ASSESSMENT OF GENDER INVOLVEMENT IN GROUNDWATER UTILIZATION IN NORTHWESTERN BANGLADESH

MS THESIS

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ABSTRACT

Present study was undertaken to find out gender specific involvement in groundwater utilization in agriculture and household activities, contributionin decision making process and to identify various problems and constrains faced by gender in groundwater utilization. Rajshahi (Godagariupazila) and Chapainawabgonj (Nacholeupazila) district from northwestern Bangladesh were selected purposively as the selected districts mostly depend on groundwater for agriculture and household activities. A total of 60 households were selected randomly for empirical investigation in which 28 from Godagari (three villages) and 32 from Nachole (three villages)upazila.Among these selected households, 95 persons were interviewed in which 59 males and 36 females.FGDs, KIIs and individual case studies were also carried out. Linear regression model and perception index wereperformed to determine gender specific involvement. Study findings documented that only 9% land was possessed by female, whereas 91% for male implied clear discrimination on land ownership. Interestingly in agricultural decision making process, male perceived that they solely done most of the work and took decisions while female perceived that both male and female contributed equally. As per male opinion, about 57%agriculture decision were taken my male for rice cultivation and 79, 75 and 56% for maize, lentil and vegetable cultivation, respectively. On the other hand, based on spouse's opinion, about 68, 70 and 100% decisions were taken jointly (male and female) for rice, lentil and vegetable cultivation, respectively.On an average female spent 3.95 hours for cooking only where male spent only 0.12 hours and for other household works female spent more time than that of male. BMDA, community, personal and union parishad tube well were the main sources of household water that contributed 39, 33, 23, and 5% respectively. For irrigation purpose, BMDA tube wells alone contributed 87 percent of command area in the study villages. Linear regression result shows that age of the respondents, year of schooling, working members in agriculture, farm experience, time spent for water collection were found to be negatively associated with water utilization. On the other, farm size, training on water management, domestic water utilization found to be positively associated with decision making process regarding water utilization for irrigation. As per male perception, the most important three problems and constrains faced by male were unavailability of water, time consuming and rain & heat, while more physical labor, natural calamity and unavailability of waterwere the most important three problems and constrains faced by female,based onfemale perception.Study suggests that women's involvement and contribution to agriculture and household activities particularly on groundwater utilization should be popularized so that women can have social recognition for their real contribution.

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The Author.

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ABBREVIATION AND ACRONYMS

%	Percent
BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BIADP	Barind's Integrated Area Development Project
BMDA	Barind Multipurpose Development Authority
DAC	Development Assistance Committee
DTW	Deep Tube well
EPADC	East Pakistan Agricultural Development Corporation
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GKF	Grameen Krishi Foundation
GMB	The Ganges, the Brahmaputra and the Meghna
GWA	Gender and Water Alliance
IWM	Integrated Water Management
KII	Key Informant Interviews
LGED	Local Government Engineering Department
MANCO	Management Committees
NW	Northwestern
PI	Perception Index
SAAO	Sub Assistant Agricultural Officer
SPSS	Statistical Package for Social Science
STW	Sallow Tube Well
UNCSD	United Nations Conference on Sustainable Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Project
UNFPA	United Nations Population Fund
WHO	World Health Organization
WUAs	Water User Associations

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Life starts with water, without water human being and animal cannot survive not even the plants. In our everyday life from beginning to the end of day, we need water not only for drinking but also for many other purposes to survive. However, water is a finite resource and inadequate and excessive use of water is primarily liable for current water scarcity all over the world. In 2016, about 700 million people in 43 different countries were suffering from water scarcity and 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions by 2025 (UNDESA, 2016). This water scarcity may lead to World War-III as many countries are already fighting against each other for water distribution including Bangladesh. The allocation of Ganges water has remained a subject of conflict for almost 35 years between Bangladesh and India (Wikipedia, 2017).

Bangladesh has a unique geography with the largest delta sloping gently south and southeast ward (Amin *et. al*, 2003) to meet the longest sea-shore in the world covering only 147,570 km^2 with a total population of 163 million (World Bank, 2017). This largest delta is formed by the Ganges, the Brahmaputra and the Meghna (GBM) river system with about 700 rivers, canals and streams with a total length of approximately 22,155 km (BBS, 1998). Bangladesh depends on agriculture for feeding the world's most densely population, living 1,252 people per km^2 (World Bank, 2017) and 45% of total labor forces is directly involve in agriculture and contributes about 15% to the country's GDP (BBS, 2016). Despite having 700 rivers, canals and streams, agricultural production is mostly groundwater dependent, about 79% of cultivated land is irrigated by groundwater and the remaining by surface water (Qureshi *et. al*, 2015). Groundwater is the main source of irrigation water as well as of domestic use like drinking, cooking, cleaning etc. About 97% people of Bangladesh have access for safe drinking water (Crow and Sultana, 2002). The cost of over dependency on

groundwater is causing severe groundwater depletion especially in northwestern Bangladesh. Increasing population, food insecurity, growing economics and poor water management are putting unprecedented pressure (UNCSD, 2012) on groundwater level in northwestern Bangladesh.

The Northwestern (NW) Bangladesh covers the whole Rajshahi and Rangpur division consisting 16 districts, 8 districts under each division having the largest cropping area within the country, 35% of total cropped area (BBS, 2016) and supplies about 35% of irrigated boro rice and 60% of the wheat (Mainuddin *et. al*, 2014) as the main contributor of self-sufficiency in food production with a total cultivable area of about 1.34 million acres (BBS, 2016). Total irrigated area in NW region is higher compare to national average where NW region cover 85% of total cultivable land (Mainuddin *et. al*, 2014) and the national average is 80% (Rahman and Parvin, 2009). The availability of groundwater for irrigation is the driver for increasing agricultural production in NW region, alongside due to excessive irrigation from groundwater results in severe groundwater depletion. The most affected areas lie in the NW region especially Barind track (Qureshi *et. al*, 2015) and the districts under severe depletion is Rajshahi followed by Pabna, Bogra, Dinajpur and Rangpur (Dey *et. al*, 2013).

1.2 Status of Gender and Groundwater

Groundwater is generally used in production (mainly for irrigation) and domestic (drinking, cooking, cleaning) purpose and about 70-90% of lifted water is used for irrigation purpose and the rest for drinking and other water supplies (Zahid and Ahmed, 2005). STWs (Sallow tube well) and DTWs (Deep tube wells) are commonly used to pump up groundwater for irrigation and hand tube wells or tube wells for domestic water. Due to the availability of tube wells access to groundwater for domestic use has increased rapidly and about 97% of population (Crow and Sultana, 2002) heaving groundwater for drinking and other domestic purposes. Tube wells are mostly private owned and there are also some public tube wells installed by government institutions (Sultana, 2009a). Tube wells have been heavily promoted by the government and some development agencies as safe water sources compared to surface water that are often chemically and pathogenically contaminated and

frequently led to high morbidity and mortality rates from waterborne diseases (Sultana, 2009b).

Groundwater is the main source of irrigation for increasing crop production and sustainable agricultural intensification of Bangladesh. Groundwater irrigation has probably been the most dramatic development in Bangladesh agriculture during the past 30 years and availability of groundwater for irrigation has contributed to manifold increases in crop productivity of Bangladesh particularly in NW region (Dey *et. al*, 2013). The first groundwater development project was initiated under Bangladesh Agricultural Development Corporation (previously EPADC, East Pakistan Agricultural Development Corporation) in 1962, the Barind's Integrated Area Development Project (BIADP) in Dinajpur district under NW region (Dey *et. al*, 2015). During post liberation period the contribution of groundwater has increased from 41% to 79% in 2012-2013 (Qureshi *et. al*, 2015). The ratio of groundwater to surface water use is much higher in NW districts of Bangladesh compare to other parts of the country. In the NW Bangladesh, all rivers and canals become dry during the dry season (January- May) and make the people completely dependent on groundwater (Shahid, 2008; Shahid and Behrawan, 2008).

The issue of gender in the water sector does not simply involve access to water moreover it involves questions of rights, responsibilities and participation (equal participation by men and women both) at all level (Nahar, 2002). Within the global trend to involve communities in water management, women often continue to excluded from water governance mechanisms across the world and in Bangladesh (Hussain, 2007). Women's participation in water governance has been advocated by a wide range of actors for a variety of reasons, including integrating women's needs and knowledge, enhancing women's status and increasing women's voice in governance in general (Harris, 2009) but often the major concern that has driven women's integration in water projects has been that of ensuring project's effectiveness and efficiency (GWA and UNDP, 2006). Good number of scholars have been critical to the overall rationale and approach taken by aid organizations and government implementation agencies and some have warned against the dangers of

individualistic and equalizing measures which do not take into account the historical and social context in which gender relationships are embedded (Zwarteveen, 2009) and others have observed that enhancing women's participation in formal organizations should be considered carefully as it might devolve responsibilities without actual power and even in certain instances, disempower women by weakening some of the informal rights they had (Harris, 2009).

Research on gender and water relationships has largely focused on particular elements, such as the division of tasks and labor between men and women, rights and access to water and women's participation in decision making through their involvement in water management organizations (Crow and Sultana, 2002) but gender relations are influenced by not just direct resource use/control/access and the implications of different types of waters, but also by the ideological constructs of masculinity/femininity, which can work in iterative ways to influence how people relate different kinds of water (Sultana, 2009b). Women participation in water user's organizations is minimal because the formal and informal membership criteria exclude women, moreover the balance between costs and benefits of participation is often negative for women because complying with the rules and practices of the organization involves considerable time costs and social risks (Dick and Zwarteveen, 1998).

1.3 Rationale of the Study

Bangladesh has achieved a remarkable progress in the water supply during the last few decades because of the availability of groundwater. It has reported that over 97% of total population have access to tube wells/hand pumps, taps or ring wells (Crow and Sultana, 2002). A favorable geological condition, support from government and development partners and a vibrant private sector ensured installation of millions of hand pumps supplying bacteriological safe drinking to the entire country (Nahar, 2002). In case of groundwater utilization gender issue reflects differently where males are responsible for agricultural production water and females are responsible for domestic water. Production purpose is related to mainly irrigation for agricultural crop production and domestic purpose is related to drinking, cooking, cleaning,

bathing etc. All over the developing world including Bangladesh, female members of the households are primarily responsible for fetching water and use of it. For instance, their spending time for water collection ranged from 1.5 hours to 2 hours and occasionally time spending increases and during water collection female face an array of physical, psychological and social problems. The time spent for water collection imposes significant opportunity costs as loss of income and education opportunity (Faisal and Kabir, 2005) as water fetching for domestic use has no economic value and those who collect water never get paid. Whereas fetching water has no economic value and also there is no chance of getting paid like all other household activities having no change of paying, male left the task for female because there is no pride on it and chosen irrigation instead because irrigation is totally an economic activity and also more prestigious.

Over the last few decades use of groundwater for irrigation purpose has increased notably as one of the important green revolution technology. Ownership of land and mechanized pumping of groundwater has provided the main form of access to irrigation water for the green revolution. New technologies involve new property rights, usually define as the right of men (Agarwal, 1994) has made a powerful argument that male control of property, particularly land as well as irrigation (Crow and Sultana, 2002). Using irrigation water is not confined to men, women do use water both for production and domestic purposes. In addition, women provide labor or other resources to the maintenance of irrigation systems and they directly or indirectly benefit from the use of irrigation water. They do so mostly in their capacity as co-farmers, working in close collaboration with their husband to irrigate crops on their husband's (or family) plot. In such a situation, the nature of husband and wife's needs for water is usually quite similar, both want and need a supply of water that is adequate for successfully growing one or more crops in a year. Differences of opinion and in preferences may nevertheless exist, regarding the timing and timeliness of water deliveries, which are based on gender divisions of tasks and responsibilities or on different crop preferences (Dick and Zwarteveen, 1998).

In most irrigation cases, women appear to be almost absent from the organization of user's group or association of irrigation. This is partly because membership is often confined to one member of each irrigated household, either the official land owner or the head of the household. Both criteria apply to men far more often than that of women; the only women who can potentially participate in water user's groups are either widow or single mother with no adult male living in the household. In a way, the non-involvement of women or their needs and interests, in irrigation management has become a self-fulfilling prophecy. Because of irrigation is commonly conceived as a male activity and because women are nor seen as direct stakeholders in irrigation systems, they have become excluded from efforts to organize water users. Since women's specific concerns thus remain outside formalized decision making processes, they are often not recognized as real concerns and remain marginal (Zwarteveen, 2009). Policy statements of agencies in the groundwater sector are increasingly emphasizing the need for a more complex gendered approach that takes into account the complexities of livelihoods (DAC, 1994).

A good number of study was already being integrated at national and international levels based on gender-water relationship and the contribution of some renowned researcher like Zwarteveen (2009 and 2016), Nahar (2002), Sultana (2009a and 2009b), Crow and Sultana (2002), Faisal and Kabir (2005), Hussain (2007) have enriched gender-water relationship studies in Bangladesh. Their study can be categorized under three statements- (i) gender and water resources management; (ii) gender and irrigation management and finally (iii) gender and water management organization. Assessment of gender involvement in groundwater utilization in northwestern Bangladesh, the current study has some similarity with the earlier study in one point, this study is also based on gander-water relationship and the rest is far more different like none of the them consider NW Bangladesh for similar kind of study. Researcher has tried to combined all three subgroups mentioned above on the basis of gender involvement. The earlier studies emphasized on water management but in this study tries to find out groundwater utilization related decision making process. It is reasonably claim that this study is different from earlier studies and may contribute significantly to the existing literature as well social science discipline. Moreover, this

study will be immensely useful for the researchers, development workers and policy makers for future groundwater utilization on gendered perspectives.

1.4 Research Questions and Objectives

Present study has tried to answer following research questions through empirical investigation.

1. Who does what in respect to groundwater utilization?
2. Who makes decision over groundwater utilization?
3. What are the factors that affect groundwater utilization related decision? and
4. What are the main gender specific problems and constrains in groundwater utilization?

Based on above research question, this study, therefore, set following specific objectives.

1. To determine broad socioeconomic characteristics of the households;
2. To assess gender involvement in agriculture and households;
3. To determine decision making process on groundwater utilization; and finally,
4. To identify gender specific problems and constrains in groundwater utilization.

1.5 Research Assembly

The whole study has been assembled within 8 chapters. Chapter one contains preliminary information and an overall idea about the study including research questions and research objectives. Chapter two comprises literature review on gender-water relationships and groundwater utilization. Third chapter explains the methods of the research with specific analytical techniques. Chapter four consists of socioeconomic characteristics of the households as well as the respondents. Fifth chapter assesses gender involvement in agricultural and household activities including decision making process on agricultural activities. Chapter six measures gender specific groundwater utilization and factors affecting decision making process. Seventh chapter is about the gender specific problems and constrains in groundwater utilization and the final chapter, chapter eight conclude the study with summary and some recommendations for future use.

1.6 Conclusion

This chapter provides a general idea about the present study by gathering available information using secondary sources. The rationale of the study justifies the importance and validation of this research. The research objectives as well as research questions has been mentioned in this chapter and describe the outline of the thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is a text of scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and do not report new or original experimental work (Lamb, 2014). It is an evaluated report of information and knowledge found in the literatures relevant to the proposed research. A literature review is designed to provide an overview of sources explored during researching a particular topic. The demonstration of how gender is involved in groundwater utilization in NW Bangladesh fits within a larger field of study is the prime concern of this chapter. In the search of most relevant literatures a number of books, scholarly articles, research papers, and web sites documents were incorporated. But before going to present the reviews, it is important to clarify the concept of '*Gender*' as the term is quite controversy and have diverse meaning.

