

Recovery Pattern of Vegetation during Succession Following Slash and Burn Agriculture in Mizoram, North-East India

Keywords: Shifting cultivation; Succession; Fallow age; Quadrats; Ecological indices; Recovery percentage

Abstract

The recovery of forest after shifting cultivation (locally known as 'jhum') has multiple complications as observed in various forest types, disturbed regimes, climate conditions and so forth. Rate of recovery and species composition are of major concern to understand the process of succession. The present study was carried out in Champhai district of Mizoram, India with the aim to comprehend the recovery of vegetation at different stages of succession after abandonment. Jhum fields of 5, 10, 15 and 25 fallow ages were located from the satellite imagery and the plot was navigated using GPS. Quadrats were randomly laid within those plots and the plants were enumerated and analysed. The species were contiguously distributed. Ecological indices indicated high diversity and species richness for tree and shrub components but low diversity and species richness for herbaceous component. The number of tree species declined by 5.1% from 5 years fallow to 10 years fallow. However, it increases from 10 years to 15 years fallow by 8.1% and was further enhanced to 32.5% on 25 years fallow. It was also observed that the number of shrub species declined from 5 years to 10 years fallow by 4.9% which worsened to 15.4% on 15 years fallow. Nevertheless, there was a distinct rise in the number of species on the 25 years fallow by 54.6%. Interestingly, the number of herbaceous species was observed to decrease from 5 years to 10 years fallow by 6.8% and further declined by 2.4% and 17.5% on 15 years and 25 years fallow, respectively. Therefore, the percent recovery of tree and shrub species from 5 years to 25 years fallow was 35.9% and 24.4%, respectively, while 25.0% of herb species declined during the same fallow period.

Introduction

Slash and burn agriculture or shifting cultivation is the predominant and primitive agriculture in the hills of Northeast India, wherein settled cultivation constitutes only a small portion of the total cultivated land mostly confined to the valley areas. This agriculture involves the cutting of forest followed by burning of the plant material. When the soil loses its fertility and crop productivity becomes meagre the farmer shifts to another piece of virgin or secondary forest for cultivation, leaving the abandoned land to regenerate naturally during the fallow period. The farmer then returns back again to the same piece of land for cultivation after a certain period of cropping and fallow depending on ethnicity, population and land ratio [1].

A series of disturbances that the slash and burn agriculture constitute such as cutting, burning and weeding have dramatic effects on the mortality and regeneration of plant species [2]. The combine effect of each of these events may reduce or eliminate the potential for on-site species regeneration, leaving seed dispersal as the major way for establishing of species from the nearby forest.

The rate of recovery in species diversity, species richness, basal

area and species density are influenced by the climatic conditions. Studies have shown that the rate of recovery is higher in the humid and moist tropics, whereas regeneration to restore the structure of a mature forest is faster in the dry tropical forest [3]. Vegetation succession following shifting cultivation in tropical regions also indicated that the diversity of woody species gradually increases with fallow age [4-7].

The cropping period as well as jhum cycle affects the vegetation recovery process [2,7]. Studies from tropical rainforest of Madagascar have shown that higher frequency of jhum cycle decreased the richness and abundance of tree seedlings and sapling, and therefore suggested that reducing slash and burn intensity will increase the speed of tree recruitment and fallow recovery [8].

In present scenario, shifting cultivation is considered unsustainable due to decrease in the jhum cycle with the rise in population resulting in very low input-output ratio [1,9,10]. When the jhum cycle drops below a critical time period, the natural regeneration of vegetation is negatively affected [11-13]. The short jhum cycle in Northeast India has resulted in arrested succession where weedy species were not succeeded by pioneer woody species, and over time the soil seed bank is replaced with seeds of weedy shrubs [14].

Since the practice involves a continuous cycle of clear-felling and regeneration, shifting cultivation sites provide an opportunity to understand the secondary succession patterns. However, relatively few studies have examined the recovery pattern of vegetation following shifting cultivation in Northeast India in general and no attempt was done in Mizoram in particular. The present work is an attempt to study the recovery pattern of plant communities during succession following slash and burn agriculture.

Materials and Methods

Site description

The study was undertaken in shifting cultivation areas in Dulte



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Table 1: Number of species, families, density, basal cover and diversity indices of tree, shrub and herb species on different fallow ages.

