A SEMINAR PAPER ON

Sustenance of Farming System in the Context of Water Scarcity in the Chittagong Hill Tracts of Bangladesh

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Submitted To:

Course Instructors	Major Professor
1. Dr. Md. Mizanur Rahman	Md. Nasimul Bari
Professor	Professor
	Dept. of Agronomy
2. Dr. A. K. M. Aminul Islam	
Professor	
3. Dr. Md. Rafiqul Islam	
Professor	
4. Dr. Dinesh Chandra Shaha	
Assistant Professor	

Submitted By:

Aung Sing Hla Marma

MS Student

Reg. No: 13-05-2981

Department of Agronomy

BANGABANDHU SHEIKH MUJIBUR RAHMAN AGRICULTURAL UNIVERSITY,

SALNA, GAZIPUR-1706

1. ABSTRACT

From the beginning, water scarcity problem has been an issue of serious obstruction for the farming operation in the hilly regions of Bangladesh. Agriculture in Chittagong Hill Tracts of Bangladesh is predominantly rain-fed with an average 2210 mm monsoonal rain, but rainfall during dry winter period (December to February) is inadequate for winter crop production. The natural soil water content (as low as 7%) of hill-slope and hilltop during the dry season is not suitable for shallow rooted crop cultivation. A study has been conducted to find out the potentiality of the rainwater harvesting and its impact on the local cropping development. Rainwater harvesting potential has significantly mitigated the scarcity problems in the hill cropping system. The irrigation facility has increased the cropping intensity from 155% to 300%. The study showed that there is high potential for rainwater harvesting during rainy season and subsequent use of harvested water for gravity-flow valley land irrigation and suction mode pumping to hilltop and hill-slope with a low capacity 1–2 hp pump. The watershed management system in the hilly area has remitted the degradation of watersheds and conserved the natural resources(soil and nutrients) without hampering the local livelihood. Water productivity and benefit cost ratio analysis show that vegetables and fruit production were more profitable than rice cultivation under irrigation with harvested rainwater. As the production can be increased by following the conservation techniques in the hill farming, it will create a good impact on lifestyle of the indigenous people.

2. TABLE OF CONTENTS

3. LIST OF TABLES

4. LIST OF FIGURES

CHAPTER I

1. INTRODUCTION

Chittagong Hill Tracts (CHT) is located in the south-eastern part of Bangladesh. The geographical feature of the hilly areas is different from the plain land. This area is undulated, erosive and sloppy with distinctive and specific characteristics of water resources compared to the remaining part of the country. Farming system in Chittagong Hill Tracts of Bangladesh is predominantly rain-fed with an average 2210 mm monsoonal rain. Rainfall during dry period (December to February) is inadequate for winter crop production. The soil moisture content is as low as 7% of hill-slope and hill-top during the dry season which is not suitable for shallow rooted crop. (Tariqul *et al.,* 2016). The total area of the CHT is about 13,184 square km (9 % area of the country) of which 92 % is highland, 2 % is medium highland, 1 % is medium lowland and 5 % is homestead and water bodies (Ullah *et al.* 2011).

Shifting cultivation which means keeping the land fallow after certain number of cultivations is still the major cultivation system in this region due to little input, small capital, very limited irrigation facility, unavailability of modern technologies and affinity to indigenous cultivation methods. Bangladesh is an agro-based country where about 63 % of the cultivable land is under irrigation, but irrigated area in the CHT is only 33 % (BBS 2012). As a result, the production is comparatively less and peoples suffer from food scarcity. Bangladesh has the highest per capita fresh water available among South Asian countries which is annually 795,000 cubic meters of water through surface flow and about 2030 mm of rainfall (BMD 2000). However, it is hardly made proper use of the resources due to poor internal water management practices. There is excess water in the monsoon and scarce in the dry season create a situation of water insecurity in the area. It affects the water supply for domestic, crop production and fisheries. Small water bodies, canals and creeks are the sources of irrigation in the dry period for farming practices of small landholders in the CHT (District Statistics 2013).

