Bulletin of Arunachal Forest Research **ISSN 0970-9487**
Vol. 28 & 29 Nos. 1 & 2, (2012 - 2013). pp. 77- 81

BAMBOOS AS SECONDARY SUCCESSOR AFTER SHIFTING AGRICULTURE AT LOWER ELEVATION IN EASTERN HIMALAYAN REGION

S. P. Singh
State Forest Research Institute
Van Vihar, P.B.No.- 159, Itanagar
Arunachal Pradesh

ABSTRACT

Jhum cultivation is being practiced in agriculture in Eastern Himalaya region of India since time immemorial. This is rapid secondary succession due to manmade disturbance. The plant communities are continually developing, changing and disappearing, giving way to another community. Bamboos are one community which prevails on these lands for a longer period of time due to their longevity and fast growth. The species seen in Northeast India are *Dendrocalamus hamiltonii, Bambusa tulda, Neohouzeua dulloa and Bambusa khasiana.* Their varied densities, growth patterns and adaptability towards a changing environment help in community stabilization. The greater affinity of bamboos towards actions, particularly potassium, helps to conserve these elements. The present study investigates the role played by bamboos in succession, especially in the conservation of nutrients, which is an important factor in the management of successional forests in Northeast India.

INTRODUCTION

This is universally accepted fact that most of the vegetation are subject to temporal changes both in species composition and in the relative importance of constituent life forms. These changes are of two kinds: successional and cyclic. The successional change is characterized by progressive alteration in the structure and species composition of vegetation (Clements, 1916; Watt, 1947). Bamboos are one community that colonizes disturbed lands in the tropics (Drew, 1974; Soderstrom & Vidal, 1975). Troup (1921) and Haig *et al.* (1958) also stated that as a result of shifting agriculture, huge expanses of grass and bamboo forests have been established in Asia. In Northeast India, bamboos constitute the major vegetation after slash and burn agriculture (Ramakrishnan *et al.,* 1981; Toky & Ramakrishnan, 1983a). Due to their adaptability (Rao & Ramakrishnan, 1987; 1988a, b) and nutrient conservational role (Toky & Ramakrishnan, 1982; Rao & Rarnakrishnan, 1988c), they play a special role in succession. The present study deals with the role of bamboos in succession.

METHODS

The study conducted at different places in Eastern Himalaya Region of India during last decade and a summary of observations is presented here. The vegetation association was analysed in the 1,5, 10, 15, 20, 25 and 60 year old fallows using thirty 10 x 10 quadrats for shrubs and trees and thirty 1 x 1 quadrats for herbaceous vegetation. Biomass estimations were done by the destructive method for herbs and bamboos and a linear regression (diameter at breast height and plant weight) was determined for trees and shrubs (Rao, 1986). The chemical composition was analysed using techniques suggested by Allen *et.al.* (1974).

RESULTS AND DISCUSSION

The farming settlements in the humid tropics follow traditional bush fallow agriculture also called as slash and burn agriculture or shifting cultivation. This process, locally called 'jhum', involves slashing of forest vegetation, burning and cropping for a short period followed by placed by a regeneration (fallow) period till the next cropping. This cycle was previously long (about 30 yr); however, under present conditions it has been reduced to as low as four to five years. Shorter cycles adversely affect the quality of environment both in terms of soil fertility and vegetal cover (Toky & Ramakrishnan, 1983a, b; Mishra & Ramakrishnan, 1983a, b).

The pattern of secondary succession in the fallow during the first few years when weed species dominate varies considerably depending upon the length of cropping. Thus our research reported four types of weed communities during early succession. This phase is gradually replaced by the bamboo community, shrubs and trees. Though bamboo belongs to grass community, it was observed that pure *Macaranga denticulata* communities colonised after a prolonged weed (*Imperata cylindrica*) stage on sites where Citronella grass was cultivated for a longer duration. The bamboo community of North-east India is chiefly *Dendrocalamus hamiltonii* Nees and Am., *Neohouzeua dulloa A. Camus* and *Bambusa khasiana* Munro. If the jhum cycle was shortened repeatedly, succession would be arrested indefinitely at the weed stage (Saxena & Ramakrishnan, 1984). This was also noted in the 'lua' forest in Yhailand (Zinke et al., 1978) and further, environmental degradation due to prevailing climatic conditions may lead to permanent desertification (Ramakrishnan, 1985).