Trees	J₅	J₁₀	J₁₅	J₂₅
No. of species	39	37	40	53
No. of families	21	20	24	31
Density (ha ⁻¹)	810	960	1045	1560
Basal Area (m ² ha ⁻¹)	8.44	12.51	22.99	33.75
Shannon Diversity Index (H')	3.426	3.387	3.530	3.716
Pielou's Evenness Index(J')	0.674	0.623	0.663	0.648
Simpson Dominance Index (C)	0.039	0.039	0.033	0.029
Margalef Species Richness Index (D _{mg})	7.478	6.625	7.327	9.065
Shrubs	J₅	J₁₀	J₁₅	J₂₅
No. of species	41	39	33	51
No. of families	21	20	19	27
Density (ha ⁻¹)	15296	15407	13148	13259
Basal Area (m ² ha ⁻¹)	130.74	31.39	2.40	1.33
Shannon Diversity Index (H')	3.279	3.338	3.041	3.462
Pielou's Evenness Index(J')	0.544	0.554	0.520	0.590
Simpson Dominance Index (C)	0.056	0.048	0.058	0.044
Margalef Species Richness Index (D _{mg})	6.641	6.306	5.471	8.519
Herbs	J₅	J₁₀	J₁₅	J₂₅
No. of species	44	41	40	33
No. of families	24	22	26	22
Density (m ²)	92000	101750	88500	112750
Basal Area (m ² ha ⁻¹)	2.68	3.89	2.62	3.32
Shannon Diversity Index (H')	3.569	3.464	3.397	3.241
Pielou's Evenness Index(J')	0.604	0.572	0.579	0.530
Simpson Dominance Index (C)	0.032	0.039	0.041	0.047
Margalef Species Richness Index (D _{mg})	7.278	6.767	6.648	5.234

village in Champhai district of the state Mizoram in North-east India located at 23.4454° N, 93.1780° E with an area of 3,185.83 square kilometers. Champhai has a moderate climate with average annual rainfall of 1,814 millimeters. In winter the mean temperature varies from 10 °C to 20 °C and in summer, it ranges from 15 °C to 30 °C.

Data collection

Vegetation analysis were carried out in two replicate sites for fallow aged 5 (J₅), 10 (J₁₀), 15 (J₁₅) and 25 (J₂₅) years during the month of January and February. The fallow age of the jhum fields was located from the satellite imagery and the plot was navigated using a GPS. Within each sample plot, ten quadrat of 10 × 10 m, fifteen quadrat of 3 × 3 m and twenty quadrat of 1 × 1 m were randomly laid for identifying trees, shrubs and herbs respectively. The diameter at breast height (dbh) of trees was measured at 1.3 m height but in case of shrubs and herbs the dbh was measured on the ground level. The heights of all individuals were also measured. Mature trees were defined as stems with > 30 cm girth at breast height (1.3 m) and > 5 m height, poles as individuals > 10 cm to < 30 cm girth and > 2 m height, saplings are individuals > 1 cm to < 10 cm collar girth and > 0.5 m to < 2 m height, seedlings as individuals > 1 cm collar girth and

> 0.1 to < 0.5 m height and recruits as individuals > 1 cm collar girth and up to 0.1 m height. All plants were enumerated and analyzed in each sample plot.

The species sampled in the five layers of vegetation were classified into the five growth forms, namely tree, pole, shrub, herb and recruit. All the emergent species were grouped under trees and poles. Shrubs included species that were found in sub-canopy, were shade-loving, prevalent in understory. Bamboo and woody climbers were also considered in shrub category. Herbs and recruits included shade-loving, annual, biennial or perennial, and herbaceous climbing species.

Analysis of plant diversity

Analysis of plant diversity was carried out by calculating Shannon Diversity Index (H'), Simpson Dominance Index (C), Pielou's Evenness Index (J') and Margalef Species Richness Index (D_{mg}). These indices were adopted for their low sensitivity to the sample size [15].

$H' = -\sum p_i \ln p_i$ where p_i is the proportional abundance of species (i.e., number of species divided by total number in the community).

$C = \sum p_i^2$ where p_i is same for Shannon's index.

Table 2: Dominant species of each stratum of different fallow ages.

