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Evaluation of Traditional Jhum Management and Crop Production in Kohima, Nagaland

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ABSTRACT

Although, jhum cultivation is a major traditional agricultural practice in Nagaland, little is documented about such practice. Understanding management practices is necessary for sustainable agricultural land use to improve food production. This study evaluated and compared the traditional jhum cultivation in Mima and Kohima villages for the first year jhum cropping season of 2017. Qualitative and quantitative data were collected through field interviews with twenty farmers and on-site measurements from each farm. Data were collected for farm size, fallow period, cropping system, time investment on farm management activities and rice yield. The average farm size of Kohima village was bigger (0.38 ha) than Mima village (0.20 ha). Both the villages practice mixed cropping with an average fallow period of 13 years. The total time investment on farm management throughout the cropping season was 83% greater for Kohima compared to Mima village. However, the average yield of rice was 62% greater for Mima than Kohima village. Slightly longer duration of fallow period, relatively more time investment for weeds management and longer growing period of rice in Mima likely contributed to greater yield. Results from this study suggest that better approaches to management such as extended fallow management, appropriate variety selection and proper weeds management can potentially contribute to better crop yield.

1. Introduction

Jhum cultivation, also known as slash and burn or shifting cultivation is a common agricultural system practiced in different parts of the world (Bhagawati *et al.* 2015). Being one of the most complex and multifaceted form of agriculture, jhum cultivation consists of several activities. Selection and cutting of forest plot for cultivation is generally carried out in the months of December and January, followed by clearing and burning in February or early March. Planting of crops occur in the months of March to May. The fields are utilized for one to two years and then left as fallow for several years to restore soil fertility (Sati *et al.* 2014). Reduced soil fertility from the preceding cropping phase is restored during the fallow period (Liang *et al.* 2009).

Nagaland is located in the Northeastern part of India covering an area of 16,579 km^2 with a total population of 1,980,602 (Census 2011). Out of the total geographical area in Nagaland, 43% is cultivable area and about 55% of the total population is engaged in farming (Maongtoshi and Sinha 2014). The climatic and the geopolitical factors make jhum cultivation an unavoidable farming practice in Nagaland (Nongkynrih *et al.* 2018) which account for 59% of the annual net cultivated land (Senotsu and Kinny 2016). So far, traditional methods of soil management, pests control, food grains and seed preservation have been sustaining jhum practices (Senotsu and Kinny 2016). Parameters such as, cropping period, fallow period and area cultivated per head contributes to the sustainability of jhum system (Nakro, 2011). Cropping system is an important component of a farming system that explains the cultivation pattern of crops over space and time, interaction of crops with farm resources, farm enterprises and available technology (Rana and Rana 2011). Jhum cultivators in the Northeast India follow a mixed-cropping pattern and the choice of crops varies among cultivators (Kerkhoff and Sharma 2006). Mixed-cropping of rice (*Oryza sativa*) and taro (*Colocasia* spp.) is common among the Khasis and Garos of Meghalaya, while mixed-cropping of maize (*Zea mays)*, rice, chilli (*Capsicum annum*), pumpkin (*Cucurbita* spp.) and beans (*Phaseolus* spp.) is common in Ukhrul, Manipur (Kerkhoff

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and Sharma 2006). Although, jhum cultivation is a popular agricultural practice in Nagaland (Kithan 2014) little is documented about the jhum crop management and its impact on agricultural productivity and food security in Nagaland. There is a strong need to study and design cropping systems in jhum cultivation to cope up with the emerging social, economic and environmental concerns related to agriculture. The objectives of this study were (i) to evaluate the cropping system and management of few major crops and (ii) to understand the various farm management practices and its impact on the rice production by comparing between two villages practicing jhum cultivation

2. Materials and Methods

Study site and design

The study was conducted in two villages in Nagaland, Kohima village (25°41' N, 94°06' E) and Mima village (25°35' N, 94°06' E) for the cropping season of 2017. The main inhabitants of these two villages are the Angami Nagas. A survey method was used to collect quantitative and qualitative data. Data was obtained through on-site personal interviews using structured questions, further discussion with the farmers and field observations and measurements. Each village was represented by ten farmers. The farmers to be interviewed were selected representing sector division in both the villages, preferably including those individuals who have been practicing jhum cultivation for more number of years.