2.2 Introducing Gender

The word '*Gender*' has been used since 14th century as a grammatical term, referring to classes of noun designated as masculine, feminine or neuter in some languages meaning kind, sort, genus and type or class of noun. In 1955 sexologist, John Money introduced the terminological distinction between biological sex and gender as a role (Urdy, 1994; Haig, 2004) but the meaning did not become widespread until 1970, when feminist theory embraced the concept of a distinction between biological sex and the social construct of gender. Gender is noun word meaning either of the two sexes (male and female) especially when considered with reference to social and cultural differences rather than biological ones (Oxford English Dictionary).

Gender is an old word using with new meaning while it refers to power relationship between men and women. But gender is not an isolated issue- it is an integral part of all relationships, i.e. family systems, social or economic systems. It does not mean only women- it means men and women both, so women should not be treated as an isolated

or separate interest group. Women should be treated as development partner of the development activities and they should be involved at all level of activities as much as possible considering as a human being. The goal of development could not be achieved if specific plan and expertise do not work to improve women's position and condition. It is needed to think what approach could be initiated for having a balanced community where men and women will not be unequal partner (Nahar, 2002).

2.3 Defining Gender

Gender refers to the different roles, rights, and responsibilities of men and women and the relationship between them. Gender does not simply refer to women or men, but to the way their qualities, behaviors, and identities are determined through the process of socialization. Gender is generally associated with unequal power and access to choices and resources. The different roles of women and men are influenced by historical, religious, economic and cultural realities (GWA & UNDP, 2006). Different scholars and institutions have defined gender differently but the most popular and used definition are given by WHO and UNFPA. Those definitions stated below:

World Health Organization (WHO) definition of gender as-

"Gender refers to the socially constructed characteristics of women and men-such as norms, roles and relationships of and between groups of women and men. It varies from society to society and can be changed. While most people are born either male or female, they are taught appropriate norms and behaviours- including how they should interact with others of the same or opposite sex within households, communities and work places. When individuals or groups do not fit established gender norms they face stigma, discriminatory practices or social exclusion- all of which adversely affect health. It is important to be sensitive to different identities that do not necessarily fit into binary male or female sex categories."

The United Nations Population Fund (UNFPA, 2009) provides the following definition of gender:

"The term gender refers to the economic, social and cultural attributes and opportunities associated with being male or female. Gender attributes and characteristics, encompassing, inter alia, the roles that men and women play and the expectations placed upon them, vary widely among societies and change over time. But the fact that gender attributes are socially

constructed means that they are also amenable to change in ways that can make a society more just and equitable".

Gender refers to the roles, rights, responsibilities and relationships of women and men. These are socially constructed and taught from families, societies and culture. The characteristics of men and women varies from society to society and with the change of time can be change. The concept of gender includes our expectations about the characteristics, attitudes and behaviors of women and men, and is vital in facilitating gender analysis.

Every society has specific expectations of men and women and often their positions and opportunities vary greatly. The differences in tasks and relative status of men and women, lead to a difference in access to and control over resources and right. Gender interacts with and reinforces other power differences based on age, socioeconomic class, ethnicity, caste, etc. Gender relations vary from one country to the next because they are shaped socially and culturally. What is acceptable behavior for a woman of a certain age in one culture, may be totally unacceptable in another culture. Unequal gender relations are often considered 'normal' as well as static but over time societies and perceptions about gender can change and consequently, gender relations can also change (GWA & UNDP, 2006).

2.4 Groundwater Situation in Bangladesh

Zahid and Ahmed (2005) states that about 75 percent of cultivated land is irrigated by groundwater and the remaining 25 percent by surface water. Of the abstracted groundwater about 70-90 percent is used for agricultural purposes and the rest for drinking and other water supplies. High rates of pumping for irrigation and other uses from the shallow aquifers in coastal areas may result in widespread saltwater intrusion, downward leakage of arsenic concentrations and the general degradation of water resources. Besides, use of agrochemicals may cause contamination of shallow groundwater and sediments. Continuous decline of groundwater tables due to over-withdrawal has also been reported from some areas. **An IWM study (2006)** judges that the abstraction of groundwater for irrigation requirement was higher than the recharge, causing constrains for *boro* paddy cultivation, but the northern part has

suitability for further groundwater development to meet the requirement for *boro* paddy cultivation. Studies also have noted that careful management can avoid problems in over exploitation of resources and environmental degradation of this area. Besides, distributing the water in right time in right amount or flow adjustment is the prime issue of concern for minimizing the impact of global environment change. Similar results were found in the study of **Wahid *et al.* (2007)** conducted in Teesta riverine and **Mamunul *et. al* (2012)** conducted in Padma riverine. **Wahid *et. al* (2007)** verifies that due to spatial variation in abstraction, nine out of 21 *thanas* (sub-districts) in the Teesta riverine area may still be able to expand groundwater-irrigated cropland and a groundwater use potential of 40 mm/year may be created if deep-set shallow tube wells are used by the farmers to abstract groundwater. **Mamunul *et al.* (2012)** found that total abstraction of groundwater (15000 million litres/year) is lower than total recharge of aquifer. But shortage of groundwater only in vicinity of River Padma (1,000 million litre/year) in dry season results from lowering of water level. As groundwater abstraction is increasing every year to meet the demand, taking suitable measures are necessary to preserve aquifer potentiality.

Another study of **Dey *et. al* (2013)** reveals a declining trend of groundwater table over the last 30 years (1981-2011). The district under severe depletion of groundwater was Rajshahi followed by Pabna, Bogra, Dinajpur and Rangpur. The magnitude of the decline in groundwater table was found between -2.3 to -11.5m during the study period. The survey and the FGDs with farmers reveal that 73% of them were well aware of lowering of groundwater level in their agricultural fields, while 53% of farmers complained that they did not get enough water during the irrigation period. Over 88% of the farmers were well aware of excessive pumping. Drying up of local water bodies and rivers were noted by almost every one. A study of **Imon and Ahmed (2013)** found that about 2/3 of the area showed gradual fall in the water level both in dry and wet seasons. Most of the remaining area, situated in the west, east and south east, experienced lowing of the water level either in the post monsoon season or during the lean period. Only small areas in Shibganj and Gomastapur in the west and Naogaon in the east exhibited a rise in water level. The study of **Mainuddin *et. al* (2014)** by supporting the situation adds that lower groundwater levels in the pre-

monsoon period have meant a shift towards less groundwater moving to streams and more water moving from streams; more water infiltrating through the land surface, with a probable reduction in surface runoff and reduced return flow to streams. Aquifers are losing water to most major streams. The exceptions appear to be above junctions of major rivers and/or in areas where landscape is flattening. The total surface water-groundwater fluxes for the northwest region appear to be smaller than previously thought and are not likely to be more than 20 billion cubic metres per year. Another study from **Aziz *et. al* (2015)** reported that in Northwestern Bangladesh specially in Rajshahi district groundwater levels are dropping. Only two aquifers exist and in NW area shows effective aquifer thickness is shorter than South East portion. Average rates of maximum depth (dry season) and minimum depth (wet season) groundwater depilation are 0.23meter/year and 0.38meter/year respectively in Rajshahi district, some upazilas these rates are much higher than that of average. Groundwater recharge condition is very poor in Tanore, Godagari, Mohanpur and Baghmara upazilas and vulnerable for Boro rice i.e. irrigated rice. A crucial relationship remains between Boro production and groundwater depletion, so crop diversification or less water consuming crops can be option for the study area.

2.5 Groundwater Management

Dey *et al.* (2006) postulates that the economic benefits that the country can achieve if improved irrigation management is followed in Bangladesh. Proper irrigation water management means that water should arrive at the right place, at the right time, with the required volume and with minimum loss. Considering all cost regarding to groundwater management they concluded that The government of Bangladesh is to spend only an amount of US$1.74 million for successful implementation of proper irrigation and other management activities, when in total an amount of US$1,344.26 million may be thus saved and added annually in the economy of Bangladesh. A study of **Wichelns and Oster (2006)** confesses the same result and suggest that irrigation should be discontinued in some areas and water should be re-allocated to nonagricultural uses. Another study of **Droogersa *et al.* (2010)** advances that water managers and policy-makers need accurate estimates of real (actual) irrigation

applications for effective monitoring of irrigation and efficient irrigation management. They identified three main strategies by which agricultural water management can deal with these large trade-offs: a) improving water management practices on agricultural lands, b) better linkage with management of downstream aquatic ecosystems, and c) paying more attention to how water can be managed to create multifunctional agro-ecosystems. They suggested if ecological landscape processes are better understood the values of ecosystem services other than food production are also recognized. **Qureshi *et. al* (2015)** noted that the policy available in Bangladesh over groundwater focus so far has been largely on "*resource development*", and not on "*resource management*". They suggested that attention must be given to the development and management of surface water resources to ease pressure on groundwater. In addition to supply-side solutions, water demand will also need to be curtailed by increasing water use efficiency through the adoption of water conserving management practices, for example reduced tillage and raised bed planting, and the right choice of appropriate crops. Decreasing water availability both in terms of quantity and quality suggest that the unchecked expansion of dry season *boro* rice cultivation is probably not a long-term option for Bangladesh. Therefore, cropping patterns need to be rationalized – starting with the promotion of feasible alternatives to *boro*-considering water availability and the sustainability of aquifers. On the contrary, a study of **Chowdhury and Rasul (2011)** argues that the governance of water resources in Bangladesh is biased towards structural solutions of flood control and irrigation through a centralized approach that ignores the other uses of water such as drinking and sanitation, fisheries, navigation, and ecology, and ignores the costs borne by the rural poor. Often, the access to water resources and the costs and benefits of water resources project is distributed unequally. While the rich get more access to water resources, the poor bear the cost. Successful water resource management involves balancing the needs of a wide range of water-users along with the needs of the environment. Water resource management should not be based on economic benefit alone. Social, environmental and ecological aspects should be considered in the process of identification, planning, implementation, operation and maintenance of water management projects.

To ensure sustainable water management, **Rasul and Chowdhury (2010)** proposes a framework for promoting equity in water management and preserving the environment. This includes:

- Ensuring multi-objective planning and decision making.
- Prioritising public health security.
- Maintaining ecosystems, protecting livelihoods and providing multi-functional infrastructure in rural areas.
- Ensuring public participation and forming water and ecosystem-based local management zones.
- Formulating regulations governing equity and the environment.

Dey *et. al* (2017) advances that efficient irrigation management practices, such as low water demanding high value crops, volumetric water charging system, wet and dry irrigation system, etc. can be introduced widely to reduce excessive withdrawal of groundwater. Efficiency of existing water lifting devices including STW and DTW can be enhanced for increasing command area, and discouraged for new installation of tube well. Bangladesh has recently experienced moderate rainfall during September-October. If the boro rice transplantation is completed by November, boro cultivation may benefit from late-monsoon rains and place less pressure on groundwater resources.

2.6 Gender as Groundwater User

Dublin Principle 3 (1992) judges the distinct responsibilities of women and men in using and managing water and water systems. In most societies, women and girls collect every liter of water for cooking, bathing, cleaning, maintaining health and hygiene, raising small livestock and growing food. Rural men need water for irrigation and larger livestock, but women often care for the milk cattle and young animals. But women have pressing needs too for water to engage in economic production, including agriculture and microenterprise. Gender disparities ensure that those needs frequently go unmet, with discrepancies in land tenure, access to water, participation, resource control, capacity and skill development, marketing and commercial linkages. A study from **Faisal and Kabir (2005)** postulates the distinction

in using and managing water and includes how water is collected depends on income/social class, location of water source, time of the day, and religious/cultural factors. The time spent for water collection imposes significant opportunity costs as loss of income and education opportunities. There is very little participation of women in agricultural water management as 'right to water' is perceived as linked with 'right to land', over which women have little control. These hardships and deprivations are fundamentally caused by the lack of a number of factors: awareness, education, access to resources, empowerment, and institutional support. **Sultana (2009b)** adds that gender relations are influenced by not just direct resource use/control/access and the implications of different types of waters, but also by the ideological constructs of masculinity/femininity, which can work in iterative ways to influence how people relate to different kinds of water. Gender–water relations are not just intersected by social axes, as generally argued by feminist scholars, but also by ecological change and spatial relations vis-a`-vis water, where simultaneously socialized, ecologized, spatialized and embodied subjectivities are produced and negotiated in everyday practices. **Ahlers and Zwarteveen (2009)** postulates that rights to water are less fixed and more prone to be contested at various levels and in different socio-legal domains than rights to other natural resources. Water reforms articulate with wider political-economic structures and historical dynamics characterized by new ways of capitalist expansion. Another study from **Zwarteveen (2009)** verifies that the inclusion of users in operating and managing irrigation systems most often occurs through the organization of user's groups or associations. In most irrigation cases, women appear to be almost absent from those groups. This is partly because membership is often confined to one member of each irrigating household, either the official landholder or the 'head' of household. Both criteria apply to men far more often than to women; the only women who can potentially participate in water users' groups are either widows or single mothers with no adult male living in the household.

In a study, **Crow and Sultana (2002)** introduces a framework for disaggregating conditions of access to water and uses it to examine three pressing questions in Bangladesh. They highlight new directions for the analysis of interactions among water, class, and gender and tended to focus on the implications of gender analysis

for government policy, especially development projects and water resources management, and for women's organization.

2.7 Gender in Groundwater Management

Hussain (2007) explores that while making large contributions to irrigated agriculture, women depend on, and benefit from, irrigation water in a variety of ways including water uses for domestic and livelihood purposes. Designing the irrigation infrastructure such that the irrigation systems become multiple use systems can enhance the benefits of investments in irrigation for the poor women. It's also supported by **Wahaj *et. al* (2012)** report that women's role in the management of water resources has been increasingly acknowledged by development agencies, policymakers, national governments and non-governmental organizations over the past decade. Programmes and projects that include supporting components such as capacity-development, access to capital and awareness-raising achieve better results in encouraging women's participation and improving their livelihoods. One of the major findings of the study was although the problems and issues in women's participation in water management are well documented, there is insufficient information, apart from some anecdotal evidence, on successful efforts to involve women in water projects. But **Zwarteveen (2016)** argues that documenting gendered patterns of water work and water use, rights and responsibilities is a first step in recognizing women's importance as water actors. And she also added that irrigation came to be a masculine domain as a consequence of engineering becoming a man's profession. Irrigation texts do not explicitly exclude women, but professional irrigation identity and men came to belong to each other at symbolic and metaphoric levels.

Nevertheless, **Nahar (2002)** verifies that the issue of gender in the water sector does not simply involve access to water. It involves questions of rights, responsibilities and participation (equal participation by men and women both) at all levels. When women are not encouraged to participate in water management, they are simultaneously de-linked from the urgent effort to protect these vital natural resources. However, as a major group of stakeholders, women are unable to effectively participate in these

processes due to certain widespread constraints. These include: culturally determined inhibitions to their participation in public activities; their resulting lack of skills and experience in public participation and in leadership and management activities.

2.8 Gender in Different Groundwater Organization

Jordans and Zwarteveen (1997) documents the attempts of Grameen Krishi Foundation (GKF) to involve women in its irrigation program. In the GKF working area in North-West Bangladesh, women and particularly those who belong to the poorer categories of households, which constitute the GKF target group-carry out about 50 percent of all tasks in rice production. Even the presumably male task of irrigation is carried out by women and they share 50 percent of this work. But another study from **Dick and Zwarteveen (1998)** argues that despite the rhetoric on women's participation, a review of evidence from South Asia shows that female participation is minimal in water user's organizations. One reason for this is that the formal and informal membership criteria exclude women. More formal participation of women can strengthen women's bargaining position as resource users within households and communities. Greater involvement of women can also strengthen the effectiveness of the organization by improving women's compliance with rules and maintenance contributions. **Cleaver (1998)** includes that the conceptualization of institutions is primarily an organizational one, which, whilst alluding to the role of norms, practices, and conventions, focuses primarily on formal manifestations of collective action; contracts, committees, and meetings. Where women's participation is concerned, he illustrated that incentives to cooperative may be devised from reproductive concerns and the minor exigencies of daily life (as well as from productive concerns) and that alternative models of institutions may better reflect the way in which decisions are made and implemented within a social context. A study by **Mjoli and Nenzhelele (2009)** advances that women were not getting any benefits from their involvement in Water User Associations (WUAs) because they did not own land and water rights in their individual capacity. Men who owned land and water rights had the power to influence the decisions on the allocation of water resources. Women interviewed for their study indicated that their participation in Management Committees (MANCO)

of WUAs had provided them with an opportunity to learn about the water resources management and they also learned from the experience of other members of MANCO.