Dominant Tree	Fallow (year)	C
<i>Castanopsis tribuloides</i> (Sm.) A.DC.	J ₅	0.00652
<i>Dysoxylum excelsum</i> Blume	J ₁₀	0.00191
<i>Schima wallichii</i> Choisy	J ₁₅	0.00402
<i>Sapium eugeniaefolium</i> Buch.Ham	J ₂₅	0.00301
Dominant Pole	Fallow (year)	C
<i>Scaphium scaphigerum</i> (Wall.ex G. Don) G. Planch.	J ₅	0.00467
<i>Protium serratum</i> (Wall.ex Colebr.) Engl.	J ₁₀	0.00618
<i>Sapium eugeniaefolium</i> Buch.Ham	J ₁₅	0.00152
<i>Cinnamomum glanduliferum</i> (Wall.) Meisn.	J ₂₅	0.00059
Dominant Sapling	Fallow (year)	C
<i>Urena lobata</i> Linn.	J ₅	0.00366
<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob.	J ₁₀	0.00756
<i>Senecio cappa</i> Buch.-Ham.ex D. Don	J ₁₅	0.00960
<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob.	J ₂₅	0.00869
Dominant Seedling	Fallow (year)	C
<i>Pteris quadriaurita</i> Retz.	J ₅	0.00425
<i>Dichrocephala integrifolia</i> (L.f.) Kuntze	J ₁₀	0.01057
<i>Molineria capitulate</i> (Lour.) Herb.	J ₁₅	0.00822
<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob.	J ₂₅	0.00869
Dominant Recruit	Fallow (year)	C
<i>Pteris quadriaurita</i> Retz.	J ₅	0.00003
<i>Dichrocephalai ntegrifolia</i> (L.f.) Kuntze	J ₁₀	0.01057
<i>Gynura bicolour</i> (Roxb.exWilld.) DC.	J ₁₅	0.00354
<i>Mikania micrantha</i> Kunth	J ₂₅	0.00783

$J' = H' / \ln S$ where H' is the number derived from the Shannon diversity index and S is the total number of species.

$D_{mg} = (S-1) / \ln N$ where N is the total number of individuals in the sample and S is the number of species recorded.

Analysis of community structure

Quantitative community characters were studied by determining density, frequency, abundance, basal area and Important Value Index (IVI) of each species in the selected communities following the methods given by Mueller-Dombois and Ellenberg (1974) [16]. Horizontal structure of selected communities was analysed by Whitford Index.

Results

Species richness and abundance

Tree Species richness per 0.2 ha increased from 39 species in J₅ to 53 species in J₂₅. However, there was a decrease in the number of species in J₁₀ consisting of 37 species. Shrub species richness per 270 m² was lowest (33) in J₁₅ and highest (51) in J₂₅. However, herbaceous species richness per 40 m² was highest in J₅ (44) showing gradual decrease with age of the fallows with lowest species (33) in J₂₅ (Table 1).

Distribution of tree, shrub and herb species within the different girth classes showed contrasting pattern in all the four fallow ages (Figures 1-3). Number of tree species was highest in the girth class 20 - 40 cm in J₅ and decreased gradually in the higher girth classes. Similarly, maximum number of shrub and herb species occurred in the lowest girth class (0 - 15 cm) in J₂₅ and (0 - 2 cm) in J₅, respectively. Number of shrub and herb species decreased with the increase in the girth class.

Stratification

The jhum fallow stands showed five strata viz., (i) Tree, (ii) Pole, (iii) Sapling, (iv) Seedling, and (v) Recruit. In each fallow age, the dominant species of each stratum was calculated using Simpson Dominance Index (C). Table 2 represents the dominant species of each stratum in jhum fallows of different ages with C value.

Spatial distribution pattern

On the jhum fallows, majority of the tree species (85 - 100%), shrub species (98 - 100%) and herb species (100%) showed clumped or contiguous distribution pattern. Very few tree species (1.9 - 15%) and shrub species (2%) showed random distribution pattern but did not show regular distribution pattern. Random and regular distribution pattern was not observed in the herb species at different fallow ages (Figures 4-6).

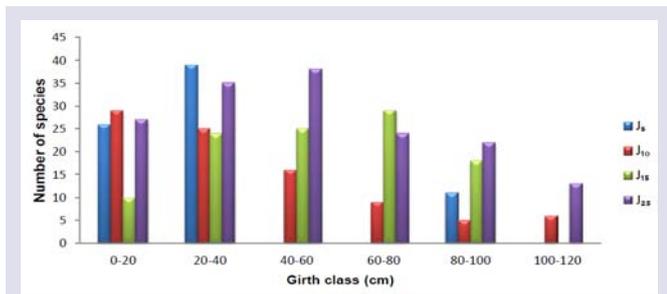


Figure 1: Distribution of tree species in different girth classes in jhum fallows of different ages.

