Bamboo Flowering, Rat Floods and Food Security in the Chittagong Hill Tracts, Bangladesh: Coping Mechanism

Mahfuzul Haque

Department of Sociology, Bangladesh University of Professionals, Dhaka, Bangladesh

Email: drmahfuzulhaque@yahoo.com

Abstract: Outbreak of rodent population due to bamboo flowering is a scientifically accepted phenomenon happening in the South Asian region of India, Bangladesh and Myanmar for ages. The dominant gregarious bamboo species in the region generally flower on a 40-50 year cycle. Rats feed on the seeds. Expansion of the rat population occurs through reproductive rate. When the bamboo seeds eventually become scarce, the rats move out into agricultural fields and rural communities in search of food, eating everything they can find and create food insecurity in a jhum-based economy, otherwise known for food abundance. People's livelihood is at stake. Damages caused by the rats in the Chittagong Hills are 4-5 times more than seen in other parts of the country. Following devouring of field crops, the rats get into people's houses, eating stored food and damaging all sorts of personal possessions, even biting people while they sleep. A potential threat of bubonic plague loom large entering from plague-endemic neighbouring country of Myanmar. Similar attack in 2006 in the north eastern state of Mizoram, India entered Bangladesh in late 2007 continued till 2015 causing food insecurity in an area, otherwise known once as a "bread basket". Rat infestation is a slow onset natural disaster, not known to many and is particularly a dreadful event that periodically visit the Jhum areas in the Chittagong Hill Tracts (CHT), Bangladesh. Based mainly on secondary sources of literature and the author's extensive field work during writing of his dissertation, the paper argues that due to indigenous knowledge and practices of the local tribal communities, rat menace was curbed substantially. The paper looked at various methods applied by the local communities starting from trapping, use of repellants, rodent proofing and barriers, use of predators, various environmental and cultural methods in reducing the damages. The paper comes up with some recommendations based on age-old practices of the indigenous community.

Keywords: Bamboo Flowering; Rat Floods; Rodent; Chittagong Hill Tracts; Jhum Cultivation.

INTRODUCTION

Bamboos are in abundance in the Chittagong Hill Tracts, south-east of Bangladesh, where traditionally, they are used for a variety of purposes-housing, fencing, basket and handicraft making. Bamboos constitute an important industrial raw material and are vital for the economy of many countries. Death of bamboo forests after gregarious flowering causes not only ecological crisis but also livelihood insecurity. This peculiar behavior of periodic bamboo flowering has intrigued mankind for long and still remains a mystery (John *et al* 2002). From time immemorial, many beliefs are associated with bamboo flowering and in general, bamboo flowering is considered a bad omen.

Mizoram in India experienced sporadic flowering of bamboos during 2004-2006. Bamboo represents one of the largest vegetation in Mizoram and plays a dominant feature of the state's landscape. The bamboo brakes are entirely of secondary origin due to clear felling of primary forests for jhum cultivation. The government of Mizoram took a comprehensive action plan in order to tackle severe famine and plague caused by gregarious bamboo flowering (Govt of Mizoram 2004-2007). The Action Plan included publicity, awareness campaign, training of farmers, cash incentives for rat tails and distribution of free rodenticides (safer for humans and livestock) for controlling the rodents.

Starting on taxonomy of bamboo species, flowering of bamboos, production of seeds and influx of rodents in the South Asian region, the article dealt with the "rat floods" and pest-induced famine that swept parts of the Chittagong Hill Tracts in the south-eastern Bangladesh in 2007. The article unearthed the scientific background of periodic flowering of bamboos, their life-cycle, production of seeds attracting the rodents and eventual death of the bamboo groves. As the disaster is not a regular phenomenon, it is only identified by the elders of the local indigenous community. In most of the affected areas, the farmers took the disaster as fait-accompli. Based mainly on secondary sources of literature and the author's extensive field work undertaken earlier,

the paper argues that unless the local farming communities are made aware of impending menace and abatement strategies, famine would continue to create havoc in that already impoverished region-victim of years of neglect and remoteness.

The article deliberated on the land, forests and hills of the CHT and the people therein. Local agricultural practices, like jhum cultivation, were also discussed in threadbare. Various reports available in secondary sources were looked into in order to understand the rodent species and their foraging pattern. The article looked at various methods applied by the local communities starting from trapping, use of repellants, rodent proofing, erecting barriers, use of predators and various environmental and cultural methods in reducing the damages. The paper discussed various rodent control devices in practice in the region and deliberated on coping strategies adopted by the jhumiya farmers in the Chittagong hills. Finally, the article in conclusion, suggested some recommendations.