Qualitative and quantitative data were collected on farm size, total number and types of crops grown, fallow period, labour involvement and time spent on wood harvest, pre-plant activities, in-season management and harvest activities, planting density and seeding depth of four major crops (rice, maize, chilli and pumpkin), months in which different activities were carried out (wood harvest, pre-planting activities, planting activities, in-season management and harvest activities), rice yield, equipment used for the above mentioned activities and family size of the farmers. The four crops i.e., rice, maize, chilli and pumpkin have been selected for this study because, these crops were grown commonly in the jhum fields of both the villages which contributes to the diet of the villagers.

The following conversions were made from the primary data given by each farmer based on their personal approximation: (a) time spent on the above mentioned activities were collected in terms of days and daily working hours was estimated to 7 hours per day, (b) rice yield data was obtained in terms of rice weight at the time of harvest collected in gunny bags (1 gunny bag = 4 tins; 1 tin = 15 kg i.e., 1 gunny bag = 60 kg of rice) and the values obtained were converted into tonne per ha (t ha^{-1}). The approximate weights and measures followed by the farmers in both locations were the same.

Statistical analysis

The data were analyzed using independent *t*-tests at $P \leq 0.05$ in Microsoft Excel (Microsoft Excel 2010, Microsoft Corp., Redmond, WA, USA). The independent variables assigned for the study were: location (Kohima and Mima villages) and crops (rice, maize, chilli and pumpkin). The response variables were area (farm size), fallow period, time spent on different field activities (wood harvest, pre-planting, in-season management and crop harvest), planting density and seeding depth of chilli, maize, pumpkin and rice, and rice yield. Crop maturity (estimated from planting to harvest for each crop) data was analyzed using PROC MIXED in SAS®Studio (SAS 9.4 2016). Location and crops were considered as fixed effects and farmers were taken as random effects. Normality and homogeneity of variance were checked using Q-Q plot of residuals versus quantiles and scatter plots of residuals versus predicted values. The correlation between area of the farm and wood harvest time was performed using linear regression in Microsoft Excel.

3. Results and Discussion

Farm size and fallow period

The farm size was significantly different (P = 0.002) between Kohima and Mima villages (Table 1). The average farm size of Kohima village was bigger (0.38 ha) compared to Mima village (0.2 ha), which could be due to more active members per family engaged in farming in Kohima village with an average 5 persons compared to 3 in Mima, making it possible to cultivate a larger farm size. Qualitative data obtained from Mima village also showed that, majority of the households had alternative avenues such as apiculture, piggery, and poultry farming, etc. for income generation and not completely reliant on farming to sustain their livelihood. Additionally, there were more families in Mima who practiced jhum farming compared to Kohima village which likely contributed to smaller farm size available to farm per family.

There was no difference in fallow period between the two villages. An average fallow period of 12.5 years was maintained by both the villages which indicate a shorter length of fallow period than it used to be a few decades ago in both the villages. According to the farmers, an average 20 years was kept as fallow period, 30 – 40 years back, but this had reduced to 10 – 15 years by the year 2017. A major reason for this, according to the farmers, could be because of the increase in population and decrease in forest area over the years, which are in agreement with the previous works done by Gilruth *et al.* (1995) and Hassan *et al.* (2005).

Table 1. The *P*-value for independent *t*-test and mean comparisons on farm size, number of crops grown, fallow period, rice yield and time spent on different activities of farm management between Kohima and Mima villages.

Location	Farm size	Number of crops grown	Fallow period	Rice yield	Farm management time			
					Wood harvest	Pre-planting	In-season	Crop harvest
P-value	0.002*	0.486^{ns}	0.380^{ns}	0.003*	0.002*	0.006*	0.009*	0.012*
	ha		*yr*	*t ha^{-1}*	*hr*			
Kohima	0.38 a[a]	10.6 a	13.6 a	2.31 b	656.6 a	114.3 a	185.4 a	66.6 a
Mima	0.20 b	11.0 a	12.5 a	3.74 a	342.2 b	64.3 b	114.9 b	38.7 b

[ns]not significant; *significant at $P \leq 0.05$.

[a]Within a column, treatment means followed by the same lowercase letter are not significantly different at $P \leq 0.05$.

