The Clarion Volume 4 Number 2 (2015) PP 64-74

The Clarion

International Multidisciplinary Journal

ISSN : 2277-1697

Transition from shifting cultivation to rubber cultivation in Tripura : socio-economic and ecological impact.

Manidip Roy[1], **Sibani Saha**[2], **Jhuma Das**[3] and **Mihirlal Roy**[4]

1. Department of Economics, R. K. Mahavidyalaya, Kailashahar, Tripura, India
2. Department of Fisheries, Government of Tripura, Agartala, India
3. State Health & Family Society, Agartala India
4. Tripura State Council for Science and Technology, Agartala, India

Abstract

In the Southeast Asian uplands including Tripura, a North Eastern state of India, agricultural transition is underway from subsistence production of shifting cultivation to commercial plantation of rubber (*Hevea brasiliensis*). Though there are reports of positive impacts of this transition both on the socio-economic conditions of the concerned people and on the ecology of the concerned area, still it is questionable as there are certain adverse reports and assumption. In the light of studies in different Southeast Asian Countries including Tripura of India, the prospects and concerns of its impact have been reviewed in this paper in Tripura perspective.

Keywords: shifting cultivation, transition, rubber plantation, socio-economic impact, ecological impact, tripura.

1. Introduction

Shifting cultivation (also called swidden cultivation or rotational farming), regarded as the first step in transition from food gathering and hunting to food production, is an oldest cultivation system practiced throughout the tropics and subtropics (zones of high rainfall, moderate temperature, and steep slopes) of the globe, spread right across tropical Asia, Africa and South America (Ramakrishan, 2001), dating back to the Neolithic period, *i.e.,* 13000-3000 B.C. (Spencer, 1966; Sharma, 1976; Mazoyer and Roudart, 2006).

Actual number of peoples world wide dependent on shifting cultivation is not available till date. However, it has been estimated that, it could be up to one billion (Erni, 2005). In Asia, around 400 million people live in and with forest, and most of them practice some form of shifting cultivation (Annonymous, 2001). In India, the shifting cultivation be traced in almost all parts, however, over the years it is almost extinct from the southern and western parts. Presently it is found mostly in northeastern states, Orissa and eastern ghats of Bihar in eastern part, Madhyapradesh and part of Maharastra in central zone and eastern ghat region in upper southern part of the country (Task Force of Government of India estimation, 1983 in Maithani, 2005).

Though, there are advocations in favour of shifting cultivation from ethno-ecologists, by and large it is perceived as primitive, backward, wasteful, unproductive, exploitive and the cause of widespread environmental degradation. Given the negative perception, the underlying premise of all government policies are to replace the practice with permanant, settled agriculture or other settled land-based activities. Among the resettlement schemes, the rubber cultivation occupy important place. In Motain Mainland Southeast Asia, more than 500,000 hactares

Corresponding author : mdiproy@gmail.com

land have already been converted to rubber plantations and by 2050, it is likely be more than double or triple (Ziegler *et al*., 2009). In Tripura, a northeastern state of India too, resettlement of shifting cultivators in rubber plantation claimed to be an successfull effort not only for stabilization of shifting cultivation and providing alternative livelihoods (Nath *et al*., 2010), but also in restoring degraded ecological system of land effected by repeated shifting cultivations (Krishnakumar *et al*., 1991; Krishnakumar and Meenattoor, 2003). However,there are also concerns voiced from certain sections globally on the initiative that, the effort may even turn to be worse than the disease (Ziegler *et al*., 2009a).

In view of above, the pros and cons of the impact of transition from shifting cultivation to rubber cultivation in Tripura have been reviewed here.

2. Shifting cultivation : arguments 'for' and 'against'

According to Gadgill and Guha (1992), the traditional shifting cultivation may not be as destructive as alternative being pursued presently. Clearance of small patches of forest with long fallow periods in shifting cultivation may even enhance biodiversity in the landscape due to the creation of variety of habitats (Gadgill and Guha, 1993). It preserve agrobiodiversity through local rules, practices and the informal networks of exchange of seeds and knowledge, thus ensure food securities of the concerned communities (Annonymous, 2009). Along with the replacement of shifting cultivation comes the collapse of these networks, which results in a substantial loss of crop genetic resources (Annonymous, 2009). According to Sharma (1976), the merits of this system are : causes least disturbances to soil, build up natural fertility through remains of mixed cropping (rice, maize, sesame, cotton, beans, cucumber, chillies, yam, ginger, banana *etc*.) on moderate to steep slopes with minimum tillage under rainfed condition depending on local resources. According to Ramkrishnan (1984,1992), it is far from being primitive and inefficient. He (Ramkrishnan, 1984) advocates that, the science behind jhum is based on intuitive experience of the farmer based on long tradition, it is an ingenious system of organic multiple cropping well suited to the heavy rainfall areas of the hill tracts of northeastern region. He (Ramkrishnan, 1992), also opined that, the economic and energetic efficiency of jhum is higher than alternative forms of agriculture such as terrace and valley cultivation. Further, it is not simply a farming technique but a way of life (Annonymous, 2009), have cultural importance too to indigenous tribes.