There is a possibility to conserve the water for farming through different practices. Such as rainwater harvesting techniques, integrated watershed management (IWM) practices and so on. There is rainwater potential in the hilly areas to harvest for irrigation purposes because of its high annual average rainfall and availability of suitable landscape. In this type of condition, developing rainwater harvesting technologies for irrigation would be very useful for local agricultural production (Zhang et al. 2014). By constructing small water reservoirs in upstream hilly canyon, rainwater can be harvested to irrigate both hill-top and hill-slope areas by pumping and the valley areas by gravity flow. Integrated Watershed Management (IWM) is generally applied at the catchment level which has emerged as the preferred model worldwide for watershed planning (Heathcote 1998). IWM creates the general concept of sustainable development operation for the management of freshwater resources. A holistic approach is adopted by IWM, which indicates that information is needed on the circumstance of economy, society, environment, and their inter-relationships (Steiguer *et al*. 2003). Watershed Management (WM) has developed to respond to the complex challenges of natural resource management using the watershed as a practical unit of execution. Soil and water conservation for agricultural productivity enhancement with fertility improvement leading to better livelihoods for the communities within the watershed should be the main focus of WM in CHT.

Objectives of the study are-

a) To review the water conservation technique to eliminate scarcity problem for sustainable farming system in the hill tracts regions of Bangladesh.

b) To highlight the better option for the livelihood of indigenous people by managing the watersheds in the Chittagong Hill Tracts.

CHAPTER II

2. MATERIALS AND METHODS

This paper is exclusively a review paper so that all of the information has been collected from the secondary sources. During the preparation of the review paper, I went through various relevant books, journals publications etc. The related topics have been reviewed with the help of library facilities of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), journals and books from Krishi Gobeshona Foundation(KGF), Bangladesh Agricultural Research Institute (BARI) and Bangladesh Rice Research Institute (BRRI), internet browsing and CD search. After collecting all the available information, it has been presented as per the objectives of this paper.

CHAPTER III

3. REVIEW OF FINDINGS

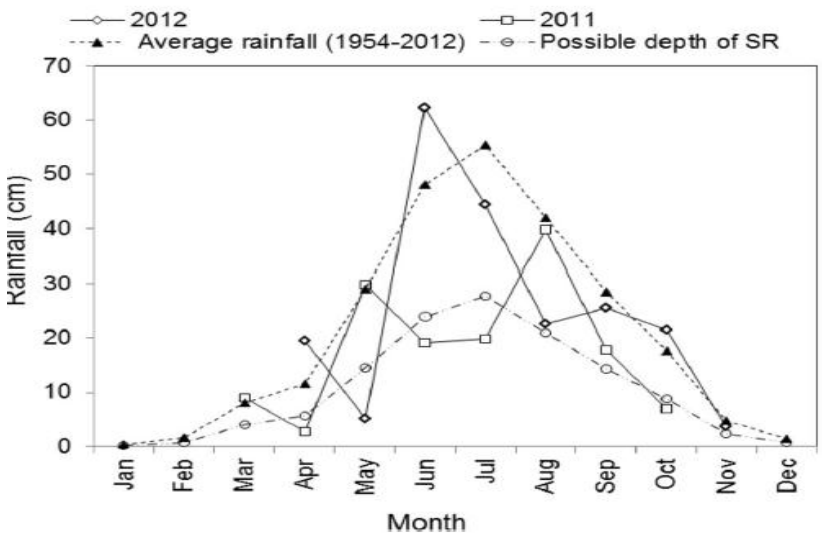
Watershed of Chittagong Hill Tracts is rich reservoir natural resources. The CHT is natuarlly tropical evergreen. The headwater of the Sangu, Matamuhuri, Rinkheong, Kassalong and Maini rivers were originated within Forest Reserves. The Forests are mainly two types: Tropical wet evergreen and Tropical Mixed evergreen. These forests are multistoried in nature, provide a continuous dense canopy cover but a litter cover to absorb the rainfall impacts of the heavy tropical storms. It encourages rapid infiltration of the water into the soil profile.

