- On an average, 9.8 to 11.4% decline in nitrogen availability in soils.
- Very low phosphorus availability.
- A decline in available potassium from 150 to 125 kg ha^{-1} and 319 to 203 kg ha^{-1} in soils under shifting cultivation.
- Low zinc and high iron / manganese availability .

A view of improved shifting cultivation

Year 2004 Publication No. 6

Prepared by :

Dr. M. Datta, Principal Scientist
Dr. K. R. Dhiman, Principal Scientist
Prof. N. P. Singh, Joint Director

Technical Support :

Ms. A. Suklabaidya, SRF, NATP
Mr. N. Acharjee, Tech. Asstt.

For details please contact :

Prof. N. P. Singh, Joint Director, ICAR Research Complex for NEH Region, Lembucherra, Tripura (West), 799 210, Phone : (0381) 400 047/2865537 (O), 235 3725 (R), Fax (0381) 286 5201/286 5537, E-mail : narendraprataps@yahoo.co.in.

&

Dr. K. M. Bujarbaruah, Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya, 793 103, Phone : (0364) 257 0257 (O), 257 0302/222 6808 (R), Fax : (0364) 2570363 / 2570501, E-mail : director@icar.neh.ren.nic.in.

Printed at Caxton Printers, J.B. Road, Krishnanagar, Agartala, Tripura.
Ph. 230 7500/232 4500

nalp (cgp II)

भाकृअनुप
ICAR

Shifting Cultivation

— A case study

To Evaluate Soil Fertility

भाकृअनुप - पूपक
ICAR - RCNEH

ICAR Research Complex for NEH Region
Tripura Centre, Lembucherra
Tripura

Introduction

Shifting (Jhum) cultivation which, on global basis, is practised in about 350 M ha involving nearly 250 million people, is transitory in time and space. In India, this traditional cultivation being under operation since time immemorial is widespread (Fig.1) in North Eastern regions.

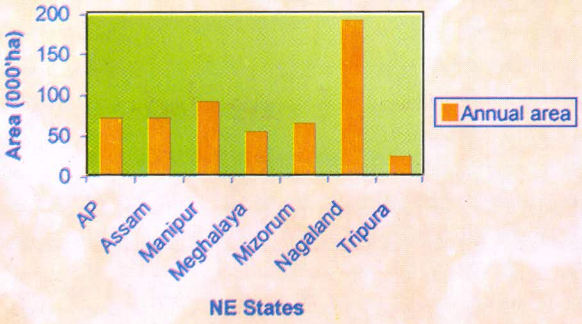

Fig. 1 Area under shifting cultivation in NE region

A variable quantum of soil loss (2 to 200 t ha^{-1} yr^{-1}) is reported thus leading to steep fall in soil fertility and biological productivity in areas under shifting cultivation. The sharp decline in shifting cycle from the earlier 5 - 6 years to a present level of 2 - 3 years or even less mainly owes to deterioration in soil health. Moreover, rampant deforestation carried out in shifting cultivation leads to destabilise our ecosystems. So there is a need to document the nature of soil changes over a period of shifting cycle. Such information may be utilised to have a strategic plan to bring about an improvement in shifting cultivation which is, in fact intermingled with traditional ethics of the aborigines .

Deforestation – loss of biodiverstiy

Experimental

Soil samples (Typic Dystrochrepts) at the depth of surface (0 - 0.15m) and subsurface (0.15 - 0.30m) were collected from two shifting cultivation sites in Mohanpur (Fine, Kaolinitic, Typic Kandiudults) in West Tripura and Birchandramanu (Fine, Kaolinitic, Typic Kanhapludults) in South Tripura over a period of 3 years. The soil samples were dried and ground to pass through 2 mm sieve. Soil pH, organic carbon, cation exchange capacity, exchangeable cations and available NPK were determined using the standard procedures. Bulk density and water holding capacity were also estimated. Micronutrients extracted using DTPA were analysed. Humic acid characterisation was also done in soils over the shifting cycle continued for a period of 3 years.