LAND CHARACTERISTICS OF THE CHT

The Chittagong Hill Tracts, comprising of the three hill districts of Khagrachhari, Rangamati and Bandarban, is geographically an isolated region of Bangladesh. The area constitutes 10 per cent of the total area of the country is full of hills, ravines and cliffs covered with dense vegetation (trees, bush, creeper and jungle etc). The hilly region comprises of seven main valleys formed by the rivers of Feni, Karnafuli, Chengi, Myani, Kassalong, Sangu and Matamuhuri. The valleys are covered with dense bamboo breaks, tall trees and creeper jungles (Haque 2008). Main features of the vegetation are tropical evergreen or semi-evergreen rainforests dominated by tall trees. Most of the CHT slopes have severe limitations for plough cultivation. Steep slopes, heavy monsoon rainfall, shallow soil depth, low soil fertility and droughts are the main features of this landmass.

According to the soil and land use survey conducted by a Canadian Company (Forestall Survey, 1966), the soil has been classified into seven categories. The most important ones are clay loam, sandy loam and silty clays. The most extensive is silty clay loam, which covers 67 per cent of the total area. Only 3.1% of the land is suitable for arable agriculture and categorized as class A and 2.7% is suitable for terraced agriculture or horticulture and categorized as class B. About 89% of land categorized as C and D is suitable for tree cropping and forestry only (Haque 1997; Tripura *et al* 2003; and Rasul 2009). The area experiences a complete tropical monsoon climate with hot wet summer and dry cool winter seasons. In such an isolated hilly and difficult terrain with poor soil conditions and hostile climate, the local indigenous community had no other choice but to practice jhum cultivation (slash and burn) in the steep slopes of the hills.

Jhum is a dominant form of agricultural land-use in the hilly region of the Chittagong Hill Tracts of Bangladesh. Eleven minority ethnic groups practice this form of slash and burn method. The majority of Mros (86.4%) and Tripuras (54.8%) and a large number of Marmas (42.3%) are involved in jhum cultivation, while only 22.7% of Chakma farmers practice jhum cultivation (Rafi et.al. 2001, p.100). Approximately, 41,000 ha of land of this region (14% of total cropped area) is used for shifting cultivation every year and about 73,000 families are engaged in this traditional form of agriculture (Rasul 2009, p.4). Women play an important role in the family as they take active part in clearing and burning of bushes, selection of plots and seeds, opportune moment for sowing after the first rain, guarding the jhum fields from marauding animals and organize harvest. They have also a leading role in collection of water from the fountains, cooking, weaving clothes from jhum cotton, raising children and visiting local markets to sell their produce. These independence-loving women are the backbone of subsistence agricultural economy of the Chittagong hills.

Shifting cultivation or Jhum is common across lower and medium altitudinal ranges of the eastern Himalayas. Across Asia, more than 400 million people are dependent on tropical forests and a majority of them practice shifting cultivation (Kerkhoff *et al* 2006, p.4; Haque 2014). Most of them belong to indigenous minority groups and they subsist on variations of forest farming supplemented by hunting and gathering activities. Shifting cultivators remained on the fringes of the hills and are amongst the poorest of the community. There were many efforts by the government and Forest Department officials to restrict jhum cultivation terming it as destructive.

Despite intensive government efforts to control shifting cultivation, the practice remained entrenched over the large areas of the Asian region. Besides, the South Asian countries, shifting cultivation is also practiced in many other tropical countries of Laos, Cambodia, Thailand, Philippines, Indonesia and many countries of Africa and Latin America. As a method of cultivation, jhum is known in many other names, like, shifting cultivation, slash-and-burn, extensive agriculture, swidden agriculture, bush-fallow agriculture, forest farming, rotational agro-forestry etc. (Tripura, P. *et al* 2003, p.60). Jhum is a kind of community agriculture (Gain 2013, p.48). The whole family or community gets engaged in it that requires hard labour and constant care. It has also a great influence on the culture of the indigenous peoples. Jhum happened to be a way of life for the Jhumiyas, it was a self-sustaining economy, from where a Jhumiya family used to get all their basic needs, starting from food, clothing, herbal medicine to shelter-the bamboo huts. They used to grow enough food for themselves with an annual surplus. They have developed a symbiotic relationship with Jhum. They are the sons and daughters of the Jhum. Without Jhum, their lives are meaningless. They tend to be independent, self-sufficient peoples and their entire cultures are often neatly integrated with their agricultural cycles (Bodley 2008, p.136). Losing jhum crops due to rat invasion and thereby creation of a famine like situation has long-time telling effects on this marginal and peripheral community.

