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Intercropping of nitrogen-fixing tree species (NFTs) with agriculture crops as a sustainable farming system

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Abstract

A study was carried out on the intercropping of nitrogen-fixing tree species (NFTs) with maize and rice on hill slopes of Mizoram. Three species of nitrogen fixing trees, namely *Flemingia microphylla* Willd. Merr. (family Fabaceae), *Leucaenia leucocephala* Lam. de Wit (family Fabaceae) and *Tephrosia candida* Roxb. DC. (family Fabaceae) were planted as hedgerows. The different nitrogen-fixing tree species introduced as hedgerows were found to increase the yield of the test crops, conserve soil nutrients, and improve efficiency of the system. The present study reveals that NFTs can be successfully intercropped with agriculture crops such as rice and maize in the hill slopes of Mizoram, India.

Key words: *Flemingia microphylla*; *Leucaenia leucocephala*; Maize; nitrogen fixing trees; rice; *Tephrosia candida*.

Introduction

The major problem in north-eastern hill region of India is that the available land is subjected to heavy soil erosion and land degradation resulting from the practice of shifting cultivation and deforestation coupled with heavy rainfall. The cultivation along the hill slope without conservation measures and rapid loss of tree cover from mountain have rendered the land susceptible to accelerated soil erosion, loss of soil nutrients, landslides and loss of habitat. Several studies were carried out by various workers on shifting cultivation and its impact on rural economy, forest, biodiversity.[1-8] The rehabilitation of mountains and proper management of its resources, particularly the common resources of forests require special attention in the present situation.

Various attempts have been made by the Government of India as well as state governments to settle the farmers practicing shifting cultivation. These programmes have been implemented by the concerned departments such asagriculture, soil conservation, forests, etc. through a multi-disciplinary approach. It is suggested to introduce intensive hedgerows or alley cropping or wide alley cropping system for solving problems attributed to jhum land

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like soil erosion, increase run-off and loss in nutrient status.[9] Tree foliage can be used as mulch and fertilizer for food crops,[10] fast-growing nitrogen-fixing trees such as *Flemingia macrophylla*, *Leucaena leucocephala*, *Glyricidia sepium* Jacq. Kunth, *Tephrosia candida*, *Ipomoea fistulosa* Mart. ex Choisy have been used as hedgerows.[11] However, there are only few studies on the feasibility of intercropping of N_2-fixing trees with agriculture crops in the hill slopes of Mizoram, India.

Materials and Methods

Study site

The present study was conducted in Kolasib District, Mizoram. The experimental site was located at the outskirt of Kolasib town; it lies adjacent to Krishi Vigyan Kendra (KVK) complex, below the National Highway 54 to Aizawl about 700 m from the main road. The experimental plot was a private garden previously used for growing paddy and vegetables. It is situated in a south-east direction, and is moderately sloped; it has well textured soil, naturally free from stubbles, rocks, stones and debris. The elevation of the site is about 722 m above mean sea level. During the study period the annual temperature ranges from 14.82 to 25.71°C in winter and 23 to 32°C in summer. The month wise maximum noon temperature recorded in 2005 was 31.66°C in the month of June and 30.4°C in the month of July in 2006. The total annual rainfall received by the study area during the first year (2005) and the second year (2006) of the study was 3506 mm and 3091 mm respectively.

Experimental design and field operation

The investigations reported in this thesis were carried out during wet seasons in the months of May to October in 2005 and 2006. The experiment was performed using randomized block design (RBD) with three replications. There were 18 sub-plots in each replication (2 agricultural crops x 3 woody legumes x 2 pruning management + 6 control plot) and the total sub-plots were 54 for 3 replications. The size of each sub-plot is 4 x 3 m (12 sq m) and 0.5 gap between the sub-plots.

