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RESEARCH ARTICLE

FOOD SECURITY IN CHITTAGONG HILL TRACTS (CHT), BANGLADESH AND WAY FORWARD FOR ACHIEVING THROUGH SUSTAINABLE AGRICULTURAL PRACTICES

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ABSTRACT

The Chittagong Hill Tracts (CHT) is situated in southeastern Bangladesh having an area of 13,295 sq. km. The 3 hill districts of CHT (Khagrachari, Rangamati and Bandarban) remains behind in comparison to other parts in development indicators, such as poverty, income, food security, health, and education, and in access to roads, infrastructure, electricity, and credit facilities. This paper is based on the review of published papers, reports, books related to CHT giving emphasis the landscape, natural resources, community and the food situation of the indigenous peoples and the Bengalis in the CHT. The nature and factors contributing to food and nutrition security in CHT are more complex than those in the plains because of the harsh biophysical environment, poor accessibility, and weak market infrastructure. The paper is the outcome of available publications related to CHT resources, degradation of natural resources of land, soil, forest, fisheries and livestock etc. Traditional agricultural system of jhum cultivation is not sustainable due to population pressure, reduction of fallow period and soil degradation. The paper analysis the major causes of resource destruction and also the opportunity and challenges exists to address the food security in CHT. Few smart food crops are also mentioned to address the improvement of livelihoods and food security of the hill people. Prolonged conflict of land tenure and settlement of plain land people should need to be addressed adequately. Modern agrological technology with quality seeds, horticultural improvement, proper market and value chain development may improve the livelihoods and food security situation of CHT.

INTRODUCTION

The Chittagong Hill Tracts (CHT) consists of Bandarban, Rangamati and Khagrachari hill districts and is situated in the southeast of Bangladesh with a land area of 13,295 sq. km covering about 10% of the total land area of the country (Khan *et al*. 2007). CHT is the disadvantaged and vulnerable regions in Bangladesh in terms of almost all major development indicators (Barkat *et al*. 2009). Development in the CHT has been slower than in other parts of the country as a result of several factors including social tension (Rasul and Tripura 2016). A long history of conflict and political unrest, combined with the remoteness has resulted in weak integration with the mainstream developmental trends of most parts of Bangladesh (WFP 2017). At present, the socio-economic disparity between the hills and plain areas in Bangladesh is quite distinguishable.

"Food security means when all people, at all times, have physical and economic access to sufficient, safe and nutritious food" (FAO 2008, Hossain 2013, WFP 2016). It is important that each and every household including all its members has access to safe, nutritionally adequate, and culturally acceptable food (Gillespie and Mason 1991).

Globally there are a number of initiatives were taken about the food security of the human being (Sunderland and Vasquez 2020). National Food Policy of Bangladesh aims to ensure dependable food security for all people of the country at all times. The goal applies not just at the national or household level but also at the individual level. In particular, achieving nutritional well-being for all requires a focus on the most vulnerable segments of the population such as the extreme poor people and mothers, children and other vulnerable groups (Shahabuddin *et al*. 2015). In Bangladesh yet food security has not been achieved, and whatever progress been made would be difficult to sustain in view of the growing pressure of population on extremely scarce natural resources. The food security situation in the CHT region is much worse than in comparison to other parts of the country (Barua *et al*. 2015). Most of the rural people in the CHT are food insecure, especially from June to August. The rural population in CHT has a daily average energy intake of only 1,798 kcal per person per day, whereas the average level among those in absolute poverty in Bangladesh is 2,122 kcal. Among the communities, the values are lowest for the Bawm (1,440 kcal) and the Lushai, Chak, and Khyang is 1,600 kcal (Barkat *et al*. 2009).

Since a number of Sustainable Development Goals (SDGs) are closely related to food and nutrition security in the CHT and the success of SDGs is depending with the success of food and nutrition security (Rasul and Tripura 2016). Achieving food and nutrition security has direct and indirect implications for achieving other SDG goals and targets. Ensuring healthy lives may depend on achieving food and nutrition security. A failure to ensure food and nutrition security in the CHT, Bangladesh would imperil the region's other targets of SDGs such as ending poverty, ensuring healthy lives, achieving gender equality, and reducing inequalities as well as adaptation and mitigation of climate change (Rasul 2015).

MATERIALS AND METHODS

The paper is broadly categorized as review paper in a sense that it reviews the published papers related to Chittagong Hill Tracts (CHT) giving emphasis the landscape, resources, community, livelihood and the food situation of the Indigenous peoples of CHT and the Bengalis in the CHT. It incorporates primary literature to produce relevant arguments on the stance. The paper also involves both qualitative and quantitative analyses, especially in the introductory part to strengthen the reliability of the proposition. Qualitative analyses involve literature texts, data observation sourced from documents-like peer-reviewed journal articles, related government and NGO/INGO websites and academic discourses. Information also searched PubMed, CABI, Elsevier, Google Scholar, and Web of Science as well as the Websites of several international organizations, including the FAO, the World Food Program and the International Food Policy Research Institute..