Cropping system

The different types of crops grown in the first year jhum of the two villages in the year 2017 were rice, maize, chilli, pumpkin, tomato (*Solanum lycopersicum*), ginger (*Zingiber officinale*), beans (*Phaseolus vulgaris*), taro (*Colocasia esculenta*), Naga dal (*Vigna umbellate*), cucumber (*Cucumis sativus*), spring onion (*Allium fistulosum*), garlic (*Allium sativum*), soybean (*Glycine max*), bottle gourd (*Lagenaria siceraria*), mustard leaves (*Brassica* sp.) and Job's tear (*Coix lacryma-jobi*). The cropping season between Mima and Kohima villages was similar. Planting of the various crops were done during the months of March and April (Table 2). In both villages, farmers practice mixed-cropping system. The crops were grown in the field simultaneously, with no distinct row arrangement. Most jhum cultivators, particularly in the Northeastern parts of India, are known to practice a mixed-cropping and the choice of crops to be grown vary among cultivators (Kerkoff and Sharma 2006). Out of the different types of crops grown, rice, maize, chilli and pumpkin were commonly grown crops in both the villages. A more detailed analysis was performed for these commonly grown crops. The soil bed preparation activities were completed in the month of February followed by sowing of seeds in March in both villages. The average time spent for planting, month of crop harvest and average time spent for harvest of rice, maize and chilli were different between Mima and Kohima villages (Table 3; Table 4). The average time spent for planting ($P < 0.004$) and harvest ($P < 0.012$) of pumpkin between the two villages were different (Table 3), but there was no difference in month of harvest between locations (early October). Rice was sown in most jhum fields by mid-March to the last week of March. For some, who were pre-occupied with other household activities, sowing of rice was delayed to April first week. Sowing of the other crops followed simultaneously. Sowing activities of first year crops were completed by the last week of April. Management of the

Table 2. Cropping season of rice, maize, chilli and pumpkin in Kohima and Mima villages.

Location	Crop	Planting	Harvest
Mima	Rice	March/April	Oct-Nov
Mima	Maize	March/April	July-Aug
Mima	Chilli	March/April	May-July
Mima	Pumpkin	March/April	Oct-Nov
Kohima	Rice	March/April	Sept-Oct
Kohima	Maize	March/April	July-Aug
Kohima	Chilli	March/April	June-Sept
Kohima	Pumpkin	March/April	Sept-Nov

Table 3. Significance for independent *t*-test on planting month, time spent for planting (planting hour), planting density, seeding depth, harvest month and time spent for harvest (harvest hour) of rice, maize, chilli and pumpkin between Kohima and Mima villages.

Crops	Planting month	Planting hour	Planting density	Seeding depth	Harvest month	Harvest hour
	P value					
Rice	0.503^{ns}	<0.001*	0.143^{ns}	0.143^{ns}	0.012*	0.013*
Maize	0.290^{ns}	<0.001*	0.451^{ns}	0.458^{ns}	0.020*	0.006*
Chilli	0.388^{ns}	<0.001*	0.584^{ns}	0.583^{ns}	0.004*	0.001*
Pumpkin	0.057^{ns}	0.004*	0.134^{ns}	0.134^{ns}	0.331^{ns}	0.012*

^{ns}not significant; *significant at $P \leq 0.05$.

crops dominated over the next 4 - 5 months. The earlier harvest of rice in Kohima village as compared to Mima village, despite the similar planting month, may be because of differences in rice varieties and micro-climatic conditions, although such factors were not evaluated in this study. The later harvest of chilli in Kohima village compared to Mima village was because Mima harvest green chilli and Kohima mostly harvest matured red chilli. Larger farm size of Kohima village likely contributed to more time investment in planting and harvest of rice, maize, chilli and pumpkin.

The growing season, from planting to harvest, of rice, maize, chilli and pumpkin were analysed between the villages. The growing season was influenced by location × crops interaction ($P = 0.026$). The growing season was longer for rice and pumpkin, followed by maize and shortest for chilli in both the villages (Table 5). Although statistically not significant, rice growing season last about 6.5 months in Kohima village compared to 7.0 months in Mima village. The growing season of maize and chilli were 0.8 and 1.1 month longer in Kohima compared to Mima village. The pumpkin growing season was similar in both the villages with an average 6.8 month.

Plant density is an important agronomic factor that affects growth, development and yield formation of crops. There was no difference in the plant density of rice, maize, chilli and pumpkin between Kohima and Mima villages. The average plant spacing of rice from the data collected were 20 x 20 cm. This is in agreement with the work done by Mohapatra *et al.* (1989), where they reported suitable plant spacing of 20 x 20 cm under normal soil for good rice productivity. Seeding depth of crops is another important factor in crop management practices. The average seeding depth for rice and chilli was 2 cm and for maize and pumpkin were 6.9 cm and 6.1 cm, respectively, for both villages.