2.9 Conclusion

The above reviews and discussions indicate that very few detailed studies were undertaken to show the relationship between gender involvement and groundwater utilization in Northwestern Bangladesh. So, it is necessary to undertake an in-depth study to investigate the motivating factors of gender involvement and its impacts on the groundwater utilization. For this reason, the present study is conducted to make an in-depth study to fulfill the knowledge gaps in the field of gender involvement in groundwater utilization in Northwestern Bangladesh.

CHAPTER 3

METHODOLOGY

3.1 Introduction

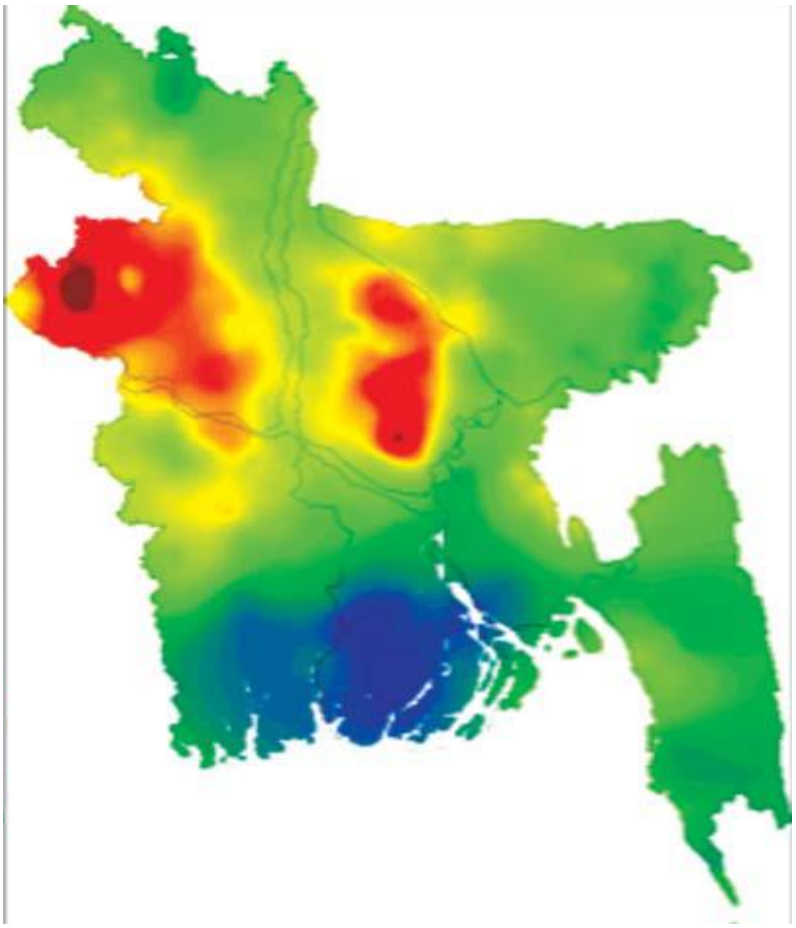
The validity and reliability of a successful research depends on appropriate methodology because an unreliable method produces unreliable results. To fulfill the overall aims and objectives of a research work, valid and reliable methodology required. So, methodology should be such that it would enable the researcher to collect valid and reliable information and to analyze those data to arrive at correct decision. By considering all above issues, the researcher took utmost care for ensuring appropriate method.

The chapter is intended to explain each and every steps that were adopted for the study. Why the study area was chosen and what sampling techniques were used and also how the primary data for this study were collected explain clearly. On the other hand, it mentions the secondary data sources from where secondary data were collected for the study. The various aspects concerning the methodology of the present study have been described in this chapter.

3.2 Selection of the Study Area

Selection of the study area is an important step and largely depends on the objectives set for the study. Due to limitation of time and resources, the inclusion of the whole Northwestern Bangladesh for investigation was not possible. To explore the assessment of gender involvement in groundwater utilization in Northwestern Bangladesh, Rajshahi and Chapainawabgonj district were selected because in 2015, Rajshahi, Naogaon and Chapainawabgonj districts were identified as risk due to gradually lowering of groundwater level (The Daily sun, 13 February, 2017), Naogaon district was excluded due to resource constraints. The remaining two districts are most depleted area due to the geographical location and groundwater availability. The ratio of groundwater to surface water use is much higher compared to other part of the country. All the rivers and canals of these area become dry during dry season and make the people completely dependent on groundwater (Shahid 2008; Shahid

and Behrawan 2008). One upazila from each district was chosen to have overall information on total area, land area, riverine area, total irrigated area, sex ratio, number of pond, dighee, river flow, power pump, tube well, deep tube well and total crop production.



Source: Cereal System Initiative for South Asia-Mechanization and Irrigation (CSISA-MI)

N.B: Red colored is the riskiest in groundwater level

Figure 3.1: Groundwater level in Bangladesh

For study purposes, basic secondary level data were collected from Rajshahi (particularly from Godagari upazila) and Chapainawabgonj (particularly from Nachole upazila) district to understand the broad socioeconomic characteristics of the respondents. On the basis of preliminary information, three villages from each upazila were selected namely Ishoripur, Nimghutu and Fulbari from Godagari upazila of Rajshahi district and Ajhoir, Belpukur and Paikura from Nachole upazila of Chapainawabgonj district were selected for empirical investigation. In these villages most of the people are involved in agriculture.

The area was selected based on the following aspects.

- Preferred area was suitable to fulfill the objectives of the study;
- Both location falls under Northwestern regions;
- People of these area mostly depend on groundwater for irrigation as well as for household uses;
- This type of study was not conducted before in this area.

Source: LGED, Bangladesh

Figure 3.2: Map showing Godagari upazila

Source: LGED, Bangladesh

Figure 3.3: Map showing Nachole upazila

3.3 Selection of Sample and Sampling Technique

Sampling technique is an important part of any survey research because without a proper sampling technique survey research may fail to fulfill its objectives. In a census, the required information is collected from each and every element of the population, which is very costly and time consuming. The normal practice is to select a sample of representative households, which could represent reasonably a true picture of entire population. Considering the objectives, time and availability of fund and man power, three villages from each upazila were selected purposively. Mainly farming households were selected from the selected villages. With the help of Sub Assistant Agriculture Officer (SAAO), a list of farmers was prepared from the villages mostly who grow rabi crops (dry season). This study used simple random sampling technique to select sample respondents. A total number of 60 households were interviewed in which 28 from Godagari upazila and 32 from Nachole upazila in order to meet the objectives of the study. Both male and female from the selected households

were interviewed and a total of 95 respondents were interviewed in which 59 were male and 36 were female respondents.

Both male and female (main respondent and spouse) from each household were separately asked about their role and contribution in both agriculture and groundwater and also about the role and contribution of their male/female partners. In some cases, only male/female respondents were interviewed. This is because, the male from that particular household was absent during survey due to some work and the interviewer could not able to conduct interview with the female because of some social customs like 'Purdah' for the Muslim women or the male respondent did not allow a male researcher to talk with his wife. Distribution of sample according to different categories has been presented in Table 3.1

Table 3.1 Distribution of sample

Godagari, Rajshahi				**Nachole, Chapainawabgonj**			
Union	Village	Total		Union	Village	Total	
		Male	Female			Male	Female
Deopara	Ishoripur	11		Kasba	Ajhoir	22	
		11	0			11	11
Deopara	Nimghutu	11		Kasba	Belpukur	22	
		6	5			11	11
Deopara	Fulbari	11		Kasba	Paikura	18	
		11	0			9	9
Total		33		Total		62	
		28	5			31	31

Source: Field survey, 2017

3.4 Preparation and Pretesting of Interview Schedule

The interview schedule was prepared to collect necessary information to fulfill the objectives of the study. At first, a draft interview schedule was prepared in such a way that the relevant information of the objectives of the present study could be collected. Then the draft schedule was presented to the supervisor and co-supervisor for their valuable comments. After receiving the feedback from supervisors, interview

schedules were corrected and pre-tested among 10 households. The aim was to pre-test the interview schedule to see the questions were understood by respondents and the questions were in a logical order. The interview schedule was then revised and adjusted based on the pre-tested response. Some questions were reformulated in order to make them easy to understand and some were completely changed.

3.5 Period of Data Collection

For the present study, the author himself collected data through personal interviews with the selected respondents. Primary data were collected through household survey, Key Informants Interviews (KIIs), Focus Group Discussion (FGD) and Case Studies during the period of September to October, 2017. In order to obtain reliable data, the author first visited the study area to select the study location. For collecting data, the author stayed at Regional Research Station of Bangladesh Agriculture Research Institutes so that the selected respondents could reach at their suitable time. At the time of interview, the author asked questions systematically and explained whether it was found necessary. The author explained the purpose of the study before interviewing and the respondents were assured that the study was an academic one, which would not have any adverse effect on them.

3.6 Distribution of Primary Data

Distribution of primary data in each location is presented in Table 3.2. It is depicted that 3 FGDs, 10 KIIs and 2 individual case studies were carried out. More importantly, 95 respondents were interviewed for gathering detailed information on household and farm.

Table: 3.2 Area wise activity conducted during the study

Name of activity	Number of activity						Total
	Godagari upazila			Nachole upazila			
	Ishoripur	Nimghutu	Fulbari	Ajhoir	Belpukur	Paikura	
FDG	0	1	0	1	1	0	3
KIIs	1	2	2	2	2	1	10
Household survey	11	11	11	22	22	18	95
Case study	0	1	0	0	1	0	2

3.7 Household Survey

Household survey is a very effective instrument that facilitates in collecting data from large, diverse and widely scattered groups of people. Household survey is used for quantitative data as well as accruing information of qualitative nature. A household survey contains definite, concrete and pre-oriented questions. This type of schedule is prepared in advance and was used with both open and close ended questions. Before beginning interview each respondent was given a brief description about the nature and purpose of the study. Then the questions were asked in a simple manner with explanation wherever necessary. The information supplied by the respondents was recorded directly on the interview schedule. Interviewees were requested to provide correct information as much as possible. The information was checked carefully before leaving the study area. In order to minimize errors, data were collected in local unit. These were subsequently converted into appropriate standard unit.

3.8 Focus Group Discussion

Focus Group Discussion (FGD) was conducted by the researcher himself to build rapport with the respondents and also to be acquainted with their perceptions regarding gender involvement in groundwater utilization. Total three FGDs were conducted by the researcher and each FGD session comprised of roughly 8-10 participants and took of around 60-90 minutes on an average. During the FGDs, the questions were open-ended and the researcher had freedom to change the approach

of questioning according to the demands of the FGD situation. The issue for discussion in FGD were based on the researcher's judgement. The researcher was careful about not prompting answers or revealing his own biases.

Figure 3.4: Focus Group Discussion with the participants

3.9 Key Informant Interviews

Total ten KIIs were conducted, at least one from each village of the study area. The key informant under this study were selected purposively based on age, sex, designation, social position and experience. After selecting the key informants, they were interviewed through prepared semi-structure questionnaire to collect historical as well as fact-facing information.

Figure 3.5: Key Informant Interview with participant

3.10 Case Study Method

Case study is a common methodology in both qualitative and quantitative research. Under this study, the researcher himself conducted several case studies but only two presented in this thesis considering its relevancy. The adoption of this method allowed the researcher to examine factors influenced the decision making process for both agriculture and groundwater utilization. Moreover, it enabled the researcher to provide the discernments into the gender, agriculture and groundwater situation in the study area from different perspective.

Figure 3.6: Case Study with participant

3.11 Sources of Secondary Data

In order to learn the gender involvement in groundwater utilization (both for household and irrigation), groundwater organization, groundwater status and management, secondary data were collected. The basic source of secondary data for this study are previous studies, books, periodicals, reports, magazines, newspapers, thesis, journals, reports and different websites. To have secondary data, various books, periodicals, reports, magazines, newspapers and articles through web-sites were accessed.

3.12 Data Processing

The data and information collected from household survey, FGD, KIIs, case studies, observations and communications with the respondents were scrutinized, classified, edited and coded. The exploratory responses of the respondents given in the local language (Bangla) were initially recorded in electronic device and then transcribed into English by the researcher. Data entry was done by the researcher himself. Different computer software packages like Microsoft Excel and SPSS (Statistical Package for Social Science) were used for data entry and processing.

3.13 Data Analysis

After completion of data entry data were classified, tabulated and analyzed to accomplish the specific objectives of the study. Tabular method was followed in some cases because it is simple in calculation, widely used and easy to understand. Some mathematical and statistical techniques were also used in the study. Data analysis were done by using Microsoft Excel and SPSS.

3.13.1 Linear regression model

To examine the relationships of different factors on decision making process regarding groundwater utilization, linear regression model was fitted. Following linear regression model was adopted for explaining the factors influencing in the decision making process.

$Y = \alpha + \beta Xi + e$

Where,

Y= Dependent variable (Groundwater utilization for irrigation);

Xi= Explanatory variable (including constructing system);

α = Intercept;

β = Coefficient of respective factors; and

e= Error term.

3.13.2 Perception index

When both men and women participate in groundwater utilization, they face a bunch of problems and constrains. For measuring their perception, a 4-point Likert Scale was used. There were 11 statements including only the favor judgements against 4-point scale. All the statements were arranged randomly. Perception score for each respondents was calculated by Perception Index using the following formula:

Perception Index (PI) = 4×VO + 3×O + 2×S + 1×N

Where,

VO= Total number of respondents expressing their perception 'Very Often' for the statement;

O= Total number of respondents expressing their perception 'Often' for the statement;

S= Total number of respondents expressing their perception 'Sometimes' for the statement; and

N= Total number of respondents expressing their perception 'Never' for the statement.

3.14 Measurement of Variables

This section outlines variables as they are understood in the analysis. Mainly there are two variables, dependent and independent variables. From the observed data set, the specific dependent variables and the independent variables were selected. The researcher has selected only those variables having less number of missing values and well defined.

3.14.1 Dependent variables

Irrigation water utilization was considered as dependent variables of the study. Scores are assigned from the respondents using a 4-point Likert scale as 4,3,2 and 1 to the result of very often, often, sometimes and never respectively.

3.14.2 Independent variables

There are many factors that have effect on using irrigation water were considered as the independent variables. The independent variables were classified into different categories indicating the susceptibility to be involved in irrigation water utilization. The important independent variables are- age, year of schooling, working members involve in agriculture, farm experience, farm size, time spent for water collection, participation on water management training program, total income and domestic water utilization. Domestic water utilization was measured in 4-point Likert scale as irrigation water utilization.

Unit distribution for independent variable:

Age- years;

Year of schooling- years;

Working members involve in agriculture- number;

Farm experience- years;

Time spent for water collection- hours;

Participation on water management training program- 1 or 0 (1= yes, 0=no);

Total income- Taka;

Domestic water utilization- four point Likert scale.