Major ecological arguments against the shifting cultivations are : (i) destruction of forests and biodiversity, (ii) causes soil erosion and nutrient loss, and (iii) effect of burning on soil fertility (Karthik *et al*., 2009; Saha *et al*., 2012). These and other similar environmental impacts are considered as consequences of shortened fallow cycle, which are likely an offshoot of increasing human population (Karthik *et al*., 2009). However, Singh (1996) has pointed out that there is often no strong relationship between population pressure and jhum cycle, the duration of the fallow period is influenced by the easy and clearing the vegetation and the soil fertility levels following the slash and burn operations. But, it can not be denied that, the practice of shifting cultivation can be sustainable and can support biodiversity, if in the overall landscapes large tracts of relatively mature forests are preserved and fallow cycle are relatively long (Uhl, 1987; N'Dja *et al*., 2008), which is not the present scenario in most of the places of the world, as well as in Northeastern India including Tripura. Moreover, being a subsistence level farming system having very low output input ratio (Tripathi and Barik, 2003), yields barely enough to survive (Banerjee *et al*., 1986). Therefore, it is not sustainable, if demographic growth leads to accelerating crop rotations (Brady, 1996; Thrupp *et al*., 1997), when the fellow period goes below 3-4 years, soil fertility is not renewed, and erosion and weed competition increased dramatically (Ramakrishnan, 1992; van Keer, 2003).

3. Policy initiatives and legal remedies for regulation/control of shifting cultivation

Globally, inspite of controversies, Governments are in favour of stoping shifting cultivations and hence, there are national policies which include 'outright banning of shifting cultivation', declaring areas as 'forest reserve' excluding people and resettling people into other forms of cultivation (Fox *et al*., 2012).

In Asia too, in the name of forest conservation and development, colonial and post-colonial governments have since more than a century devised policies and laws seeking to eradicate shifting cultivation (Bruun *et al*., 2009).

In India, the control measures ranged from legal remedies for regulation of shifting cultivation (apparently not prohibiting) to complex ameliorative

programmes (which includes soil and water conservation, commercial plantations, watershed management) and rehabilitation of shifting cultivators on permanent agriculture and other avocations.

The Indian Forest Act, 1927, asserted that the practice of shifting cultivation shall in all cases be deemed as privilege subject to control, restriction and abolition by the State Governments, which did not specifically provided blanket restrictions. Echoing the same sentiment, the National Forest Policy, 1952 too, suggested regulation (rather than control) of shifting cultivation by combining it with forest regeneration. Similarly, the National Forest Policy, 1988 while expressing serious concern on the adverse effects of shifting cultivation on environment and productivity, suggested action to contain such cultivation within the area already affected by propagating improved agriculture practices. In conformity with these perceptions and prescriptions the policy and legislation came in different states to recognise the prevalent practices and preferred a regulatory approach till a workable alternatives was found to totally abandon it (Maithani, 2005).

But, unlike other tribal states of the country, in Tripura, the Forest Reservation Act was promulgated as early as in 1887, under which, in some forests shifting cultivation was prohibited (Maithani, 2005). However, during Union Territory administration time, the Tripura Forest Rules,1952 given concession to limited shifting cultivation solely for the livelihood (Darlong, 2012), but, again in the same Union Territory administration in 1960, the state got Tripura Land Revenue and Land Reforms Act, adopted by the Parliament which, in a sweeping manner changed the very complextion of land relations in the State (Maithani, 2005). The Act, completely divested the tribal communities of the traditional customary rights over forest lands where they were practising shifting cultivation for generartion. As a result 40,278 operational holdings of tribal farmers covering an area of 3,55,592 hectare were declared unauthorisedly operated (Ganguli, 1990). This in reality meant that, simply by enacting a law, the community lands where the tribals traditionally practiced shifting cultivation were made government's 'khas' land and thereby the shifting cultivators were reduced to the status of unauthorised agricultural operators (Maithani, 2005).

Inspite of that, the shifting cultivation in Tripura could not be stopped. It was due to lack of acceptable and appropriate alternatives. Rather miseries of shifting cultivators increased due to harassment by administration on the ground of shifting cultivation as well as on the ground of collection of other forest minor produces, which further excerbated by the exploitation by the plainland businessman. This situation prevailed till the formation of the Left Front Government in Tripura in 1978. Thereafter, the liberal application of Forest laws by the state government, declaration of 'Protected Forest' as 'Unclassified Government Forest' and adoption of different approaches towards the development of tribal livelihood systems started to exhibit prospects.

Among the different schemes implemented in Tripura, rehabilitation through rubber plantation claimed to be success one. Here one policy adopted was to transfer the ownership right of the plantation to the beneficiaries as the tree mature (Bhowmik, 2006a). The future transfer are also restricted so that the tribals do not become landless again. The existing land rights in the state also restrict transfer of ownership from tribals to non-tribals.

Subsequent adoption of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act., 2006 (FRA) in the Parliament and allotment of 1.78 lakh hectare forest land among 1.17 lakh tribal families in Tripura (Annonymous, 2011) has opened further opportunities, though it is also a challenge to ensure sustainable and better livelihood utilising the allotted lands in eco-friendly manner for concerned tribal population including the shifting cultivators.