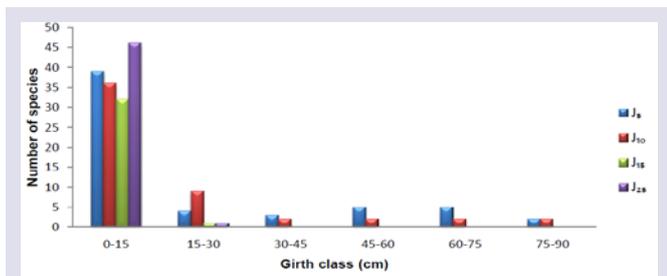


Figure 2: Distribution of shrub species in different girth classes in jhum fallows of different ages.

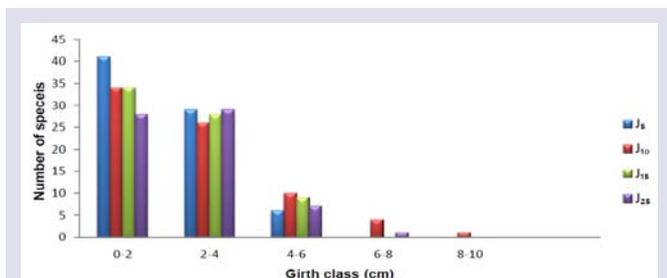


Figure 3: Distribution of herb species in different girth classes in jhum fallows of different ages.

Density

The total stand density of tree species varied considerably among all four fallow ages. The tree species largely contributing to the stand density were *Castanopsis tribuloides* (Sm.) A.DC. and *Scaphium scaphigerum* (Wall. ex G. Don) G. Planch. in 5 years fallow, *Protium serratum* (Wall. ex Colebr.) Engl. and *Actinodaphne angustifolia* (Nees) Blume in 10 years fallow, *Schima wallichii* Choisy and *Mallotus nudiflorus* (L.) Kulju & Welzen in 15 years fallow, and *Sapium eugeniaefolium* Buch. Ham and *Hymenodictyon orixense* (Roxb.) Mabb. in 25 years fallow. Density - distribution of tree species in different girth class reveals that the girth class 20 - 40 cm constituted 63.0% in J₅, 28.1% in J₁₀, 29.7% in J₁₅ and 37.2% in J₂₅ (Figure 7). In all the four fallows, the percentage contribution to the total stand density decreased with the increasing girth class, except there is increased from girth class 0 - 20 cm to 20 - 40 cm.

The shrub species largely contributing to the stand density were *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda and *Bambusa tulda* Roxb. in 5 years fallow, *Dendrocalamus hookeri* Munro and *Imperata*

cylindrical (L.) Raeusch. in 10 years fallow, *Chromolaena odorata* (L.) RM King & H Rob and *Seneci cappa* Buch.-Ham. ex D.Don in 15 years fallow, and *Urena lobata* Linn. and *Chromolaena odorata* in 25 years fallow. Density - distribution of shrub species in different girth class reveals that the lowest girth class (0 - 15 cm) constituted 42% in J₅, 78.4% in J₁₀, 98.6% in J₁₅ and 99.4% in J₂₅ (Figure 8). In all the four fallows, the percentage contribution to the total stand density does not follow a pattern but fluctuates with increasing girth class.

The herb species largely contributing to the stand density were *Pteris quadriaurita* Retz. and *Polygonum chinensis* Linn. in 5 years fallow, *Dichrocephala integrifolia* (L.f.) Kuntze and *Gynura bicolor* (Roxb. Ex Willd.) DC. in 10 years fallow, *Molineria capitulate* (Lour.) Herb. and *Ageratum conyzoides* (L.) L. in 15 years fallow, and *Mikania micrantha* Kunth and *Dicranopteris linearis* (Burm.f.) Underw. in 25 years fallow. Density - distribution of herb species in different girth class reveals that the lowest girth class (0 - 2 cm) constituted 70.4% in J₅, 74.2% in J₁₀, 73.7% in J₁₅ and 69.4% in J₂₅ (Figure 9). In all the four fallows, the percentage contribution to the total stand density decreased with the increasing girth class.