3.15 Problems Faced in Data Collection

In conducting the fieldwork, a number of problems were faced by the researcher. Some of them are mentioned below:

- The first and most important problem faced in data collection was to convince the respondents for interview and to adjust time as they were really very busy during data collection period;
- Most of the respondent have no idea about research work, for this reason, it seemed difficult to explain the purpose of the study to convince them;

- ❖ Due to lack of proper knowledge, the respondents were indifferent to the objectives of the study and answered questions in careless manner. However, repeated attempts were made to collect the correct information as much as possible.

In spite of all difficulties pointed out above it is hoped that the study could fulfill its objectives from the respondents by constant persuasion and untiring patience of the researcher that would help for future research and for formulation of policy formulation.

3.16 Conclusion

A socioeconomic study depends to a great extent on the appropriate methodology used in the research. Unsuitable methodology may come up with faulty results. The researcher incorporates a scientific and logical methodology for carrying out this research.

CHAPTER 4

SOCIOECONOMIC CHARACTERISTICS

4.1 Introduction

The aim of this chapter is to present a brief description of the socioeconomic characteristics of the respondents and households. Socioeconomic characteristics have a very important role in gender issues to a great extent. It is the reflection of individual's positive and negative qualities. In this chapter, socioeconomic characteristics have been discussed in two separated sub-categories. The first on is about households and the other one is about respondents. A number of socioeconomic aspects were considered for the present study. Socioeconomic characteristics like age, educational level, occupation, annual income, family size and land holdings have been discussed based on empirical evidence.

4.2 Socioeconomic Characteristics of the Households

A number of socioeconomic aspects of the household were examined. These are family size and composition, land holdings and household income.

4.2.1 Family size and composition

In this study, a family has been defined as a unit in which a number of persons live together under the administration of one family head and take meal from the same kitchen. It includes wife, children, brother, sister and parents. If any person of a family is employed outside but takes meals from the same kitchen while at home and shares income and expenditure of the family, he or she has been considered to be a family member. Persons employed in a household works like servants, caretaker etc. excluded from the definition of the family.

It is evident from Table 4.1 that average family size for the study area was 4.83. All aspects were dominated by the male as usual and dependency ratio is higher among female. Working members and working members in agriculture was found 1.85 and 1.60 respectively. The average number of earning and dependent member in a family

was found to be 1.85 and 1.61 respectively. The dependency ratio for male was 0.64 while it was 5.76 for female and total dependency ratio was 1.61.

Table 4.1: Family size and composition

Sex	Family size	Working members	Working in agriculture	School going	Dependency ratio
Male	2.47	1.50	1.33	0.67	0.64
Female	2.37	0.35	0.27	0.52	5.76
Total	4.83	1.85	1.60	1.18	1.61

Source: Field survey, 2017

4.2.2 Land holdings

In this study, land holdings were divided into two categories, total land cultivated by the household and total land owned by the household. Both categories were measured in decimal and the researcher converted into standard unit as most of the respondent were answered about their land holdings in bigha (a local measurement for land, 1 bigha=33 decimals). The average land size cultivated by the household was about 270 decimals and average land size owned by the household was about 220 decimals. Minimum land size cultivated by a single household was zero (0) decimals as only one respondent household sell labor for agricultural cultivation (from Godagari upazila) otherwise it is 33 decimals (1 bigha) and maximum land size is 1,485 decimals (from Nachole upazola). In case of total land owned by the household, it was 3 decimals and 1,650 decimals (both from Nachole upazila) respectively.

In South Asian societies, size of land holdings by people is one of the key determinants of achieving high economic status in both rural and urban areas (Hossain, 2009). The common land holding prototype in rural Bangladesh indicates that land is mostly owned by male whereas female hardly get any ownership of land. For this study, households were divided into four categories namely marginal, small, medium and large households based on their land holdings both for cultivated land and owned land. During the measurement of cultivated land size, a full crop calendar wise yearly cultivated land size was measured. Crop calendar of Bangladesh was followed, which

starts from 1st day of last Bengali month Chaitra (16 March) and ends in last day of 1st Bengali month Joistho (15 March). For this measurement, last year cultivated land size was prioritized whereas many households do not have own cultivable land and depend on land owners will, many households do not have a full cropping year cultivable land. In this instance, the land size which was cultivated during the last dry season (Robi season) or for the last time, which came first was considered. Figure 4.1 shows the number of households based on cultivated land size for Godagari and Nachole upazila and total number of households for each category. Figure 4.2 shows the percentage of each categories based on owned land both for Godagari and Nachole upazila and also the total number.

The four household categories based on BBS criteria presented below:

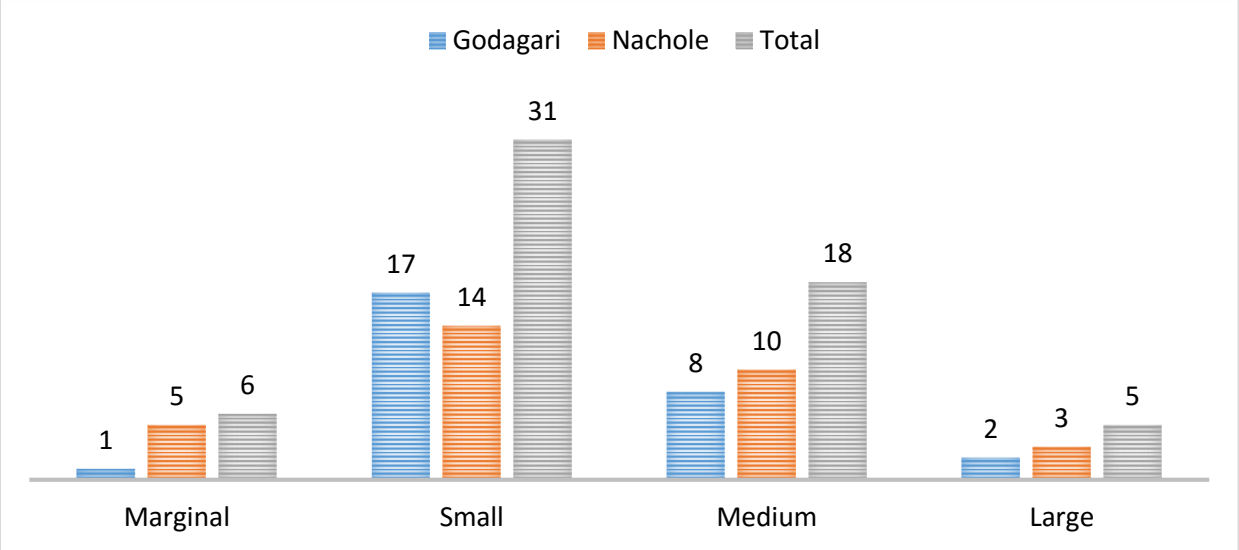
► Marginal households (0-49 decimals of land);

► Small households (50-249 decimals of land);

► Medium households (250-749 decimals of land); and

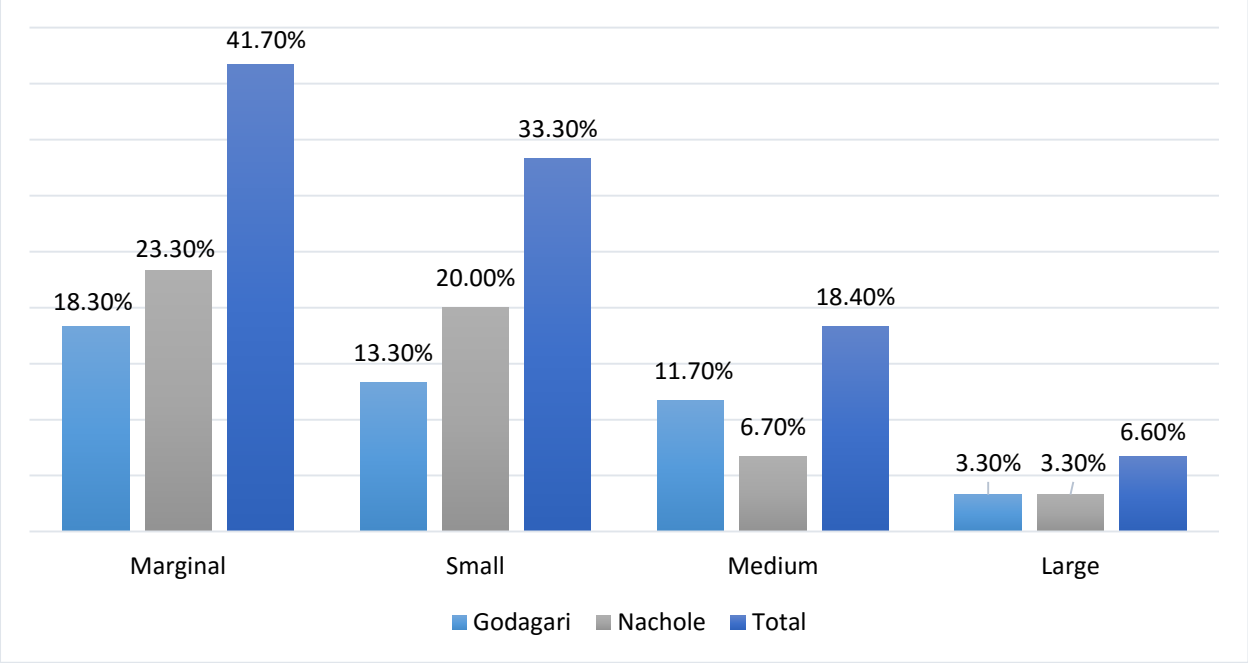
► Large households (750 decimals and above land).

Results of Figure 4.1 indicate that the majority of households belong to small households followed by medium, marginal and large households. Small households cover about 31 (more than 50%, 31 out of 60 households). It is clear from the figure below that most of the land size cultivated by a household is between 50 to 249 decimals. In Godagari upazila, number of small households were found higher number but marginal, medium and large households were found higher in Nachole upazila.



Source: Field survey, 2017

Figure 4.1: Number of households based on cultivated land size



Source: Field survey, 2017

Figure 4.2: Percentage of households based on owned land size

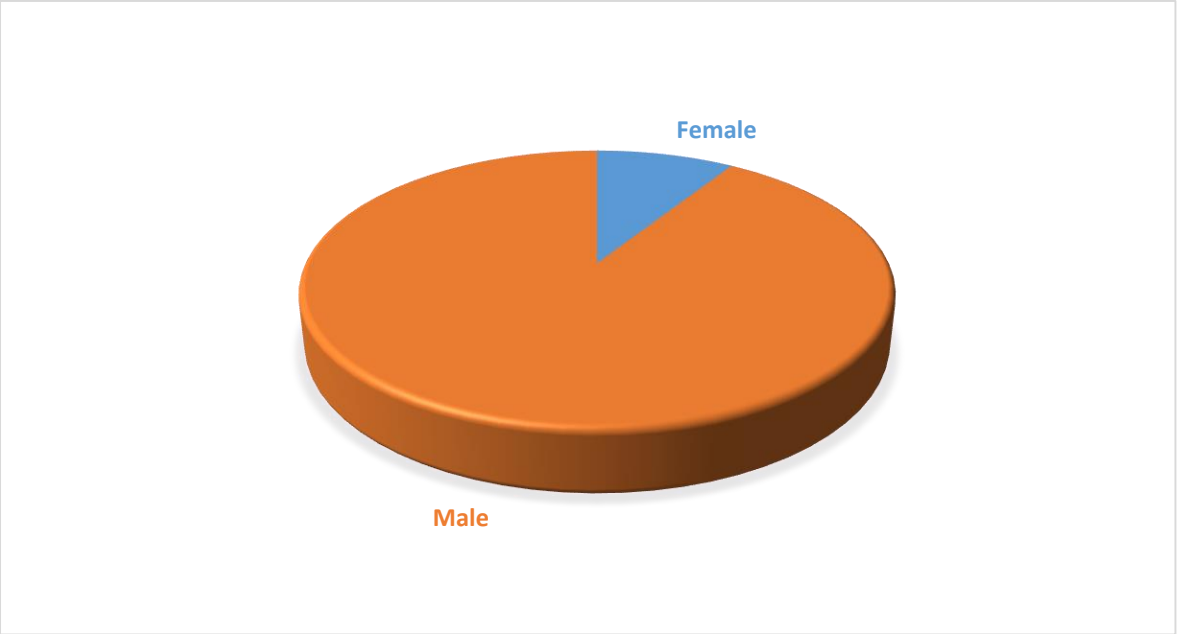
Result from Figure 4.2 shows that the greater portion of the households had very small amount of owned land. About 42% of total households owned land between 0 to 49 decimals. Minimum land size owned by a household is 3 decimals and maximum is

1,650 decimals, which is a biggest example of discrimination. Nachole upazila dominated the categories as it has the highest percentage for marginal and small households. The percentage for medium households were higher in Godagari upazila and for large households it was similar.

It is evident from Figure 4.1 and Figure 4.2 that though most of the households cultivated land between 50 to 249 decimals but owned land remained between 0 to 49 decimals. The reason behind this situation is that most of the household's act as sharecroppers though they had no or very few cultivable land. Due to limited landholding, they depended on farming through sharecropping and not involved in alternative sources of income.

Women as a social class is the poorest among the poor in most parts of the world (Nahar, 2002) as well as in Bangladesh mostly in rural areas. In Bangladesh, data from various sources shows that female have less access to the property including land holdings. It is said that female's access to and control over and ownership of land has been raised over the periods differently. The study area for this research is no difference. Male from the study area possessed most of the land ownership and a very few lands are owned by the female. This situation is almost same for all patriarchal community. Figure 4.3 shows the land distribution among male and female. As prediction, male possessed much more land compared to female. Female possessed only 9% of land and male possessed 91% of land. Female owned this small amount of land because the only way is getting land ownership for them is the inheritance from father or after death of husband if she had no son to get inheritance or not aged enough. Inheritance from father is much more complex. In most cases their brother gave them a negligible amount of money in exchange for the inherited land or they transfer their inherited land ownership to her husband and son. Only a few possessed inherited land ownership. For Santal community, it is too much simple. Santal women do not have the right to hold land ownership and they do not get any inherited land. During discussion with Santal community, one Santal woman gave following response while asking "if anyone only have daughter then who will get the inheritance?"

"Of course the closest male relative like nephew. But things are changing these days. One person from our village has transferred his lands ownership to his daughters but it is the first time this is happening. Only god knows what will happen after his death. Will his daughters hold the ownership or their husbands or sons?" (Case study, 1)

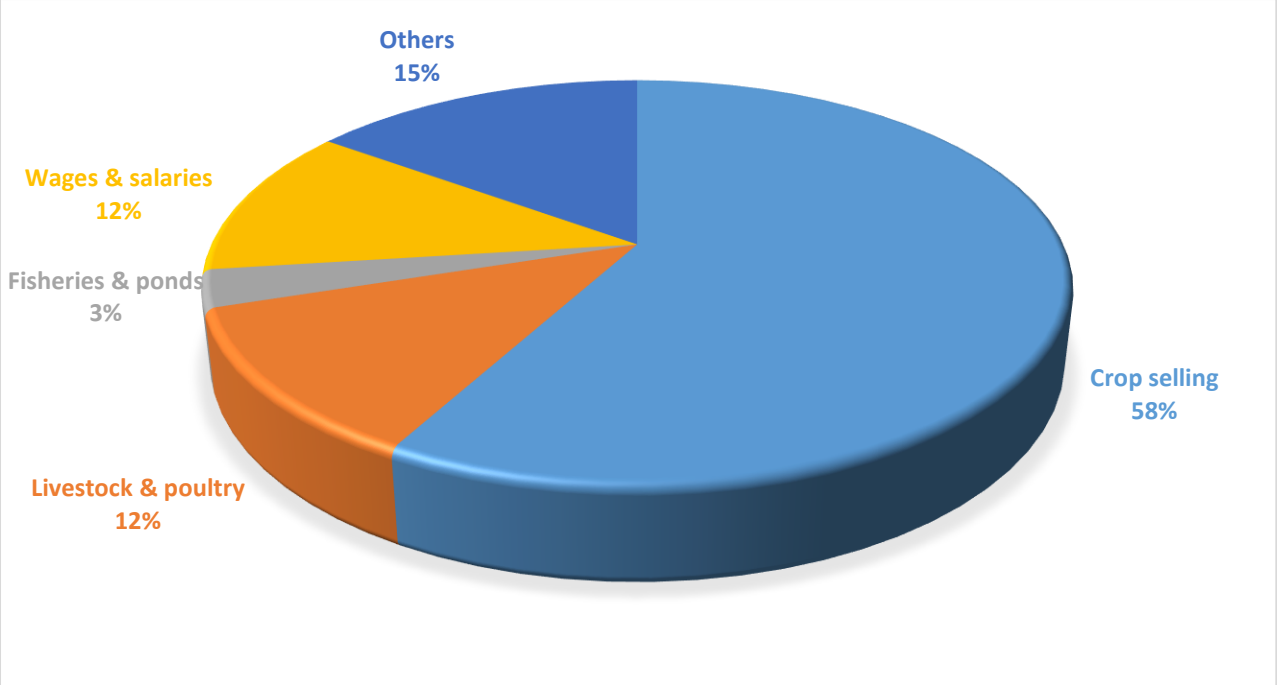


Source: Field survey, 2017

Figure 4.3: Land distribution among male and female

4.2.3 Household income

In this study, household income was calculated as the summation of annual income by all family members from crop selling, livestock and poultry, fisheries and ponds, wages and salaries and other activities. The average household income was estimated Tk. 247,950 and highest percentage of income came from crop selling 58% followed by others, livestock and poultry, wages and salaries and fisheries and ponds.