4. Alternative options

Searching alternatives to 'shifting cultivation' is based on the perception that, in one hand it keeps the cultivator in perpectual poverty, on the other hand it damages the 'service functions' of the eco-system. Detereotion of life supporting eco-system negatively impact further on productivity of the land, hence, a vicious cycle. Therefore, the target is to find suitable options, which may be more profitable as well as ecologically less detrimental or beneficial. Underlying these premise, number of options have been proposed by number of researchers, and tried in different places of the different countries. In India too, similar attempts have been made and, numbers of alternates to the shifting cultivation have been tried over the last 100 years, which includes agroforestry practices, settle terrace cultivation, intensified valley cultivation with a shift to plantations/horticultural crops on hill slopes (Ramkrishnan, 2001). ICAR (Indian Council for Agricultural Research) Research Complex for North

Eastern Hill Region, Shilong also proposed model of land use for the hilly areas in the North East India and tried in fields (Annonymous, 1990). The model consist of bench terracing for agriculture at the lower portion of the hill slopes, conversion of mid-portion of the hill slope into half-moon terraces for horticultural and the top portion for forestry. Tripura have also gathered experiences in settlement in agriculture (plough cultivation), horticulture based cultivation, animal husbandry, pisciculture and plantations of tea, coffee, rubber.

In most of the cases, when making choice, weightage has been given in favour of ecological benefit in comparison to the need of poverty alleviation, and as such the initiative has not got wide acceptance among the targeted population. On the other hand, when there is more economic profit, got acceptance, even when modern monocropping agriculture, though number of ethoecologists consider this as threat to ecology. According to Ramakrishnan (2001), it is monotonous not only because of uniformity being imposed at a landscape level, but also because of intensive use of external energy subsidies basesd on petrochemicals, resulting in reduction in above-ground and below-ground biodiversity. According to him (Ramakrishnan,2001), intensively managed fruit plantations and orchards, vegetable crops and intensive cereal production system are some of the examples.

In large areas of the Southeast Asia, including Tripura of Northeastern India,rubber monoculture has got acceptance, mainly because of economic profitability, though it has got arguments both in "favour' and 'against'. Study in Tripura reflect that, among beneficiaries economic benefit has got consideration over potential ecological consequences (Matouleibi, 2012).

5. Resettlement initiatives : Tripura scenerio

The attempts to resettle shifting cultivators started in Tripura even before indepence and merger of Tripura with Indian Union (Bhattacharyee, 1992; Maithani, 2005). In 1930-31, the first attempt was made by the than Maharaja Bir Bikram Kishore Manikya Bahadur (1923-47) to settle shifting cultivators in plough cultivation in 28,160 hactare fertile plain land outside forests in Kalyanpur reserve in the then Khowai Sub-division (Bhattacharyee, 1992; Maithani, 2005). In next order, in 1941, the total area reserved for this purpose was raised to 5,05,053 hactare (Menon, K.D., 1975; Bhattacharyee, 1992). After independence (as well as after merger of Tripura with Indian Union), in accordance with the recommendation of the commission constituted by the Government of India under article 338 of the constitution, the Union Territory administration of Tripura formulated Settlement Scheme and Colonisation Scheme in 1953, both being part of the overall strategy of ''Shifting Cultivation Control Scheme''of the nation initiated in the first plan period (Bhattacharyee, 1992; Maithani, 2005). Subsequently, by the end of Sixth Five Year Plan (1984-85), a total of 45,000 families had been rehabilitated in 28 projects of resettlement colonies (Maithani, 2005). Composition of the colony schemes targeting family comprised of provision of dwelling unit, homestead land, orchards, and agricultural land with or without irrigation facility and in addition, facilities of drinking water, primary education, medical facility, veterinary facilities, approach road and co-operative society for credit and marketing (Bhattacharyee, 1992; Maithani, 2005). During the Seventh Plan, a fresh approach towards settlement cultivators was introduced in which more emphasis was on horticulture, plantation crops, animal husbandry, pisciculture and watershed management and in Eighth Plan emphasis was on watershed management under the national watershed development projects (Maithani, 2005). But, as most of these measures failed to curb shifting cultivation in forest lands (Annonymous, 2003), the government took different approach towards resettling mainly through four plantation schemes, *viz.*, Horticulture, Rubber, Tea and Coffee. Resettling scenario of the period 1986-87 to 2004-05 showed that rubber has been established as an important means of rehabilitation (Annomynous, 2007).

As per available oldest estimation, in Tripura in 1961, 25,000 families were dependent on shifting cultivation (Ganguly, 1968). As per landmark survey conducted by the Government of Tripura in 1978 and 1987, the estimated numbers of families dependent on shifting cultivation found 45,854 (2,59,000 persons) and 55,049 (2,88,000 persons) respectively (Annonymous, 2007). Further, according to the Department of Tribal Welfare, Government of Tripura, in 1999, the estimated number of shifting cultivator families were 51,265. According to first-ever census enumeration of shifting cultivators, conducted in 2007 by the Forest Department, Government of Tripura, 27,278 hardcore families (1,36,000 persons) solely dependent on shifting cultivation. These counts though shows a clear decline in the shifting cultivator families,

also shows that, till in 2007, 10 per cent of the tribal population in Tripura dependent on an oldest and high risky cultivation system (Annonymous, 2007).