Over 90 percent of the catchment area for the rivers in Bangladesh lies outside of the country. As a consequence, huge inflows of water enter the country, over which we have no control. The lack of controls is a critical problem because our agriculture is dependent on water. Bangladesh has either too much or too little water at different times within a year. The average surface flow of water in peak-wet season (August) is nearly 112 billion cubic meters and in the dry season (February), it is about 3.7 billion cubic meters. During the wet period (June - September), voluminous river flows in a flat topography (which severely limits effective drainages) and further strengthened by high rainfall occurring only in a limited four months period which makes flooding a recurring phenomenon (ADB, 2004).

The most critical aspects alternating flood and water scarcity during the wet and dry seasons due to i) over-expanding water needs of a growing economy and population, ii) massive river sedimentation and iii) bank erosion. We have a growing need for providing total water quality assessment, management, and maintenance of the eco-system. Moreover, there is an urgency to satisfy multi-sector water needs with limited resources, promote efficient and socially responsible water use, imprint public and private responsibilities, and decentralize state activities where appropriate.

7.1. Rainwater Distribution

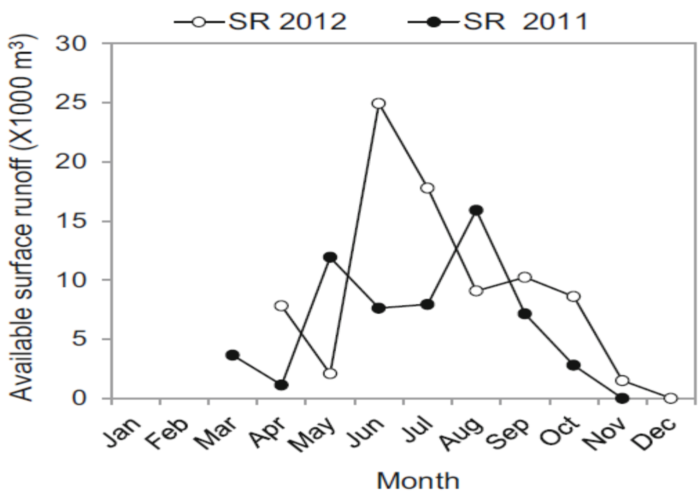
The rainfall pattern in the hilly area is high and uncertain (30-year annual average rainfall is 3030 mm). These areas are one of the high rainfall areas of Bangladesh. The months from December to March are dry and rainfall is 4.6 %. Transitional period between dry and wet season with irregular rainfall of 16.3 % is the time between April and May. The rainfall data shows that the rainy season is duration between May and October with 90 % annual rainfall (Fig. 1). The surface runoff (SR) (calculated) shows that the rainwater can potentially be harvested in the hilly area during the period from May to October (Fig. 1).



(Source: BMD, 2000)

Fig.1. Rainfall pattern of the hilly area (SR is for surface runoff)

The rainwater can be used during the dry period spanning from December to April. The system collected overland flow water (surface runoff) directly without any treatment because the runoff water quality was well suited to irrigation. The capacity of the studied reservoir was 7548 cubic meters. The volume of the available surface runoff in the rainy season was enough for the full storage of the reservoir (Fig. 2) for the year 2011 and 2012. Evidence was found from the direct observation that the reservoir became full before end of May. Excess water was bypassed through the spill-way during the rainy season which was from mid-May to October.



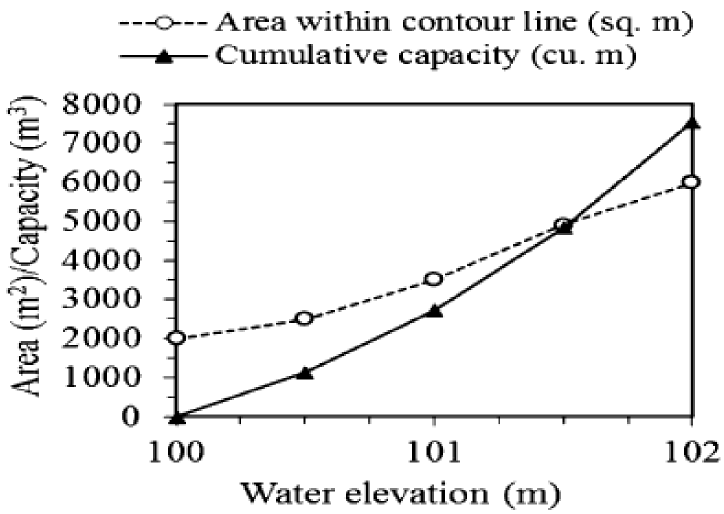
(Source: Tariqul *et al.,* 2016)