Source: Field survey, 2017

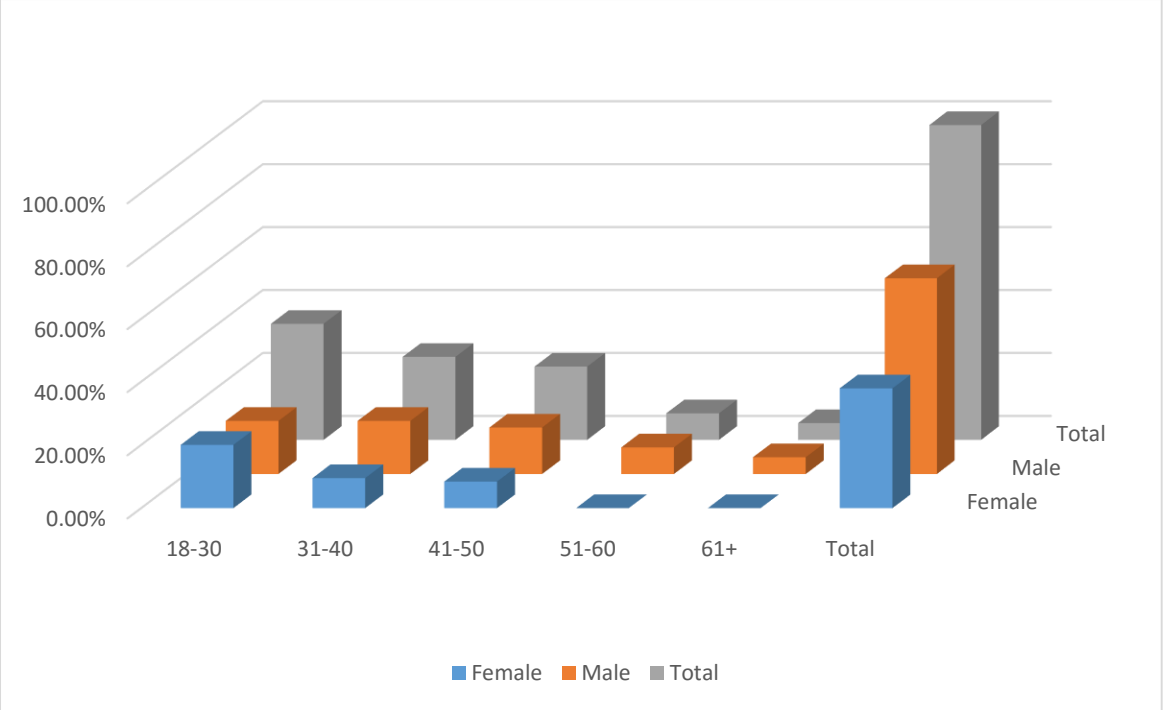
Figure 4.4: Household income

4.3 Socioeconomic Characteristics of the Respondents

A number of socioeconomic aspects of the respondents were examined. These are age and sex distribution, educational level and occupational status on the basis of gender.

4.3.1 Age and sex distribution

Age and sex are two most important element of demographic studies and these two attributes largely influence in individual's role in society. It is quite likely that the age and sex of a person plays a critical role in determining various facts of his/her livelihood. For example, male and young person enjoys better livelihood compare to female and old aged. As this study give emphasis on gender involvement in groundwater, both male and female respondent were selected. The respondents that were interviewed for this study aged from 18 to 64 years. Total 95 respondents were interviewed among them 59 were male and 36 were female. For the purpose of the study, age was divided into five age cohort likely 18-30, 31-40, 41-50, 51-60 and 61 and above years of age. Figure 4.5 shows the age and sex distribution of the respondents.



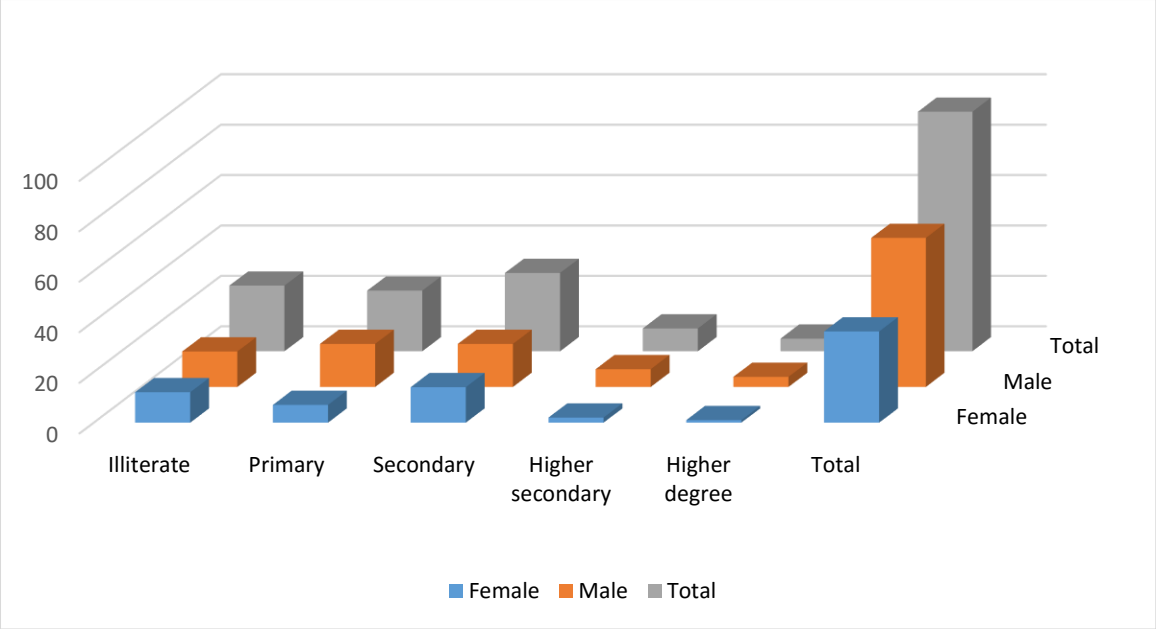
Source: Field survey, 2017

Figure 4.5: Age and sex distribution

The survey results presented in Figure 4.5 reveals that, the highest proportion of the respondents belonged to the age group 18-30, about 37% of the respondents. Percentage of male and female was also highest within the same age group followed by 31-40 years, 41-50 years, 51-60 years and 61 and above years.

4.3.2 Educational level

Education is the fifth basic need of human life and is the first and foremost step of progress. Education is the most potent tool for socioeconomic mobility and a key instrument for building a just and equitable society. Proper education not only enhances efficiency but also augments the overall quality of life. Although education is not in itself a sufficient condition for development of agriculture, it is certainly a necessary condition (Mellor, 1974). It is now recognized that the problem of illiteracy in Bangladesh is embedded more in illiteracy among female than male. After the impressive progress made in education sector the females are still lagging behind due to early dropout as many girls get married at young age. Figure 4.6 shows the educational level of the respondents.



Source: Field survey, 2017

Figure 4.6: Educational level of the respondents

Results from Figure 4.6 re-confirmed the assumption that female respondents are still lagging behind compared to male respondents whereas only 2.10% of female respondents have completed higher secondary level education and in the case of higher degree (Hon's and M.S) the rate was very low, only 1.10%. Only 2 out of 95 respondents had complete higher secondary level of education and for graduation completed one respondent. The greater number of female respondents enrolled to high school and very few of them completed the level.

4.3.3 Occupational status

Occupation means "a person's usual or principal work or business, especially as a means of earning a living or any activity in which a person is engaged." The main occupation of the rural Bangladesh is agriculture for male and female stay at home as a housewife and do homestead work like cooking, cleaning, washing, looking after child and elderly etc. and very few of them do some job. But it is not true for all, the poor women go out for work along with their male partners to increase the overall family income. In middle and higher class households, female usually do sewing and handy craft as a hobby and they did not consider it as an occupation. Usually in

farming, one need not to work all the year round and in some cases not even the whole day and after sunset there have nothing to do. For the proper use time many people are involved in some other work beside farming and many are involved in farming along with other sort of work like job and business. By keeping this in mind, for this study occupational status were categorized into two different sub-categories, main occupation and secondary occupation.

Table 4.2 shows the percentage of occupational status of the respondents where most of the male respondents were involved in farming and females were housewife and in case of secondary occupation the male given first choice as farming because respondents whose main occupation was business or job also involved in farming as part time work. The rate of female participation in farming activity was higher among Santal people because of their tradition. Traditionally, Santal women work in the agricultural field alongside their male partners. Beside tradition, as most of the Santal household belongs to the poorer and deprived section, Santal women also work as a hired labor on others land and during the off period they sell labor to increase the household income. Only one respondent was student that was unintended.

Table 4.2: Occupational status of the respondents

Occupation	Main occupation			Secondary occupation		
	Female	Male	Total	Female	Male	Total
Farming	3.20	50.50	53.70	9.45	9.45	18.90
Labor selling	1.10	1.10	2.20	3.20	4.20	7.40
Business	0.00	5.20	5.20	3.20	7.30	10.50
Job	1.10	4.20	5.30	0.00	5.30	5.30
Housewife	32.50	0.00	32.50	3.20	0.00	3.20
Student	0.00	1.10	1.10	0.00	0.00	0.00
Do nothing	0.00	0.00	0.00	18.90	35.80	54.70

Source: Field survey, 2017

4.4 Conclusion

In this chapter socioeconomic characteristics of respondents as well as the households have been discussed on the aspects like age & sex, educational level and occupation for individual respondents and family size and composition, land holdings and household income for households.

CHAPTER 5

GENDERED INVOLVEMENT IN AGRICULTURE AND HOUSEHOLDS

5.1 Introduction

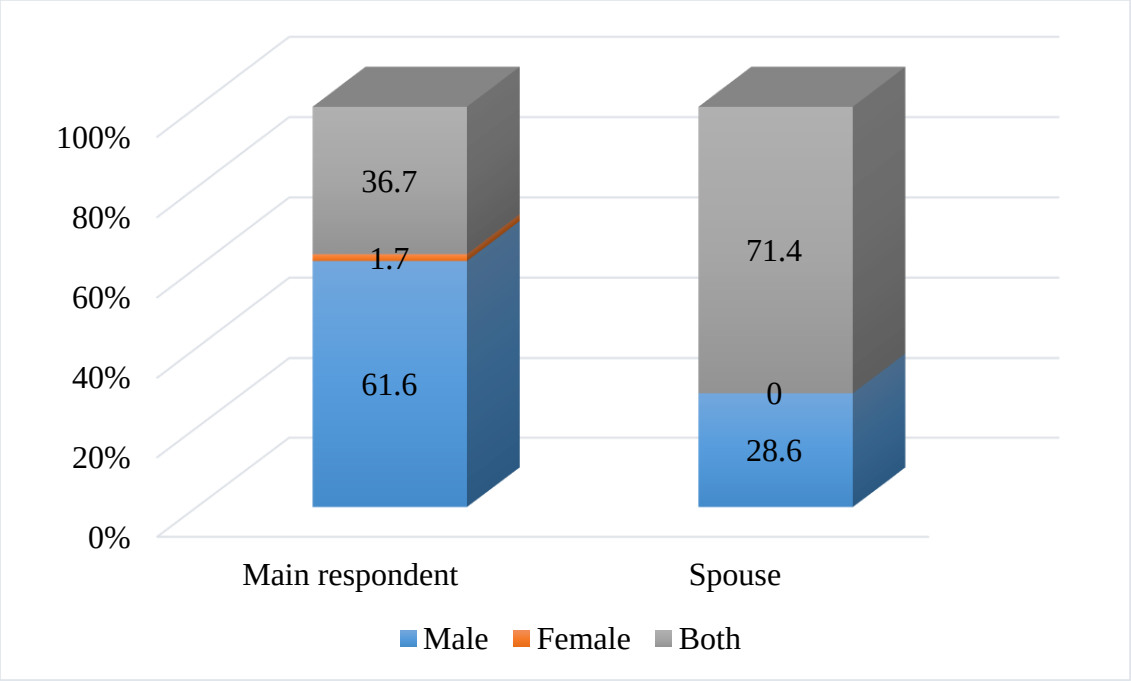
The word gender is quite controversy and have diverse meaning. It does not mean only female it means both male and female, so female should not be treated as an isolated or separate interest group (Nahar, 2002). So, both male and female roles and contributions are incorporated in this chapter. Intension of this chapter is to identify the role of both male and female both in agriculture and households. Basically males are responsible for crop production and protection of family assets and also making all the decisions, on the contrary female do manage the household, take care of the family members and homestead garden. This chapter has been categorized into three different sub-sections, first section deals with the role of male and female for agriculture related decision making, in second section agricultural labor force and in final section household labor force have been discussed.

5.2 Agriculture Related Decision Making Process

"Smart decisions are the triumphs of judgement while bad decisions are opportunities to learn from and rectify our strategy. The way to get better decisions is learning from experience and not repeating the same mistakes again." Life Positive Way

The key to success is to make a right decision at the right time but making right decision is crucial at every level. For agriculture, right decision at right time is definitely the most important and crucial task as agricultural goods are highly perishable and a small mistake can turn all efforts into ashes. Usually male do pre harvesting, harvesting and threshing for agricultural commodity where female do post-harvest work but in the case of decision making both male and female have more or less equal share. Unfortunately, most of the cases female's contribution are not acknowledged by the counter partner. It is because they cannot identify female's role in decision making or they think that if they acknowledge female's contribution that will abolish their superiority in the household and also in the society. To find out the

truth, opinion of male members is not enough as sometimes they hide the contribution of female, female's opinion also needed. In this section, unlocked the truth by incorporating the responses for male and female from the same household (main respondent and spouse). Figure 5.1 shows the respondent's opinion regarding on decision making process related to overall agricultural operations.



Source: Field survey, 2017

Figure 5.1: Decision making process related to agricultural operations

It is clear that decisions related to agricultural operations are made by male according to main respondents who are mostly male (54 out of 59 main respondents) but according to spouse (31 out of 35 are female) both male and female equally contributed in decision making. Only one respondent reported that decisions were taken by female as the household is female headed.