RESULTS AND DISCUSSION

The CHT is situated in southeastern Bangladesh having an area of 13,295 sq. km. The most striking distinction between the CHT and the rest of Bangladesh is the topography of the terrain. In contrast to the plain lands, the CHT has hills and even some mountains, extending off the Himalaya Hindu Kush range (Khan *et al*. 2007). The hilly landscape of the CHT is the result of geological uplifting, faulting, tilting, folding and dissection of sedimentary rocks dating back to the Tertiary Period. The vast majority of the CHT land consists of steep and undulating hill slopes and only about 5% is suitable for intensive agriculture (FAO 2013). The land type and its suitability are shown in Table 1. The population of CHT is more than 1.6 million includes 12 ethnic communities with unique cultures and traditions (Rasul and Tripura 2016). Though CHT has immense biological, cultural, and environmental resources, it remains one of the most disadvantaged and vulnerable regions in the country (UNDP 2009, Barkat *et al*. 2009). The demographic profile of CHT shows that the population of the CHT is far below than the nationals (Table 2). The incidence of poverty in the CHT is about 60% (Table 3) which is much higher than the national average of 32% (Barkat *et al*. 2009). However, with the spread of education and economy, many educated hill people especially Chakmas, Marmas and Tripuras have migrated to urban areas for education, employment and other non-agricultural occupations. As a result, the society began to be divided into class like rich and poor, educated and illiterate, urban and rural etc. (Chakma 2019).

Major resources and economy of CHT is largely based on the forest, agriculture, fishery and livestock sectors (Millat *et al*. 2002, Barkat *et al*. 2009, Baten *et al*. 2009, Ahammad and Stacey 2016). More than 70% of the rural population depends on agriculture, forestry, fisheries, and horticulture for their living (Rahman 2005, Rasul and Tripura 2016). The CHT has rich natural and environmental resources like hills, forests (with diverse flora and fauna), rivers, and lakes with an areas of outstanding scenic beauty. The CHT provides important ecosystem services that play a significant role in economic development, environmental protection, ecological sustainability, and human wellbeing both for the people of CHT and downstream (Rasul 2015, Rasul and Thapa 2006, Jannat *et al*. 2020).

Major Livelihood Activities in CHT: Some livelihood activities are common nationwide, whereas some are more typical in the CHT region that are due to geophysical specialities of the region, conditioned by its unique systems, opportunities and cultural practices of the communities. Of the agriculture-related activities, some people work independently as owners/farm managers while others are lessees, sharecroppers or wage labourers. Others are involved in traditional activities exploiting of natural resources (collecting firewood) or make a living with skill activities (weaving, furniture making, handicrafts, house construction, etc.). Agriculture is the predominant source of livelihood, particularly for ethnic communities. In the CHT, 49 per cent of households live on agriculture compared to 46 per cent in rural Bangladesh. The reliance on agricultural livelihood is more dominant among the Tanchangya (72 percent), Khumi (69 percent), Marma (68 percent), Mro and Bawm (67 percent each) (Barkat *et al*. 2009).

Agriculture: Majority of rural people in the CHT are involved with agriculture (Khan *et al*. 2002, FAO 2019), and hence land is the prime source for them (Nayak 2014). Over 50% of the annual net income of all CHT households comes from different agriculture related sources. Food and cash incomes are generated by at least one agricultural related activity. Agricultural activities include ploughing lands, shifting cultivation, paid wage labor, livestock and poultry rearing, tree nurseries, fruit gardening, fishing and making agriculture implements (Ahammad and Stacey 2016). Land suitable for intensive field crop cultivation is less than 5 percent of the total area (**Table 3**). The traditional agricultural economy is based on growing paddy and other crops in the valley bottoms. The utilization of hill slopes by shifting cultivation is locally known as jhum. The main farming systems in mountain areas are upland jhum cultivation, plough land farming system, homestead cultivation system, horticulture farming system, fruit and tree crop farming system, mixed orchard farming system, vegetable farming system, fringe-land farming system, forestry farming system, forest product wood production farming system, rubber plantation, agar plantation, non-wood production system (Broom grass- *Thysanolaena maxima*, bamboos), domestic animal production system (livestock and poultry), and aquaculture fish farming systems etc. (FAO 2019). Barua *et al*. (2015) showed that 55.4% households harvest single crop, 26.3% households harvest double crops, 10.8% households harvest triple crops in a year and only 7.5% households practiced jhum cultivation.