Soil sample collection and analysis

Soil samples were collected from one location in each replication using spade from a depth of 0-15 cm at an interval of 45 days starting from the date of sowing of tree species in the first year and in the second year, soil samples were collected from 45 days after sowing of crops. In the first year of the study, soil samples were collected four times while the samples were collected three timesin the second year of experimentation. These soil samples of the same plots were mixed thoroughly and 1 kg from mixture was taken out and packed with sterile bags, and as soon as possible returned to the laboratory and processed within 2 days. The moist surface soil samples were dried at 105°C in an oven for determination of soil moisture content. Part of the moist soil samples were air-dried and sieved to obtain fine soil samples (<2 mm). Soil pH was measured with soil water (1:5) slurry using a glass electrode. Organic carbon was determined according to the Walkley and Black method,[12] total nitrogen was determined using the Kjeldahl method, and available Phosphorus was estimated using the Bray method. All analyses were conducted as described by Jackson.[13]

The growth parameters of the test crops, *viz*. maize and rice were recorded for the two years of the study. The growth parameters studied are plant height and yield (Kg/Plot). In case of the N_2 fixing trees, plant height and basal thickness are measured in each year.

Result and Discussion

The results of crop yield and soil nutrient status under different treatments are presented below:

Yield of maize

Statistical analysis of maize grain yield per plot showed significant results in both the two years of experimentation, the highest average yield per plot was obtained from treatment combination of *F. macrophilla* + maize + 2 prunings (T14). It was observed that maize intercropped with NFT species generally produced higher mean yields than control plots (maize alone), maize grown with *F. macrophilla* resulted the highest grain yield (Table 1 and Fig. 1). However, the effect of pruning management on grain yield in case of maize alley-cropped with *L. leucocephala* was not significant; similarly, there was no significant effect of yearly and half yearly pruning on crop yield.

Yield of rice

Yield of rice *viz.* weight of grains per plot (in kg), 1000 grain weight (test weight) of rice at harvest for the two years of experimentation are presented in Table 2 and Figure 2. Highest yield of rice was recorded in plots under *F. microphylla* + rice + 2 pruning (T17) followed by T11 and T5 and least in Control plots. The rice yield under NFT plots were significantly higher than control ($p<0.01$) but no significant difference was observed in the second year. This requires further study of the intercropping system for a few more years before making any concrete conclusion. In the present experiment the effect of pruning intervals on the yield of crops was not significant.

Soil nutrient status

Result of the chemical analysis of the soil samples taken from 0-15 cm of the surface soil, before the start of the experiment of the present study, showed that all the soil samples are low in available nitrogen content. The result further showed that the organic carbon, phosphorus and potassium content of the study site were low to medium before the start of the experiment.

The soil nitrogen content after harvest of crops was observed to have decreased in all the NFT plots except that of *F. microphylla*. The low N_2 content in *L. leucocephala* plots may be due to its poor survival and growth. Further, the decline in N_2 content may be attributed to heavy nutrient uptake by the com-

Table 1. Yield of maize.

Treatments	Average yield of maize per plot in kgs	Average 1000 grain weight at harvest in gm
T1	2.44	0.36
T2	2.53	0.38
T7	2.18	0.34
T8	2.66	0.37
T13	2.13	0.35
T14	2.995	0.38
Control	1.75	0.34
SE ±	.152	0.006
SD	0.404	0.017

T1 = *L. leucocephala* + maize + one pruning
T2 = *L. leucocephala* + maize + two prunings
T7 = *T. candida* + maize + one pruning
T8 = *T. candida* + maize + two prunings
T13 = *F. macrophylla* + maize + one pruning
T14 = *F. macrophylla* + maize + two prunings

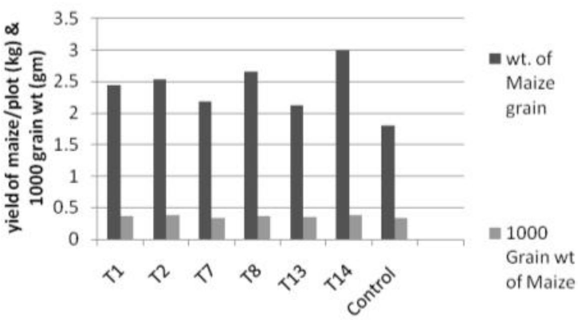

Figure 1. Yield of maize per plot (in kg) and 1000 grain weight (in gm).

Table 2. Yield of rice.