To identify the male and female contribution in decision making process for different agriculture work the four major agricultural crops were taken into account which were rice, maize, lentil and vegetable. In fact, beside rice many farmers cultivate maize, lentil and vegetable. Table 5.1 and Table 5.2 show the contribution of male and female in decision making process regarding different agriculture operations of four

major crops. Table 5.1 presents the responses of main respondents while Table 5.2 presents the responses of spouse.

Table 5.1 Decision making process regarding different agricultural activities, (based on main respondents)

Decision type	Rice			Maize			Lentil			Vegetable		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Selection of land	66.7	1.7	31.7	83	0	17	77	0	23	57	7	36
Time of tillage/ land preparation	70	3.3	26.7	100	0	0	92	0	8	57	0	43
Time of planting	58.3	5	36.7	67	0	33	85	0	15	64	0	36
Time of weeding	61.7	1.7	36.7	67	0	33	85	0	15	57	0	43
Selection of fertilizer	68.3	3.3	28.3	100	0	0	85	0	15	57	0	43
Time of application	65	1.7	33.3	100	0	0	85	0	15	71	0	29
Selection of pesticides	71.7	3.3	25	100	0	0	92	0	8	71	0	29
Time of application	70	1.7	28.3	100	0	0	92	0	8	71	0	29
Time of irrigation	63.3	1.7	35	100	0	0	85	0	15	71	0	29
Method of irrigation	68.3	1.7	30	100	0	0	92	0	8	79	0	21
No. of irrigation	68.3	1.7	30	100	0	0	92	0	8	57	0	43
Time of harvesting	53.3	1.7	45	67	0	33	77	0	23	50	0	50
Method of threshing	55	1.7	43.3	83	0	17	77	8	15	0	0	0
Consumption decision	11.7	6.7	81.7	33	0	67	15	0	85	28	7	64
Storage	5	11.7	83.3	17	0	83	15	0	85	7	14	79
Selling	51.7	1.7	46.7	50	0	50	61	8	31	43	0	57
Total	57	3	40	79	0	21	75	1	24	56	2	42

Source: Field survey, 2017

Table 5.1 shows that male solely carry out most of the agriculture related decision but for post-harvest operations like consumption decision and storage they had consult with female members. Most of the time, male alone and in some cases male and female jointly took the decisions but only a few cases female solely took decisions related to agriculture (true for female headed household). In case of rice and vegetable

cultivation, the percentage of making decisions jointly was found very close to decisions made by male alone but for maize and lentil the difference was reported at higher rate.

Table 5.2: Decision making process regarding different agricultural activities, (based on spouse response)

Decision type	Rice			Maize			Lentil			Vegetable		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Selection of land	37.1	0	62.9	0	0	0	25	0	75	0	0	100
Time of tillage/ land preparation	31.4	0	68.6	0	0	0	25	0	75	0	0	100
Time of planting	28.6	0	71.4	0	0	0	25	0	75	0	0	100
Time of weeding	31.4	0	68.6	0	0	0	50	0	50	0	0	100
Selection of fertilizer	31.4	0	68.6	0	0	0	25	0	75	0	0	100
Time of application	37.1	0	62.9	0	0	0	25	0	75	0	0	100
Selection of pesticides	37.1	0	37.1	0	0	0	50	0	50	0	0	100
Time of application	40	0	60	0	0	0	25	0	75	0	0	100
Time of irrigation	34.3	0	65.7	0	0	0	50	0	50	0	0	100
Method of irrigation	48.6	0	51.4	0	0	0	50	0	50	0	0	100
No. of irrigation	40	0	60	0	0	0	50	0	50	0	0	100
Time of harvesting	25.7	0	74.3	0	0	0	25	0	75	0	0	100
Method of threshing	25.7	0	74.3	0	0	0	25	0	75	0	0	100
Consumption	5.7	5.7	88.6	0	0	0	0	0	100	0	0	100
Storage	5.7	2.9	91.4	0	0	0	0	0	100	0	0	100
Selling	25.7	0	74.3	0	0	0	25	0	75	0	0	100
Total	30	2	68	0	0	0	30	0	70	0	0	100

Source: Field survey, 2017

Table 5.2 shows totally opposite results from Table 5.1 where male decided most of the agriculture operations but in Table 5.2 shows that male and female jointly decided when and how do the activities. Results of decision making for rice and lentil were

found almost the same but for vegetable cultivation all decisions were taken jointly by male and female as those households cultivate vegetable for mainly family consumption. In fact, this is mostly grown by female in homestead areas. In case of maize cultivation, no spouse was found to work at field.

Table 5.1 and Table 5.2 shows the similar results like Figure 5.1 in which main respondents (mostly male) reported that male dominated in decision making process and spouse said that (mostly female) male and female jointly made most of the decisions.

5.3 Agricultural Labor Force

Agriculture is the largest employment sector in Bangladesh by far and 45% of the population is directly employed in agriculture and around 70% depends on agriculture in one form or another for their livelihood (Seven-Five-year plan, 2015). As we know farming is totally dependent on labor force. From land preparation to selling in every steps of farming human labor required. Rich farmers can afford to hire labor but for poor and tenant they rely on their own labor force. In this case they depend on family labor which includes brothers, wives, sons and daughters where male members are responsible for pre- harvesting and females for post harvesting operations. It is more or less true in Bangladesh as it is an Islamic country and women follow 'purdah', so they do not often go out for work in agricultural field but there are also some special cases where female also work alongside male, it is mostly among the poor who do not have any other alternative. But for Santal women it is very common to work in agricultural field. It is their tradition that the females also participate in agricultural operations. During FGD with Santal community at Godagari upazilla, one of the participants gave following statement while asking about Santal women's involvement in agriculture.

"Women from our village willingly participate in agricultural operations. We mainly do planting and weeding in pre harvesting period and also harvest crop not only in own land but also in other's land as hired labor and all post harvesting operations for own household."

On the other hand, in Nachole upzila participant mentioned following aspect.

"We are the poorest people in this area and we do not have own cultivable land. We cultivate land as sharecropper so we cannot afford the luxury of hiring labor and for my husband it is too much hard if he works alone. So I help him in all agricultural operations and beside that I also work as hired labor for planting, weeding and harvesting. Many women in our village do the same."

Table 5.3: Percentage of agricultural labor force, (main respondent's view)

Types of work	Rice (boro)		Maize		Lentil		Vegetable	
	Male	Female	Male	Female	Male	Female	Male	Female
Preparation of seedbed	95	5	100	0	0	0	90	10
Growing seedlings	95	5	100	0	0	0	89	11
Collection of seedlings	93	7	92	8	0	0	91	9
Preparation of land/Tillage	96	4	92	8	100	0	88	12
Planting	72	28	83	17	96	4	77	23
Weeding	82	18	83	17	88	12	77	23
Fertilizing	95	5	92	8	100	0	95	5
Application of pesticide	96	5	100	0	100	0	100	0
Irrigation	92	8	92	8	100	0	88	12
Harvesting	79	21	83	17	88	12	75	25
Preparing threshing floor	71	29	73	27	76	24	0	0
Threshing	83	17	92	8	92	8	0	0
Drying	38	62	37	63	42	58	0	0
Storage	47	53	45	55	43	57	49	51
Seed selection & storage	65	35	75	25	73	27	58	42
Managing by-products	61	39	50	50	67	33	62	38
Selling	86	14	92	8	98	2	82	18
Total	79	21	81	19	83	17	80	20

Source: Field survey, 2017

It is evicted from Table 5.3 that agricultural labor force is dominated by male and the average agricultural labor force provided by male and female are almost same for all crops ranges from 79 to 83 percent for male and 17 to 21 percent for female. In most of

the household's female participation is mainly post-harvest operations oriented. Few percentages were found in other operational activities due to the Santal women.

Table 5.4: Percentage of agricultural labor force, (spouse's view)

Works type	Rice (boro)		Maize		Lentil		Vegetable	
	Male	Female	Male	Female	Male	Female	Male	Female
Preparation of seedbed	93	7	0	0	0	0	0	0
Growing seedlings	93	7	0	0	0	0	0	0
Collection of seedlings	94	6	0	0	0	0	0	0
Preparation of land/Tillage	97	3	0	0	100	0	75	25
Planting	75	25	0	0	100	0	75	25
Weeding	78	22	0	0	72	28	50	50
Fertilizing	95	5	0	0	100	0	100	0
Application of pesticide	97	3	0	0	100	0	100	0
Irrigation	94	6	0	0	100	0	75	25
Harvesting	79	21	0	0	82	18	50	50
Preparing threshing floor	55	45	0	0	56	44	0	0
Threshing	79	21	0	0	90	10	0	0
Drying	41	59	0	0	16	84	0	0
Storage	45	55	0	0	32	68	55	45
Seed selection & storage	71	29	0	0	70	30	25	75
Managing by-products	70	30	0	0	66	34	100	0
Selling	87	13	0	0	100	0	80	20
Total	79	21	0	0	77	23	71	29

Source: Field survey, 2017

Results from Table 5.4 have not found much difference compared to Table 5.3 and for rice farming it was the same, about 79% labor force provided by male and 21% by female but for other crops the difference was about 6 to 9 percent. As reported, Aduri Maddi, a Santal woman from Godagari upazila who won Bangabandhu National Agriculture Award in 1422 Bangla (2014-15 English) for producing compost fertilizer using earthworm. She works beside her husband for producing compost fertilizer, but in case of working in field for production purpose she only participate in planting, weeding and harvesting. Her response was-

"Not only I but also all other female from my village do the same. We like to work in the field but except planting, weeding and harvesting all other operations require too much strength and naturally we are not that much strong but we help our husband in those operations as much as we can." (Case study, 2)

5.4 Household Labor Force

Basically, males are responsible for crop production and protection of family assets and also making all the decisions, on the contrary female do manage the household, take care of the family members and homestead garden. In this section, it is tried to unearth the spending hours both by male and female in household works like cooking, cleaning, child caring, livestock rearing and leisure period. To unearth these, every respondent's spending hours on daily basis were measured. How much time did he/she spent for respective works not how much his/her spouse spent? Spending hours in household works by male and female are shown in the Table 5.5

Table 5.5: Spending hours in household related works in a day

Works type	Spending hours		
	Male	Female	Total
Cooking food	0.12	3.95	4.07
Collecting fuel	0.89	1.13	2.03
Collecting water	0.13	1.09	1.22
Cleaning and washing	0.02	1.61	1.63
Child caring (feeding, bathing, preparing for school etc.)	0.09	1.56	1.65
Looking after elderly	0.29	0.41	0.70
Preparing food for livestock	0.57	0.66	1.23
Cleaning waste and bathing of livestock	0.51	0.52	1.03
Managing shed	0.72	0.28	1.00
Leisure	1.97	1.47	3.45
Social/Community work	1.26	0.56	1.82

Source: Field survey, 2017

The results are as presumed, female spent more time than that of male in household works. The most important help that female got was collecting fuel for cooking purpose. Otherwise, female spent much more time in household activities. like male do most agriculture operations in the field. Male enjoyed more leisure time than that of female and also spent more time to participate in social/community work.

5.5 Conclusion

This chapter provides an evidence of real picture of the society where females are equally contributing in decision making process along with male but male never confess their contributions. But for agricultural labor force the truth is different where females are consciously avoid working in the field. Present study findings can compare with FAO (2011) findings, average share of female in agricultural labor force ranges from 35% in South Asia to almost 50% in East and Southeast Asia, 50% in sub-Saharan Africa, 40% in Southern Africa, 50% in Eastern Africa, 45% in Northern Africa and 20% in the developing countries of America (FAO, 2011).

CHAPTER 6

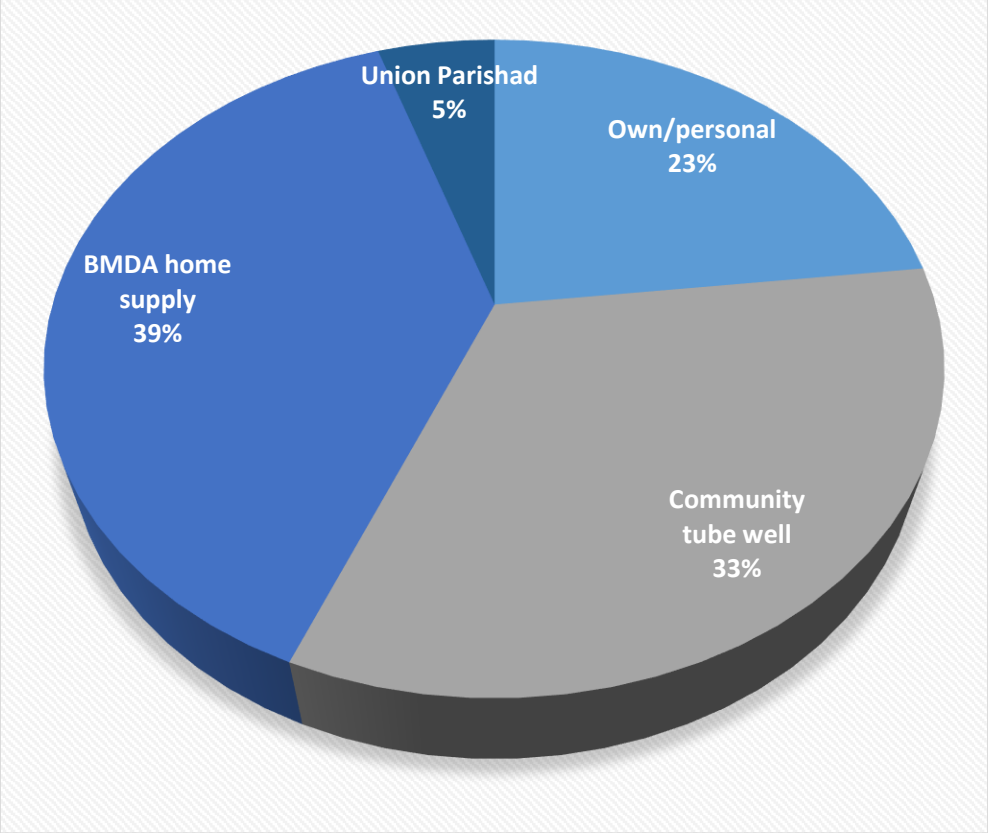
DECISION MAKING PROCESS ON GROUNDWATER UTILIZATION

6.1 Introduction

Water plays a pivotal role in economic activity and in human well-being. Because of the prominence of water in production (primarily for irrigation) and in domestic use (drinking, washing, cooking), conflict over water and the effects of gender influenced decisions about water may have far-reaching consequences on human well-being, economic growth and social change (Crow and Sultana, 2002). Like all other resources, the access to and control over water and water resources are influenced by gender relationships because of socially-constructed patterns of differences between male and female. The purpose of this chapter is to find out how this relationship induce in groundwater utilization and decision making process.

6.2 Groundwater Sources

The principle purpose of heaving groundwater is to use for agriculture and domestic work. Agricultural use of groundwater is mainly in irrigation purpose and domestic use is related to drinking, washing, cooking, cleaning and household purpose. For the purpose of drinking and other household work people commonly rely on tube well or hand pump water. The implementation of tube well or hand pump is very costly in the study area and for most of the people it seems luxurious to have tube well. So, they rely on different sources for domestic water. Figure 6.1 shows the sources of groundwater for domestic use.