Fig.2. Surface runoff (SR) available for harvesting in the studied watershed for the year 2011 and 2012

7.2. Suitability of rainwater storage reservoir

Various features that includes the size, shape, slope and depth of the suitable place between two parallel ridges which influence the area–elevation relation and storage capacity of the reservoir. The area–elevation of the reservoir was almost linear (Fig. 3). The height of contour elevation of the reservoir was taken up to 102.5 m and the considered reduced level of the dead storage was as 100 m. The slope of this reservoir was represented by the area– elevation relationship curve. Up to the level of 102 m, the cumulative capacity of the reservoir was 7548 m3. Due to the losses of seepage and percolation (S&P), evaporation and outflow, the effective use of the water in the reservoir was varied. The intermediate value of storage capacity of the reservoir can be taken from the graph, from which decision can be made how much water to be used at different time intervals.

Gravity flow irrigation of valley land and low lift pump irrigation of both hilltop and hillslope land were facilitated by the reservoir.



(Source: District Statistics ,2013)

Fig.3. Area–elevation and capacity–elevation relationship of the rainwater storage reservoir

The losses that occur due to S&P and evaporation characterize the suitability of a site for a rainwater harvesting reservoir. The S&P and evaporation losses of the reservoir in the dry season was gradually increased from December to April (Table 1) due to higher temperature and wind speed in the later months. During these dry months, cumulative loss due to S&P and evaporation was 645 mm. There would be deficit of irrigation water if this amount of loss is not considered during the design of a reservoir. Due to more evaporation than rainfall, the dry seasonal evaporation exerted water stress condition in soil. The average annual evaporation varies from 51 to 183 mm in different parts of Bangladesh. The evaporation in this eastern part is lower than western part of the country. The daily average evaporation and S&P loss of studied reservoir in dry season was 3 and 1.2 mm/day, respectively. However, the soil condition can be the cause of considerable variation of the S&P losses. In porous sandy soil, the seepage loss is high and reduces gradually due to siltation in 1 or 2 years.

Table.1. Water losses from the reservoir in different months and subsequent water level changes

Month	Losses (mm)		Total loss (mm)	Cum. loss (mm)	Water level (mm)
	E	S&P			
Dec	62	33	95	95	1905
Jan	72	24	96	191	1809
Feb	84	21	115	306	1694
Mar	110	59	169	475	1525
Apr	122	48	170	645	1355

E evaporation, *S&P* seepage and percolation

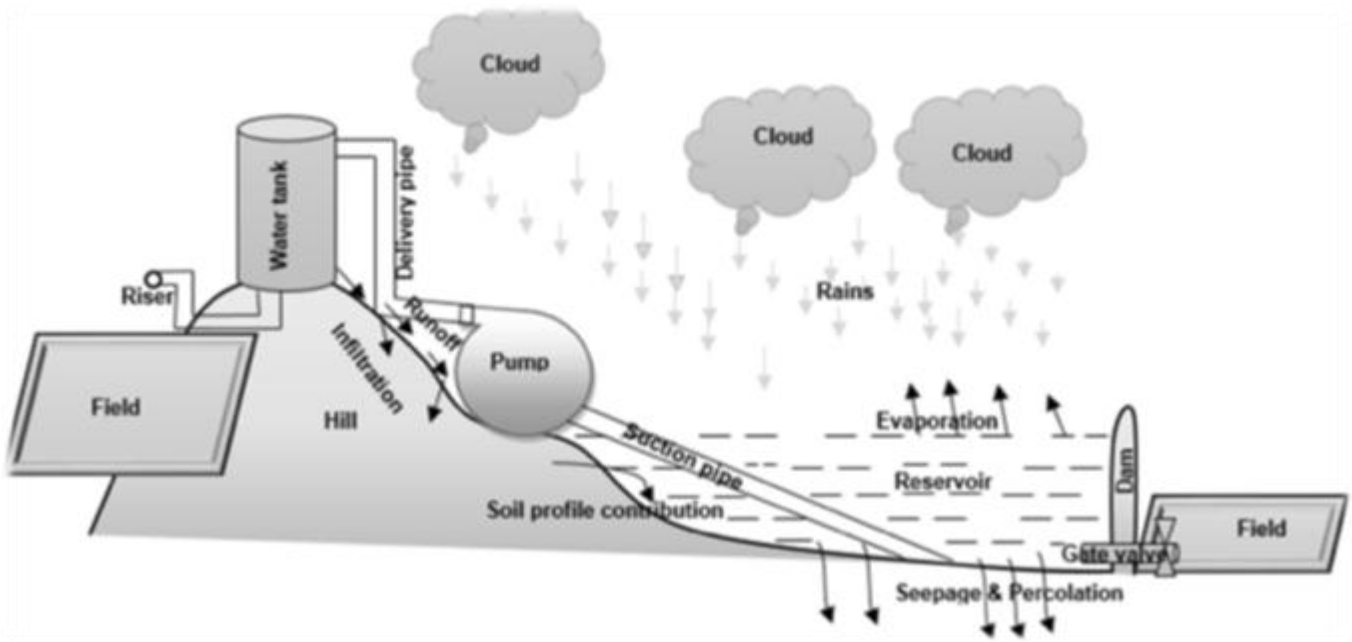
(Source: Bala ,2010)