6. Rubber plantation : as alternative

Introduction and take-off : Recent political and economic reforms facilitated shift in agriculture away from shifting cultivation and towards a diverse array of cash crops, rubber being one of the foremost (Ziegler *et al*., 2009). However, in Tripura, though the rubber plantation based rehabilitation scheme for shifting cultivators got momentum in 1992 due to the Block Planting Scheme (BPS) under World Bank support (coinciding with initiation of economic reforms in the country), entry of rubber plants in the state and its organised plantation for rehabilitation of shifting cultivators began long before. In early fifties of the last century trials started (Bahuguna, 2006). Its organised plantations started in 1963 (Bahuguna, 2006). Linking up it with rehabilitation of shifting cultivators started in 1976 (Sinha, 2012).

Though the rubber plantations both in economic and sociological terms revolutionised the life pattern of the concerned population (Bhowmik, 2006; Annonymous, 2007; Sarkar, 2010; Matouleibi, 2012), its entry in Tripura was not for rehabilitation of shifting cultivators. It was valued for its capacity for giving soil cover in soil conservation afforestation programme (Bahuguna, 2006), but its economic aspects too played role.In human development report of the state published in 2007, it has been mentioned that, the Tripura experiment was modelled on the experiment of the Kerala rubber economy, where the 'Rubber for the Poor' project attempted to provide tribal and other marginal farmers with a steady income (Annonymous, 2007). This also has been supported by Sinha (2012), as he mentioned that, desire of replication of Kerala success of commercial rubber plantation in Tripura have played role.

High point in rubber story in Tripura came about in 1976 with the establishment of Tripura Forest Development and Plantation Corporation Limited (TFDPC Ltd.), which took up the issue for improvement of degraded forestlands as a principal strategy and simultaneously to wean away a cluster of tribalies of Warangbari from shifting cultivation by providing wage employment through rubber plantation (Sinha, 2012). Sinha (2012) also mentioned that, in a queer coincidence, soon thereafter, the Soil Conservation Department of undivided Assam had also raised rubber plantations, and according to Bhattacharya (19092), TFDPC Ltd like public sector organisation also came up in Assam, Meghalaya, Mizoram, Nagaland and Arunachal Pradesh of Northeastern states, but it was in Tripura only the enormous potential was promptly realised and persued (Sinha, 2012).

Though, through rubber plantations, the shifting cultivators of the state could improve their socio-economic conditions, initially the beneficiaries have not took it spontaneously, rather they reacted against the endeavour (Bhattacharya, 1992). In Warangbari, soon after the site clearance had began, concerned community got wary of permanent loss of land for shifting cultivation and an array of other livelihood necessities that the land delivered, which resulted protest *en masse* (Sinha, 2012). On the face of that determined protest, the government had to accept their unusual demand for commitment to allot the planted land to them on maturity. The families thus worked on daily wages under the corporation for establishment of rubber plantations in government land, which were allotted to them subsequently on maturity. It was amazing that, protest of the beneficiaries gave birth of an system design of rehabilitation of shifting cultivators in Tripura where wage labourers of the plantations acquired the status of owner of the plantations having steady income. In fact in Warangbari and subsequent endeavour in other places of the state this has played vital role in making rehabilitation of shifting cultivators' success.

Initially, the Rubber Board of India too did not show interest towards expansion of rubber in Tripura, rather argued negatively on the ground of harsh winter and protracted dry season of the state (Sinha, 2012). But, while 'traditional rubber belt' of the country reached to saturation and demand of natural rubber increased, the situation compelled them to search for non-traditional areas. Side by side from trials in mid 1970s in Tripura by the Forest Department, they came to realise that, as *Hevea brasiliensis* is fairly adaptable to some deviations from the ideal climatic requirements and as adverse impacts to an extend can be moderated through management, it will have prospects in Tripura (Sinha, 2012). Therefore, they took interst and set up initially one man office in 1967 and upgraded it to a regional office in 1979 at Agartala for undertaking development and extension activities (Paribalam, 2006). In the same year, a Regional Research Station too was established for undertaking location specific research. On the other hand, the Warangbari experience induced the state government

too to establish a separate agency named Tripura Rehabilitation Plantation Corporation Limited (TRPC Ltd.) in 1983, solely for rehabilitation of marginal tribal families on rubber plantations. These events, no doubt acted as impetous in rehabilitation scheme of shifting cultivators through rubber plantations in Tripura.

The endeavour again got new dimension on introduction of World Bank aided Block Plantation scheme in 1992-93 (Bhowmik, 2007a). Scheme was designed on the basis of earlier experiences. Important key features were : minimum 50 hactare contiguous land, each beneficiaries had to have clear land title, beneficiaries had to hand over the land to Rubber Board for a period of 7 years, they were expected to work as labour and also engage other family members in the plantation, the beneficiaries had to agree to form a Rubber Production Society (RPS) after the period of maturity of the plantation, further plantation had to be given for 2 more years to the Rubber Board for stabilizing harvesting, processing and linking up for marketing before finally and fully handing over the plot back to beneficiaries with mature plantations (Matouleibi, 2012).

In overall, from Government of Tripura, the Forest Department, two agencies, *viz*., TFDPC and TRPC, the Department of Tribal Welfare, the Department of Rural Development, Sub-Divisional Administration, the Tripura Tribal Areas Autonomous District Council (TTADC), from government of India, the Rubber Board and the World Bank made contribution to make rehabilitation of shifting cultivators a success.