Source: Field Survey, 2017

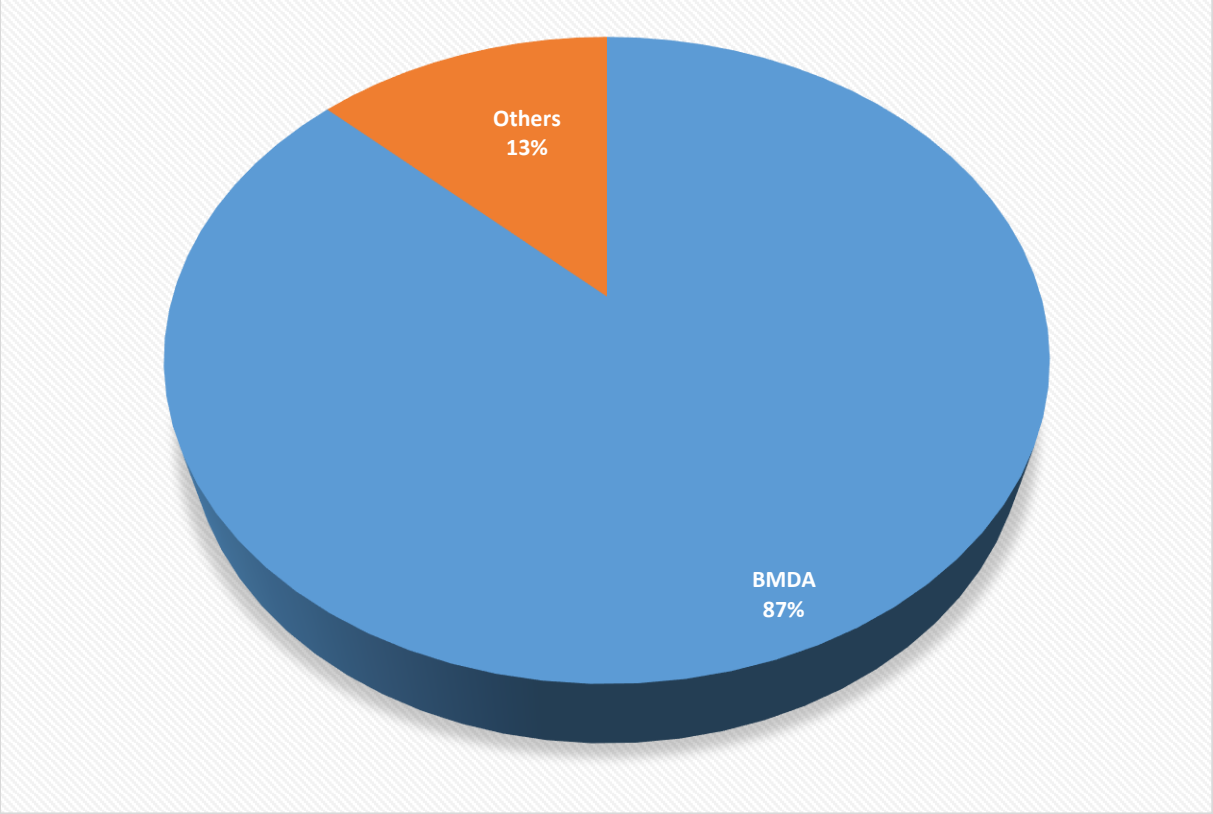
Figure 6.1: Sources of groundwater for domestic use

There are mainly four kind of domestic water source in the study area, only 23% of surveyed households had own/personal tube well and rest depended on different water sources like community tube well, BMDA home supply and union parishad tube well based on distance favorable to households. About 39% of the surveyed households depend on BMDA home supply, 33% on community tube well and only 5% on union parishad tube well. To describe the situation, one statement of FGD's participant is mentioned here.

"In our area tube well installation is very expensive and most of us do not have the ability to install tube well. So, to meet the domestic water demand about 20 households from our area decided to install a tube well and thus we are having a tube well in our area."

Groundwater is the main source of irrigation for increasing crop production and sustainable agricultural intensification. Availability of groundwater for irrigation is the main factor behind the current self-sufficiency in rice production of Bangladesh.

In the study area, due to the high cost of tube well and water pump installation most of the surveyed households had no possession of personal irrigation pump and most of the cases an entire village depended on one or two water source for irrigation. Figure 6.2 shows the main groundwater sources of irrigation.



Source: Field survey, 2017

Figure 6.2: Groundwater irrigation sources

In the study area, for irrigation most of the households relied on BMDA deep tube well and very few of them had own irrigation pump. The reason for collecting water from BMDA tube well is that it requires lower cost and in some areas there were no other alternatives. One FGD participant mentioned to describe the cause

"As irrigation is very costly and irrigation pump installation is way much costly, so we depend on BMDA deep tube well for irrigation water."

Another FGD participant mentioned,

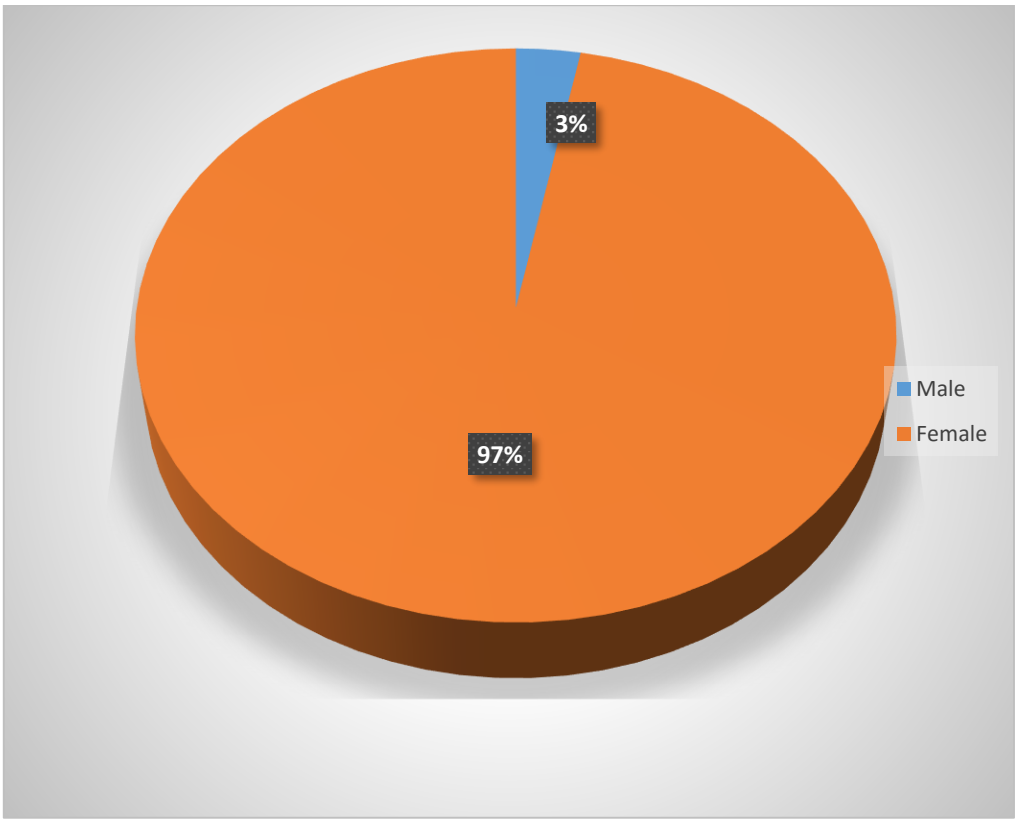
"We actually do not look for other alternatives because BMDA's water is less costly."

6.3 Gender in Groundwater User Groups

It has been found from different research, male and female play different role and have different impacts on groundwater utilization. It involves questions of rights, responsibilities and participation at all levels. Even National Water Policy (1998) gave emphasis on equal participation of male and female in water resources management. National Water Policy stated that-

"To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement to the water management objectives through broad public participation."

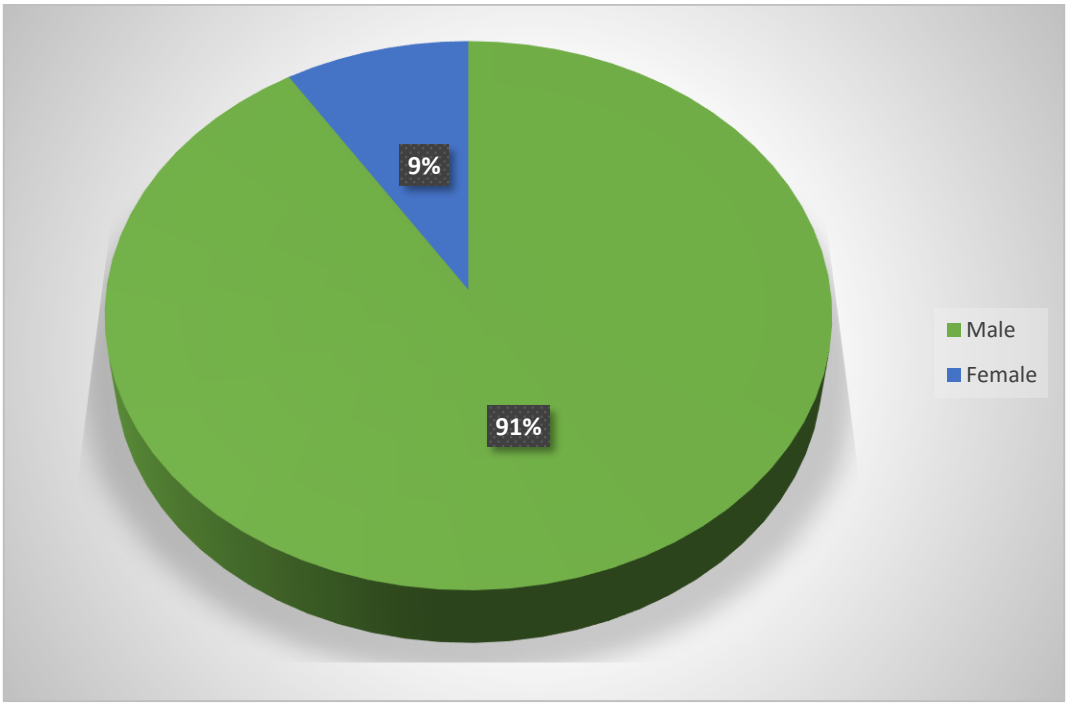
Groundwater is mostly used in two purposes, households and irrigation. Female collect households water and male use water for irrigation purpose. Contribution of male and female in household water collection are shown in the following Figure 6.3



Source: Field survey, 2017

Figure 6.3: Contribution of male and female in household water collection

It is evident from the Figure 6.3 that almost in all household female collect water for household purpose, about 97% household water were collected by female and remaining 3% water were collected by male. So, the current study results support the studies of Hossain (2007), Dublin Principle 3 (1992) and Faisal and Kabir (2005) on gender and water nexus. In most of the world including Bangladesh, groundwater is mostly used for agricultural purpose especially for irrigation. From previous research on gender and water nexus it is already been established that this irrigation water is used by male.



Source: Field survey, 2017

Figure 6.4: Contribution of male and female in irrigation water management

The situation is not that much worse like household water management. About 9% irrigation water was collected by female and remaining 91% water collected by male as Faisal and Kabir (2005) mentioned that, there is very little participation of women in agricultural water management as 'right to water' is perceived as linked with 'right to land', over which women have little control.

6.4 Groundwater Organization

There was only one active groundwater organization BMDA (Barind Multipurpose Development Authority) in the study area and this organization singly supply most of the irrigation water as well as domestic water in the study area. It has already been shown in the Figure 6.2 that about 87% of the irrigation water among the surveyed households and Figure 6.1 about 39% of domestic water is supplied by BMDA.

For irrigation water, a particular area there is only one BMDA supported deep tube well and a local person been appointed by BMDA to operate the tube well. There is procedure to convince water buyer but all farmers those land had within the command area got the right to claim for irrigation water. For collecting water, every farmer (male/female, one person from each household) should have a pre-paid meter card. It is an identity card of farmer what work similarly like SIM card where farmers need to recharge first and on the basis of recharged amount each farmer got water. The cost of irrigation is calculated on hourly basis and the cost of irrigation for one-hour range from 120 to 130 taka, regarding to land category and distance. 'Come first, get first' is the process of getting water from BMDA deep tube well. A good number of respondents were not happy in the process as they claimed that they did not get water according to their demand. They also accused for biasness against the operator. The respondents also confessed, rich farmers get more priority than that of poor.

From the same deep tube well, BMDA supply water for domestic use and in this regard BMDA built water tank (water reservoir) but this water tank had limitation to cover all area under the deep tube well. The reasons behind this; (i) the water tank was not big enough and (ii) the facility had not yet able to reach to all. For home supply of water, BMDA has installed a single water tape for at least 4 to 5 households within a suitable place for all households with limited cost is 10Tk/person/month.

6.5 Groundwater Utilization and Impact on Decision Making Process

It is clear that in a perfect sunny day, irrigation requires much more water compare to domestic use and also boro rice requires most of the irrigated water. The purpose of this section of the study is to identify the perceptions of the respondents in case of

some selected agricultural activities and also on some household activities and their impacts on decision making process. Of course in all the activities groundwater have a crucial role. Though the activities were selected by the researcher using current cropping pattern from secondary data sources like Yearbook of Agricultural Statistics, but some activities were included and excluded, for example Aus rice was excluded from the list as none of the respondents cultivate Aus rice. For understanding groundwater utilization, respondents had full freedom to rank using their own experience and knowledge. Ranking for agricultural and domestic activities had been measured separately. A four-point Likert scale were used for score measurement and respondents were asked to refer a certain scale for a certain activity as per his/her experience and knowledge. The point distribution for the scales are- Very much-4, Much-3, Not too much-2 and Less-1 and total score was calculated by using summation of all scales of each activity and scales score by multiplying scales points with number of respondents. According to total score the ranking was measured as high the score high position in ranking and accordingly.

Finally, total of 7 agricultural activities were fixed for ranking and presented in Table 6.1 according to rank with scores.

Table 6.1: Groundwater utilization for agricultural activities

Activity	Very much	Much	Not too much	Less	Total	Rank
Boro rice	86	9	0	0	371	1
Vegetable	3	31	60	1	226	2
Wheat	0	26	65	4	212	3
Maize	0	22	73	0	211	4
Aman	0	6	87	2	194	5
Lentil	0	1	57	37	154	6
Orchard	0	0	33	62	128	7

Source: Field survey, 2017

It has already been proven by many researcher boro rice cultivation requires highest amount of irrigation, about 80% of groundwater is used for irrigation, of which 73%

is used for boro farming (Rahman and Ahmed, 2008) and this study result have similar kind of findings. Groundwater utilization for boro rice cultivation ranked 1st among all agricultural activities with highest score in very much scale with a total score of 371 where the possible highest score could be 380.

During the last few decades the production of boro rice has increased significantly due to dramatic improvement of irrigation system all over Bangladesh, especially in the NW region. Because of the availability and improvement of irrigation system by installation deep tube well and semi deep in the NW region where few years back during the winter (Robi season) most of the cultivable land were fellow. After development of groundwater irrigation, the boro rice production has also been increased more with a giant leap. In a KIIs, regarding the question on agriculture production system, cropping pattern and groundwater-surface water situation from the past. The summary of the responses can be presented as-

"At present, our main agricultural crop is boro rice because we have BMDA deep tube well for irrigation and we are able to produce many other crops of what we never dreamt. Ten years back the availability of groundwater was not similar and we depended on surface water but surface water sources are very few as we saw in our childhood and during dry season water availability reached nearly zero. Then we produced aus and aman, besides vegetable and potato were cultivated in the village. And 20 or 30 years before, only cultivated crop was jute and rest of the time fellow. In that time groundwater irrigation system were unavailable and even many of us had not the idea about it"

Boro rice production requires highest amount of irrigation but the production is high, the yield growth of boro rice is 101% and 83% higher than that of aus and aman rice respectively (Mainuddin *et. al*, 2014) and thus boro cultivation is the prime concern of all farmers. The 2nd ranked agricultural activity is irrigation water for vegetable cultivation with a total score of 226. Majority of the surveyed households did not cultivate vegetable for commercial purpose, only for home consumption.