Major agricultural crops in different cropping systems

- ***Jhum farming based on mixed cropping***: Rice, corn, vegetables, sesame and turmeric are common. Crop seeds sown in April-May and harvested from July to December. Yields of jhum rice (local) range from 2.5–3.0 t/ha compared with national yields in the same season of high-yielding varieties range from 3.5–4.0 t/ha (Chowdhury 2019).
- ***Upland monocrop***: Includes ginger, turmeric, different kinds of taro (aroid), cassava and different spices.
- ***Floodplain and valley land***: Rain fed rice-based farming mainly use high yielding or hybrid rice varieties with yields ranging from 4.7–6.5 t/ha.
- ***Vegetable-based farming***: Household consumption or commercial production includes off-season vegetables (gourd, chilli, eggplant, beans, etc.) in upland fallow in summer, and cabbage, cauliflower and tomato in lowlands in winter.
- ***Horticulture-based farming systems***: Sloping landscapes include banana, mango, litchi, pineapple, jackfruit, guava, olive, malta oranges, and bay leaf (Tej-pata), which are grown commercially or for domestic consumption.
- ***Cash-crop-based cultivation***: Includes sugarcane (mainly the chewing variety), cotton and tobacco.

Jhum or Shifting cultivation: Shifting cultivation is a common traditional land-use practice of ethnic populations in the region known as 'slash and burn agriculture' and referred to locally as '*Jhum cultivation'.* Locally available paddy, ginger, turmeric, maize, sweet potato, other vegetables and banana are the most common crops in this system. The size of shifting cultivation practices range from 0.5–3 ha in a family. For centuries, the indigenous communities have managed the forests in a sustainable manner by keeping the rotation of their shifting cultivation long enough of 15-20 years to 2-3 years (Hossain 2011, Rasul and Thapa 2003, Tiwari 2003). Shifting cultivators nowadays are forced to use a shortened fallow period of 2 - 3 years because of population pressure, over cropping and soil erosion, illegal logging in forest areas and lack of suitable land (Rasul and Thapa 2003, Roy and Halim 2002, Rahman *et al*. 2007). The traditional agro-practice (Jhum) in CHT is currently struggling to sustain because of low productivity due to shorter crop cycles, limited availability of land and increased population pressure (Farid and Husain 1988).

At present, jhum activities also comprise the planting of fruit species, e.g. pineapple, banana, jackfruit and mango. Traditional forms of jhum were based on only annual crops and retaining trees largely available in remote areas. Intensive forms of agriculture (i.e. mix of fruit trees and teak plantations) are now increasing in areas closest to markets and roads (Thapa and Rasul 2005). In the jhum land, crops are grown in a mixed way and the number of crops are more than that of plain land (where only mono rice crop is grown) and it has been found that the total gross profit for one hectare of jhum rice in one year is about 36,310 Tk., which is rather low in comparison with plain land rice (gross profit is about 72,040 Tk. in one hectare of land in one year) (Swapan *et al*. 2010). In the last two decades, the intensity of shifting cultivation has decreased or been modified with cropping patterns, mostly involving planting fruits and trees that have increased economic benefits. At present, 16% of land is cultivated with this traditional system each year (Bala *et al*. 2010).

Forest and livelihoods: Hill people consider the forests as common property to them. They collect bamboo, timber, fuelwood and forage for food, roots, vegetables and herbs (Nasima *et al*. 2020). Hunting, fishing and bird trapping for consumption are common activities. Due to population pressure, CHT communities have been compelled to alter their attitude to forest resources and their livelihood. Hill people still extract timber, bamboo, fuelwood and other forest products and these are sold to earn cash to support them.

Forest resources that contributes to the livelihoods: The CHT is one of the most biologically diverse parts of Bangladesh which make up almost 44% of total forestlands in Bangladesh (BFD 2015, Hossain 2015, Rasul and Tripura 2016, Rahman *et al.* 2017). The forests play important role in conserving biodiversity, protecting the environment, preventing erosion, maintaining water quality, regulating water flow, reducing the severity of floods, and regulating local and regional climate (Baten *et al*. 2009, Sunderland and Vasquez 2020). Forest and trees provide direct and indirect economic benefits to local communities in CHT (Jashimuddin and Inoue 2012, Jannat *et al*. 2018, 2020) as well as to the national economy. Forests are an important repository of biodiversity, with the highest concentration of native species in the country found in CHT (AF 2010, Khan 2015, Hossain 2016, Khan *et al*. 2012). Forests contribute a significant portion of the economy (46%) at local followed by crop/fruit production in the region (Ahammad and Stacey 2016, Jannat *et al*. 2018). The CHT supports almost 80% of the country's total biodiversity (Nishat and Biswas 2005), and is riched by people from 12 ethnic groups (Rasul 2007, Rasul and Thapa 2006) who depend largely on forest resources to fulfil their livelihoods (Jannat *et al*. 2018). Historically, local ethnic communities depend on timber for day-to-day traditional uses such as fuelwood, making seasonal agricultural implements (i.e. baskets for crop harvesting and storing and constructing shelters in the village) (Rasul 2015). Commercial timber plantations on hills or home gardens are a relatively new concept and have been popular since the 1990s. In many villages, agricultural lands have been gradually converted with mono plantations, mainly with teak or gamar (Khan *et al*. 2012).