Socio-economic impact : Socio-economic improvement of the shifting cultivators in Tripura on transition from shifting cultivation to rubber plantations have been reported by number of researchers (Annonymous, 2007a; Bhowmik, 2006a, 2007; Nath *et al*., 2010; Sarkar, 2010; Joseph and George, 2011; Sinha, 2012; Matauleibi, 2012). Not only steady and improved income, improved health, improved sanitation, increased education and overall better outlook of the community towards development have been obsereved (Matouleibi, 2012).

Family size have also decreased (Sarkar, 2010). Now, they have enough food (though mostly purchaged from marked), they have been able to come out from indebtness and broken the vicious cycle of poverty (Sarkar,2010;Krishnakumar and Meenattor, 2012; Matouleibi, 2012). Improvement in household assets (Sarkar,2012; Matouleibi,2012), possessing of concrete house or mud house with GCI sheet roofing, fencing boundary of resident with bamboo splits or GCI sheets, TV, dish antennae, mobile phone,different electrical/electronic gadgets, durable furniture, scooter or byke/motorcycle and even in certain cases car can also be noticed.

Women are able to spend more for cloths and even gold jewellery (Matouleibi, 2012). Increased in education level in 2nd and 3rd generation, mostly in 3rd generation can be noticed as they invest for that to make them study even at private 'English Medium Schools' and feel that, even if in future rubber crops collapse, their children will have better future (Sarkar, 2012; Matouleibi, 2012). Basic facilities like drinking water, improved sanitation, better infrastructure are also seen (Matouleibi, 2012). Reports of decline of village youth joining the extremist organisations (Matouleibi, 2012), even of surrendering of extremists and their involvement in rubber plantations have been found.

However, alongwith economic development, certain negative implications or vices have arisen which are : women's withdrawal from working outside the house (contrast to shifting cultivation) and their limited role in economy (largely confined to working in the household), dowry demand by groom in marriage (unheared earlier in tribal community, even there was contrast custom in which groom had to serve as labour in the house of bride), devaluation of women's contribution at community/village level, increase of drinking and gambling (Matouleibi, 2012) and other crimes. Even in resettled villages, there are certain left out, possess no title of land and plantations, works as tapper and hence, according to Matouleibi (2012), as a result of rehabilitation of shifting cultivators through rubber plantations, such new class of landless have emerged in the community.

Impact on microclimate and ecology : There is a general perception in Tripura that, the local climate is changing due to expansion of rubber plantation. Though increase of minimum temperature in all seasons (mean annual minimum temperature at a rate of 0.05^0C per year over a span of 25 years during the period of 1984-2008), increase of maximum temperature during South-West monsoon at a rate of 0.04^0C (no change in annual maximum temperature) has taken place and changes of seasonal distribution of rainfall being experienced, there is no trend of declining of annual rainfall. Consistency have also been observed in the non increase of hot days during the summer (Sailajadevi, 2010). Whatever changes

have taken place, for that, wheather blaming the rubber plantations be wise? Though, there is no specific study in and/or for Tripura yet, from the study conducted for Hainan Island of China by the Research Centre for Environmental Sciences of Chinese Academy of Sciences, we can get an idea for Tripura too that, the possibility is remote. Based on 40 years (1951-1990) climatic data, analysing the hydrological dynamic characteristics of rubber plantation and estimation of the water balance in the rubber plantation, they came to conclusion that, even the large-scale substitution of the natural vegetation of 19 counties of Hainan Island with rubber plantations had not made significant effect on local rainfall (Jiang and Wang, 2003). According to them (Jiang and Wang, 2003), main reasons are : (1) Eighty per cent of the rainfall in Hainan Island is brought by typhones; (2) the proportion of 11.6 per cent rubber plantations in total forest coverage in Hainan Island is not enough to influence the local rainfall; and (3) although, the rubber plantation is artificial vegetation, it has the similar function to the tropical rain forest. But in Tripura the villagers and the civil society now blame the large-scale substitution of indigenous vegetation by rubber for the drying hill streams and village well (Sinha,2012). On the other hand, according to Krishnakumar and Meenattor (2003), rubber trees utilises much less water than many forest species for a comparable biomass production. Based on interview with the residents of the locality of 8 rubber growing villages (5 villages under Belonia Sub-Division and 3 villages under Udaipur Sub-Division of earlier South District of Tripura, Bhowmik (2006) came to conclusion that, the rubber plantation is rather helping conservation of water and recharge acquifers. Arriving to a conclusion based on perception and without proper and indepth study appears to be over simplistic. Number of studies in China suggest that, rubber deplete the subsurface water resource (Guardiola-Clarmonte *et al*., 2008, 2010; Qui, 2009; Zhang *et al*., 2011), though, in depth and more accurate studies are advocated (Ziegler *et al*., 2009).