Basal area

Basal area has been shown to be an important predictor of successional changes [17]. Basal cover of the tree species differed

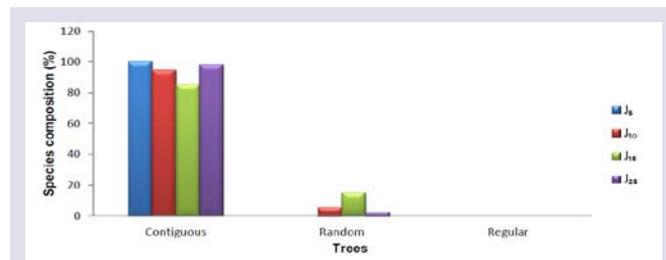


Figure 4: Spatial distribution of trees on the jhum fallows of different ages.

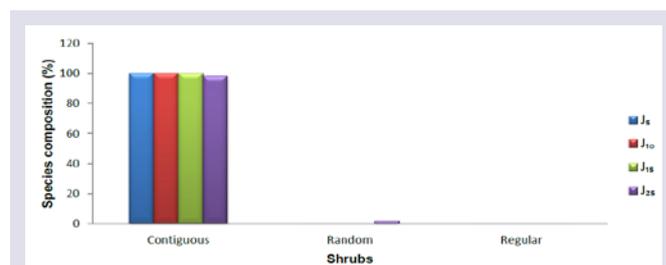


Figure 5: Spatial distribution of shrubs on the jhum fallows of different ages.

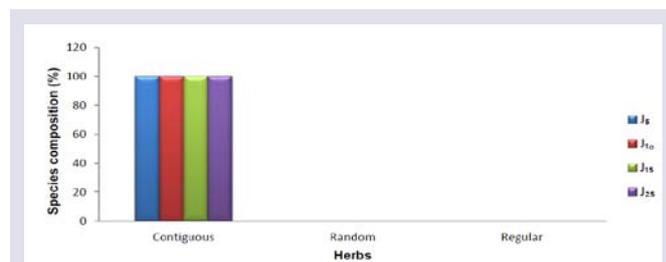


Figure 6: Spatial distribution of herbs on the jhum fallows of different ages.

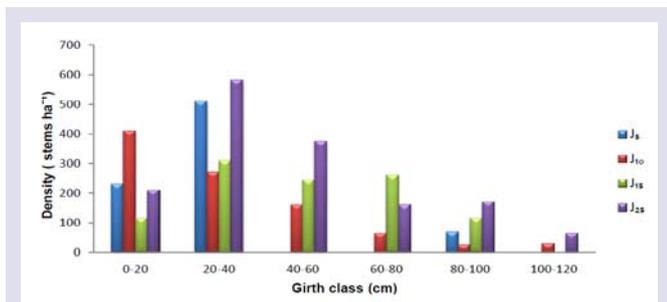


Figure 7: Density - diameter distribution of tree species on the jhum fallows of different ages.

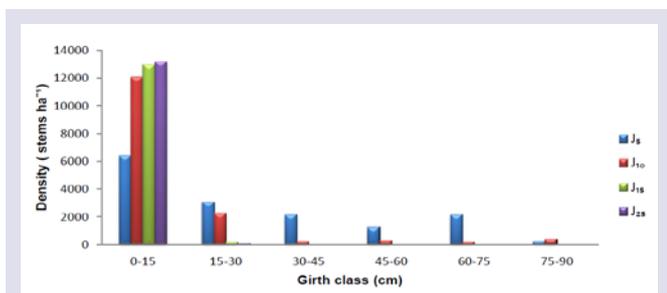


Figure 8: Density - diameter distribution of shrub species on the jhum fallows of different ages.

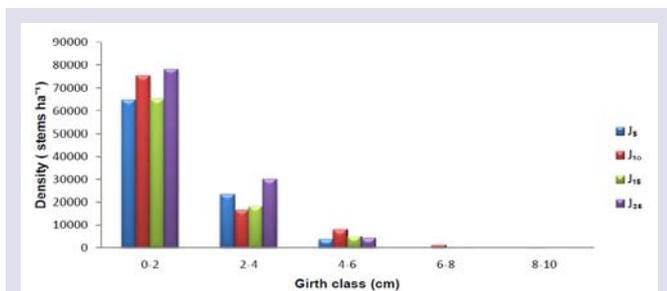


Figure 9: Density - diameter distribution of herb species on the jhum fallows of different ages.