Village Common Forests (VCFs): Village Common Forests, a natural forest patch managed by indigenous communities in CHT is yet significant repositories of food, biodiversity and medicinal plants (Kamruzzaman *et al*. 2018). VCF are mostly small, averaging 20-120 ha in size and consisting of naturally grown or regenerated native vegetation (Hossain 2016), and the indigenous people established VCF 50-100 years ago (Kibria *et al*. 2015). VCFs are still the source of water, fuel wood, herbs, root crops, bamboo shoots, wild fruits, vines or leaves for cooking or medicinal plants necessary to sustain the lives of the indigenous communities in the CHT (Miah and Chowdhury 2004, Rasul and Karki 2006, Rasul 2007, Baten *et al.* 2009, Jashimuddin and Inoue 2012). VCF is rich in biodiversity compared to government managed reserve forests in CHT (Adnan and Dastidar 2011) though biodiversity is decreasing day by day. VCFs are good examples of effective community-based forest management under certain customary rules and regulations (Halim and Roy 2006, Baten *et al*. 2009). Total number of VCFs in CHT is 379 covering an area of 29,423 acre. However, VCFs comprise very small (0.87%) portion of

total forest lands in CHT (**Table 4**), and many VCFs are under severe threats because of population pressure, livelihood insecurity, socio-political conditions, etc. (Jashimuddin and Inoue 2012).

Non-Timber Forest Products (NTFPs): NTFPs play a vital role in the traditional culture and life supporting functions of ethnic communities in the CHT (Mukul 2010, Miah *et al*. 2012, Jannat *et al*. 2018). However, a lack of formal economic valuations of NTFPs may often undermine the appropriate numbers of people's dependency and their potential benefits to regional and national economies. For example, bamboo- and cane-made products (i.e. different handicrafts) and raw materials are in demand in the building construction industry and in nearby urban markets and cities. Broom grass (*Thysanolaena maxima*) has potential in hedge for erosion control and also having commercial value (Khisa *et al*. 2004). Timber, bamboo, rattan, fuel wood, fruits and different types of grasses are the major sources of forest-based annual income. Poor households are engaged in collection, processing and marketing of NTFPs and have relatively higher dependency on receiving annual income from forest-based economic activities. However, the number of people dependent on forest-based economic activities is difficult to estimate due to a lack of available studies for the region. In CHT, more than 60% of forest products including NTFPs are used at the household level and the remaining 40% are sold at local markets to generate cash income (Kar and Jacobson 2012, Misbahuzzaman and Smith-Hall 2015).

Bamboo resources in CHT: Among the NTFPs, bamboo is most commonly used for making baskets, collecting and storing food grains and fencing around farming plots. People manage and collect at least four different bamboo species for household subsistence use and commercial purposes. Natural forests still provide the largest stocks of bamboo, but the availability and sustainability of bamboo is yet to be clearly estimated, e.g. Kassalong reserve (164,446 ha), Rankhiang reserve (77,104 ha) and Sangu & Mathamuhuri reserve (74,500 ha) natural bamboo growing areas. Forest bamboo species are *Melocanna baccifera* (Muli), *Bambusa burmanica* (Mitinga), *B. polymorpha* (Pharua), *Dendrocalamus longispathus* (Orah, Rupai), *D. hamiltonii* (Pencha bans), *Melocalamus compactiflorus* (Lotabans), *Schizostachyum dullooa* (Dolubans), and *Gigantochloa andamanica* (Kalibans). Muli grows in pure brakes but the others grow sporadically in small patches. Encroachment, illicit felling, over-exploitation, unscientific management, gradual conversion of bamboo forests into plantations through clear-felling and burning, gregarious flowering/fruiting, shifting cultivation followed by uncontrolled fire and other different biotic interferences have markedly reduced the bamboo, e.g. the annual loss of bamboo area has been 2.53% at Kassalong, 2.83% at Rankhiang, 0.93% in Sangu and Matamuhuri and the average annual loss of bamboo forest area is 2.6%.

Medicinal plants in CHT: Many of the plant species naturally grown in CHT have important medicinal uses. The tribal community in CHT is in continuous search of plants for various uses, and in course of time they have accumulated much knowledge of the use of wild plants (Motaleb *et al*. 2015). The ethnic groups of CHT have their own culture, tradition and primary health care system acquired through close observation of nature and a good number of people in CHT still depend upon the herbal healers and herbal medicine for treatments (Mohiuddin *et al*. 2012, Barua *et al*. 2013). At least 69 plant species identified by local ethnic people that contribute to primary health care (Khan *et al*. 2012). It is the cultural tradition of the tribal women to collect some wild plants every day to meet their daily needs from the surrounding forest without destroying the habitats (Esha *et al*. 2012).

Private forests in CHT: Apart from the formally recorded or recognized categories of forests, the ethnic people of the CHT own significant patches of forest areas. There is no accurate survey of these forest areas, although the estimated area of private forests in CHT is approximately 273,791 ha, which is mostly composed of teak and gamar plantations (DoE 2015). While most of these forests have already been converted into teak forests, the recent interest of the local indigenous people in horticulture suggests that the extent of these forests may be declining.