Soil erosion is a problem everywhere, which decreases the nutrient of soil, as we know that nutrients are naturally available in top soil. As a offshoot of population increase, the shortened fallow cycle of shifting cultivation also results in soil erosion (Karthik *et al*., 2009). In Tripura too it is a challenging task to improve the soil of large areas subjected to continuous shifting cultivation. It has been found that, the rubber as plant can play role in restoring such soil, as its root concentration occur in the top 18cm of the soil and horizontally they spread up to 2 meters from the plant base (Philip *et al*., 1996). Being a surface feeder, rubber tree affords good soil binding and reduced erodibility of soil considerably (Sethuraj, 1996). The thick canopy helps to cut down direct radiation and intercepts rain. According to Rahman (1994), once the trees establish a complete canopy, the rate of run-off generally differs little from that for similar areas with natural forest. Thus, soil moisture status is improved and soil erosion is prevented. The reduced soil temperature leads to reduced oxidation of soil organic matter and favour its built up (Jacob, 2000). Shifting cultivation usually proceeds by clearing of vegetation and burning the organic debris, which lead to destruction of organic matter, soil structure, thereby decrease the soil fertility and soil microbial population as well as reduce water intake capacity of soil due to deposition of hydrophobic aliphatic hydrocarbons (Mandol and Pal, 2010). In this context, studies conducted in rubber plantations in degraded lands of Tripura due to shifting cultivation, revealed that, rubber plantation improve the physical (bulk density, porosity), chemical (nutrient availability), and biological (soil microbe) properties of soil (Krishnakumar *et al*., 1991a; Krishnakumar and Potty, 1992).

Jones (1997) reported that, biodiversity remains remarkably high in rubber plantation, in marked contrast to most other forms of monoculture. The leaf coverage and the root system of rubber trees regulate the microclimate allowing a range of secondary plants to flourish and the trees also offer a habitat for a great variety of fauna (Kox, 1990). But, we can not deny the fact that, the rubber plantations in Tripura being expanded in substitution of indigenous vegetation (Sinha, 2012), and almost in all rubber plantations of the state, there are only standing trees and clear ground with dry leaves, which does not sense true forest (Nath *et al*., 2010). In Tripura, rubber plantations might have increased forest coverage, but at the cost of local biodiversity (Nath *et al*., 2010). This is not because of species *'per se'*, but as being raised as 'monoculture plantations' and according to Bhowmik (2006), perhaps, this is the largest drawback of the rubber plantation from the point of the environment.

References

Annonymous. 1990 : ICAR-Technology Bulletin – ICAR Research Complex for NEH Region during the decades (1975-1985), Vol. 1 : Crop Science. ICAR Research Complex for NEH Region, Shilong, Meghalaya.

Annonymous. 2000 : Who were indigenous peoples in Asia. Asian Indigenous Peoples Pact (AIPP) and International Work Group for Indigenous Affairs (IWGIA). p.5.

Annonymous. 2001 : Shifting cultivation : towards sustainability and resource conservation in Asia. IFAD, IDRC and IIRR, Cavite, Philippines. P.24f.

Annonymous. 2003 : Annual Tribal Sub Plan, 2003-04. In : 10th Five Year Plan , Government of Tripura. p.10.

Annonymous. 2007 : Enumeration of shifting cultivators in Tripura. Forest Department, Government of Tripura.

Annonymous. 2007a : Tripura Human Development Report (Ed. Swaminathan, M.). Government of Tripura.

Annonymous. 2009 : Shifting cultivation and climate change. In : *UNFCC Intersessional Meeting*, Bangkok.p.8

Annonymous. 2011 : Annual Plan : 2011-2012, Department of Agriculture, Government of Tripura.

Annonymous. 2012 : Drivers of deforestation ? Facts to be considered regarding the impact of shifting cultivation in Asia. Asian Indigenous Peoples Pact (AIPP) and International Work Group for Indigenous Affairs (IWGIA).p.11.

Bahuguna, V. K. 2006 : Rubber cultivation in Tripura. In : *Natural rubber in Tripura : base line data and future planning* (Ed. Bahuguna, V. K.). Tripura Rubber Mission, Government of Tripura. pp. 17-18.

Banerjee, A., Dasgupta, M. and Roy, O.P. 1986 : The importance of forests in the economic life of jhumias of Tripura. In : *Forestry Development in North-East India* (Eds. Dasgupta et.al.), Omsons Publications, Guwahati.

Bhattacharya, S. 1992 : From Jhuming to Tapping. Directorate of Research, Department of Welfare for Scheduled Tribes, Government of Tripura. pp. 85.

Bhowmik, I. 2006 : Rehabilitation of jhum cultivators through rubber plantations : problems and prospects. In : *ICHR Seminar*, Tripura University, Agartala.

Bhowmik, I. 2006a : Status report on rubber plantations in Tripura. In : *Natural Rubber in Tripura : baseline data and future planning* (Ed. Bahuguna, V.K.). Tripura Rubber Mission, Government of Tripura, Agartala, India. Pp. 41-52.

Bhowmik, I. 2007 : Socio-economic profile of the shifting cultivators of Tripura. In : *ITTO Pre-Project Workshop*, Agartala.

Brady, N.C. 1996 : Alternative to slash and burn : a global imperative. *Agricult. Ecosyst. Environ.*, 58 : 3-11.

Bruun, T. B., de Neergaard, A., Lawrence, D. and Ziegler, A.D. 2009 : Environmenttal consequences of the demise in swidden cultivation in southeast Asia : carbon storage and soil quality. *Human Ecology*, 37 : 375-388.

Conklin, H. 1969 : An ethnoecological approach to shifting agriculture. In : *Environmental and Cultural Behaviour*, Academic Press, New York.pp.221-233.

