

Traditional Knowledge: Watering and Irrigation Practices of Khasi Tree-Crop Gardening System in the Northeast Bangladesh

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Abstract

Indigenous Knowledge base tree crop farming system is prevalent from time immemorial to Khasi community in Bangladesh. This is their main subsistence and earning economy. However, environmental degradation with global warming and the shortage of natural resources has threatened the overall cultivation system. The topsoil of landscape with water bodies and ground water are not adequate for watering in the field. Therefore, it is burning question how Khasi manage and organize tree-crop farming in the field and what types of initiatives are taken by them to grow tree crops. To explore these issues a qualitative approach and participant observation method with in-depth interviewing techniques, group discussion and key informant methods were employed to elicit data from the field. The collected data have been analyzed in inductive approach and categorized it from various chunks of information as objectives. The findings showed that traditional knowledge as local knowledge of the Khasi has been modified to the context different topographical structure and texture of soil with hill surrounding natural setting considering the local ecology, environment and biodiversities. The obtained findings uphold some empirical issues of indigenous practices with scientific practice of tree crop cultivation for getting soil moisture, fluid and water, which derives from rotted tree-twigs. While organic wastes and the foliage are not adequate, they use harvested rainwater, shallow-well water and ground water by using diverse ways and techniques. The watering and irrigation practice in the tree-fields are administered by the influence of modern irrigation inputs, including traditional Knowledge.

Keywords: Khasi, Traditional knowledge, Sustainable Farming, Tree Crops, Watering, Irrigation.

Introduction

Khasi are one of the main ethnic communities of northeast Bangladesh, depending on tree crop cultivation systems for their earnings and livelihood. Their traditional farming practice is ethnoecological based without exploitation of over natural resources, which is their age-old farming system (Nath, Makoto, Islam, and Kabir, 2003). It is emerged by local farmers through generation after generation of their communication with nature and natural resources for every day need. It is an

indigenous method of farming tree crops by using own locally origin available materials without use of massive external/global materials. Indigenous cultivation system, once was extensive all over the world, is now almost eroded from the developed countries limited to some ethnic dominated areas of developing countries engaging more than half of tillable land (Thurston, 1992). Anywhere they are, the general aspect of indigenous cultivation is the existence of spatial and temporal heterogeneity frequently with mix plant age arrangement, intercropping, multi-cropping, host-pathogen

interactions and practice of easy instruments to till and harvest the crop. In Bangladesh Khasi use indigenous farming systems due to the diversity of agro-ecological settings and occupied by them, which is being practiced as age-old farming system since generation in a location of particular conditions. It is a tribal farming method, which gets the local people from the nearer skill people with respect of the nature and environment (Emery, 1996).

Khasi's tree crop farming tools and techniques either unidentified or least understood. However, with the arrival of scientific farming, customary cultivation system in Bangladesh is widely confined to uphill areas where the peripheral regions green revolution could not affect local and indigenous farmers. Khasi practice tree crop cultivation by using organic farming inputs with watering surface and ground water. Most of the Khasi upland surface could be considered as having a number of watersheds. But currently, environmental and ecological issues in the area are rapidly decreasing the natural forest resources. The inappropriate land use practices of migrants and lowlanders have degraded the water bodies (Misbahuzzaman, 2007). Hill cutting, making agricultural plot, making house, and building of infrastructure by development agencies and overall deforestation have seriously affected the hill streams and environment. Now, most of the Khasi hills have no adequate natural water bodies. The overall land degradation factors are the reasons for soil erosion, siltation of lakes and rivers (Khasa, Shoaib, & Khan, 2006). Mono-culture of commercial organization and others non-eco-friendly activities in the large piece of hill forest have degraded the soil, and the sediments have blocked the water flow of fountains and springs as well as destroyed the water bodies. In the dry season, the planted trees of rainy season are protected by using organic mulch which discharges water and moisture at tree-roots.

The local hill people once depended on sources of surface water, now they have fallen into a water crisis in the tree gardens. The daily lives of farmers with plant, animal, fishes and farming system have deteriorated (Misbahuzzaman, 2007). The indigenous knowledge-based expert skill for watering practice from surface water is not being used. Because of the ground water level has decreased and wells do not provide adequate water in the dry season. Khasi try to keep ecofriendly and locally adapted farming system. During the monsoon they have to harvest rain water for the dry season for cultivation. Ultimately, Khasi subsistence, flora and fauna are adversely affected.

Khasi to overcome this impact, integrate local and global scientific knowledge and practice in the field through diverse farming material - traditional and/or industrial.