Animal husbandry: Emphasis has given to livestock development to meet the growing demand for milk, meat, and eggs, and to create employment and generate income for the rural poor (Rasul and Tripura 2016). The CHT has the potential for livestock development for a number of reasons, e.g. availability of land for grazing and fodder production, natural water resources, hard working population, changing lifestyles of the hill people, increasing literacy rate, and presence of indigenous breeds of different species of livestock and poultry suited to the local conditions. The lakes in the CHT can be used for duck farming with minimum investment. The CHT is suitable for sustainable pig farming, poultry farming, especially broilers and layers, goat farming as there are abundant grazing areas. Considering the potential for livestock development in the CHT, both the public and private sectors should need to undertake special initiatives and livestock can be one of the key livelihood options for disadvantaged ethnic communities.

Fisheries: Aquaculture offers important economic prospects for the CHT through enhanced fish farming and increased fish production in the abundant freshwater creeks and ponds and Kaptai Lake. There are an estimated 5,573 creeks with a total area of 1,378 ha that could be used for aquaculture with a slight modification of the natural flow using structures like small earthen dams ((Rasul and Tripura 2016). Increasing creek aquaculture together with cage farming in the lake could may improve productivity and generate income and employment, thus improving rural livelihoods. The annual production of fish from the lake is only 130 kg/ha, whereas 110 kg/ha from natural catch. But, the yield from creeks is several times higher (966 kg/ha) than the natural catch from the reservoir (FAO 2013). Kaptai lake is the main water body of water in the CHT for fish culture, and covers around 68,300 ha in the monsoon and 58,000 ha in the dry season. Average fish production in the lake is 130 kg/ha, which is far below its potential. Prospects for integrated farming of fish-cum-poultry, fish-cattle-poultry, and fish-livestock-agriculture in the hill districts may improve the economic conditions of hill people and also their nutritional status.

Miscellaneous income: Labour is the most important and often productive asset that CHT people have. Household income in the CHT is derived from agricultural products such

as banana, seasonal fruits, jhum products, fishing from the Kaptai lake, backyard poultry etc. and limited number of services, industrial employment, agricultural labour, fishing (mainly from Kaptai lake), animal farming (cattle, pig etc.), trade, traditional activities such as weaving, bamboo and cane work, collection of fire wood, hunting etc. Pineapple, mango, orange and malta oranges are also grown (Chowdhury 2019).

Opportunities and scope of improving the natural resources and agriculture development to address food security in CHT

Conservation of local knowledge and wisdom: Ethnic community of CHT has traditional knowledge, practices and technologies which is unique to their culture and society. The knowledge and practices are environmentally and socially appropriate and sustainable (Karim and Mansor 2011) and being transmitted from generation to generation orally (Khan *et al*. 2007, Mohiuddin *et al*. 2012). Traditional knowledge supports livelihood, influences life style, land use planning, resource conservation, culture and unique to a given culture or society. Mohiuddin (2009) documented 26 traditional knowledge practices by the tribal communities where identified 289 ethno-medicinal and food plants growing in wild habitat in Bandarban. The community has vast experiences in utilization and conservation of biological and ecological diversities and ecosystems (Khisa *et al*. 2006, Motaleb *et al*. 2015).

Indigenous knowledge and the food security: There are a number of research and academic studies those documented some traditional knowledge, innovations and practices from the CHT and other parts of the country (Alam 1996, 1997, 1998, 2002, Alam and Khisa 2000, Alam and Mohiuddin 2001, Kibria *et al*. 2015, Mohiuddin 2009, Mohiuddin and Alam 2011, Khan *et al*. 2002, Khisa *et al*. 2006). The hill people in the CHT developed and practices different farming practices by their own effort. In most cases it is location and sometimes community specific. The role of indigenous people and traditional knowledge on natural resource management in CHT has been well focused by a number of studies (Khisa 1997a, 1997b, 1998, Millat-e-Mustafa 1998, ADB 2001, Mainuddin *et al*. 2007). There is no systematic effort by the government to document and integrate this knowledge in any sector plan or biodiversity conservation planning. Recently an effort has been taken on the rehabilitation of Village Common Forests through Chittagong Hill Tracts Development Facility (CHTDF) program.

Vegetables as a component of food-based strategies: Improved vegetable production and consumption is the most direct, low-cost method for many of the urban and rural poor to increase micronutrients in their diet. Vegetable legumes (mung bean, vegetable soybean or cowpea) as a protein source are recommended for populations with low-protein intakes. Vegetables, especially tomatoes and leafy vegetables, serve as sources of vitamin A.

Bringing back the forests with native species: The degraded natural forests of CHT have natural regeneration potential, providing proper protection.