Treatments	Average yield of rice per plot in kgs	Average 1000 grain weight at harvest in gm
T4	2.105	32.445
T5	2.49	32.555
T10	2.175	32.55
T11	2.665	32.475
T16	2.475	32.355
T17	2.705	32.51
Control	1.78	32.34
SE ±	0.126	0.032
SD	0.335	0.087

T4 = *L. leucocephala*+ rice + P1
T5 = *L. leucocephala*+ rice + P2
T10 = *T. candida* + rice + P1
T 11 = *T. candida* + rice + P2
T16 = *F. macrophylla*+ rice + P1
T 17 = *F. macrophylla*+ rice + P2

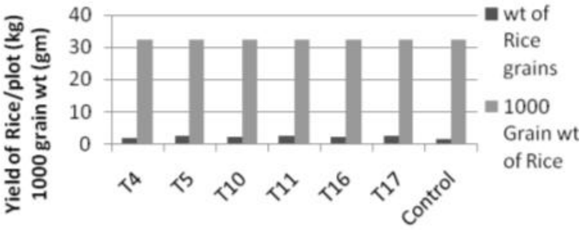

Figure 2. Yield of rice per plot (in kg) and 1000 grain weight (in gm).

ponent crops, *viz*. rice and maize. The higher N_2 content in *F. microphylla* plots may be attributed to low consumption of Nitrogen by *F. microphylla* as compared to other two NFTs. Studies have shown that mulching with pruning of *F. macrophylla* have resulted in significantly higher retention of soil moisture and lower soil temperatures, retarding weed development than mulching with prunings of *L. leucocephala.*[14,15] It was also reported that root nodulation was rare with *F. macrophylla* and he concluded that *F. macrophylla* is less demanding in terms of soil fertility and may potentially perform better under situations of lower soil nutrient status than *L. leucocephala* and *G. sepium.*[16]

It was also observed that there is comparatively low phosphorus and potassium content in control plots than the NFT plots; this may be due to the fact that there are no hedgerows in control plots and a large quantity of nutrients is absorbed by the crops while the unused portion is lost from the soil through leaching, surface runoff. The present observation supported the findings of Kang *et al.*[17] who stated that alley cropping with the leguminous spe-

Table 3. Soil nutrient status of experimental plot.

Treatment Plots	Soil nutrient status of experimental plot					
	Nitrogen (Kg/ha)		Phosphorus (Kg/ha)		Potassium (Kg/ha)	
	Before sowing of crops	After harvest of crops	Before sowing of crops	After harvest of crops	Before sowing of crops	After harvest of crops
Control plot	301.06	254.22	21.17	7.62	204.29	85.57
F. macrophilla	278.62	282.06	24.3	12.99	153.44	93.41
T. candida	303.02	258.65	19.38	11.31	250.88	229.84
L. leucocephala	275.97	213.6	23.63	12.77	287.84	125.89

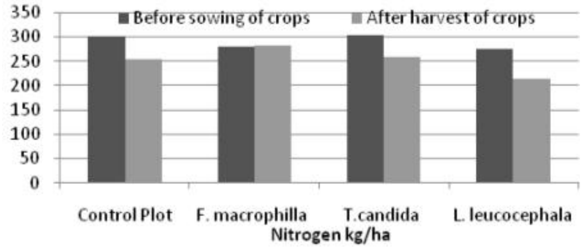

Figure 3. Soil nitrogen content of the experimental site (kg/ha).

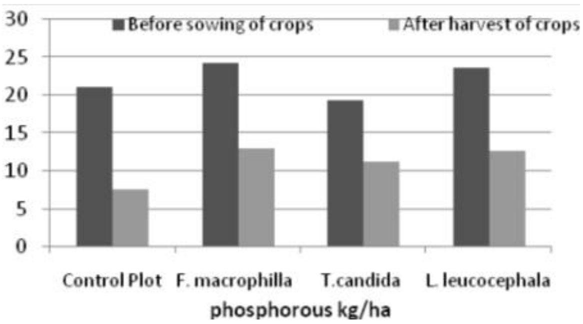

Figure 4. Soil phosphorus content of the experimental site (kg/ha).

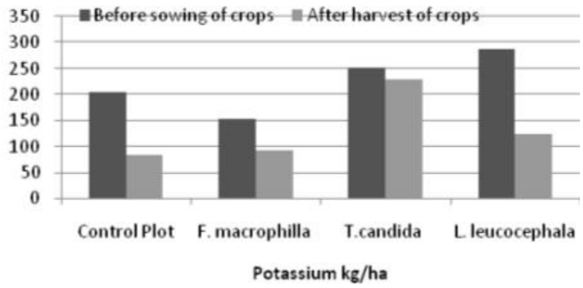

Figure 5. Soil potassium content of the experimental site (kg/ha).

cies appeared to maintain higher soil organic carbon, phosphorus and potassium levels than control.