Bamboo-drip and shallow-well watering farming practice has a long tradition among indigenous people of Khasi, where tree crops are growing widely in the field following agro-climatic setting. Indigenous people know the farming environment in different seasons and react to it from planting to harvesting (Jeeva, Laloo, & Mishra, 2006). Traditional tree-based farming practice helps in conserving and improving the field, optimizing the integrated production of various tree-species (Jeeva et al., 2006). In this system, there is a symbiotic relationship among the grown tree-species. In Khasi indigenous knowledge on farming, part of environmental issues especially the soil, air and water are most commonly considered in the tree-crop fields. These farming materials are very much integrated and cross linked to the whole farming production system (Arnold & Dewees, 1997)

Khasi hill farmer trim trees and twigs, manage shade, provide mulch and allowed optimum sunlight in the field to grow up tree crops (Haider et al., 2013). Moreover, they manage surface and ground water in the uphill by applying local knowledge and intelligence. Some trees that are watery release water through their roots and stems to other surrounding trees. Khasi cultivate barren land and plant trees because of insecurity of land and make it fertile by using the surrounding flower litter and decomposed plants, which help to make soil wet. Khasi arrange partial shade by planting fast-growing trees with the use of extra organic manure from different sources.

The maximum attributes of sustainable farming systems are prevalent in Khasi hill-farming system. However, the non-indigenous people exploit natural tree-resources overly due to the pressure of overpopulation, and the consequent fall on hill-farming environment. The effects of globalization, commercialization, and industrialization have declined the natural resources (Guha & Gadgil, 1995). Hill farmers have not found available natural farming inputs. This is why recently, for their subsistence need and economic tree crops production, Khasi use commercial or industrial farming inputs with integrating natural farming inputs. They accumulate local knowledge and scientific knowledge and use both domains' cultivating materials at an optimum level to grow tree crops eco-friendly in the fields.

Materials and Methods

The study site

Khasi reside mainly in the greater Sylhet Division in the North-eastern area and border of Bangladesh. The study was carried out among them. For the study purpose Kulaura sub-district was selected considering Khasis' uphill tree-crops field with forest surrounding streams and water bodies. The area lies between latitude 24°01' to 25°15' north and longitude 91°05' to 92°15' east. The north-eastern part of Sylhet is a broad, level valley. Indian Khasi and Jaintias' hills to the north form a barrier the base of which builds the district border. The study area was situated in a remote place and far from the district town of Sylhet. The soil, including clayey and sandy loams of hilly ground is especially fertile. The climate of Sylhet district is warm and humid, mean maximum and mean minimum temperatures are 33°C and 18°C respectively. Mean humidity is 80% and mean annual rainfall is 3800 mm (Ahasan, Chowdhary, and Quadir, 2010). There were one *punji* (village) under this study, namely Singuir Punji. The population of this village (*punji*) is near about 200. The inhabitants' source of livelihood of this village is forest, traditional hill-farming system, based on local watering and irrigation systems. The selected village was an interesting site, because of having physical proximity, it is dominated by un-classed State forest Department. Villagers farming technique and categories of trees, system, concept, geographical location and landscape with secondary natural forest are almost similar. However, for looking similarities and contrast in tree-crop farming system of indigenous knowledge about the organizing of watering and irrigation system is observed on selected village.

Methodology

The data has been gathered for this study over a period of nine months from 2014 to 2016. Researcher engaged in 70 village inhabitants in open-ended interviews, which is administered in Bengali language. The study used a purposive sampling strategy considering the entire farming population of knowledge dynamics those age ranges are 15 to 55 years. In some instances informants were selected through snowball sampling techniques. The purposive sampling technique was employed to recruit in in-depth interviews those directly related to knowledge generation, integration and implementation activities in farming community. The snowballing strategy is adopted to recognize

the knowledgeable and potential key informants to indigenous and modern and /or mix knowledge users, who were interviewed, asked for further names, and so on. In other ways they were selected with the help of community leaders to cover a broad spectrum of socioeconomic classes, ethnic religious groups, gender, and age group as well as formal and informal education, certain experiences. Using a general interview guide that was openly changed as new situations and information arose. Researcher discussed watering and irrigation knowledge with the influence of modernity and the consequence of it in overall farming knowledge dynamics in tree crop cultivation.

Interviews were open-ended nature, though not all topics were sheltered in all interviews, but each main topic was at least covered by a large adequate sample to be flexible to some form of analysis. While the concentration of the study was surrounded by concept, knowledge and practice of farming community, discussion often also turns to general to acute farming knowledge dynamics about Khasis' watering and irrigation system, which were also recorded. This study employed the combination of emic (internal) and etic (external) approaches to understand the inherent quality of data, because the way in which they were elicited and the method in which they were analyzed. The open-ended nature of interview questions permitted the informants to describe their knowledge, thought and ideas of modern observation were often jotted down in order to protect emic nature and farming knowledge. But real generalization and conceptualization of these individual, insider views into a widespread system was in large part carried out later by researcher from an etic perspective.