Not only that, a number of indigenous tree species in hill forests had the potential of regeneration through coppice shoot production (Kamruzzaman *et al*. 2018). If the coppice shoots after felling are managed properly, the forests may be managed for 4-5 rotations without further establishment of new plantations. However, managing such forests need to consider the age and diameter of felled trees, rate of stump deterioration, height and characteristics of the stumps, timing or season of felling and the number of shoots retaining per tree.

Contribution of wild foods to diets: Wild and uncultivated or uncared edible plants can contribute a significant part of the diets for most of the rural communities of the world, especially when the supply of agricultural products is unsatisfactory (Bisht *et al*. 2017, Termote *et al*. 2014, Nasima *et al*. 2020). Nasima *et al*. (2020) identified 71 wild edible vegetables from Khagrachari which are eating for their leaves, tubers and roots, shoots, stems, fronds etc. available for the human consumption round the year. The study is an important pioneer step in taking a holistic view of the subsistence value of WEVs that may be helpful for policy makers to strengthen food and nutrition security in a changing climate through prioritization, cultivation, utilization and conservation of WEPs in a sustainable manner.

Local climate condition as an indicator for crop selection: Climate of an area is an important parameter for selecting crops of a particular area. The Murang community of Empu Para, Bandarban district has select crops considering the climatic-conditions such as thanda (coldness) and gorom (warmness) of a locality depending on altitudinal variation. The farmers at a higher altitude in Chimbuk hill (about 875 meter) grow citrus fruits like orange (*Citrus reticulata*), malta (*Citrus sinensis*), jambura (*Citrus grandis*), and Satkora (*Citrus macroptera*) etc. in addition to jhum farming. They do not go for pineapples though the farmers near Bandarban and Ruma grow pineapples. Empu Para is situated at higher elevation than Bandarban and Ruma. The climate is comparatively cooler in Empu Para and this condition is locally called as thanda and considered as suitable sites for citrus cultivation and not suitable for ginger cultivation. Foggy weather during flowering time is considered to be suitable for good citrus fruit setting. On the other hand, Sharon Para is comparatively hotter (gorom) than Empupara, and, considered suitable for ginger cultivation. Climate is considered comparatively warmer (gorom) in Ruma and Bandarban than Empu Para, and farmers grow here pineapples, mango, banana, lichi, boroi and papaya. Use of this knowledge helps in species selection for farming practices of a particular sites based on local climate. Similarly Anik and Salam (2017) identify drivers of production and technical efficiency in okra and eggplant production in CHT.

The hill people of Empu Para and Rwangchari have their traditional knowledge for crop selection based on the altitude and wind velocity of the locality. The farmers of the Empupara do not cultivate til (*Sesamum indicum*) in jhum at high altitudes, because when the til fruit ripe, the pods split up and disperse by high wind velocity. Cashew nut (*Anacardium occidentalis*) is an important cash crop of the Bawm community of the Rowangchari but farmers of Sharon Para do not cultivate cashew nut. Farmers of Sharon Para reported that high wind velocity during flowering season in the areas causes less fruit setting than Rwangchari.

Table 1. Land characteristics in Chittagong Hill Tracts (CHT), Bangladesh

Class	Type of land and its utility	Area (acre)	%
A	Suitable for wet-rice cultivation	76,466	3.2
B	Suitable mainly for horticulture and only partly for rice of terraced	67,871	2.9
C	Suitable for horticulture and tree crops with intensive soil conservation	3,66,622	15.5
C-D	Intermediate class between C and D	32,024	1.4
D	Suitable only for forestry and less than 10% of class D land was suitable for horticulture	18,16,930	77
Total		23,59,913	100

Table 2. Demographic profile of CHT in comparison to National (Barkat et al. 2009)

District	Area (km_2)	Household	Population			Population per km_2
			Male	Female	Total	
Bandarban	4 479	80 102	211 628	192 465	404 093	87
Khagrachari	2 700	133 792	326 621	312 346	638 967	227
Rangamati	6 116	128 496	325 823	294 391	620 214	97
CHT	13 295	342 390	864 072	799 202	1 663 274	120
Bangladesh	147 570	32 173630	74980386	74 791 978	149772 364	1015

Table 3. Agricultural lands in the CHT (FAO 2019)

Land area (ha)	Rangamati	Khagrachhari	Bandarban	CHT total (ha)
Area	611 600	270 000	447 903	1 329 503
Net cultivated land	50 372	44 030	35 520	129 922
Single crop land	23 872	22 820	20 119	66 811
Double crop land	23 070	188 780	12 931	54 781
Triple crop land	3 430	2 430	2 470	8 330
Fallow land (temporary)	10 963	6 581	5 153	22 697
Fallow land (permanent)	5 262	1744	78 600	85 606
Total crop land	80 302	67 670	53 391	201 363
Cropping Intensity (%)	159	154	150	155
Horticultural crop land	37 347	16 364	45 897	99 604
Forest	469 872	141 330	273 050	888 980
Kaptai Lake	58 300	0	0	58 300