Table 4. Comparison of time spent on planting (planting), month of harvest (harvest month) and time spent on crop harvest (harvest) between location (Kohima and Mima) for each crop (rice, maize, chilli and pumpkin).

Crop	Location	Dependent variable		
		Planting (*hr*)	Harvest month	Harvest (*hr*)
Rice	Kohima	22.50 a[a]	9.60 a	63.35 a
	Mima	9.10 b	10.20 b	36.40 b
Maize	Kohima	1.00 a	7.7 a	1.34 a
	Mima	0.75 b	7.1 b	1.04 b
Chilli	Kohima	1.95 a	6.80 a	1.58 a
	Mima	0.69 b	5.90 b	0.99 b
Pumpkin	Kohima	0.67 a		0.36 a
	Mima	0.49 b		0.22 b

[a]Within a column, treatment means followed by the same lowercase letter are not significantly different at $P \leq 0.05$.

Table 5. Cropping season in the first year jhum cultivation as influenced by location (Kohima and Mima villages) and crops (rice, maize, chilli and pumpkin) interaction during the cropping year of 2017.

Crop	Location	
	Kohima	Mima
	month	
Rice	6.5aA[a]	7.0aA
Maize	4.6bA	3.8bB
Chilli	3.5 cA	2.4 cB
Pumpkin	6.9 aA	6.7aA

[a]Within a column, treatment means followed by the same lowercase letter are not significantly different at $P \leq 0.05$. Within a row, treatment means followed by the same uppercase letter are not significantly different at $P \leq 0.05$.

Time investment on farm management

Evaluation of time investment in this study was performed for wood harvest, pre-planting, in-season management and crop harvest activities. The time investment on wood harvest included activities such as felling of trees, cutting of logs into smaller pieces and piling of those pieces at a particular place. Male members of the family were mostly involved in this activity compared to female in both the villages. The time spent on wood harvest between Kohima and Mima villages was significant at $P < 0.002$ (Table 1). Kohima village took 314.4 hr more time than Mima village to harvest wood (Table 1) because of larger area to be cleared for cultivation. There was a positive correlation between area and time spent on wood harvest in the two villages (Fig.1). The difference in sizes of the farms accounted for 94% of the differences in the time investment on wood harvest in Kohima village and 96% in Mima village. Thus, differences in farm size explain a greater portion of variability in time investment during wood harvest activities.

The pre-planting time investment between Kohima and Mima villages was significant at $P = 0.006$ (Table 1). Pre-planting or land preparation activities consisted of ploughing the field, breaking of large soil clods into smaller pieces and soil bed preparation, which were carried out after slashing and burning of vegetation for cultivation. Kohima village spent more time (114.3 hr) on pre-planting activities than Mima village (64.3 hr). This difference could be because of the difference in soil type prevailing in the farm area in addition to farm size. An estimated 84% of females were engaged in the overall farm management activities compared to 16% of male, in both the villages.

There was a significant difference ($P = 0.009$) in the time spent on in-season management between Kohima and Mima villages (Table 1). Sowing of seeds was followed by the management of crops which included weeding, removal of withered or damaged leaves from the developing crops and light tillage. All these activities were carried out three times in each cropping season. Kohima village took more time (185.4 hr) on in-season management as compared to Mima village (114.9 hr). Considering that in both locations weeding was done three times in a cropping season, the larger farm size of Kohima village was a main contributor for more time investment on in-season management. Time investment on crop harvest was also greater for Kohima village than Mima village because of the larger farm size of Kohima village (Table 1).

The total time investment on farm management beginning from wood harvest to crop harvest in Kohima was 83% more than Mima (560 hr). In Kohima and Mima village, 64 and 61% of the time, respectively, were utilized for clearing of forest and wood harvest indicating this as the most labour intensive activity in the farming process. Second most labour demanding activity was found to be in-season crop management that constitutes three sequential weeding. It took 18 and 21% of the time in Kohima and Mima, respectively. Pre-plant farm management and crop harvest took 11 and 7% of the time, respectively, in both the locations. In both villages, use of power tools was not recorded and the entire activities were performed manually using traditional tools. Thus, introduction of compatible power tools appropriate in such farming system may greatly reduce the labour cost and improve farm management.