7.3. Techniques to reduce the water loss

The losses from the reservoir can be reduced considerably by 1) lining with soil-cement, bentonite, brick, and 2) low-density polyethylene lining (LDPE) of reservoir bottom, and 3) covering water surface by monolayer alcohol. On the other hand, the groundwater storage was S&P loss increases (Jebamalar *et al.* 2012). The evaporation losses will be reduced to 60 % if the water surface is covered by 600 gauge LDPE sheets (Panigrahi *et al.* 2006). Recent research shows that environmentally innocuous surfactant monolayer cover on water surface reduced the evaporation rate about 40–70 % (Dawood *et al.* 2013). Seepage losses were reduced by biocrete, clay and polythene by 93.81, 56.73 and 76.37 %, respectively, as observed by (Jayanthi *et al.*2004). The catchment area, system efficiency and storage capacity of rainwater harvesting system had strong influence of on water volumes and the depletion of water during dry seasons and drought periods (Wallace and Bailey,2015). To conserve the soil and increase infiltration rate contour cultivation, terracing should be practiced.

7.4. Rainwater harvesting system

The reservoir system at the study site consisted of a cross dam, spillway, gate valve, pump, storage tank, water conveying channel, pipe networking and risers. A cross dam between two hills collects surface runoff during rainy season from June to November. Zhao et al. (2009) suggested that large gentle slope hills with slight modification are better rain collecting surface. The overland runoff part of rainfall was stored in the reservoir. The runoff water was not treated because it was enriched with wash load including silts and clay particles and suitable for irrigation. A simplified sketch of the rainwater harvesting reservoir system is shown in Fig. 4.



(Source: Tariqul *et al.*, 2016)

Fig. 4. Sectional sketch of the rainwater harvesting reservoir system studied

7.5. Pumping from rainwater reservoir

It is important to choose of an efficient pump and operating condition for an economic and environmentally friendly operation. Operating cost at micro-level and small savings of energy consumption can contribute to the economic benefit of the system and also the overall sustainability of farming system. The need of pumping was required to lift water from the storage reservoir to hillslope and hilltop. There was variation in the pump discharge due to suction lift, delivery lift, rpm (revolutions per minute) of the motor, suction pipe diameter, delivery pipe diameter and pump capacity. The relative performances of the measured values of water horsepower, efficiency and discharge of two locally available pumps installed at the rainwater harvesting reservoir were observed in the table 2. It was observed that pump-1 was 1.5 hp with a suction pipe of 381 mm diameter and a delivery pipe of 254 mm diameter. Pump-2 was 2 hp with a suction and delivery pipe of 254 mm diameter. The total lift of pump-1 was 10.2 m and for pump-2 was 13.27 m. It was citable that the suction pipe diameter of pump-1 was much larger than that of pump-2. Therefore, the discharge of pump-1 was higher than pump-2 despite the higher capacity of pump-2. But the efficiency of both pumps was low. The reason was the operation of pumps at field condition without setting optimum stipulation (rpm and head) which made the performance low. The performance of a pump varies considerably with the variation of rpm, blade angle, blade number, impeller outlet diameter as well as pipe diameter and total lift as suggested by Bacharoudis et al. (2008) and Islam and Kader (2015). Installation of solar panel can provide electricity where not available.