Soil erosion in a hill slope due to shifting cultivation

Physico-chemical Properties

Data on the average changes in the properties of shifting cultivation sites over a period of 1 - 3 years are presented in Table 1.

Table 1. Effect of shifting cultivation on soil physico chemical properties.

Properties	West Tripura			South Tripura		
	I	II	III	I	II	III
pH (H_2O)	4.70	4.60	4.50	5.10	5.10	5.00
Exchangeable acidity [c mol $(p^+)kg^{-1}$]	2.33	2.30	2.46	1.95	2.31	2.51
Org. matter (g kg^{-1})	12.56	11.52	11.18	14.28	12.04	10.49
Bulk density (mg m^{-3})	1.30	1.30	1.30	1.20	1.30	1.30

Water holding capacity (%)	34.00	32.00	32.00	40.00	35.00	35.00
Cation exchange capacity [c mol (p^+) kg^{-1}]	4.22	3.86	3.38	4.29	4.20	3.33
Exchangeable cations [c mole (p^+) kg^{-1}]	0.84	0.76	0.75	1.10	1.37	1.06
Base saturation (%)	20.40	19.90	22.40	25.80	32.10	34.40

I,II & III denote 1st, 2nd and 3rd year of shifting cycle.

Soils were acidic with pH ranging from 4.5 to 5.1. A decline in pH from 0.1 to 0.2 units was registered with the rise in shifting cycle from 1 to 3 years. The exchange acidity varying from 1.95 to 2.51 showed a rise from 1st to 3rd year of shifting cycle. Due to rapid mineralization over the shifting cycle, organic matter underwent rapid oxidation as noted from the decrease in values from 12.56 to 11.18 and 14.28 to 10.49 g kg^{-1} in soil sites under study.

Loss of plant nutrients in a steep slope (>20%)

Sesamum-rice intercrop across the slope

Bulk density remained unchanged but water holding capacity showed a decline from 34 to 32% and 40 to 35% probably due to reduction in organic matter and erosion of finer soil fraction from the soil matrix. On the other hand, cation exchange capacity (CEC) showed a decreasing trend primarily due to erosive loss of soil clay and organic matter. Exchangeable cations underwent a decline with the rise in shifting cycle owing to leaching losses. But per cent base saturation which is the ratio of exchangeable cations and cation exchange capacity showed an increasing trend mainly due to sharp decline in CEC.

Nutrient Availability

Data on nutrient availability in soils under shifting cultivation are presented in Table 2.

Table 2. Nutrient availability in soils influenced by shifting cultivation.

Nutrient	West Tripura			South Tripura		
	I	II	III	I	II	III
N (kg ha^{-1})	589	561	522	567	558	511
P (kg ha^{-1})	1.89	3.59	2.70	4.34	6.21	5.31
K (kg ha^{-1})	150	125	134	259	319	203
Zn (mg kg^{-1})	0.92	0.75	0.90	0.82	0.63	0.48
Fe (mg kg^{-1})	47	87	49	36	51	53
Mn (mg kg^{-1})	23	20	21	20	20	21

Available nitrogen, the status of which varied from high to medium showed a sharp decline with the rise in shifting cycle. Available phosphorus (Bray P_1) was low. Available potassium varying from low to medium also showed a decreasing trend in soils under shifting cultivation. Available Zn varied from 0.48 to 0.97 mg kg^{-1} indicating low availability with the rise in shifting cycle. On the other hand, available Fe/Mn underwent an inconsistent variation but the soils were found to contain adequate amounts of these cations considering 4.5 and 2.5 mg kg^{-1} as their critical limits, respectively.

Soil Humic Acid

Soil humic acid being the store house of plant nutrients, maintains soil physical properties congenial for plant growth. Thus soil humic acid was extracted from surface soils under shifting cycle and was analysed (Table 3) for its characterization.