BAMBOO FLOWERING IN THE CHT

People in the CHT, specially the Jhumiya farmers believe that bamboo flowering is the harbinger of famine- a bad omen. The gregarious flowering of bamboo produces large quantities of nutritious seeds resulting in population explosion of rats, as these rodents feed on the seeds. When seeds are eaten, the rodents move towards the jhum field, the farmers store houses and food granaries causing a famine like situation. Such famines are prevalent in some East Asian hilly terrain of Mizoram in India and Myanmar. In the northeastern region of India, bamboo forests are in abundance. Patches of jhum fields within the bamboo groves are invaded by marauding rodents, when the bamboo seeds are all eaten. Given the peculiar geography and cultivation practice in northeast India and also in the Chittagong hills of Bangladesh, it is strongly believed that there is a connection between the incidence of bamboo flowering and famine, which is not a myth but a reality (John *et al* 2002).

In 2006, bamboo flowering started in the northeastern Indian state of Mizoram, which is adjacent to the CHT, the phenomenon crossed the border in late 2007 with reports on incidence of rat plague and the negative consequences of food shortages and destruction of livelihood opportunities (Nishorgo 2008). This slow onset disaster is particularly dreadful among the Jhumiyas. Bamboo flowers only once in the plant's lifetime and dies after flowering. "Rat floods" in the CHT are related to a little-known aspect on the biology of bamboo. Most types of bamboo undergo what is called periodic gregarious mass flowering and seed masting. Unlike many plants, bamboo does not produce flowers every year. The type of bamboo commonly found in the CHT only flowers every 40-50 years. When this happens, all the bamboo groves in the hill tracts start to flower and produce seeds over a 3-4 year period. This bamboo flowering starts in the north of the CHT in the Indian states of Tripura and Mizoram, moving towards Bangladesh and onwards into Myanmar. Rats find the abundant bamboo seeds to be tasty and nutritious. With such an abundant food supply, the rats grow large and are able to produce many more offspring than they normally would. When the bamboo seeds are all eaten, the large population of rats moves out of the forest in search of other things to eat. As the "rat flood" event is occurring in Myanmar, a country where bubonic plague is endemic, there is a risk of plague entering Bangladesh over the Myanmar borders through dispersing rodent populations.

The bamboo flowering and rodent crisis that started in 2007 continued for successive three years. Although, the situation improved over time, the loss of crops for a third year running has left communities extremely vulnerable. The rats have declined in numbers, but the bamboo groves are dying, causing livelihood insecurity for the local indigenous community. There are report of further crop damage in 2009, caused mostly by wild pigs as well as the rats. The UNDP report (2008) stated that around 130,000 people, or about 10 percent of

CHT's population were affected by the rat-induced famine. The destruction of people's livelihoods can be severe as the rats not only destroy all agricultural produce, but also ruin local stocks of yarn for weaving, finished goods such as blankets and clothing, and cause disease outbreaks by contaminating water supplies and/or biting people while they sleep. This population, isolated and remote, has already faced successive shocks over the last few years by the rodents, wild pigs, marauding wild elephants and livelihood insecurity due to loss of bamboo brakes.

RAT TAXONOMY

Against the backdrop of rodent outbreak in the CHT during 2006-2007 period, a taxonomic study was conducted in Bandarban hill district to understand the rodent species in the affected areas (Chakma *et al* 2018). The study found that diversity of rodents was high in Bangladesh-around 20 rodent species. Rattus rattus was the dominant rodent species comprising 54.06% of the sample collected. In Mizoram, Assam and Nagaland in India, the main species also was found to be R. rattus. This very species was reported to be the main pest during the rodent outbreaks in the Chin State of Myanmar as well as in Lao PDR. Knowing the species of the rodent is very important, as it helps the farmers, the agricultural scientists and the policy makers to know habitat, food habit and foraging of the rodents in order to control this menace.