Results and discussion

Settlement and Gardening

The Khasi live permanently in the uphill surrounding forest, habituated on the tree crop farming system. The land-use system comprises tree growing in the homesteads and uphill fields. Their living and subsistence are coming from the tree crop farming economy with various categories of trees cultivated year-round without practicing *jhum* or swidden agriculture. Population pressure and insecurity of land prompt them to practise uninterrupted tree crop farming (Saha & Azam, 2004). The pressure of overpopulation, land scarcity and poverty influence Khasi to utilize the natural resources intensively for sustainable development. The government has taken initiative to rehabilitate

the forest and conserve biodiversity by using effective land use system. Forest Department has provided the Khasi certain quantity of land for living and farming peacefully with employment (Saha & Azam, 2004). In addition to the assigned forest work of Forest Department, Khasi are entitled to grow extra tree crops in their allotted farm land. The Khasi indigenous people have appeared as a dynamic social group with social security and economic benefits with a sustainable hill farming system. Also, they contribute through the adoption of local knowledge of agrofarming system to fill up the forest reserves of a specific region.

Khasi indigenous cultivators use friendly ecological approaches to protect and operate their trees for farming. Thus, Khasi upland tree-crop farming comprises a unique land-use action that integrates the key process of the tree cultivation system such as classification, production, management and adoption of agroforestry tree genetic resources (Leakey & Tchoundjeu, 2001). It also shows a substantial indigenous knowledge base. Khasi agroforestry tree farming is considered as a farmer-need, under marketing process and concentrate on usual timber-tree improvement which appeared in the early 1990s (Simons & Leakey, 2004). The consequence is that the significant developments achieved by traditional gardeners over generations are widely through sporadic and uncoordinated activities and agricultural changes conducted by market economies in the past.

Landscape and soil fertility

Problems found in farming land include landslides, erosion, excessive tree shade and hard sunlight. Khasi minimise uphill soil erosion and protect soil moisture through the traditional process by using bamboo culms, special creepers and barriers made of mulch and gunny bags filled with soil. They consider soil and its fertility by different physical aspects such as size, shape and colour. They classify soil based on colour and texture as well as their experiences of the potentiality and limitations of the soil. Some Khasi cultivate non-cereal crops especially nitrogen-fixing trees to conserve the organic matter in the soil. These trees facilitate the conservation of the soil, even if some nutrient minerals are run off from the topsoil. Employment of green leaves, twigs, lops and others tree residues with farmyard manure are the traditional way of increasing the condition of the soil fertility with moisture. The very common ones among these plants litters are used in tree plantation of tree roots and pits or top soil in dry season.

Generally, this technique helps to augment soil fertility by fixing nitrogen using micro-organisms (Bregman, 1993). Each Khasi household possesses some amount of land for cultivation which they try to keep fertile for subsistence. They do not clear fuel and flower litter from the field so as to augment organic fertilizer for the soil.

Watershed and Water

Most of the Khasi upland surface could be considered as having a number of watersheds. But now, the current environmental and ecological issues in the area are rapidly decreasing the natural forest resources. The inappropriate land use practices of migrants and lowlanders have degraded the water bodies (Misbahuzzaman, 2007). Hill cutting, making agricultural plot, making house, and building of infrastructure by development agencies and overall deforestation have seriously affected the hill streams and environment. Now, most of the Khasi hills have no adequate natural water bodies. The overall land degradation factors are the reasons for soil erosion, siltation of lakes and rivers (Khasa, Shoaib, & Khan, 2006). Mono-culture of commercial organization and others non-eco-friendly activities in the large piece of hill forest have degraded the soil, and the sediments have blocked the water flow of fountains and springs as well as destroyed the water bodies.



Photograph 1: Photos indicating the source of natural watering in uphill shallow-well and harvested rainwater reservoir (23 November, 2014)

The rapid decline of the watershed has contributed to severe soil erosion and deterioration of water quality. The local hill peoples who once depended on sources of surface water have fallen into a water crisis in the tree gardens. The daily lives of farmers with plant, animal, fishes and farming system have deteriorated (Misbahuzzaman, 2007). The indigenous knowledge-based expert skill for watering practice from surface water is not being used. Even the ground water level has decreased and wells do not provide adequate water. During the

monsoon season they have to harvest rain water for the dry season. Ultimately Khasi subsistence, flora and fauna are adversely affected.