Darlong, V. 2012 : Shifting paradigm of shifting cultivation : revisiting challenges and options for transforming 'lives, landscapes and livelyhoods' in Tripura from the experiences of NERCORMP-IFAD in northeast India. In : *Shifting Cultivation in Tripura*, Tribal Research and Cultural Institute, Government of Tripura, Agartala, India.pp. 5-34.

Dove, M.L. 1983 : Theories of swidden agriculture, and the political economy of ignorence. *Agroforestry Systems*, 1: 85-99.

Dove, M.L. 1985 : The agroecolgical mythology of the Javanese and the political economy of Indonesia. *Indonesia* No. 39 (April). Cornell Southeast Asia Program.

Erni, C. 2005 : Shifting cultivation and indigenous peoples in Asia. *Indigenous Affairs*, pp. 4-5.

Fox, J., Castella, J., Ziegler, A.D. 2009 : Swidden, rubber and carbon can REDD+ work for people and the environment in montone mainland southeast asia? In : *Working paper No. 9, CGIAR Res. Programme on Climate Change*, Agriculture and Food Security, Copenhagan,Denmark.

Gadgil, M. and Guha, R. 1993 : The Fissured Land : An ecological history in India. University of California Press.pp.274.

Ganguly, J.B. 1969 : Economic Problems of the Jhumias of Tripura.Bookland Pvt. Ltd., Calcutta.p.115.

Ganguly, J.B. 1990 : The Process of Transition from Communal to Individual Land Tenure System in Tripura. Tripura University, Agartala, India.

Guardiola-Claramonte, M., Troch, P.A., Ziegler, A.D., Gimbelluca, T.W., Vogler, J.B. and Nullet, M.A. 2008 : Local hydrologic effects of introducing non-native vegetation in a tropical catchment. *Ecohydrology*, 1 : 13-22. DOI :10-1002/eco.3.

Guardiola-Claramonte, M., Troch, P.A., Ziegler, A.D., Gimbelluca, T.W., Vogler, J.B. and Nullet, M.A. 2010: Hydrologic effects of the expansion of rubber (*Hevea brasiliensis*) in a tropical catchment. *Ecohydrology*, 3 : 306-314. DOI : 10.1002/eco.110.

Jacob, J. 2000 : Rubber tree, man and environment. In : *Natural Rubber : Agromanagement and Crop Processing* (Eds. George, P.L. and Jacob, C.K.), Rubber Reasearch Institute of India, Kottayam. pp. 509-610.

Jiang, J. and Wang, R. 2003 : Hydrological eco-service of rubber plantations in Hainan Island and its effect on economic development. *J. Environmental Sciences*, 15(5) : 701-709.

Jones, K.P. 1997 : Rubber and the environment. In : *Joint Workshop of the International Rubber Study Group (IRSG) and Secretariat of the United Nations Conference on Trade and Development (UNCTAD) on Oppurtunities and Constraints for the Internalization of Environmental Costs and Benefits into the Price of Rubber.* IRSG and UNCTAD.

Joseph, J. and George, T.K. 2011 : Income inequality among beneficiaries under natural rubber block planting scheme in Tripura : a preliminary assessment. *Natural Rubber Research*, 24(2) : 203-210.

Kartik, T., Veeraswami, G.G. and Smal, P.K. 2009 : Forest recovery following shifting cultivation : an overview of existing research.*Tropical Conservation Science*, 2(4) : 374-387.

Kox, H.L.2000 : Ecological advantages of NR latex production. Nature Rubber, 17(1) : 4

Krishnakumar, A.K., Gupta, C., Choudhury, D. and Meenattoor, R.J. 1991 : Rubber (*Hevea brasiliensis*) plantation in Tripura : some ecological considerations with reference to microclimate. In : *National Seminar on Resource Management*, Agartala, Tripura.

Krishnakumar, A.K., Gupta, C.,Sinha, R.R., Sethuraj, M.R. , Potty, S.N., Eappen, T. and Das, K. 1991a : Ecological impact of rubber (*Hevea brasiliensis*) plantations in North East India.2. soil properties and biomass recycling. *Indian J. Nat. Rubb. Res*., 4(2) : 134-141.

Krishnakumar, A.K.and Potty, S.N. 1992 : Nutrition of *Hevea* . In : *Natural Rubber : Biology, Cultivation and Technology* (Eds. Sethuraj, M.R. and Mathew, N.M.). Elsvier, Amsterdam, pp. 239-262.

Krishnakumar, A.K and Meenattoor, R. J. 2003 : Restoration of denuded lands in the north eastern India through rubber plantations. *Leisa India*, December. pp. 23-24.

Nath, T.K., Inoue, M. and De Zoysa, M. 2010 : Rubber planting for forest rehabilitation and enhancement of commercial livelihood : a comparative study in three south asian countries. In: *18th Commonwealth Forestry Conference*, Edinburgh.

Maithani, B. P. 2005 : Shifting Cultivation in North-East India : Policy Issues and Options, Mittal Publications, New Delhi, India. pp163.

Mandal, D. and Pal,T.K. 2010 : Rubber plantation in North East India and its influence on soil properties and ecosystem—an appraisal. In : *State level seminar on frointier areas of Chemistry to commemorate 150th Birth Anniversary of Acharya P.C.Roy*. Department of Chemistry,Tripura University and Tripura Stae Council for Science and Technology.