FARMERS' COPING STRATEGIES

Farmers of the South-Asian region use several traditional techniques for controlling the rodents. The available rodent control options follow a two-prong approach: lethal or reduction of population; and non-lethal or preventive measures (Parshad 1999). The lethal approach, mainly considers the use of rodenticides. Trapping is often considered the most practical, economical and effective method in combating this disaster. Non-lethal or preventive measures involve environmental, cultural and biological methods. The most common practices within the environmental and cultural methods are as follows:

Shrinking Habitat: Garbage, junk and other hiding and nesting materials provide a congenial atmosphere for the rodents to nest. The periodic removal of rubbish and good hygiene, discourage rodents to thrive. Mechanization of agriculture has also reduced wasteland and wild vegetation on crop field boundaries, which would otherwise provide safe habitat for the rodents. Dikes, bunds and the earthen embankments of water channel are favourite places for the rodents to make burrows and nest. Regular repair and maintenance of bunds and dikes help discourage the rodents to make burrows. Deep poultry litter provides a congenial atmosphere for the rats to thrive, as they make nests and hide below the litter bed and feed on grass hoppers. Regular cleaning of poultry litter deters rats to make nests. As weeds form an important component of diet of rodents, regular weeding of crops through use of chemicals help curtail their food sources. Removal of additional food sources for rats in stores and godowns and food scraps left from feeding domestic animals, if not removed, attract rodents.

Construction of Barriers: There are some species of rodents that climb trees and buildings. Different techniques, such as barriers, electric fences, repellents and rat proofing, can be used to prevent the rodents from climbing. Banding the trunk of coconut trees with metallic sheet prevent rodents climbing to the crown of the coconut trees. About 7.5% coconut trees were reported infested with rats in an area where the tree trunks were banded compared to 25% of trees, which were not banded (Parshad 1999). Occasionally, some farmers use crude electric fence to drive away the rodents.

Repellents: There are some traditional ways to repel the rats, such as placing of screw pine leaves along the edges of paddy fields and flagging of palm leaves or polythene pieces on a pole to make rattling sounds to scare away the rodents. Damage caused to treated cardboard cartons showed that surface application of 1.5% and 4.5% solutions of copper oxychloride and thiram in water and peanut oil, respectively, provided a degree of protection to the cartons.

Rodent-proofing: Rodents often enter human dwellings, animal houses, shops, stores and godowns through several openings. Proofing of these entries with appropriate techniques would reduce damages. Use of metallic drums and improvements in traditional storage structure help reducing the damage to stored food grain in rural areas.

Cultural Practices: There are certain cultural practices, which would control spread of rodents and reduce damages substantially. Traditionally, farmers conduct deep tillage, which destroys rodent burrows and their habitat. Wheat sown after mulching with rice straw often develops large population of rats with deep burrows during the ripening stage. Ploughing of vacant land around wheat fields causes about a 49% reduction in burrows (Parshad 1999). Diversify of agriculture, like replacing rice with sunflower and horticulture may reduce rodent infestation and damage throughout the crop period. Sugarcane fields are highly vulnerable to attack by the rodents. Flooding of fields before rice plantation drives away rodents into adjoining sugarcane and permanent boundaries.

Biological Methods: Biological control involves the use of predators, parasites, pathogens and reproductive inhibitors against rodents. Environmental changes due to over exploitation of land and forest resources have disrupted the natural control of rodents. The major predators of rodents are cats, mongeese, jackals, foxes, owls, hawks, kites, monitor lizard and snakes. Population of these predators has declined substantially due to depletion of forests and land use changes. Farmers sometimes place tree branches of T-shaped perching poles in the crop field to encourage the predators like barn owls and birds in various parts of Bangladesh.

Parasites and Diseases: The potential of micro-parasites (viruses, bacteria and protozoans) and macro-parasites (helminthes and arthropods) as bio-control agents of rodents is well known. They play an important role in controlling these rodents. The salmonella bacteria has been found to be effective in many parts of the world in controlling this pest, although it's adverse effects on humans and livestock cannot be ignored.

Mechanical Methods: Mechanical techniques such as hunting, killing and trapping require high labour costs. However, integrating this method with chemical control techniques would prove better result. Chemical use of rodenticides may have adverse effects on humans and livestock.

Physical Killing: During ploughing of fields and flooding of burrows, bandicoot rats could be hunted and killed with sticks. After harvesting, the bandicoot rats roam in the field and store grain in their burrows allowing an opportune moment for the farmers to kill them. They can also be hunted by rat dogs. Sometimes, the tribal people, who eat rats, catch them live from the burrows by digging or by smoking the burrows by burning cow-dung cakes or rice straw through one end of the opening of the burrows. In coconut plantations, villagers organize rat hunts engaging the entire community. Process includes climbing of the trees, cleaning the crowns and violently shaking the tree leaves. Rats free fall on the ground and get caught. Trapping rodents in the fields and premises by traditional traps are also a common practice.

