generate additional income from the watershed-based farming systems.

TABLE 3. INPUT-OUTPUT DETAILS OF FISH PRODUCTION IN SEASONAL POND

(*per pond*)

Particulars	Unit	Rate	Quantity	Cost/Return
(1)	(2)	(3)	(4)	(5)
Input				
Fingerlings	Numbers	0.50	4480	2,240 (11)
Lime	Kg	0.55	1000	550 (3)
Manure	Kg	0.50	8225	4,113 (21)
Urea	Kg	4.00	46	184
SSP	Kg	3.20	115	368
MOP	Kg	3.80	22	84
Total fertiliser (Rs.)				636 (3)
Mustard oil cake	Kg	3.00	750	2250 (11)
Rice polish	Kg	2.50	750	1,875 (10)
Human Labour	Man-days	40.00	198	7,920 (40)
Total cost	Rs.			19,583
Output				
Fish	Kg	40.00	837	33,480
Net Return	Rs.			13,897

Figures in parentheses indicate the percentage share in total cost.

3.2 Comparison of Cost and Returns

The indicator for the success or failure from the farmer's point of view is the return, which he is earning from his farm. It will be more reliable to explain on per hectare basis due to the variations in size of operational holdings. An in-depth examination of different cost and corresponding income for different farming systems has been done and is presented in Table 4.

TABLE 4. COMPARISON OF DIFFERENT FARMING SYSTEMS

(*per hectare*)

Particulars (1)	Livestock (2)	Forestry (3)	Silvi-pasture (4)	Agri-pasture (5)	Agri-horti-silvi pasture (6)	Horticulture (7)	Timber farming (8)	Shifting cultivation (9)
Total Return (Rs.)	94,326	9,391	11,236	65,401	33,883	62,650	15,598	6,756
Total Cost (Rs.)	58,905	2,520	4,490	39,170	12,107	22,535	2,861	5,320
Net Return (Rs.)	35,421	6,871	6,746	26,231	21,776	40,115	12,736	1,436
B-C Ratio	1.60	3.73	2.50	1.67	2.80	2.66	5.45	1.27

It is obvious from the table that the total returns varied in different farming systems ranging from Rs. 6,756 per hectare in shifting cultivation to Rs. 94,326 per hectare in livestock farming system. The total cost was the least in forestry (Rs. 2,520 /ha) and was the highest in livestock-based (Rs. 58,905 /ha) farming system. Net income was the highest in horticulture farming system amounting to Rs. 40,115 per hectare, followed by Rs. 35,421 per hectare in livestock based, Rs. 26,231 per hectare in agri-pasture, Rs. 21,776 per hectare in agri-horti-silvi-pasture and Rs.12,736 per hectare in timber farming system. It was the lowest in silvi-pasture (Rs.6,746 / ha), forestry (Rs.6,871 /ha) and shifting cultivation (Rs. 1,436) farming systems. Among the different farming systems, the benefit-cost ratio was the highest for timber farming (5.45) followed by forestry (3.73) farming system. It was low in agri-pasture (1.67), livestock-based (1.60) and shifting cultivation (1.27) farming systems as compared to other farming systems.

3.3 Comparison of Sectoral Shares

Agricultural diversification is an important instrument for economic growth. Diversification means selecting more than one enterprise in order to meet the risk or reduce the income variability. Table 5 indicates the sectoral share or share of different enterprises in the net income for different farming systems. The farming system agri-horti-silvi-pasture was highly diversified comprising four enterprises. The contribution of horticulture (51 per cent) in the net income was the highest among the different sectors, followed by agriculture (33 per cent), pasture (9 per cent) and forestry (6 per cent). The next highly diversified farming systems were agri-

TABLE 5. SECTORAL SHARES IN INCOME FOR DIFFERENT FARMING SYSTEMS

(per cent)

Farming systems (1)	Agriculture (2)	Horticulture (3)	Forestry (4)	Pasture (5)	Animal husbandry (6)
Livestock	-	-	-	35	65
Forestry	-	-	100	-	-
Silvi-pasture	-	-	47	53	-
Agri-pasture	22	-	-	22	56
Agri-horti-silvipasture	33	51	6	9	-
Horticulture	-	100	-	-	-
Timber farming	-	-	100	-	-
Shifting cultivation	59	22	-	-	19

pasture and shifting cultivation farming systems. In agri-pasture farming system, the share of animal husbandry (56 per cent) was the highest followed by agriculture and pasture (22 per cent). In shifting cultivation system, the share of agriculture (59 per cent) was the highest followed by horticulture (22 per cent) and animal husbandry (19 per cent). The other less diversified farming systems were livestock-based and silvi-pasture. In these farming systems, only two enterprises were contributing to the net income. The income sources were from single enterprise in the case of horticulture, forestry and timber farming systems and were not diversified.