Clements (1916) and Odum (1969), Proposing a 'relay floristic model'pointed out that each set of species makes the environment less favourable for itself and more favourable for those that follows. Egler (1954) suggested that the 'initial floristic composition' dominates the subsequent stages of succession after a major perturbation. Saxena and Ramarkrishnan (1984) found that the early stages of secondary succession following the burning, tended to conform closely to the initial floristic composition model under shorter jhum cycles but followed the 'relay floristic model' under longer jhum cycles. Further the studies in North-east India showed that species diversity increased while dominance decreased during secondary succession (Toky & Ramakrishnan, 1983a; Mishra & Rama-krishnan, 1983a).

The importance value index of vegetation (IVI) shows that bamboo density increased till 25 years of fallow re-growth and drastically decreased in a 60-year-old one. The detailed vegetational analysis (Rao & Ramakrishnan, 1987) shows the predominantly R-strategists (weeds) were displaced by more competitive K-strategists (bamboos and perennial weeds) and the succession involves the C-S-R-strategies of Grime (1979).

Standing biomass contribution by the ruderal (R-) strategists (herbs) reduces drastically with increase in fallow age while competitive (C-) strategists (bamboos) and stress-tolerant (S-) strategists (tree and shrubs) contributed more. Bamboos, with their plasticity in architecture (Rao & Ramakrishnan, 1988a), create shade and reduce nutrient availability, thereby affecting the reproductive efforts of ruderals. While the biomass contribution of bamboos increases up to 25 years of fallow regrowth (Rao & Ramakrishnan, 1988a). In a 60-year-old fallow, shrubs and trees contribute more (Singh & Ramakrishnan, 1982).

A sharp increase in the above ground biomass occurs during secondary succession. According to Lugo (1973) the maximum biomass value for tropical forests is approached in about 30 years at a level of 250 t/ha. The rate of accumulation of biomass is faster in the early stages of succession but may decline in the subsequent years. The rate also depends upon the type of initial vegetation established and on other environmental conditions (Uhl & Jordan, 1984; Toky & Ramakrishnan, 1983a; Mishra & Ramakrisshnan, 1983a). It is noted that the slower growth rate of shrubs and trees, in comparison to herbs during the early stages of succession is due to the heavy loss of photosynthetic for supporting structures at the expense of leaf area. The competitive bamboos have rapid rates of dry matter production, continuous stem extension and leaf production during the growing period and rapid phenotype adjustments in leaf area and shoot morphology in response to shade (Rao & Ramakrishnan, 1988a,b).

While losses of nitrogen, phosphorus, calcium and magnesium were found to diminish with fallow age, losses of potassium increased up to 20 years of fallow re-growth (Toky & Ramakrisnan, 1983b). Nitrogen, phosphorus and potassium are the most essential elements in tropical soils. After burning, nitrogen is volatilized (Allen, 1964; Knight, 1966; Debell & Ralston, 1970) and phosphorus is fixed into unavailable forms or volatilized (Lloyd, 1971; Gebhardt & Coleman, 1974; Tinker, 1977; Parfitt & Lee, 1979; Mishra & Ramakrishnan, 1983b; Swamy, 1986). Loss of potassium through run off and percolation is higher than calcium and magnesium because of its easily soluble nature (Allen, 1964; Lloyd, 1971). While the reduction of losses in nitrogen, phosphorus, calcium and magnesium is due to their accumulation in standing biomass, the continued potassium losses can be attributed to the high turnover of this element through bamboo leaf litter.