considerably in the four fallows, from 8.44 m² ha⁻¹ in J₅ to 33.75 m² ha⁻¹ in J₂₅ (Table 1). The highest basal area was found in *Sapium eugeniaefolium* covering 2.85 m² ha⁻¹ on 25 years fallow and lowest was found in *Vaccinium sprengelii* (G. Don) Sleumer covering 0.00045 m² ha⁻¹ on 5 years fallow. The distribution of basal area in different girth classes revealed that trees in girth class 80 - 100 cm contributed maximum to the basal cover of 31.3% (Figure 10). In shrubs, the highest basal area was found in *Dendrocalamus hookeri* covering 41.74 m² ha⁻¹ on 5 years fallow and lowest was found in *Meizotropis buteiformis* Voigt covering 0.000037 m² ha⁻¹ on 25 years fallow. The distribution of basal area in different girth classes revealed that shrubs in girth class 60 - 75 cm contributed maximum to the basal cover of 51.2% (Figure 11). In herbs, the highest basal area was found in *Eulalia trispicata* (Schult.) Henrard covering 1.14 m² ha⁻¹ on 10 years fallow and lowest was found in *Molinaria capitulate* covering 0.00075 m² ha⁻¹ on 5 years fallow. The distribution of basal area in different girth classes revealed that herbs in girth class 2 - 4 cm contributed

maximum to the basal cover of 46.3% (Figure 12).

Dominance

The jhum fallows showed altogether different patterns of dominance based on the IVI values of the tree, shrub and herb species. In 5 years fallow, *Castanopsis tribuloides* (IVI 27.64) was the dominant tree species and *Scaphium caphigerum* (IVI 17.85) and *Magnolia pleiocarpa* (Dandy) Figlar & Noot. (IVI 16.33) were the co-dominant tree species. In 10 years fallow, *Dysoxylum excelsum* Blume (IVI 17.37) was the dominant tree species and *Actinodaphne angustifoliac* (IVI 15.52) and *Hibiscus macrophyllus* Roxb. ex Hornem. (IVI 15.48) were the co-dominant tree species. In 15 years fallow, *Schima wallichii* (IVI 14.29) was the dominant tree species and *Persea odoratissima* (Nees) Kosterm. (IVI 13.66) and *Engelhardtia spicata* Lechen ex Blume (IVI 12.05) were the co-dominant tree species. In 25 years fallow, *Sapium eugeniaefolium* (IVI 17.87) was the dominant tree species and *Hymenodictyon orixense* (IVI 15.04) and *Tectona grandis* Linn (IVI 12.87) were the co-dominant tree species (Figure 13).

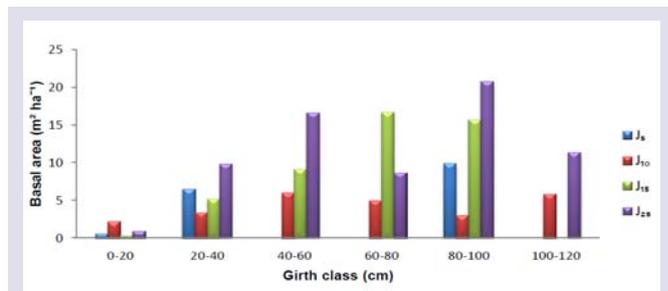


Figure 10: Distribution of basal area of tree species in different diameter classes on the jhum fallows of different ages.

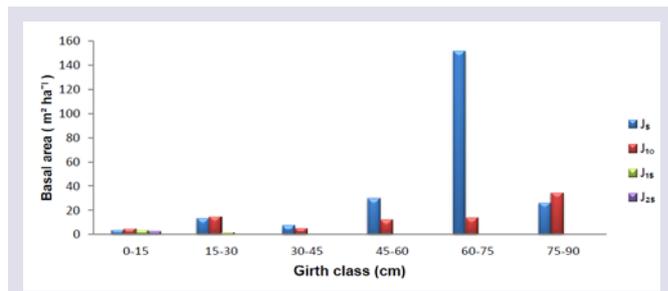


Figure 11: Distribution of basal area of shrub species in different diameter classes on the jhum fallows of different ages.

