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Rejuvenation of abandoned *jhum* land in the hill region of Karbi Anglong district in Assam

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Abstract : The natural rejuvenation of jhum land (shifting cultivation area) was studied for 5 consecutive years (1998-2003) in three locations of hill district of Karbi Anglong, Assam. The burning of stubbles associated with shifting cultivation (jhuming) enhanced soil pH by 0.62 to 0.69 units, electrical conductivity and organic carbon by 0.13 to 1.24% respectively. There was also enrichment of available P and K by 1.2 to 3 times and 1.3 to 2.1 times respectively. The mixed cropping of jhum land for two consecutive years resulted in gradual decline in pH, E.C., organic carbon, available P and K. The decline was most pronounced in respect of available K. The rejuvenation of soil characteristics started after abandoning of jhuming land after two years of cultivation. The revival of original soil characteristics was observed after 3 years of discontinuation of cultivation.

Additional key words : *Shifting cultivation, stubbles, soil characteristics, rejuvenation, jhum land*

Introduction

The shifting cultivation called 'slash and burn' agriculture, is an age old cultivation practice in the hill zone comprising of Karbi Anglong and North Cachar Hills district (24° 54' to 26°41' N and 92°08' to 93°58' E) of Assam. Locally known as *jhuming*, it is practiced in 70000 hectares by about 58000 families (Department of Agriculture 1996). The study using satellite data, carried out by Assam Remote Sensing Application Centre (Anonymous 2000) indicated that *jhuming* is increasing at annual rate of 1.2 % in the hill district of Karbi Anglong thus affecting about 60.01 % of the total area. In the *jhuming* or shifting cultivation, a piece of hill slope is cleared for forest cover in the months of March to May, followed by burning of stubble. The land is cultivated for mixed cropping without any manure and fertilizer for 2 to 3 years and then left fallows for a period ranging from 20 to 30 years in earlier times and 2 to 5 year at present. The land is again revisited for *jhuming* after the fallow periods (Chatterjee and Maiti 1984; Sarma *et al.* 1995). The shifting causes widespread land degradation. Of late, the productivity of *jhum* land was drastically reduced due to shorter fallow period. The length of fallow period determines extent of natural rejuvenation of abandoned *jhum* land. It also depends on soil, climatic condition and topography. The present investigation was undertaken to study and monitor the natural rejuvenation process of *jhum* land under moderate annual rainfall (1000 to 1200 mm) and gentle to moderate hill slope (10 to 30%) in the hill district of Karbi Anglong of Assam.

Materials and Methods

The present study was initiated in three *jhum* lands located in the three villages *viz.* Christian Basti-1, Christian Basti-2 and Hapjan surrounding Diphu town (25°50' N and 93°30' E), the district headquarter of Karbi Anglong district of Assam during 1998 to 2003. The surface soil samples (0-6") were collected from upper,

middle and lower hill slope before start of *jhuming*, after burning of stubbles in the month of April-May and after harvest of crop in the month of December, for two years of cropping. The soil collection was continued for another three years of fallow periods. The soil samples were dried, ground and analyzed for soil characteristics (Jackson 1967).

In the *jhum* land, mixed cropping was generally practiced. The subsistence hill farmer usually grow all the crops that are necessary for their household consumption. The major crops grown were upland hill rice, maize, sesame, cotton, gourd, chili, ginger/turmeric, colocasia, okra, arum and sweet potato.

Results and discussion

The soils of the location were moderately deep and were classified as fine, mixed, hyperthermic Ultic Hapludalf (Chakravarty and Baruah 1984). The soils are sandy clay loam in texture.