Mazoyer, M. and Roudart, L. 2006 : A History of World Agriculture from Neolithic to the Current Crisis. Earthscan Publishers, London.

Matouleibi, S. 2012 : How wonderful is the wonder crop ? Block rubber plantation and indigenous tribal women in Tripura. Research paper submitted for Master of Arts in Development Studies, International Institute of Social Studies, The Hague, The Netherland.

N'Dja, K., Justin, K. and Guillaume, D. 2008 : Successional patterns of plant species and community diversity in a semi-deciduous tropical forest under shifting cultivation. *Journal of Vegetation Science*, 19 : 809-820.

Paribalam, P. 1006 : Role of Rubber Board in Tripura. In : *Natural Rubber in Tripura : Baseline Data and Future Planning* (Ed. Bahuguna, V.K.). Tripura Rubber Mission, Government of Tripura, Agartala, India. pp. 41-52.

Philip, V., Rao, D.V.K.N., Varghese, M., Vinod, K.K., Pothen, J. and Krishnakumar, A.K. 1996 : Spatial distribution of roots and nutrients in soil under rubber plantations in Tripura. *Indian J. Natural Rubber Research*, 9(2) : 106-111.

Qui, L. 2009 : Where the rubber meets the garden. *Nature*, 457 : 246-247.DOI : 10-1038/457246a.

Rahaman, W.A. 1994 : Natural rubber as a green commodity – Part.1.*Rubber Developments*, 47 : 13-16.

Ramkrishnan, P.S. 1984 : The science behind rotational bush fallow agriculture system (Jhum). *Plant Sciences*, 93(3) : 379-400.

Ramakrishnan, P.S. 1992 : Shifting Agriculture and Sustainable Development : An Interdisciplinary Study from North-Eastern India. MAB Series, Vol. 10.UNESCO, Paris.

Ramakrishnan, P.S. 2001 : Rehabilitation ecology and degraded rural landscape. In : *Ecology and Sustainable Development*, NBT, India, New Delhi. pp. 132-149.

Saha, R., Choudhury, R.S. and Somasundaran, J. 2012 : Soil health management under hill agrosystem in north east India. *Applied and Environmental Soil Science*, Article ID696174, 9 pages, doi : 10.1155/2012/696174.

Sailajadevi, T. 2010 : Has the climate changed in NE India ? In *: International Workshop on Climate Change and Rubber Cultivation : R & D priorities*, Rubber Reasearch Institute of India, Kottayam, India.

Sarkar, S. 2010 : Revolution of jhumia's life through rubber plantation : a case study of Dhalai District, Tripura.

Sethuraj, M.R. 1996 : Impact of natural rubber plantations on environment. In : *Natural Rubber : An Eco-friendly Material*, Rubber Board, Kottayam,pp. 55-59.

Sharma, T.C. 1976 : The pre-historic background of shifting cultivation. In : *Shifting Cultivation in North-East India*, NEICSSR,Shillong, India.

Singh, D. 1996 : The Last Frontier People and Forests in Mizoram. Tata Energy Research Institute, New Delhi.

Sinha, A. K. 2012 : Rubber plantations in Northeast India : hopes vs. concerns. *The Tripura Foundation*, pages 3.

Spencer, J.E. 1966 : Shifting Cultivation in Southeastern Asia. University of California Press.

Tang, Z., Zhang, Y., Sony, Q., Liu, W., Deng, X., Tang, J., Deng, Y., Zhou, W., Yang, L., Yu, G., Sun, X. and Liang, N. 2011 : Rubber Plantations act as water pumps in tropical China. *Geophys. Res. Lett*., 38 : L24406, doi : 10. 1029/2011/GL050006.

Tripathi, R.S. and Barik, S.K. 2003 : Shifting cultivation in North East India. In : *Proc. Approaches for Increasing Agricultural Productivity in Hill and Mountain Ecosystem* (Eds. Bhatt, B.P., Bujarbaruah, K.M., Sharma, Y.P. and Patiram). ICAR Research Complex for NEH Region, Umiam, Meghalaya, India. Pp. 317-322.

Thrupp, L.A., Hecht, S.B. and Browder, J.O. 1997 : The Diversity and Dynamics of Shifting Cultivation : Myths, Realities and Policy Implications. World Resource Institute, Washington DC. Pp. 48.

Uhl, C. 1987 : Factors controlling succession following slash-and-burn agriculture in Amazonia. *Journal of Ecology*, 75 : 377-407.

Van Keer, K. 2003 : On-farm agronomic diagnosis of transitional upland rice swidden cropping system in northern Thailand. Ph. D. Thesis, Fuculteit Landbouwkundige en Toegepaste Biologische Wetenschappen-katholieke Universiteit Leuven, Leuven.S

Ziegler, A.D., Fox, J.M. and Xu, J. 2009 : The Rubber Juggernaut. *Science*, 324(5930) : 1024-1025.

Ziegler, A.D., Bruun, T.B., Guardiola-Claramonte, M., Giambelluca, T.W., Lawrence, D., Nguyen, T. 2009a : Environmental consequences of the demise in swidden agriculture in SE Asia : geomorphological process. *Human Ecol.*, 37(3) : 361-373. DOI : 10.1007/s10745-009-9258