3.4 Human Labour Use in Different Farming Systems

An attempt has been made in this section to analyse the human resource use in the selected watershed-based farming systems. The human labour use per hectare for different farming systems is presented in Table 6. The agri-pasture farming system generated the highest employment of 179 man-days in which animal husbandry contributed the highest (91 man-days) as compared to agriculture (88 man-days). The shifting cultivation and livestock farming system were the next highest employment generating systems. The horticulture and agri-horti-silvi-pasture farming systems generated 111 and 59 man-days, respectively. The forestry (9 man-days) and timber farming (12 man-days) farming systems contributed the least towards the employment generation per annum. This suggests that the farming systems which are having the additional components like animal husbandry would generate more employment.

TABLE 6. HUMAN LABOUR USE IN DIFFERENT FARMING SYSTEMS

(man-days per hectare per annum)

Farming systems (1)	Agriculture (2)	Animal husbandry (3)	Total (4)
Livestock	39	91	130
Forestry	9	-	9
Silvi-pasture	20	-	20
Agri-pasture	88	91	179
Agri-horti-silvipasture	59	-	59
Horticulture	111	-	111
Timber farming	12	-	12
Shifting cultivation	64	69	133

3.5 Effect of Resource Conservation Measures

The conservation measures and different components in the farming systems profoundly influenced the chemical characteristics of the soil. The soil analysis (Table 7) indicated build-up in organic carbon content in the soil in all farming systems except agri-horti-silvi-pasture. Moreover, it is interesting to note that the forestry recorded the highest enrichment of 63.73 per cent, owing to addition of substantial amount of organic matter through leaf fall. Shifting cultivation system according to the study (Anonymous, 1983) depleted the soil nutrients. Soil loss in different farming systems were ranged from 0.07 tonnes per hectare per annum to 4.37 tonnes per hectare per annum. Soil loss was the highest in shifting cultivation system with 30.20 tonnes per hectare per annum. Run-off was the highest in timber farming system followed by forestry and shifting cultivation system. This indicates that shifting cultivation causes highest resource degradation as compared to the conservation based farming system.

TABLE 7. CHANGES IN THE NUTRIENT CONTENTS IN DIFFERENT FARMING SYSTEMS

	Organic Carbon (per cent)				
Farming systems	1983	1986	Per cent change	Run-off (mm/year) (Triennium average)	Soil loss (t/ha/annum) (Triennium average)
(1)	(2)	(3)	(4)	(5)	(6)
Livestock	1.27	1.54	21.26	43.97	0.16
Forestry	1.02	1.67	63.73	239.86	0.17
Silvi-pasture	1.55	1.63	5.16	105.00	0.08
Agri-pasture	1.55	1.60	3.23	48.88	0.33
Agri-horti-silvipasture	1.72	1.72	0.00	57.35	1.22
Horticulture	1.18	1.47	24.58	109.08	4.37
Timber farming	-	-	-	517.00	0.24
Shifting cultivation*	-	-	-	214.80	76.80

Note: *Run off and soil loss data were obtained from Anonymous, 1983.

The ranking analysis (Table 8) of eight farming systems based on net return, diversification, soil loss, run-off, benefit–cost ratio, organic carbon enrichment placed livestock based farming system in the first position. The shifting cultivation occupied the last position due to the lowest return, low benefit-cost ratio and high run-off and soil loss.

TABLE 8. RANKING OF FARMING SYSTEMS

Farming systems	Net return	Diversification	Soil loss	Run-off	B-C ratio	Organic carbon enrichment	Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Livestock	1	3	3	1	7	3	1
Forestry	6	4	1	7	2	1	2
Silvi-pasture	7	3	2	4	5	5	4
Agri-pasture	3	2	5	2	6	6	3
Agri-horti-silvipasture	4	1	6	3	3	7	3
Horticulture	2	4	7	5	4	2	3
Timber farming	5	4	4	8	1	4	4
Shifting cultivation	8	2	8	6	8	8	5

IV

CONCLUSION

Among the different farming systems evaluated, the horticulture-based farming system registered the maximum annual net return of Rs. 40,115 per hectare, closely followed by livestock based farming system with Rs. 35,421 per hectare. The other profitable farming systems are agri-pasture and agri-horti-silvi-pasture where, annual net return exceeded Rs. 21,000 per hectare. The least net return was recorded in shifting cultivation system (Rs. 1,436/ha). Agri-horti-silvipasture is the highly diversified farming system with 51 per cent of net income generated from horticulture, 33 per cent from agriculture, 9 per cent from pasture and 6 per cent from forestry. Forestry and timber are the specialised farming systems. The maximum soil loss was registered in the shifting cultivation system and negligible amount of soil loss occurred in the conservation farming systems. Shifting cultivation occupied the last position in the overall ranking in terms of net returns obtained, soil loss, organic carbon enrichment, diversification and benefit-cost ratio among the different farming systems. Therefore, economically viable technology is available. The components of technology as captured through conservation based farming systems have a combination of diversification addressing efficiency and sustainability considerations exhibiting the desired impacts in the hilly region which will accelerate the pace of the agricultural development in this region. A major thrust with adequate funding support focused on conservation based farming system approach involving all the stakeholders starting from the people up to multiple institutions is strongly recommended.

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