CONCLUSION

It can be concluded from the present study that nitrogen fixing trees (NFTs) *viz*. *F. microphylla*, *L. leucocephala* and *T. candida* can be successfully intercropped with rice and maize in the hill slopes of Mizoram. The different NFTs introduced as hedgerow were found to significantly increase the yield of the test crops, and improves efficiency of the system. Further, planting of NFTs as hedgerows in abandoned jhum would improve the soil fertility, and this may be one of the ecologically and economically sound options for permanent cultivation in hill slopes of Mizoram.

REFERENCES

1. Tawnenga, Shankar U & Tripathi RS (1997). Evaluating second year cropping on jhum fallows in Mizoram, north-eastern India: Energy and economic efficiencies. *J Biosci,* **22**, 605-613.
2. Anonymous (2009). *Draft report of the inter-ministerial national task force on rehabilitation of shifting cultivation land*. Report submitted to the Ministry of Environment and Forests, Government of India. pp. 95.
3. Bruun TB, de Neergaard A, Lawrence D & Ziegler AD (2009). Environmental consequences of the demise in swidden cultivation in Southeast Asia: carbon storage and soil quality. *Human Ecol*, **37**, 375-388.
4. Cairns M & Garrity DP (1999). Improving shifting cultivation in Southeast Asia by building on indigenous fallow management strategies. *Agrofor Syst*, **47**, 37-48.
5. Craswell ET, Sajjapongse A, Howlett DJB & Dowling AJ (1997). Agroforestry in the management of sloping lands in Asia and the Pacific. *Agrofor Syst*, **38**, 121-137.
6. Mertz O, Padoch C, Fox J, Cramb RA, Leisz SJ, Lam NT & Vien TD (2009). Swidden change in Southeast Asia: understanding causes and consequences. *Human Ecol*, **37**, 259-264.
7. Ramakrishnan PS (1992). *Shifting Agriculture and Sustainable Development: an Interdisciplinary Study from North-eastern India*. Parthenon, Paris, France.
8. Ziegler AD, Bruun TB, Guardiola-Claramonte M, Giambelluca TW, Lawrence D & Lam NT (2009). Environmental consequences of the demise in Swidden cultivation in montane mainland Southeast Asia: hydrology and geomorphology. *Human Ecol*, **37**, 361-373.
9. Jha LK & Sen Sarma PK (1993*). Prospects and Problems of Agroforestry - An Alternative Agriculture. Agroforestry - Indian Perspective*. Ashish Publishing House, New Delhi, India, pp. 84-85.
10. Reynolds L, Atta-krah AN & Francis PA (1988). *Alley*

Farming with Livestock Guidelines. Humid Zone Research site, International Live Stock, centre for Africa, Nigeria, pp. 1-30.

11. Zahid Hossain Md (2001). Farmer's view on soil organic matter depletion and its management in Bangladesh. *Nutr Cycl Agroecosys*, **61**, 197-204.
12. Walkley S & Black J (1934). *Methods of Testing Soils.* British Standard, London, UK.
13. Jackson ML (1958). *Soil Chemical Analysis*. Prentice-Hall Inc., Englewood Cliffs, New Jersey, USA.
14. Banful B, Dzietror A, Ofori I & Hemeng OB (2000). Yield of plantain alley cropped with *Leucaena leucocephala* and *Flemingia macrophylla* in Kumasi, Ghana. *Agrofor Syst*, **49**, 189-199.
15. Budelman A (1988). The decomposition of the leaf mulches of *Leucaena leucocephala, Gliricidia sepium* and *Flemingia macrophylla* under humid tropical conditions. *Agrofor Syst*, **7**, 33-62.
16. Budelman A (1989). Nutrient composition of the leaf biomass of three selected woody leguminous species. *Agrofor Syst*, **8**, 39-51.
17. Kang BT, Caveness FE, Tian G & Kolawole GO (1999). Longterm alley cropping with four hedgerow species on an Alfisol in southwestern Nigeria – effect on crop performance, soil chemical properties and nematode population. *Nutr Cycl Agroecosys*, **54**, 145-155.