The initial soil characteristics of the soils (Table 1) indicated that soils are strongly to slightly acidic (pH 5.17 to 6.28) with high organic carbon content (0.69 to 1.87 %), low to high available P (2 to 35 kg ha^{-1}) and medium to high available K (197 to 840 kg ha^{-1}). The soils of lower slopes were generally less acidic. After burning of stubble, there was favourable change in soil characteristics (Table 2). There were significant rise in soil pH and electrical conductivity. The rise in soil pH is attributed to release of bases from burning of stubbles (Kyuma *et al.* 1985). There was also increase in organic carbon content, might be due to inclusion of inorganic carbon from burnt stubble. The most favourable effect of burning was on available P (7 to 47 kg ha^{-1}) and K (312 to 1026 kg ha^{-1}). All the burnt soils recorded high K status (312 to 1026 kg ha^{-1}) irrespective of their initial status of available K. This corroborates the earlier findings that burning of stubbles increased the availability of P and K in soils of *jhum* land (Awasthi *et al.* 1981 and Dey 1992). The increase in available P and K is attributed to oxidation of organic P and K to inorganic compounds during burning of stubble.

The burning of stubble in *jhum* brought changes in soil properties (Table 3). In Christian Basti, with moderate slope (22 to 28%) there was slight decrease in soil pH whereas in Hapjan with gentle slope (10 to 15%), there was either enhancement or little change in soil pH. There was an increase in electrical conductivity particularly in Hapjan (after 1 year of *jhum* circle). The organic carbon, available K and P recorded decline in all locations after one year of *jhuming*. There was an

Table 1. Initial soil characteristics of *jhum* land (before burning)

Location	Land situation in hill slope	Slope (%)	pH (1:2.5)	E.C. (dS m^{-1})	Organic carbon (%)	Available (kg ha^{-1})	
						P	K
Christian Basti-1	Upper	25-28	5.77	0.056	0.77	2	201
	Middle	23-26	5.53	0.072	0.69	2	197
	Lower	22-25	6.28	0.124	1.26	10	379
	Mean	-	5.86	0.084	0.90	5	256
Christian Basti-2	Upper	22-25	5.17	0.103	1.61	4	297
	Middle	22-25	5.46	0.114	1.46	3	387
	Lower	22-25	5.81	0.166	1.49	2	565
	Mean	-	5.48	0.128	1.52	3	416
Hapjan	Upper	10-15	6.10	0.101	1.87	15	840
	Middle	10-15	5.85	0.082	1.65	35	528
	Lower	10-15	6.25	0.385	1.71	11	394
	Mean	-	6.07	0.189	1.75	20	587

Table 2. The soil characteristics of *jhum* land after burning of stubble

Location	Land situation in hill slope	pH (1:2.5)	E.C. (dS m^{-1})	Organic carbon (%)	Available (kg ha^{-1})	
					P	K
Christian Basti-1	Upper	6.40	0.106	1.01	7	550
	Middle	6.36	0.098	0.92	12	461
	Lower	6.90	0.135	1.68	19	669
	Mean	6.55	0.113	1.20	13	560
Christian Basti-2	Upper	5.75	0.108	1.37	8	312
	Middle	6.15	0.139	1.73	11	632
	Lower	6.40	0.147	1.73	10	684
	Mean	6.10	0.131	1.61	10	543
Hapjan	Upper	6.45	0.157	2.37	18	967
	Middle	7.10	0.226	2.65	47	1026
	Lower	6.70	0.199	2.37	42	862
	Mean	6.75	0.194	2.47	36	952

Table 3. Residual soil characteristics of *jhum* land after one year *jhum* cycle

Location	Land situation in hill slope	pH (1:2.5)	E.C. (dS m^{-1})	Organic carbon (%)	Available (kg ha^{-1})	
					P	K
Christian Basti-1	Upper	6.32	0.096	1.11	3	333
	Middle	6.37	0.103	0.75	5	459
	Lower	6.72	0.166	1.26	13	558
	Mean	6.47	0.122	1.04	7	450
Christian Basti-2	Upper	5.98	0.121	0.68	7	289
	Middle	5.86	0.125	0.94	10	414
	Lower	6.23	0.134	1.05	5	450
	Mean	6.02	0.127	0.89	7	384
Hapjan	Upper	6.53	0.235	2.14	14	740
	Middle	7.17	0.404	1.58	29	954
	Lower	6.08	0.139	1.61	18	558
	Mean	6.59	0.259	1.77	20	751

increase/improvement in soil properties over corresponding initial values, even after one year of *jhuming*.

