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Effect of different soil and water management practices on sustainability of jhum cultivation

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Abstract
An experiment was undertaken in the farmers *jhum* field in the West Siang district of Arunachal Pradesh, India. The following treatments *viz.*T1-Traditional practice (Farmers Practices) T2-Jhum with FYM Application, T3-Jhum with Vermicompost & T4- Jhum with cover crop (Paddy and soybean, 1:1) were imposed in fresh jhum and in second year of *jhum* the dose of Farm Yard Manure 5 ton/ha, Vermicompost 3 ton/ha application of manure and 1:1 paddy and Soybean as a cover crop was done. The yield and soil attributes and cost involved were compared. Different components of jhum crop yield over and above the farmers practices were taken as additional yield due to our treatments of respective year of jhuming in the 2nd year of *jhum* There was considerable reduction in the yield was recorded in traditional practices, whereas the applications of organic manure and cover crop had sustain the yield in all the treatment but the benefit cost ratio was highest T4 since the remunerative price of soybean was more. Moreover the soybean is a legume crop which can fix atmospheric N in a substantial amount and maintain the soil nutrient status and this crop is also act as a cover crop which reduce the soil loss from steep sloppy land of *jhum.*

Keywords: Fresh *Jhum*, second year *Jhum*, traditional practices & intervention

1. Introduction
Jhum cultivation is a widely practiced system followed in Arunachal Pradesh where major food crops like rice and maize along with minor crops like millets, vegetables, perilla *etc.* are cultivated. Weaning away this farming system from the social and cultural integrity of the tribal farming communities is rather impossible. Effects of *jhum* cultivation is rapid soil erosion due to deforestation of hill tops and slopes and high runoff velocity and siltation of reservoirs, rivulets and valleys that resulted in the rapid decrease of *jhum* productivity due to removal of top soil by runoff water and very little time to recuperate soil fertility due to reduced *jhum* cycle. In recent times, it is reported that the fallow period has dropped from the recommended period of ten or more years [MAFS/MMR 2004] to about 3 - 4 years along major *jhum* cultivation area (Jalloh 2004) [1]. Burning of herbs and shrubs for jhum cultivation reduces oxygen generation and pumps harmful carbon-monoxide, nitrous oxides and many other gases into the air. Arunachal Pradesh, with over 50,000 sq km of moderate to very dense forests, is equivalent to 550 million cubic metres of growing stock or living assets (equivalent to 2000 million metric tonnes of carbon dioxide) that serves as one of the major "carbon sinks" or "lungs" of the globe (timesofindia.indiatimes.com), So, there has to be alternatives towards minimizing the possible ill impacts of *jhum* cultivation on the environment alongside improving the livelihood of the rural farmers through improving crops yields. There are numerous cultivation technological ideas that have been tried at farmers' field for the past 10-15 years at different locations of the state with the objective of *jhum* improvement. Different varieties of maize, rice, pulses, millets, vegetables etc. have been tested and demonstrated at *jhum* fields with their cultivation practices to observe their performances. This study was aimed to evaluate the technology in the *jhum* field in order to sustain the crop yield and soil health.

2. Materials and Methods
The study was conducted in West Siang district (Now Leparada) Arunachal Pradesh, situated between longitudes 93.570 E to 95.230 E & Latitude 27.690 N to 29.200 N. It spreads at an area of 7643 sq.km sharing its border with Upper & East Siang at east, China towards north, and Upper Subansiri at West & Assam at South.

The climatic conditions in the district vary (tropical to sub-tropical) from place to place due to mountainous nature of the terrain. The physiographic disposition of the Leparada district has an average elevation of 578 metres above mean sea level and the mean annual precipitation ranges from 2000 to 5000 mm. It has summits & ridges, steep side slope, moderately sloping side slope & narrow interhill valleys. Shifting cultivation is the traditional farming practice of tribal community in the region. It is done by clearing forest on hill having undulating topography. This study was designed in split plot. Two *jhum* field were under taken for study. One is freshly prepared *jhum* and another was second year of *jhum* field. These two *jhum* field were assumed to be main plot and following treatments *viz.* T1-Traditional practice (Farmers Practices) T2-*Jhum* with FYM Application, T3-*Jhum* with Vermicompost & T4- *Jhum* with cover crop (Paddy and soybean, 1:1) as a sub plot. These plots were made by putting wooden log across the slope and Farm Yard Manure 5 ton/ha, Vermicompost 3 ton/ha without any manure application (farmers practices) application of manure and 1:1 Paddy and Soybean as a cover crop was done. Similar practices were done in the fresh *jhum* and their yield and soil attributes, cost involved were compared. We found fresh *jhum* and yield of different component of *jhum* crop over and above the farmers practices was taken as additional yield due to our intervention of respective year of *jhuming*.

3. Result and Discussion

In fresh *jhum* there was no significant effect of our intervention on yield contribution, however in the 2nd year of *jhum* there was considerable reduction in the yield was recorded. This was also reported by Ramakrishnan and Toky (1981) [4] this is might be due loss of soil fertility. Whereas, the applications of organic manure and cover crop had sustain the yield in the *jhum* cultivation, it also added nutrients though enhanced productivity. In *Jhum* cultivation during first year, an appreciable proportion of nutrient might have been lost through outflowing water. This could impoverish the soil and hamper the yield, particularly in old field. Productivity though increased consequent to organic manure application both in 1st and second year *jhum* and the quantity of yield is compartively more in second year *jhum* than the first year *jhum* (Table 1 & 2). Since the remunerative price of soybean was higher, the benefit cost ratio was more comparing to other intervention. This intervention showed more BC ratio compared to other intervention even in the first year of *jhum*. Moreover the soybean is legume crop which can fix atmospheric N in a substantial amount and maintain the soil nutrient status and this crop is also acts like a cover crop which reduce the soil loss from steep sloppy land of *jhum*.