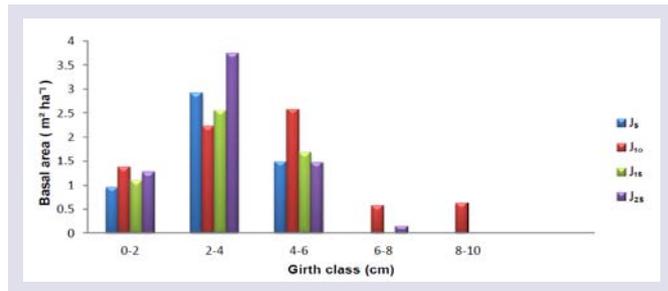


Figure 12: Distribution of basal area of herb species in different diameter classes on the jhum fallows of different ages.

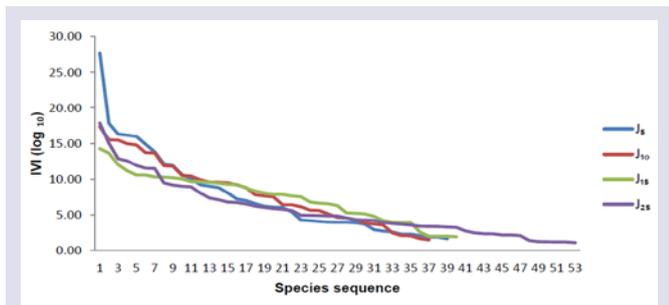


Figure 13: Dominance - diversity curves for trees on the jhum fallows of different ages.

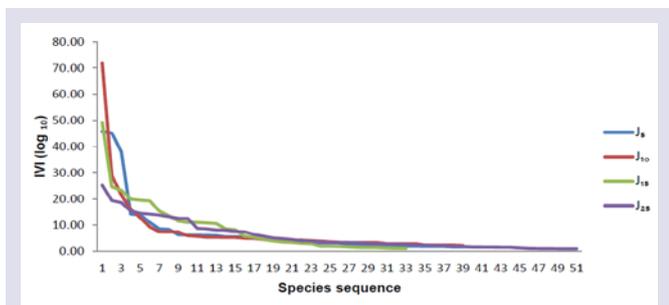


Figure 14: Dominance - diversity curves for shrubs on the jhum fallows of different ages.

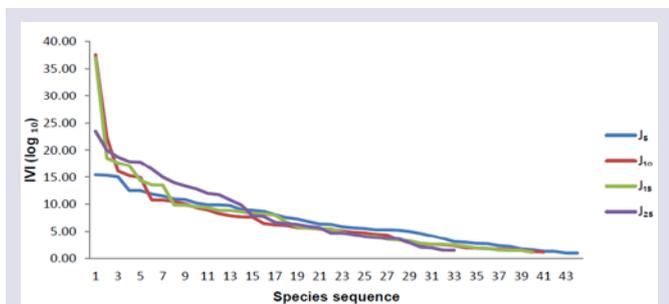


Figure 15: Dominance - diversity curves for herbs on the jhum fallows of different ages.

Among the shrub species in 5 years fallow, *Thysanolaena latifolia* showed the highest value of IVI (45.80) followed by *Dendrocalamus hookeri* (IVI 45.09) and *Melocanna baccifera* (Roxb.) Kurz (IVI 14.15). In 10 years fallow, *Dendrocalamus hookeri* showed the highest value of IVI (71.73) followed by *Bambusa longispiculata* Gamble (IVI 28.95) and *Imperata cylindrical* (IVI 21.40). In 15 years fallow, *Thysanolaena latifolia* showed the highest value of IVI (49.15) followed by *Senecio cappa* (IVI 24.51) and *Flueggea virosa* (Roxb. ex Willd.) Royle (IVI 23.23). And, in 25 years fallow, *Thysanolaena latifolia* again showed the highest value of IVI (25.15) followed by *Chromolaena odorata* (IVI 19.41) and *Urena lobata* (IVI 18.60) (Figure 14).

In 5 years fallow, the herbaceous component was dominated by *Pteris quadriaurita* (IVI 15.41), *Polygonum chinensis* (IVI 15.31) and *Eragrostis nutans* (Retz.) Nees ex Steud (IVI 15.04). In 10 years fallow, the herbaceous component was dominated by *Eulalia trispicata* (IVI 37.55), *Dichrocephala integrifolia* (IVI 22.32) and *Dicranopteris*

linearis (IVI 16.09). In 15 years fallow, the herbaceous component was dominated by *Eulalia trispicata* (IVI 36.98), *Molinaria capitulate* (IVI 18.53) and *Amaranthus spinosus* Linn. (IVI 17.64). In 25 years fallow, the herbaceous component was dominated by *Dicranopteris linearis* (IVI 23.43), *Galinsoga parviflora* Cav. (IVI 19.99) and *Mikania micrantha* (IVI 18.73) (Figure 15).