Traditional Watering and Soil Nutrient

Land management of Khasi villagers depend on their observation of different segments and space of landscape as physical location, quality and nature of soil with fluid that are related to flora and fauna. Some barren land and parts of the landscape are possible to be cultivated as fertile land by incorporating floral litter with compost of animal debris. In this situation participant Mr. Arun said, "Our parental local knowledge and individual experience of moisture management knowledge is very important. It helps to control the adequate moisture of plant, soil and flower litter to cultivate better tree crop in the fields." In hill-farm field especially in dry season, villagers take care of soil energy and protect soil moisture of tree-crops with fruiting trees, by managing and controlling shade, trees and shrubs at an optimum level by pruning and trimming the twigs and branches of trees. The open canopy allows optimum heat, while the weeds and cut remaining are used as mulch and soil nutrients.

In hill-farm, some trees are very brittle and need water in dry season such as betel vine and black pepper trees with some fruit-bearing trees. As an informant Mr. Binet said, "Some trees supply water to the soil while others soaks a lot of fluid; though they look thirsty and weak." That situation planted trees or naturally grown hilly trees and those that are watery and fluidity especially *Musa acuminata*, *Arum plant*, *Carica papaya*, *Vitex spp.*, *Artocarpus chaplsha*, *Artocarpus heterophyllus*, *Ficus racemose* that help to provide water and fluid to the soil. Banana trees and arum plant contain a lot of water, and cutting pieces are used in Singur Punji village for watering at tree root.



Photograph 2: Photographs illustrating traditional watering systems (4 April, 2015)

Some native trees are also watery. Khasi are aware that if those trees are planted and arranged appropriately in the field, the moisture will be protected. Some trees are not good, for others trees soak more sap from the soil such as *Syzygium grandis* and *Eugenia* spp. Though, some trees are planted as well as planned and organized in the fields, but in the long dry season, it may be weak or deteriorate with flower and fruits. So Khasi collect rainwater and use it in the dry season by using local farming inputs such as perforated level pipe, bamboo pot or plastic-sack and watering hand-pot. Khasi are efficient in organizing and controlling their trees for getting soil-fluid through local competence.

In Khasi tree-crop farming stage, water is one of the major elements of tree-crops production. Therefore, they give priority to the soil and tree because if they provide optimum level of water in the soil and trees, they would attain the maximum quantity of output. Khasi sometimes supply water physically to the field or plant watered trees whose root, stem and branch soaks a lot of water from the ground and store it. As a Khasi woman said, "Water and fluid are life blood of trees as well as soil." While water is needed, some watered trees secrete fluid in the field and nourish other trees. This type of fluid flow is controlled by local craft skill individuals in the community.



Photograph 3: Photographs showing pruned tree fields with cleaning, weeding and mulching (24 March, 2015)

Khasi has been practicing mulching system over a hundred years to protect and grow their main economic tree-crops and fruit trees. The material of mulching is derived from the surrounding forest and plant products which conserve and release moisture and coolness of the soil, which help to mature fruits and flower. A group of participant pronounced, "We accumulate ground shrubs, leaves and unwanted branches of trees and keep them on the ground to grow in order to protect trees." The process of mulching or manuring differs in different regions depending on the availability of local resources and environment. The villagers of Singuir punji collect extra mulch from tea garden

and the nearest forested land of Forest Department. They later use to get moisture into the soil.

Watering and Irrigation

In fact, proper watering in the field is one quality of irrigation system. Peoples' ways of living are controlled by water and its availability depends on geographical location, land structure and technology. Hill-farming is a painstaking activity to the farmer because of non-proximity of surface water and the attributes of soil and topography. However, hill surrounding water bodies and streams have declined and partially deformed by human aggression with natural effects. Only the local farmer's efficacy could provide water to shallow rooted tree-crop in the field. Khasi practice local and modern knowledge in watering system through the influence of diverse origins of farming understanding. Water is used at the practice level in the farm fields and this is explained by the concepts of hot/cold, life/death and wet/dry. And these concepts have vital quality to mediate the potency of local and global farming inputs in tree-cultivation practices. All these basic concepts are manipulated through higher abstraction.