Timings of Rodent Control: Rodenticides are used mainly during two periods- the lean period and the crop period. The months of May and June and of November and December, which fall between two major crop seasons that is summer and winter, are termed as lean period. During the lean period, food and shelter are scarce in crop lands and the rodents easily accept the poison baits in their burrows. Bangladesh showed that baiting of burrows in bunds and along roadways during early monsoon rice is effective in reducing rodent population (Sultana *et al* 1992).

The UNDP report (2008) mentioned that the farmers in famine-hit areas, hardly received 10-20% of normal harvests in the CHT. All food crops grown were badly affected including rice, maize, pineapple, potato, beans and all other vegetables. Farmers were found adopting various coping strategies. These include a) planting alternative non-food crops such as ginger or turmeric instead of rice and maize; b) ceasing to plant *jhum* field altogether; c) building trap barriers around their *jhum* fields to keep the rats out of their crops; d) diversify their incomes through the production of handcrafts and selling non-agricultural based products in order to buy food during "rat floods". However, because of remoteness of the locality away from the markets, the *jhumiya* farmers were left with little alternative but to continue planting their *jhum* fields and accept the damages caused by the rodents. To make a living, they often adopt new occupations such as wage labour, animal husbandry, cultivation of annual mono-crops and selling of livestock and forest products. In the most severely affected areas, food stocks get exhausted and the consumption of yams and bamboo shoots increased (Nishorgo 2008).

There are reports that bamboo flowering could be a blessing as the bamboo forests could be regenerated by a genetically diverse next generation seeds, provided the bamboo groves are conserved and protected in situ (Sertse *et al* 2011). In most bamboo growing areas, its flowering is regarded as a disease- a bad omen. Proper awareness raising could encourage the farmers to collect and conserve the seeds for regeneration of bamboo forests.

CONCLUSION

The traditional belief that rodent outbreaks occur in response to bamboo flowering events is clearly established from various studies (Douangboupha *et al* 2001). Effective implementation of rodent control in agricultural, rural and urban situations requires long-term awareness raising and training programmes. Economic support in the form of subsidies on metallic and non-metallic rat proof storage structures and a free supply of rodenticides considerably helped to reduce the problem. Emphasis has to be given on an Integrated Pest Management (IPM) approach which would require an effective integration of different techniques of rodent control in an ecologically based control system. With changes in agro-climatic conditions and cropping patterns, rodents are showing changes in their foraging pattern. In fact, rodents are highly responsive to environmental conditions and their population and behaviour vary with the ecological, phenological and climatic conditions of the agro-ecosystem.

Awareness raising and training of farmers, agricultural officers are required to control the rodent menace. Incentives, such as "cash on rat tails" proved very effective in various parts of the CHT during 2006-2007 rat floods. UNDP Report (2008) urged upon the government of Bangladesh to undertake a strategy building on the experiences of a similar strategy adopted by the Mizoram State Government in India. Components of this strategy are as follows: a) Community training and capacity building; b) ecosystem research; c) formation of a bubonic plague action committee; d) fire prevention; e) economic reconstruction; f) health research; g) law and order and emergency relief; and h) publicity and awareness campaign.

Several biological and socioeconomic factors interact in rodent control, these include complex behaviour of rodents, their diverse adaptation in different pest situations, the potential non-target hazards of rodenticides, self- protection mechanisms and responses of rodents to control techniques, complex social and religious perceptions, rodents as food sources to certain tribes, small land holdings with difficulties in organizing village level campaigns and low economic levels. Because of this complexity, the effective implementation of rodent control technologies, which have improved significantly during the last two decades, probably requires a special task force to plan, organize and conduct rodent control campaigns in agricultural, rural and urban situations in Bangladesh and elsewhere with similar terrain.

REFERENCES

[1] Bodley, John H. (2008). Victims of Progress, Fifth Ed., Altamira: Lanham, New York, Toronto, Plymouth, 136.