Table 3. Properties of humic acid in surface soils over the shifting cycle.

Shifting cycle	E_4/E_6	CEC [cmol(p+) kg-1]	η_{sp}/C (mL g-1)	Molecular weight	IR spectral bands (cm-1)
1st year	3.88	250	10.55	6520	3915 (M), 3700 (W), 3580 (M), 2340 (Sh), 1873 (Sh) 1800 (S), 1600 (Sh), 1461 (Sh), 1039 (S), 913 (M), 690 (M), 535 (M), 470 (Sh), 425 (Sh), 348 (Sh), 261 (Sh)
2nd year	4.24	370	10.85	6805	3700 (M), 3624 (S), 2940 (Sh), 1610 (S), 1034 (S), 915 (S), 750 (M), 688 (S), 535(S), 469 (Sh), 420 (W), 345 (Sh)
3rd year	4.66	375	8.05	4300	3700 (M),3620 (S), 2000 (M), 1860 (Sh), 1845 (M), 1830 (Sh), 1640 (S), 1558 (Sh), 1030 (Sh), 1000 (S), 910 (M), 790 (W), 750 (Sh), 690 (M), 525 (M), 460 (M), 420 (Sh), 340 (Sh),

S = Strong, M = Medium, W = Weak, Sh = Shoulder.

A strong vegetative barrier with broom grass

The ratio of optical densities at 465 and 665 mm (E_4/E_6) of humic acid showed a concomitant rise from 3.88 to 4.66 over the shifting cycle of 3 years.

A high ratio of E_4/E_6 reflects a low degree of aromatic condensation and large proportion of aliphatic structures. So humic material with high E_4/E_6 ratio may be considered to have low aromatic condensation after 2nd and 3rd year of shifting cultivation. Like E_4/E_6 ratio, the CEC of humic acids also underwent an increasing trend from 250 to 375 c mol $(p^+)kg^{-1}$. Both the reduced viscosity (η_{sp}/C) and molecular weight showed an increase followed by a sharp decline from 10.85 to 8.05 mLg^{-1} and 6805 to 4300, respectively. This indicated smaller molecules of low molecular weight and low viscosity in soils under 3rd year of shifting cycle. Salient points of IR spectra of humic acid isolated from surface soils from 1 to 3 years of shifting cycle showed medium to weak absorption in the shorter wavelength (3700-3915 cm^{-1}) due to free OH groups associated with various degrees of H- bonding. The absorption in the frequency range of 3580–3630 cm^{-1} was strong in HA of 2nd and 3rd year but weak to medium in HA in 1st year of shifting cycle. The characteristic absorption around 1600-1640 cm^{-1} due to aromatic C = C, hydrogen bonded C = O of carbonyl or quinine CO groups was strong in 2nd and 3rd years but only shoulder was noted in 1st year. Thus infrared studies showed the predominance of polymeric hydroxyl, carboxylic, carbonyl or quinone groups in humic acids with the rise in shifting cycle. Low aromatic condensation coupled with predominance of aliphatic structures in humic acids over the shifting cycle indicated a fall in organic fabric of soils.

Summary

- Acidic soil pH (4.5 to 5.1) noted in shifting cultivation sites.
- A decline in soil pH from 0.1 to 0.2 units observed with the rise in shifting cycle from 1 to 3 years.
- Dominance of exchangeable acidity in soils under shifting cultivation.
- A decline in soil organic matter from 1.28 to 3.79 g kg^{-1} due to shifting cultivation.
- Low aromatic condensation of humic acids after 2nd and 3rd year of shifting cultivation.
- Low cation exchange capacity in soils and its decreasing trend over shifting cycle.
- A decline in exchangeable cations in soils due to leaching losses in slopy areas.
- An average of 20.4 to 22.4% and 25.8 to 34.4% base saturation in soils under shifting cultivation.