Table 4. VCFs in three hill districts of CHT

Districts	No. of VCF	Total area (acre)	% of total hill forest area in CHT
Bandarban	165	9,044.5	0.27
Rangamati	146	16,561.5	0.49
Khagrachari	68	3,817	0.11
Total	379	29,423	0.87

Table 6. Smart Food Crops are recommended for the improvement of nutrient status in the CHT

No.	Local name	Type of crops	Nutrients
1	Foxtail millet	Cereal	Protein, carbohydrates and fat
2	Yam	Root	Calories, sodium, potassium, carbohydrate and protein
3	Taro (Mukhi kachu and panikachu	Root	Protein and fat
4	Giant taro (Man kachu)	Root	Protein and fat
5	Elephant foot yam (Ol kachu)	Root	Potassium, Phosphorus and Magnesium
6	Sweet potato	Root	Vitamin A
7	Cassava	Root	Calories and carbohydrate
8	Aroids (Moulavikachu, dudhkachu, astarikachu	Root	Calories, protein, fat, Iron, fibre, Calcium, Phosphorus, carbohydrates and vitamin
9	Pigeon pea	Pulse	Vitamin
10	Field pea	Pulse	Vitamin
11	Groundnut	Oil	Carbohydrate, Protein and fat
12	Snake gourd	Vegetable	Calcium, Iron, Carotene, Vitamin C
13	Amaranth	Vegetable	Manganese, magnesium, phosphorus and iron
14	Yard long bean	Vegetable	Iron, copper, manganese, calcium and magnesium
15	French bean	Vegetable	Foliate, thiamin, riboflavin, iron, magnesium, potassium
16	Ash gourd	Vegetable	Vitamin B1, Vitamin B3, Vitamin C
17	Ridge gourd	Vegetable	Vitamin C, zinc, iron, riboflavin, magnesium, thiamine
18	Okra	Vegetable	Calories, sodium, carbohydrates
19	Pumpkin	Vegetable	Vitamin A, potassium, copper, manganese
20	Bitter gourd	Vegetable	Calories, potassium, zinc
21	Custard apple	Fruit	Vitamins, magnesium
22	Wood apple	Fruit	Vitamins, calcium, phosphorus, protein and iron
23	Sapota	Fruit	Vitamins, minerals, glucose, tannins, calories
24	Black cumin	Spice	Protein, vitamins, fatty acids
25	Coriander	Spice	Vitamin C
26	Ajowan		
27	Onion	Spice	Vitamin C, dietary fibre, folic acid
28	Radish	Vegetable	Vitamins A, B6, C, E and K
29	Turmeric	Spice	Betacarotene, ascorbic acid (Vitamin C), calcium, flavonoids, fiber, iron, niacin, potassium, zinc
30	Garlic	Spice	Calcium, copper, potassium, phosphorus, iron, vitamin B1

This practice provides site-specific crop selection information and thus ensures higher productivity.

Seed collection using traditional knowledge: Traditional knowledge of seed sorting and seed storage is very important. They select healthy and disease-free plant for seeds and collect seeds from mature and bigger sized fruits. In case of upland paddy, desired seed crops are harvested in a sunny day and threshed immediately after harvests. In case of fleshy cucurbit fruits for seeds, farmers put some rice straw beneath the fruit in the field, so the fruits do not touch the soil. After collecting seeds farmers dry seeds in sun for 7-10 days and store them in bamboo tubes or hallow gourd pots. To protect insect attack and to keep moisture at optimum levels seed jars are stored near fireplace or hung under roof over stoves. It is easy method of seed collection and to maintain the local germplasm of different crops.

Maintenance of vegetation at the catchment's areas: The tribal people in the CHT maintain vegetation cover at the upper catchments area that ensures continuous flow of stream water. The hills receive rainwater in the rainy season and release it in the form of seepage water throughout the year. This water goes downwards through the streams. During dry season the tribal people of CHT use this water for irrigation and domestic purpose. Other than this when the tribal people prepare shifting cultivation field (locally known as jhum) by slash and burn they keep a strip of vegetated land along the foothills to protect soils from erosion and adjacent land from jhum fire.

Planting bamboo along stream banks for soil conservation: Indigenous people plant baijja bans (*Bambusa vulgaris*) along the canal banks to conserve soil from erosion. These initiatives by the indigenous people help in maintaining banks of canals and streams. Protection of canals and stream also protect biodiversity in the respective area.

Religious institutions based conservation involving local communities: A Pagoda or Buddha Bihar, locally known as Kiang is considered as a sacred place and people do not destroy vegetation in its premises. Most of the Kiangs in the CHT have fallow areas surrounding its campus. Many Kiangs have good portion of its compound under tree cover. Nirbanpur Buddha Bihar at Nirbanpur Headmanpara under Rangamati Sadar Upazila has about 68 ha land surrounding it having patches with natural tree species. Out of 68 ha land, 48 ha are in degraded condition. Bangladesh Forest Research Institute, Chittagong (BFRI) imitated a Kiang based tree biodiversity at Nirbanpur Buddha Bihar during 2008 – 2009. Under the leadership of the Chief Monk (Bhantee) with the technical and seedling support from BFRI the local community members planted about 20 thousand seedlings of about 34 indigenous species in the fallow degraded land of the Kiang. In addition to forestation this is also an initiative towards *in-situ* conservation of tree genetic resources.