The decline in organic carbon, available P and K recorded after one year of *jhum* cycle, also continued in the second year of *jhum* cycle (Table 4), in all locations except in Christian Basti-2, where discontinuation of *jhuming* after one year resulted in increase in their values. Even though, there was decline in soil characteristics and fertility value, after two years of *jhuming*, the soil pH, EC, available P and K status were comparable to that of initial soil status (Table 1). The organic carbon declined to a value lower than the initial status, after completion of two years of *jhuming*.

At all locations, *jhuming* was discontinued after completion of two years cycle. The soil characteristics (Table 5) at the end of 3rd year (1 year after discontinuation of *jhuming*) indicated that the soil characteristics (pH, EC and available K) recorded decline (except

Table 4. Residual soil characteristics of *jhum* land after completion of two years of *jhum* cycle

Location	Land situation in hill slope	pH (1:2.5)	E.C. (dSm^{-1})	Organic carbon (%)	Available (kg ha^{-1})	
					P	K
Christian Basti-1	Upper	6.12	0.063	0.35	2	270
	Middle	6.02	0.054	0.32	4	252
	Lower	6.51	0.097	0.32	9	405
	Mean	6.21	0.071	0.33	5	309
Christian Basti-2	Upper	6.02	0.055	0.90	9	369
	Middle	5.89	0.134	1.17	5	414
	Lower	6.31	0.132	0.70	14	516
	Mean	6.07	0.107	0.93	9	433
Hapjan	Upper	6.32	0.100	0.99	14	432
	Middle	6.97	0.100	1.49	13	450
	Lower	6.08	0.096	1.05	26	432
	Mean	6.45	0.099	1.18	18	438

organic carbon and available P) as compared to the previous years which are contrary to the general belief that soils start rejuvenating on discontinuation of *jhuming*. This deviation may be attributed to the significantly higher annual rainfall in 1999 (1580 mm) as compared to the previous year 1998 (1021mm). Further less soluble soil constituents such as organic carbon and available P were left unaffected. These constituents showed enrichment on discontinuation of *jhuming*. The soil characteristics in respect of pH, E.C., Organic carbon and available K has not yet reached the initial status at the end of 3rd year even after discontinuation of cultivation.

The change in soil characteristics in the 4th year of *jhum* cycle (2 years after discontinuation of *jhuming*) indicated that there was an increase in organic carbon content, available P and K as compared to that of 3rd year (Table 5). However, pH and EC were little affected in Christian Basti, whereas, in Hapjan, both the parameters were enhanced as compared to that of 3rd year. The rejuvenation of soil characteristics (2 years after abandoning of *jhuming*) were more pronounced with respect to soil fertility. When compared with of initial values (Table 1), it is evident that pH, E.C. organic carbon and available K have not yet regained their status even 2 years after abandoning of *jhuming*.

At the end of 5th year of *jhum* cycle (3 years after discontinuation of *jhuming*) all soil characteristics (as described earlier) recorded favourable changes (Table 5) as compared to that of preceding years (4th year), indicating that rejuvenation process continued in the 5th year of *jhuming*. All the soil characteristics were found to attain comparable value with that of initial value, suggesting that rejuvenation process of *jhum* land in terms of soil characteristics takes about 3 years after abandoning of the land.

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Table 5. Soil characteristics of *jhum* land after abandoning of *jhuming*

Location	pH (1:2.5)				E.C. (dSm^{-1})				Organic carbon (%)				Available ($kgha^{-1}$) P				Available ($kgha^{-1}$) K			
	Initial	1st year	2nd year	3rd year	Initial	1st year	2nd year	3rd year	Initial	1st year	2nd year	3rd year	Initial	1st year	2nd year	3rd year	Initial	1st year	2nd year	3rd year
Chriastian basti-1	5.86	5.67	5.63	5.88	0.084	0.049	0.060	0.103	0.90	0.77	0.84	1.55	5	6	9	11	265	303	335	343
Chriastian basti-2	5.48	5.47	5.20	6.00	0.125	0.077	0.063	0.133	1.52	1.27	1.45	1.82	3	14	29	29	416	354	387	433
Hapjan	6.07	5.52	5.78	6.17	0.189	0.076	0.075	0.140	1.75	1.53	1.57	1.73	20	22	34	35	587	438	553	593

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