Table 2. Performance of suction mode pumps to lift harvested rainwater to hilltop

Pump name	Suction lift (m)	Delivery lift (m)	Total lift (m)	Discharge (lps)	Output (hp)	Input (hp)	Efficiency (%)
Pump-1 (1.5 hp)	1.4	8.8	10.2	2.06	0.28	2.09	13.4a[1]
Pump-2 (2 hp)	1.52	11.75	13.27	1.04	0.18	2.57	7.0b

(Source: Islam, 2015)

7.6. Pumping from groundwater

The water source to be pumped and the related technical feasibility are depended on choice of water pumping modes (suction or forced mode). Because of low construction cost and easy-to-use features, suction mode pumping of surface water is preferred. Suction mode pumping was possible in the studied hilly area to irrigate hilltop and hillslope due to the created facility of rainwater harvesting reservoir. However, the groundwater level is deep (>8 m), so the suction mode principle usually does not work to pump groundwater in this hilly region. Three pumps namely pump-1: suction mode 1.5 hp pump, pump-3: force mode submersible 2 hp pump, and pump-4: force mode submersible 1 hp pump were tested at field condition (Table 3). The results represented us that the discharge of pump- 1, pump-3 and pump-4 was 2.06, 0.64 and 1.04 l/s, respectively. Volume of water lifted per unit energy consumption for the suction mode pump (pump-1), was 4.61 m3/kWh, which was higher than that of the both force mode pumps. And it was found that, the operating cost of suction mode pump was less than the force mode pump. Moreover, the suction mode pump had much less installation cost than the force mode pumps. We found that, cost of 7548 m3 groundwater pumping by a force mode pump was Tk 21,744 and the energy requirement was 2174.4 kWh (data not shown in Table). Installation and operation cost of groundwater pumping was more than the construction cost of the rainwater harvesting reservoir.

Table 3. Comparison between suction mode pumping of harvested rainwater to hilltop and force mode pumping of groundwater to hilltop

Pump	Working mode	Suction lift (m)	Delivery lift (m)	Total lift (m)	Discharge (l/s)	Specific discharge (m^3/kWh)	Installation cost (Tk)
Pump-1 (1.5 hp)	Suction	1.4 (ground)	8.8 (hill)	10.2	2.06	4.61	16,000
Pump-3 (2 hp)	Force	27.4 (ground)	14.5 (hill)	41.9	0.64	1.28	350,000
Pump-4 (1 hp)	Force and submersible	27.4 (ground)	0 (ground)	27.4	1.04	3.47	14,000

(Source: Garg, 2008)

7.7. Effect on farming system

Crop production per unit water and land is increased by the selection of water conserving crop and crop rotation in watershed scale. Most of the land remained fallow during the dry season due to the lack of irrigation facility (Table 4) before the intervention of this new water management system. In Table 4, a comparison of cropping pattern between site with and without rainwater harvesting reservoir irrigation system is shown. The cropping system in the area was mainly rainfed and the cropping intensity of the studied region was 155 %. The low yielding indigenous variety was dominant during the kharif season. The major cropping pattern was fallow-rice or maize-fallow with somewhat irregular fashion as observed during a pre-project field survey. The cropping pattern was changed at the study site and the cropping intensity increased to 300 % with sustainable crops compared to local conventional crops (jhum rice) as shown in Table 4. Jhum cultivation (shifting cultivation) is regarded to be non-ecofriendly (Bala, 2010).