Conservation through domestication of desired plants in and around homesteads: People use to grow and cultivate many fruit and food plants in and around homesteads for easy access to resources. Many traditional healer and practitioners cultivate many herbal plants in their house premises. Thus they conserve many plants through use and domestication.

Manipulated fallow management: Temporary clearing and burning of forest vegetation for cropping is characteristic for shifting cultivation. Clearing and burning releases the nutrients in the vegetation. After cropping, the fallow quickly recovers into secondary forest from coppices, underground rhizomes, root suckers and the soil seed bank. Tribal people in the CHT practice jhum in an area for one year and keep the land fallow after that to allow it to rejuvenate. But short fallow period are not able to restore the fertility. The use of "manipulated" or improved fallows provides a range of techniques which make better use of the ecological processes, leading to more sustainable practices. These improvements are based on farmers own knowledge and experience. Some of the improved techniques that have been observed being used by farmers in the CHT are using mulch for soil protection. This technique is used by farmers growing ginger and taro in hilly areas. According to farmers, mulch controls weeds, minimizes soil erosion and adds humus after decomposition. The use of mulch safeguards the topsoil against excessive soil temperatures and favours seed germination.

Action plans: Sustainable agriculture development in the CHT is in great demand. However, this must be supported by enabling policy and institutional reforms, ensuring tenurial security, generating integrated demand driven technology and service delivery, enhancing access to production and resources, credits and markets, and capacity building of farmers with strategic considerations of hill biophysical and socio-economic conditions and livelihood options of hill people. Essentials to generate more employment in agriculture by promoting niche commodities, organic farming, processing and value addition, and non-farm and off-farm employment (Rasul and Kollmair 2008). The Ministry of Chittagong Hill Tracts Affairs (MOCHTA) is responsible for the planning, implementation, and monitoring of development programs and projects in the CHT. However, the sectoral approach of line ministries and fragmented work of different non-governmental organizations often leads to overlap and fails to produce the intended outcomes. MOCHTA should be entrusted with the full responsibility of coordinating development work in CHT in an aim to ensure the development activities are more effective and sustainable and to avoid repetition (Rasul 2015). Smart Ffood crops recommended for the improvement of nutrient status in the CHT are shown in Table 6 (Chowdhury 2019). Some of the strategies and action plans are needed to achieve *Zero Hunger and Poverty Reduction* in CHT as soon as possible (FAO 2019).

Conclusion

Chittagong Hill Tracts (CHT) in Bangladesh is different from the major flood plain areas in comparison to land, people and the resources. Bangladesh has made significant progress in terms of food security in the face of growing population. However, poor households in Bangladesh do not have food security because they lack access to food, i.e. they lack sufficient food from own production, cash income and other resources to acquire enough food. Direct transfer of food grains provided through food aid is one mechanism used to increase access of poor household to food in Bangladesh. The declining trend in food aid simply illustrates fewer resources available for targeting to poor households under the safety net programs.

Despite impressive achievements in increasing food grain and reducing instability in prices, long-term food and nutrition problems remain. Bangladesh has yet to achieve comprehensive food security that resolves the problems of inadequate food intake and chronic malnutrition among poor people. Considering the poor food security scenario in CHT, strategic actions are needed to enhance food security of the CHT people. CHT cannot be food self-sufficient because of its undulating hilly terrains, limited land for intensive agriculture for the cultivation of a number of major cereal crops, specific plans and policies are therefore needed to meet the required food deficiency in the CHT. Especially the major cereal crops like rice and wheat that the CHT lack can be imported to address the growing food insecurity in the region. For strengthening food security in the CHT, there is a need to promote horticulture, agro-forestry and other high-value low-volume cash crops such as offseason vegetables in the region. Such agro-products have growing markets and demands. Due to remoteness and scattered villages in the CHT, the food distribution system has not been effective in the region. So for achieving food distribution efficiency, rural road infrastructure needs to be upgraded in the region. The other important aspect for achieving greater food security in the CHT is via enhancing income generation opportunities for ethnic communities. With greater income generation, the issue of food accessibility will be resolved. So there is a need to generate off-farm employment opportunities in areas like community based ecotourism, agro-processing industries, livestock enterprises and such others. More importantly, there is a need to adopt changing production and consumption patterns, and farmers in the CHT should be trained on value chain development of agro-products. Major efforts are still needed to address nutritional issues more directly. Coordinated programs involving nutrition education, food fortification, improvements in water quality and public health are needed. Increases in food availability and household access to food alone will not be adequate to address the malnutrition problems in CHT.

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