In general, the dominance-distribution curves for tree, shrub and herb components for all the four fallow ages showed lognormal distribution which is a feature of species-rich community [15,18].

Ecological diversity

Trees and shrubs showed increasing trend for Shannon Diversity Index and Margalef Species Richness Index but Pielou's Evenness Index decreases in trees and increase in shrubs with the increase in the fallow age. These indices indicate high diversity and species richness but the tree component is not equitably distributed while the shrub component is equitably distributed as the fallow age increases. This was also supported by the low values of Simpson Dominance Index. However, the herbaceous component showed decreasing trend for Shannon Diversity Index, Margalef Species Richness Index and Pielou's Evenness Index. These indices indicate low diversity, low species richness and inequitable distribution of herb species with the increase in the fallow age.

The number of tree species declined by 5.1% from 5 years fallow to 10 years fallow. However, it increased from 10 years to 15 years fallow by 8.1% and was further enhanced to 32.5% on 25 years fallow. It was also observed that the number of shrub species declined from 5 years to 10 years fallow by 4.9% which worsened to 15.4% on 15 years fallow. Nevertheless, there was a distinct rise in the number of species on the 25 years fallow by 54.6%. Interestingly, the number of herbaceous species was observed to decrease from 5 years to 10 years fallow by 6.8% and further declined by 2.4% and 17.5% on 15 years and 25 years fallow, respectively. Therefore, the percent recovery of tree and shrub species from 5 years to 25 years fallow was 35.9% and 24.4%, respectively, while 25.0% of herb species declined during the same fallow period.

Discussion

Regeneration dynamics of fallow vegetation generally becomes complex illustrating recovery from the preceding shifting cultivation. Grass species or annual herbs may dominate after land abandonment, then other pioneer species are established [2,19,20]. Correspondingly, our results showed that 5 years and 10 years jhum fallow were colonized by herbaceous species mostly seedlings and few recruits. *Pteris quadriaurita* from family Pteridaceae dominated in 5 years jhum fallow and *Eulalia* from family Poaceae dominated in 10 years jhum fallow. The 15 years jhum fallow was colonized by tree and herbaceous species. *Schima wallichii* from family Theaceae and *Eulalia trispicata* from family Poaceae dominated this fallow age. Also, the 25 years jhum fallow was colonized by tree species and few poles. *Sapium eugeniaefolium* from family Euphorbiaceae was dominant in this fallow age. This was observed similar to studies reported from the tropical regions that diversity of woody species gradually increases with fallow age [5].

Successional sites that recover over long periods may differ compositionally from uncut forest within a shifting cultivation landscape as these forests are often prone to other anthropogenic

disturbances [21]. Natural restoration of degraded forest ecosystems to intact forests greatly depends on the establishment ability of tree species [2]. Massive invasion of shrubs into open fallows may be one of the possible causes to hamper the growth of tree seedlings and saplings through competition [22]. Presence of large number of herbaceous species on the young fallows in the present study may be due to the strong competition offered by them to the potential woody pioneer resulting in growth suppression and mortality of the tree seedlings and saplings [23-26].

However, this study showed the increase in the tree and shrub component while the herbaceous component decrease with increase in the fallow of different ages, as shade-intolerant species established in the first year after land abandonment increased with fallow ages [27].

With increasing fallow age, the dominant species in these communities used the major fraction of available resources of the community leaving only a small fraction to be pre-empted by other species, as showed by the dominance-diversity curves of these communities. Community recovery can be accelerated when comparatively large forest area share a border with shifting cultivation site, in comparison with recovery in sites with shorter fallow cycles in the absence of adjoining forests, which act as sources for recolonization of vegetation [28].

Secondary forests after shifting cultivation are substantial carbon sinks and that this capacity to store carbon increases with abandonment age. Allowing development of such secondary regrowth has the potential to mitigate the impacts of deforestation and forest degradation and to contribute to global carbon sequestration [29].

The recovery of forest after shifting cultivation has multiple complications as observed in various forest types, disturbed regimes, climate conditions and so forth. This has challenged the restoration ecologists to seek an appropriate restoration strategy. Requirements on the rate of recovery and the similarity in species composition to the surrounding old growth forest are most important considerations [30]. Furthermore, site and elevation plays a major role in the recovery of forest following shifting cultivation [21].

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