The density of element in the standing biomass reveals that competitatively bamboos store more nitrogen, phosphorus and potassium than stree-tolerant shrubs and trees while the reverse is true for calcium and magnesium. While the amount of nitrogen and phosphorus held in the above ground biomass and that released through litter improved in older fallows, the annual turnover percentage of nitrogen declined with fallow age while that for phosphorus declined in the 10-year old fallow and improved in a 15-year-old one. Whereas the enrichment ratio for nitrogen improved, that for phosphorus remained more or less constant. Potassinm, calcium and magnesium held in above ground biomass and released through litter improved with fallow age. Annual nutrient accumulation improved with fallow age and the enrichment. Among the three bamboo species, *N. dulloa* was a more efficient conserver of nitrogen, phosphorus and potassium, as is evident from tissue concentration (Rao, 1986). Bamboos thus play an important nutrient conservational role in these ecological conditions.

The observations from the present study show that the bamboos follow a strategy of faster uptake and storage of essential elements and a quicker turnover to supplement the soil flux, thus efficiently dominating the stress tolerant shrubs and tree species for a long duration. Bamboos promote stability in the ecosystem through regulation of its functions like other competitive early successional species.

ACKNOWLEDGEMENTS

The author is thankful to **Director, SFRI** for providing encouragement and **Mc.Arthur foundation USA & UNESCO India** for providing financial assistance to carry out the study.

REFERENCES

Allen, S.E. (1964). Chemical aspects of heather burning. *Appl. Ecol.* 1: 347-367.

Allen, S.E.; Grimshaw, H.W.; Parkinson, J.A. & Quamby, C. (1974). *Chemical Analysis of Ecological Materials.* Blackwell. Sci. Publ. Oxford. pp 575.

Clements, F.E. (1916). *Plant succession: Analysis of the Development of Vegetation.* Cam. Institute Wash. Publ. pp. 5 12.

Debell, D.S. & Ralston, C.W. (1970). Release of nitrogen by burning light forest fuels. *Soil Sci. Soc. America Proc.* 34:936938.

Drew, W.B. (1974). *The ecological role of bamboos in relation to the military use of erbicides on forests in South Vietnam.* Natn,. Acad. Sci.; Nat. Res. Council, Wash. D.C. pp. 14.

Egler, F.E. (1954). Vegetation science concepts 1. Initial floristic compositiona factor in old field vegetation development. *Vegetatio* 4:412417.

Gebhardt, H. & Coleman, N.T. (1974). Anion adsorption by allophanic tropical soils. III. Phosphate adsorption. *Soil Sci. Soc.* America

Proc. 38: 255-261.

Grime, J.P. (1979). *Plant Strategies and Vegetation Processes.* John Wiley & Sons. Chichester. pp. 222

Haig, L.T.; Hubermann, M.A. & Din, U.A. 1958. *FAO Forest Products Study 13*

Knight, H. (1966). Loss of nitrogen from the forest floor by burning. *Forest Chronical* 42: 149-152.

Lloyd, P.S. (1971). Effects of fire on the chemical status of herbaceous communities of the Derbyshire Dales. *J. Ecol.* 59: 261-273.

Lugo, A. (1973). *Tropical ecosystem structure and function. In Famworth, E.G. & golley,* F.B. (eds) Fragile Ecosystems. SpringerVerlag, Berlin.

Mishra, B.K. & Ramakrishnan, P.S. (1983a). Secondary succession subsequent to slash and burn agriculture

at higher elevations of Northeast India. I. Species diversity, biomass and litter production. Acta Oecologia Oecologia Applicata 4: 95-107.

Mishra, B.K. & Ramakrishnan, P.S. (1983b). Secondary succession subsequent to slash and bum agriculture at higher elevations of Northeast India. II. Nutrient cycling. *Acta Oecologia Oecologia Applicata* 4: 237-245.

Odum, E.P. (1969). The strategy of ecosystem development. Science 164: 262-270.

Parfitt, R.L. & Lee, R. (1979).The efficiency of utilization of P in superphosphate. New Zealand *J. Exptl. Agriculture* 7: 33 l-336.

Ramakrishnan, P.S. (1985).Cherrapunji. A wet desert? *Expanse*: 65-67.