[2] Chakma, N., Sarker, N.J., Belmain, S., Sarker, S.U., Aplin, K. and Sarker, S.K. (2018). "New Records of Rodent species in Bangladesh: Taxonomic Studies from rodent outbreak areas in the Chittagong Hill Tracts". *Bangladesh J. Zool*, *46*(2),217-230. https://doi.org/10.3329/bjz.v46i2.39055

[3] Douangboupha, B., Aplin, K.P., and Singleton, G.R. (2001). "Rodent outbreaks in the uplands of Laos: Analysis of historical patterns and identity of nuu khii", Rats, Mice and People: Rodent Biology and Management. CSIRO, Canberra, Australia.

[4] Gain, P.(2013). The Chittagong Hill Tracts, Man-Nature Nexus Torn, Society for Environment and Human Development (SEHD), Dhaka, 48.

[5] Government of Mizoram 2004-2007. Achievement Reports on Bamboo Flowering & Famine Combat Scheme (BAFFACOS) during 2004-2005 & 2005-2006, Planning & Programme Implementation Department.

[6] Haque, M. (2013). Jhum or Not to Jhum: Agricultural Practices in the Chittagong Hill Tracts, Bangladesh. Bangladesh Rural Development Studies. Vol. XVII (1).

[7] Haque, M. (2013). Environmental Governance: Emerging Challenges for Bangladesh, AHDPH, Dhaka.

[8] Haque, M. (2009). "Post-Conflict Situations in the Chittagong Hill Tracts, Bangladesh" in Mizanur Rahman, ed., Post-Conflict Justice, Peace and Human Rights, ELCOP and Palal Prokashoni, Dhaka.

[9] Haque, M. (2008). Trekking the Tracts, Livelihood Security of the Indigenous Peoples in the Chittagong Hill Tracts, Bangladesh Resource Centre for Indigenous Knowledge (BARCIK), Dhaka.

[10] Haque, M. (1997). Ethnic Insurgency and National Integration: A Study of Selected Ethnic Problems in South Asia, Lancers Books, New Delhi, India.

[11] John, C.K. and Nadgauda, R.S. (2002). "Bamboo flowering and Famine". *Current Science*, *82*(3), February 2002.

[12] Kerkhoff, E. and Sharma, E. (2006). Debating Shifting Cultivation in the Eastern Himalayas: Farmers' Innovations as Lessons for Policy, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal. https://doi.org/10.53055/icimod.445

[13] Nishorgo (2008). Needs Assessment Report on Bamboo Flowering, Rat Infestation and Food Scarcity in the Chittagong Hill Tracts, Bangladesh. Hellen Keller International, Nishorgo Support Project, 2008.

[14] OCHA, (2010). Bangladesh: Rodent crisis leaves thousands hungry. ReliefWeb, 22 April, 2010.

[15] Parshad, V.R. (1999). "Rodent Control in India". *Integrated Pest Management Reviews*, *4*(2), 97-126. https://doi.org/10.1023/a:1009622109901

[16] Rafi, M. and Chowdhury, A.M.R. (2001). Counting the Hills: Assessing Development in the Chittagong Hill Tracts, University Press Limited (UPL), Dhaka, 100.

[17] Rasul, G. (2009). Land Use, Environment and Development Experience from the Chittagong Hill Tracts of Bangladesh, AHDPH, Dhaka, 4.

[18] Sertse, D., Disasa, T., Bekele, K., Alebachew, M., Kebede, Y., Eshete, N., and Eshetu, S. (2011). Mass flowering and death of bamboo: A potential threat to biodiversity and livelihoods in Ethiopia. Journal of Biodiversity and Environmental Sciences (JBES), *1*(5), 16-25.

[19] Sultana, P. and Jaeger, M.M. (1992). Control strategies to reduce pre-harvest rat damage in Bangladesh. Proceedings 15th Vertebrate Pest Conference (J.E. Borreco & R.E. Marsh eds.) University of California – Davis, 261–267.

[20] Tripura, P. and Harun, A. (2003). Parbattya Chatrograme Jhumchash (Jhum cultivation in the Chittagong Hill Tracts). *Society for Environment and Human Development* (SEHD), Dhaka, 60.

[21] UNDP, (2008). Scientific Assessment Report on Bamboo Flowering, Rodent Outbreaks and Food Security: Rodent Ecology, Pest Management, and Socio-Economic Impact in the Chittagong Hill Tracts, Bangladesh, United Nations Development Programme, Bangladesh.

[22] UNPO, (2009). Chittagong Hill Tracts: Bamboo, Rats and Famine. Unrepresented Nations & Peoples Organization (unpo.org), The New Nation, 18 February, 2009.

Received on 05-02-2023 Accepted on 20-02-2023 Published on 15-03-2023