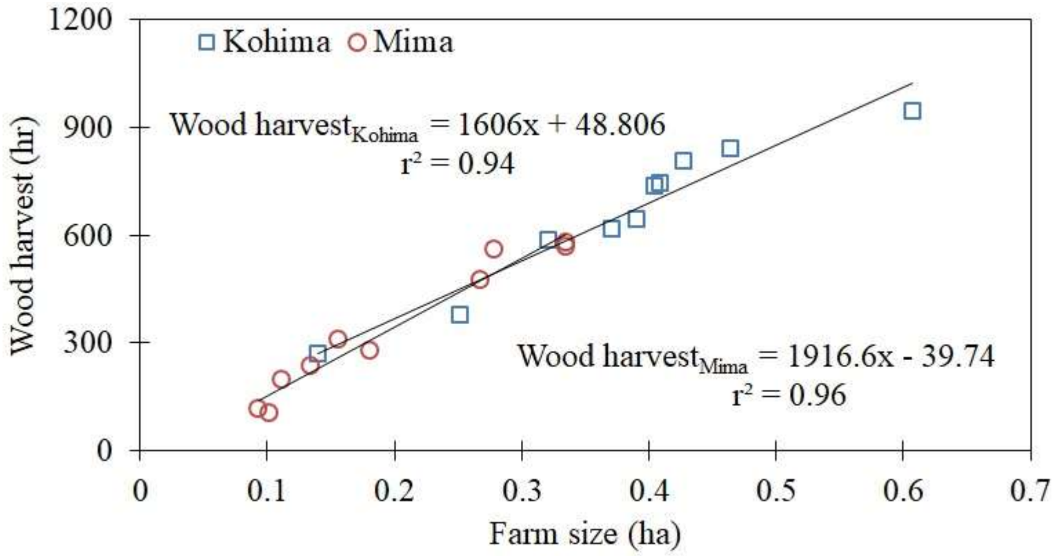

Fig. 1. Relationship between time investments in wood harvests (Wood harvest) and farm size in Kohima and Mima villages for the first year jhum, 2017.

Rice yield

The present study showed that, rice yield in Mima village (3.74 t ha^{-1}) was greater than Kohima village (2.31 t ha^{-1}) for the first year jhum in 2017. This was comparable to several rice yield data reported from jhum rice fields. Previous record on jhum rice production in Kohima district reported an average of 1.97 t ha^{-1} of rice (Department of Economics and Statistics 2017). In Bangladesh, improved jhum practice is reported to produce greater rice yield as compared to the yield obtained from traditionally managed jhum cultivation (Mahmud *et al.*, 2018). In this study, greater rice yield in Mima village was perhaps due to the better in-season management practices and slightly longer duration of rice growing season. Other studies have also shown that rice yield tend to increase with an increase in growth duration (Vergara *et al.*, 1966). Additionally, soil nutrient status may have contributed to greater rice yield as Mima maintained about 1.1 yr longer fallow period, although fallow period was not significant between the two villages. Factors like climatic conditions, in-season management practices and rice variety grown may have also influenced the yield. Rice is an important livelihood sustaining crop grown under jhum fields in Nagaland. To this day, jhum fields are managed traditionally, starting with use of local rice varieties, lack of fertilizer input, broadcast seeding, poor soil conservation methods and disease management. Therefore, introduction of improved management approaches in terms of rice variety selection, nutrient and weeds management and soil conservation efforts may enhance optimum rice yield.

4. Conclusion

This study was conducted in Mima and Kohima villages, Nagaland, to understand the cropping system, farm management and its impact on rice production for the first year jhum cultivation. The average fallow period was 13 yrs in both locations. Both showed similar practice of mixed cropping system with a total of 16 different crops recorded among the 20 farmers. Rice, maize, chilli and pumpkin were the common crops in the two villages. The time investment in farm management was 83% greater for Kohima compared to Mima. Initial cutting of forest and wood harvest was found to be more labour intensive than in-season crop management. Farm size of Kohima village was 0.18 ha greater than Mima village, a major contributor for the greater time investment on farming activities in Kohima compared to Mima. Rice yield was 62% greater at Mima than Kohima village. Slightly longer duration of fallow period, relatively more time investment for in-season management and longer duration for maturity of rice in Mima most likely contributed to greater rice yield.

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