Table 4. Comparison of cropping pattern between sites with and without harvested-rainwater irrigation

Without rainwater harvesting facility			With rainwater harvesting facility		
Rabi	Kharif-1	Kharif-2	Rabi	Khari-1	Kharif-2
Fallow	Aroid	Aroid	Cabbage	Chilli	Aroid
Fallow	Yard long bean	Brinjal	Raishak	Chilli	Aroid
Fallow	Galong (jum rice)	Sesame	Potato	Red amaranth	Yard long bean
Fallow	Choroivati (jum rice)	Sesame	Onion	Red amaranth	Yard long bean
Fallow	Rice/Maize	Fallow	Red amaranth	Maize	Aroid

(Source: Ahmed, 2013)

7.8. Performance of crop with benefit-cost ratio

In Table 5, the performance in terms of water use efficiency (water productivity) and benefit–cost ratio of different crops studied under the rain water harvesting irrigation system are shown. Selection of water saving crop is one of the important decision-making tasks for farming system development in the water deficiency region (Wang *et al.* 2010). It is suggested that adoption of water conserving cropping system can reduce irrigation cost significantly, which contributes to the economic, social, ecological benefit of sustainable agriculture system for water deficit or arid region. It was shown in table 5, water productivity of vegetable production in the study was much higher than that of fruits and grain crops. Pascale *et al.* (2011) also said that vegetables provide higher economic return and water productivity compared to grain crops. The water productivity values of crops studied were close to the literature values. The water productivity of onion variety was 59.6 kg/ha/mm, which was within the literature values, i.e. 4.5–3.8 kg/ha/mm by Roy et al. (2014) and 121.8–168.5 kg/ha/mm by Zheng *et al.* (2012). The water productivity of cabbage in the study was 193.5 kg/ha/mm, which was higher than the values (64.3–140.4 kg/ha/mm) found by Asare (2010). Both water productivity and seasonal water use of the cucumber variety studied were 40.5 kg/ha/mm and 370 mm, which was less than the values as 56 kg/ha/mm and 671.5 mm, respectively reported by Yaghi *et al.* (2013). Water productivity of maize grain was produced with 7.1 kg/ha/ mm. Similar water productivity of maize grain production (7.64 kg/ha/mm) was obtained by Ullah *et al.* (2013). The water productivity of BRRI Dhan-28 and BRRI Dhan-29 were 1.4 and 1.2 kg/ha/mm, respectively, which are found as the lowest among all crops studied. The water productivity of the rice varieties was lower than the national standard which was 3.06–4.59 kg/ha/mm. But it was in agreement with the findings of Alauddin and Sharma (2013), they stated that water productivity of boro rice was just above or below one for the area of Chittagong, Chittagong Hill Tracts, Sylhet. The water productivity for boro rice production in fine textured soil can be higher, that are 4.8–6.1 kg/ha/mm (Amin *et al.* 2003) and 5.8–6.8 kg/ha/mm (Sarker *et al.* 2006) for silt loam soil.

7.8.1. Benefit–cost ratio

Better options are made from the study results for farmers and managers to choose crop based on water productivity if needed. Under the harvested rainwater irrigation system, the economic performance of different crops cultivated varied considerably (Table 5). It was observed that the horticultural crops performed better with the highest benefit–cost ratio of 9.70 for BARI Malta, 4.9 for BARI Litchi and 4.35 for BARI Mango. The highest benefit–cost ratio was 4 for sweet gourd leaf followed by country bean (2.52), cucumber (2.4), chilli (2.36), cabbage (2) and black cumin (2). The benefit–cost ratio of red amaranth, raishak and bottle gourd was less than two. Maize cob was produced with higher BCR that was 3.8 compared to maize grain production. BRRI Dhan-28 had slightly higher benefit–cost ratio than BRRI Dhan-29. So, it is suggested that, the crops with higher benefit–cost ratio and water productivity should be selected especially in the water scarce dry winter period. It is also important to mention that the rainwater harvesting reservoir also facilitated for fish cultivation. About 0.3 ton of different fish species, such as carp, mrigal and rohita, were grown in the reservoir (Tariqul *et al.*, 2016).