Ramakrishnan, P.S.; Toky, O.P.; Mishra, B.K. & Saxena, K.G. (1981). *Slash and burn agriculture in Northeastern India.:570587.* In Mooney H.A.; Bonnicksen, T.M.; Christensen, N.L.; Lotan J.B. & Reiners W.A. (eds) Fire Regimes and Ecosystem Properties. USDA, Forest Service, General Technical Report, No 26, Honolulu, Hawaii.

Rao, K.S. (1986). EcoPhysiological Attributes of Bamboo Forests in Successional Communities in NorthEastern India. Ph.D. Thesis. North Eastern Hill Univ., Shillong, India.

Rao, K.S. & Ramakrishnan, P.S. (1987). Comparative analysis of the population dynamics of two bamboo species, *Dendrocalamus hamiltonii* and *Neohouzeua dulloa,* in a successional environment. Forest Ecol. & Management 21: I77 -189.

Rao, K.S. & Ramakrishnan, P.S. (1988a). Architectural plasticity of two bamboo species *(Neohouzeua dulloa.* A. Camus and *Dendrocalamus hamiltonii Nees &* Am.) in successional environments in Northeast India. Proc. Indian Acad. Sci. (Pl. Sci.) 98: 121-133.

Rao, K.S. & Ramakrishnan, P.S. (1988b). Leaf dynamics of two bamboo species *(Neohouzeua dulloa A. Calamus* and *Dendrocaiamus hamiltonii Nees &* Am.) in successional environments in Northeast India. *Proc. Indian Natn. Sci. Acad.* 54B: 63-69.

Rao, K.S. & Ramakrishnan, P.S. (1988c). Role of bamboos in nutrient conservation during secondary succession following slash and bum agriculture (jhum) in northeastern India. J. Appl. Ecol. (in press).

Saxena, K.G. & Ramakrishnan, P.S. (1984).

Herbaceous vegetation development and weed potential in slash and bum agriculture (jhum) in N.E. India. Weed Res. 24: 135-142.

Singh, J. (1982). Structure and function of a subtropical humid forest of Meghalaya. I. Vegetation biomass and its nutrients. Proc. Indian Acad. Sci. (PI Sci.) 91: 241-253.

Soderstrom, T.R. & Vidal, J.E. (1975). An ecological study of the vegetation of the Nam Nagum reservoir (Laos)A Report. Mekong committee. Smithsonian office of Ecology. pp. 46.

Swamy, P.S. (1986) Mophysiological and Demographic Studies of Weeds of Successional Environments after Slash and Bum Agriculture in Northeastern India. Ph.D. Thesis. NorthEastern Hill Univ., Shillong, India.

Tinker, P.B. (1977). Economy and chemistry of phosphorus. Nature 270: 103-104.

Toky, O.P. & Ramakrishnan, P.S. (1982). Role of bamboo *(Dendrucalamus hamiltonii Nees & Am.)* in conservation of potassium during slash and bum agriculture (jhum) in northeastern India. J. Tree Scientists 1: 17-26.

Toky, O.P. & Ramakrishnan, P.S. (1983a). Secondary succession following slash and burn agriculture in northeastern slash and bum agriculture in northeastern India. I. Biomass, litterfall and productivity. *J. Ecol.*71: 735-745.

Toky, O.P. & Ramakrishnan, P.S. (1983b). Secondary succession following slash and burn agriculture in northeastern India. II. Nutrient cycling. J. Ecol. 71 : 747-757.

Troup, R.S. (1921). The Silviculture of Indian Trees. Clarendon Press, Oxford.

Uhl, C. & Jordan, C.F. (1984). Succession and nutrient dynamics and burning in Amazonia. Ecology 65: 1476-1490.

Watt, A.S. (1947). Pattern and process in the plant community. J. Ecol. 35: l-22.

Zinke, P.J.; Sabhastri, S. & Kunstadter, P. (1978) Soil fertility aspects of the 'Lua' forest fallow system of shifting cultivation.In Kunstadter. P.; Chapman, E.C. & Sabhastri, S. (eds) Farmers in the Forest. East West Centre, Honolulu.