Water works as a catalyst to soften old and new farming manure into the soil and thus Khasi villagers treat it as energy/life. Khasi uphill tree-crops cultivation needs water in dry season. And the rest of the year, soil moisture provides adequate water to soil and trees. Dry season has no precipitation and with strong sunlight, ground covers and shrubs are burned. Planted trees experience a worse situation. This time, reserved water, harvested rain water and surface water are used. As a Khasi participant said, "We use harvested rainwater and the nearest fountain's water at tree roots in the farm fields by accumulating manual efforts and techniques. Recently, modern tools and techniques have been included in the watering systems. Water strengthens trees' life in farming. Local traders provide machineries with technical support for it." Poor farmers use hands to water the field which is labour-intensive and time consuming. If drought severely persists, ground water level declines, though it is used through several intervals. Only well-off farmers can afford a diesel generator for irrigation. This generator could be fixed at the shallow-well with modern level pipes, polymer pipes and plastic. Some local businessmen are accepted in the village because they provide irrigative machineries and technology with others modern farming inputs and run their business by purchasing farming outputs. Cultivators consider

water as a kind of energy and when it is used on tree roots, the soil become fertilized, trees get energy from it and grow properly.



Photograph 4: Photographs illustrating traditional and modern watering and irrigation system in uphill (18 March, 2015)

Farmers understand the necessity of water in cultivation. Adequate water protects and saves trees. However, on the hill, water is not available everywhere. Expert farmers know watery trees and cultivate them in non-moisture zone of uphill. It soaks water and moisture from ground water and nourishes other trees. "As a technique, we plant, organize and control trees while some hilly watered trees provide water and moisture to other trees in dry season. Also, we serve several pieces of stem of watered trees on tree-roots for watering with skill knowledge and existing local practice as a Khasi participant said." As I mentioned earlier some trees and tree-roots, sub-roots, skins and leaves contain water and slowly release water in tree crop fields. Within these categories of trees, some additional trees are cut into pieces and put in tree roots to release moisture for trees healthy growth. To conduct these activities, local knowledge and experiences are used. However, the recent effects of climate change have made this process to deteriorate. Khasi's watering processes are explained by the ideas of trees' life/death and wet/dry qualities. In some farming landscapes close to running water-springs, farmers connect traditional tools to supply water to the tree-fields. Now, watering and irrigation are done by a mechanized process with ground water resources.

"A few families of the punji have electricity at homestead and adjacent homestead field. We permanently set up a few deep tube-wells with irrigation conduits and concrete water reservoirs at the top of the hill. Thus, we grow different types of native trees, fruits and vegetables for the whole year commercially. We are now well off and have good margin every year. The permanent irrigation system has ensured our better life as a key informant said."

A few Khasi families of Singuir punji have electricity in their farm fields. Some are better-off and have good relations with elites outside their communities and with forest and agriculture extension officers. They are influenced by these elites and officers and get the latest information from them about external tree crop farming methods. Their acute perception facilitates the understanding of external farming system with irrigation. They prefer to combine modern knowledge and farming inputs with old methods. Watering and irrigation are vital farming elements which are related to both methods for watering. The other farming-elements are sufficient for tree-crop production. They acknowledge that water is a major controller to accumulate other farming elements successfully. It is a vital element that helps to blend various farming materials with soil. In fact, water is used sometimes as manure, energy, pest and insect killer, among others. If farmers have control of water supply, they can firmly manage the whole tree crop farms.

Conclusion

Traditional knowledge base tree crop farming system is common to Khasi community. From tree-shoot planting to pre-harvesting stages, all efforts are engaged by local skill knowledge and farmers' efficacy. This is Khasis' main subsistence and earning way, is called tree crop gardening. Except the rainy season, year-round tree crop production need water and soil moisture, which is deteriorated by the effect of overexploitation of natural resources. The water bodies and tributaries are threatened. In this case surface water, including the source of moisture from natural farming materials is inadequate. The traditional techniques of watering are not being practiced. However, for subsistence need and sustainable gardening, Khasi depend on ground water. They use modern technique, inputs and irrigation conduits for tree crop farming. Khasi landscape and tree crop garden settlement, including the fertility of the land is organized on the basis local knowledge as well as global scientific practice. Tradition watering process is shrunken and modern watering and irrigation system has been emerged. Therefore, Khasi farming and gardening system are integrated and it has been modified to the context of various topographical structures with hill surrounding natural setting considering the local ecology and environment. The findings of this study shows some experiential issues of indigenous practices with scientific practice of tree

crop cultivation for getting soil moisture, fluid and water, which derives from foliage litters. However, the reality is that organic wastes and the foliage are not adequate to generate water. Therefore, Khasi use harvested rainwater, shallow-well water and ground water by using diverse techniques. The watering and irrigation practice in the tree-fields are administered by modern irrigation inputs, including traditional knowledge, which bring forth ecofriendly cultivation system in the Khasi hill forest region.

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