Table 5. Yield, water productivity, and economic performance of grain and horticultural crops produced under irrigation with harvested rainwater

Crop	Yield (t/ha)	WU (mm)	WP (kg/ha/mm)	Total benefit (×1000 Tk/ha)	Total cost (×1000 Tk/ha)	Net benefit (×1000 Tk/ha)	Benefit–cost ratio (×1000 Tk/ha)
Sweet gourd leaf	60	340	176.5	140	35	105	4
Chilli	14.8	290	51.03	444	188	257	2.36
Red amaranth	14	270	51.8	260	140	120	1.86
Cucumber	15	370	40.5	300	125	175	2.4
Black cumin	1	250	4	200	100	100	2
Raishak	30.6	270	113.3	517	277	240	1.87
Cabbage	60	310	193.5	600	300	300	2
Onion	20	335	59.6	–[a]	–	–	–
Bottle gourd	66.9	345	193.8	669	345	324	1.94
Country bean	2	310	6.45	600	238	363	2.52
Tomato	20	360	55.55	–	–	–	–
Maize cob	14.5	270	53.8	167	43	124	3.88
Maize grain	3.5	490	7.1	65	46	19	1.41
BRRI Dhan-28	4	1100	1.4	40	29	11	1.38
BRRI Dhan-29	4.5	1250	1.2	45	38	8	1.18
BARI Malta-1	10	600	16.7	1025	106	919	9.67
BARI Litchi	7.1	510	13.9	575	117	458	4.91
BARI Mango	10.6	650	16.4	818	188	630	4.35

WU water use, *WP* water productivity

(Source: Ullah, 2011)

7.9.Watershed management approach

In a situation of degraded watersheds and continuous degradation of watersheds, watershed management has been brought up as the way in which to cease and even reverse the process of degradation. Watershed management (WM) is the integrated use of land, vegetation, and water in a geographically distinct drainage area for the benefit of the communities, with the objective of protecting or conserving the hydrologic services the watershed provides and of reducing negative downstream or groundwater impacts (ADB, 2011). WM programs usually are implemented with micro/sub-watershed as the basic management unit and that allows the integration of land, water, and infrastructure development. These programs typically adopt integrated natural resource management (NRM) approaches with the twin objectives of resource conservation and poverty reduction. We know that, NRM practices (soil and water conservation) enhance agricultural productivity through decreased erosion. Through increased agricultural productivity; better crop, livestock, tree and nutrient management; and better marketing, income and livelihoods can be improved.

Without any loss of local livelihood-based income for the upland farmers, a successful watershed management demonstration should be able to reverse watershed degradation.

In sum, livelihoods will be made locally sustainable with reduced negative external impacts.

The following indicators could be used to assess the benefits of the WM program (ADB, 2011):

(i)Reduced run-off, soil loss, and gully formation, (ii) Improved vegetation structure and composition, (iii) Increased crop productivity, (iv) Sustainable cultivation of root crops, (v) Improved water sources, (vi) Increased biodiversity.

CHAPTER IV

4. CONCLUSIONS

Chittagong hill tracts region are one of the major concerning area in regarding to the farming system. One of the main restrains in farming practices in the hilly area is the water scarcity. The dominant is slope lands in the most of the agricultural fields. It is very much difficult to supply water in the hill slopes by the irrigation channels. Especially in the dry season the water scarcity is higher. And also, it is not possible to pump the water from deep ground level. These problems are becoming a major issue for the survivability of indigenous due to less production and lack of foods. A promising technique were developed by researchers which can sort out the water deficiency problems in the agricultural land. The natural rainwater could be used to omit the irrigation problems to the crop. As the amount of rainfall is higher in wet season, a technique is implemented whether to store this rainwater in the pond or reservoir. This stored water can be applied to the crops in the dry season and also all over the year. Evaporation loss can be reduced by covering LPDE sheet and seepage loss can checked by clay or biocrete. A suction pump was installed to pump the water in the knoll or hill tops from the reservoir. The efficacy of this method in farming is very effective. The water use efficiency of the crop can be increased and it can provide high economic return.

Watershed management(WM) programs are accomplished that allows the integration of land and water use by installation micro or sub- watersheds in several areas. As this approach includes natural resource management (NRM) so the conservation of watersheds from degradation can be ensured. NRM method consists soil and water conservations, so the productivity of the land can be increased significantly. WM doesn't allow any adverse impact on local livelihood. Its integrated approach both restore the water and nutrients. As the productivity is increased, the local livelihood is improved and it will be made locally sustainable.

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