Table 1: Effect of different intervention on yield and benefit cost economics in first year of Jhum

Sl No	Fresh Jhum	Additional Cost	Average Yield (t/ha)			Cost Benefit Estimation			
			Rice (Var-Bhalum-3)	Maize (Var-RCM-1-75)	Soyabean (Var JS-335)	Extra cost /ha involve due to intervention	Extra income/ha in terms of ruppes	Net Profit	B:C
1	Farmers Practices	Nil	2.5	2.6	2.10	Not estimated kept as a benchmark			
2	Jhum with FYM Application	15,000	2.7	2.7	2.20	(3000+2000+4000)= 9000	(9000-15000)= -6000	Loss	-ve
3	Jhum with Vermicompost	30,000	2.8	2.7	2.25	(4500+2000+6000) =12500	(12500-30000) =17500	Loss	-ve
4	Jhum with cover crop (1:1)	5000	2.5	No Maize	2.50	16000	16000	16000	3.2

Table 2: Effect of different intervention on yield and benefit cost economics in Second year of *Jhum*

Sl No	Second Year	Additional Cost (in Rs)	Average Yield (t/ha)			Cost Benefit Estimation			
			Rice (Var-Bhalum-3)	Maize (Var-RCM-1-75)	Soyabean (Var JS-335)	Extra cost /ha involve due to intervention	Extra income/ha in terms of rupees	Net Profit	B:C
1	Farmers Practices	Nil	1.6	2.6	2.10	Not estimated kept as a benchmark			
2	*Jhum* with *FYM Application	15,000	2.5	2.9	2.20	(13500+6000+4000)=23500	(23500-15000)=8500	8500	0.36
3	*Jhum* with #Vermicompost	30,000	2.7	2.9	2.30	(16500+6000+8000)=30500	(30500-30500)= 500	500	0.02
4	*Jhum* with cover crop (1:1)	5000	2.3	No maize	2.30	(10500+8000)= 18500		18500	3.7

* FYM Cost @Rs 3/Kg, # Vermicompost @ Rs 10/Kg
Market price of paddy Rs 15/Kg, Maize Rs. 20/Kg & 40/Kg Cost

Table 3: Effect of different intervention on soil properties in first year of *Jhum*

Sl No	First Year *Jhum*	pH	N (kg/ha)	P (kg/ha)	K (Kg/ha)	SOC (%)	Bulk density	AWC (%)
1	Farmers Practices	5.4	365	16	381	1.44	0.95	34
2	*Jhum* with FYM Application	5.5	367	19	389	1.45	0.97	35
3	*Jhum* with Vermicompost	5.5	362	18	376	1.56	1.04	33
4	*Jhum* with cover crop (1:1)	5.6	372	19	359	1.43	1.05	35

Table 4: Effect of different intervention on soil properties in second year of *Jhum*

Sl No	Second Year *Jhum*	pH	N (kg/ha)	P (kg/ha)	K (Kg/ha)	SOC (%)	Bulk density	AWC (%)
1	Farmers Practices	5.4	323	16	381	0.94	1.05	34
2	*Jhum* with FYM Application	5.5	342	19	389	1.22	1.01	35
3	*Jhum* with Vermicompost	5.5	356	18	376	1.17	1.01	37
4	*Jhum* with cover crop (1:1)	5.6	381	19	359	1.31	0.96	38

It was observed that soil properties change when comparing with first year *jhum* to the second year *jhum*. The ranges of pH (5.4-5.6) remain same in both jhum fields (Table 3 & 4). However, the available nitrogen was found highest with 381kg/ha N in case of second year *jhum* with cover (1:1) whereas, it was found lowest in traditional practice with 323/ha N. The phosphorus and potassium content in soil found similar in both first year and second year *jhum* with respective treatments. A similar result was also reportrd by Nye and Greenland, (I960) [5], Salas and Folster (1976) [6] observed heavy loss of carbon, nitrogen during subsequent year of *jhuming*. The soil organic carbon was found highest in jhum with vermicompost with 1.56% in first year *jhum* while it was found lowest in traditional practice with 0.94% in second year *jhum*. The soil bulk density was relatively found higher in second year jhum compare to first year *jhum*. Soil organic carbon, total nitrogen, extractable phosphorus and exchangable cation pools were all depleted in the in subsequent year, and soluble nutrients progressively declined during each of the successive cropping years. Same result was also reported by Tawnenga *et al*. 1997b [3]. The percentage AWC was found highest in *jhum* with cover crop (1:1) with 38% in second year jhum while lowest was found in first year *jhum* with 33% in *jhum* with vermicompost.

4. Conclusion

The following conclusions can be narrated from this study, that economic yield sharply decline in consequent year of *jhum*. The implementation of different intervention in *jhum* cultivation upto some extent, sustain the crop yield. The crop yield decreases with continuation of *jhum* cultivation with shortening of *jhum* cycle. Second year cropping causes a further decline in ecosystem productivity in *jhum* field. Inorganic and organic manuring in isolation and in combination respond differently; while inorganic manuring has greater impact on ecosystem productivity, a combination of inorganic and organic manuring is more suitable to improve economic yield during second year cropping.

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