The 3rd ranked activity was wheat cultivation though production rate is decreasing day by day. Wheat cultivation does not require much water but due to low market prize and low productivity because of mouse the productivity curve sloping

downward. Maize cultivation had not yet gain popularity among farmers and farmers prefer boro cultivation than maize and it ranked 4th in term of groundwater utilization.

Aman rice, lentil and orchard require very small amount of irrigation water and even most of the time no irrigation needed and ranked 5th, 6th and 7th respectively.

Females are the main fetcher of groundwater for domestic like drinking, cooking, cleaning & washing, bathing and sanitation as well as some subsistence production like homestead gardening, rising of poultry and livestock. Availability and easy access of groundwater for domestic use has burden for female in the study areas as many households had no personal tube well or source of groundwater. For measuring domestic activities, 6 most important household activity were chosen considering groundwater utilization. The ranking along with total score for each activity has been presented in the Table 6.2.

Table 6.2: Groundwater utilization for household activities

Activity	Very much	Much	Not too much	Less	Total	Rank
Cleaning & washing	18	53	24	0	279	1
Cooking	2	64	29	0	258	2
Drinking	14	34	47	0	252	3
Bathing	4	46	45	0	244	4
Sanitation	2	36	57	0	230	5
Livestock	0	22	33	40	172	6

Source: Field survey, 2017

It is evicted from the table, as per respondents concern groundwater is mostly needed for cleaning & washing of household commodities and ranked 1st with a total score of 279. For cleaning & washing females spent 1.61 hours on an average and they need to go out of home as most of the households had no water source in their premises but for small scale operations, it is done within home.

For cooking female use deposited water that they fetched before starting cooking and in case of emergency they asked their children and husbands (in some households) for water fetching. Cooking ranked 2nd in groundwater utilization with total score of

258. Water fetching for the purpose of drinking were given the most importance by most of the respondents as health issue is too much related with safe drinking water and female members from households perform this difficult task. It is ranked 3rd among household activities related to groundwater utilization with a total score of 252.

The 4th ranked activity was water needed for bathing with a score of 244. For bathing purpose female does not need to fetch water too much as most of the household members complete the task within the sources but for small children and aged members who are unable, females fetch water for them.

In case of sanitation, water need to be deposit in some kind of reservoir for use but in the households with personal domestic water source, each member collect water when he/she needed. In this case female do not have any responsibility of collecting water and water for sanitation ranked 5th with a total of 230. Finally, water for livestock rearing is ranked 6th and the score is 172 as it requires very small amount of water.

In the case of decision making regarding groundwater utilization, male and female points of view never be the same as groundwater utilization is not same. So each of them need to consider different issues for groundwater utilization. Male use groundwater for irrigation in the cropland, an economic activity and for agriculture dependent households is the primary source of income, where female use water for domestic purpose, family's health issues and safety depend on it. Both have same importance but in case of water utilization their impacts are different. In groundwater utilization both male and female give more importance on the impacts of activity in their lives not on the amount required. Peoples of the study area are well concern of groundwater depletion and water requirement for each activity but for them today is more important than tomorrow.

6.6 Factors Affecting Decision Making Process

Decision making process is one of most crucial as well as very much important task in human life because a simple decision can change one's life, whither a right decision at right time is the key to success, a wrong decision is the cause of failure. To be

successful, in case of decision making a lot of factors need to consider otherwise one must fail. In groundwater utilization there's also many factors that largely effect on decision making process. Whereas groundwater is mostly used for production purpose (irrigation) and domestic purpose, among them first one is related to economy and last one to health and safety, so all the factors are not same for both purpose but there is some common factors and others are different. In this section of the study, the factors are identified that directly effect on groundwater utilization. To identify factors a linear regression model was used and the dependent variable was irrigation utilization of groundwater which was measured by using four-point Likert scale and domestic utilization was estimated similarly. The results from the estimated econometric model are presented in the Table 6.3.

Table: 6.3 Regression analysis of irrigation utilization

Variables	Co-efficient	Std. Error	t-value	Sig. level
Constant	21.858	2.144	10.193	0
Age	-0.016	0.023	-0.712	0.48
Education	-0.077	0.043	-1.816	0.076*
Working member in agriculture	-0.453	0.254	-1.781	0.081*
Farm experience	-0.02	0.023	-0.891	0.377
Farm size	0	0.001	0.174	0.863
Time spent for water collection	-1.142	0.565	-2.023	0.049**
Training on water management	1.199	0.428	2.8	0.007***
Total income	7.0907	0	0.855	0.397
Domestic water utilization	0.206	0.111	1.849	0.071*
F statistics		3.006		
R square		0.356		
Adjusted r square		0.237		

Dependent Variable: Irrigation water utilization

*, **, *** indicates significant at the level of 10%, 5% and 1% respectively.

The estimated regression equation is-

$Y= 21.858- 0.016X_1 - 0.077X_2 - 0.453X_3 - 0.02X_4 + 0X_5 – 1.142X_6 + 1.199X_7 + 7.0907X_8 + 0.206X_9$

Here, $\beta_0 = 21.858$ implies that if all other variable equals zero than the estimated irrigation water utilization is 21.858.

$\beta 1= -0.016$ implies that one unit change in age of the respondent, on irrigation water utilization of the respondents was decreased by 0.016.

$\beta_2= -0.077$ indicates that change in education level, on irrigation water utilization of the respondents was decreased by 0.077. Educational level has effected negatively on decision making process.

$\beta_3= -0.453$ refers that one unit change in working members in agriculture, on irrigation water utilization of respondents was decreased by 0.453.

$\beta_4= -0.02$ implies that one unit change in farm experience, on irrigation water utilization of respondents decreased by 0.02.

$\beta_5= 0$ indicates that one unit change in farm size, on irrigation water utilization of the respondents do not change.

$\beta_6= -1.142$ refers that one unit change in spending time for water collection, on irrigation water utilization of the respondents decreased by 1.142.

$\beta_7= 1.199$ implies that one unit change in training on water management, on irrigation water utilization of the respondents increased by 1.119. Training on water management have a great impact on decisions regarding irrigation water utilization.

$\beta_8= 7.0907$ indicates that one unit change in farm size, on irrigation water utilization of the respondents increased by 7.0907;

$\beta_9= 0.206$ refers that one unit change in domestic water utilization, on irrigation water utilization of the respondents increased by 0.206. If the domestic water utilization is high decisions on irrigation water utilization is also high.

6.7 Conclusion

The roles and responsibilities on groundwater utilization differ gender to gender as well as the sources for collecting groundwater, where male responsible for irrigation water and female for domestic water. Sometimes male members of the households help female in collecting water for drinking purpose only. Gender inequalities in access to and control over water and water resources have influenced on water utilization as well as decision making process.

CHAPTER 7

PROBLEMS AND CONSTRAINS OF GROUNDWATER UTILIZATION

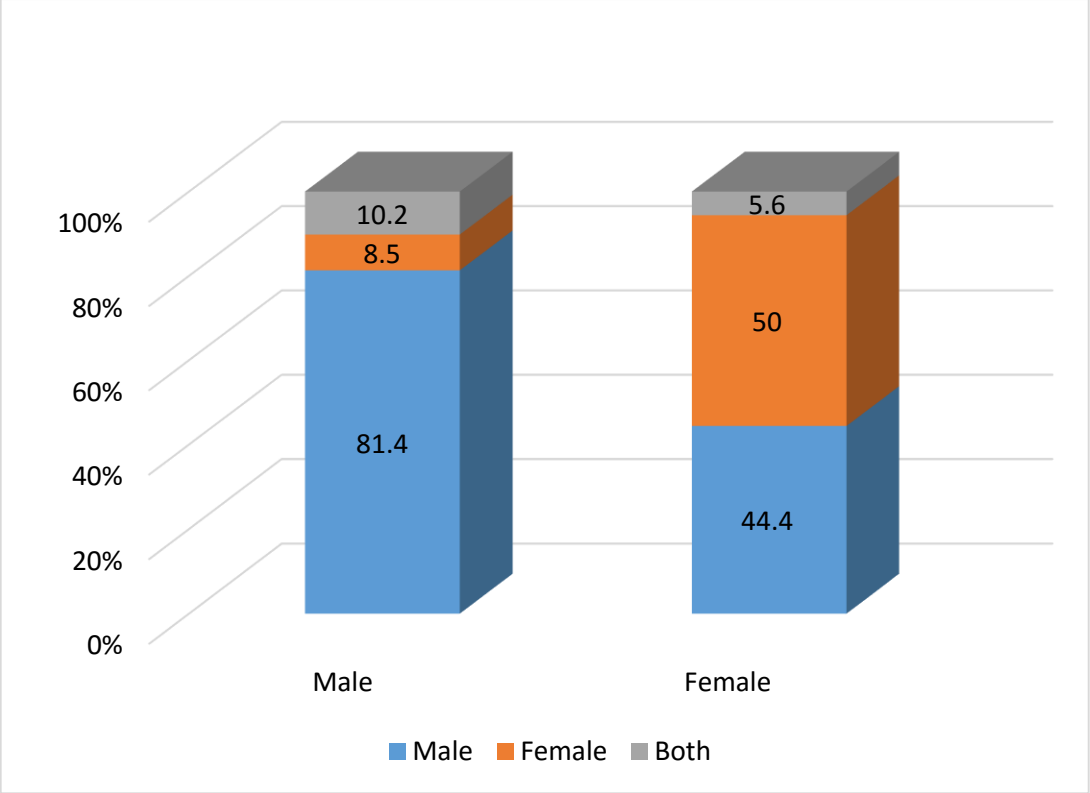
7.1 Introduction

Water is a finite resource and its use for one purpose reduces its availability for other purposes. Increased demand for water stemming from population and economic growth and ecosystem services in one hand, and the problem of exact water management on the other, have posed significant challenges for the planning and allocation of its uses among competing demands (Syme *et. al.*, 1999). As the demand increases, the problem and constraint of collecting and using water also increases. The purpose of this chapter is to find out the problems and constrains faced by both male and female in groundwater utilization by adopting 'Perception Index'.

7.2 Problems and Constrains on Groundwater Utilization based on Perception

Perception is the organization, identification and interpretation of sensory information in order to represent and understand the presented information or the environment (Daniel, 2011). In other words, a cognitive course of action by which individual turns out to be conscious of the enduring effects is called as perception. Perception for the same situation may differ from individual to individual due to difference of understanding and knowledge.

For calculating the perception index, total 11 problems and constrains were set by the researcher based on own knowledge and reviewing some related literature. These 11 problems and constrains were asked to each respondents to document the perception for both male and female. Before measuring perception index, respondents were asked who generally faces more problems and constrains? Whether it is male or female or male and female equally faces the problems and constrains. The results are shown in the following Figure 7.1.



Source: Field survey, 2017

Figure 7.1: Problems and constrains faced in groundwater utilization

It is evicted from the Figure 7.1 that both male and female respondents reported that they faced more problems and constrains compared to their partners. Male respondents exclusively (81.4%) reported that they faced more problems and constrains during groundwater utilization but from female's view the percentage was very close (50% female and 44.4% male). Only few respondents opined that both male and female equally faced the problems and constrains.

As every respondent gave their perceptions about male and female and data were collected from male and female respondents, so for luminous study the perception index has been split into two groups. In the first group, perception on problems and constrains faced by male and in second group, perception on female from the view of both male and female respondents have been discussed.

7.3 Problems and Constrains Faced by Male

Table 7.1 and Table 7.2 reveal the perception index score and ranking of the statements of male and female respondents respectively on the problems and constrains faced by male based on the perception index.

Table 7.1 computed perception index of 11 problems and constrains ranged from 75 to 155 (against a possible range from 59 to 236). The perception index score ranked 1st in the 11th statement with a total score of 155 as the majority of the male respondents opined that unavailability of groundwater was the most common problem they faced during water collection. As male mainly collect irrigation water (dry season) when irrigation mostly required the water scarcity became into its peak. This study also affirms that the NW Bangladesh where groundwater level is depleting every day and during dry season (January-May) when irrigation is mainly required groundwater level became very low due to the over exploitation of groundwater than researching aquifer (Dey *et.al*, 2013).

Table 7.1: Perception index on problems and constrains faced by male as per male

Constrains	Very often	Often	Sometimes	Never	Perception Index	Rank
Health hazard	3	14	32	10	128	5
Hindrance from owner	0	4	10	45	77	10
Rain & heat	5	17	35	2	143	3
Natural calamity	0	6	49	4	120	6
Time consuming	9	20	22	8	148	2
Risky at night	3	14	19	23	115	8
Insufficient drainage system	2	14	25	18	118	7
Unavailability of water	5	33	15	6	155	1
Depend on owners will	0	3	10	46	75	11
More Physical labor	4	15	28	12	129	4
Cause of quarrel	0	9	23	27	100	9

Source: Field survey, 2017

a. Total number of male respondents- 59
b. Calculation of perception index score for the problem of health hazard- 3×4+14×3+32×2+10×1=128

The 2nd rank of the PI score occupied by 'time consuming' with a score of 148. In this study, it was found that in most of the area irrigation water was supplied by BMDA, 86.7% and there was only one deep tube well for a particular area, moreover due to load-shedding and low water level timely water supply was not possible hence time consuming statement stood 2nd position. Male mostly responsible to carry out this task and really time consuming.

Rain and heat and natural calamity are another major problem faced by male during water collection and ranked 3rd and 6th with a score of 143 and 120 respectively. The 4th and 5th rank of the perception index were occupied by 'more physical labor' and 'health hazard' with a score of 129 and 128 respectively. These two problems are connected with each other. As more physical labor required the number of incident regarding health hazard also increases.

BMDA use underground drainage system which is good but repairing is a hassle and costly. That's why insufficient drainage system is a problem and it was ranked 7th with a score of 118.

Irrigation never an easy job and always require supervision. To meet the irrigation demand, BMDA deep tube well run all day and night long. So for timely irrigation sometimes purchaser need to stay at night and the task is done by male. This problem ranked 8th according to the male respondents with the score of 115. Other problems like cause of quarrel, hindrance from owner and depend on owners will ranked 9th, 10th and 11th with score of 100, 77 and 75, respectively.

Sometimes for water purchasing in due time, some sorts of conflict took place between water buyer and pump operator. It is not often and the effects of the quarrel never last long. Similarly, in case of community tube well especially in the case of electric motor based community tube well, happen some conflict of interest among male members who were responsible for operating and maintaining them, even during field survey researcher had observed quarrel but for some mysterious reasons the score for this problem was given poorly and that effects the rank of this problem.

Table 7.2: Perception index on problems and constrains faced by male as per female

Constrains	Very often	Often	Sometimes	Never	Perception Index	Rank
Health hazard	3	6	15	12	72	7
Hindrance from owner	0	1	8	27	46	10
Rain & heat	2	4	26	4	76	4
Natural calamity	1	2	19	14	62	9
Time consuming	8	17	5	6	99	2
Risky at night	0	14	13	9	77	3
Insufficient drainage system	0	7	16	13	66	8
Unavailability of water	4	23	8	1	102	1
Depend on owners will	1	2	2	31	45	11
More Physical labor	0	7	23	6	73	6
Cause of quarrel	0	14	10	12	74	5

Source: Field survey, 2017

a. Total number of female respondents- 36
b. Calculation of PI score for the problem of health hazard- 3×4+6×3+15×2+12×1=72

There are some similarities between male's and female's perceptions on problems and constrains faced by male. Like male, female also thought that 'unavailability of water' and 'time consuming' are the 1st and 2nd ranked problem faced by male and 'hindrance from owner' and 'depend on owners will' ranked 10th and 11th with a score of 102, 99, 46 and 45 respectively.

Other problems like risky at night, rain and heat, cause of quarrel, more physical labor, health hazard, insufficient drainage system and natural calamity ranked 3rd, 4th, 5th, 6th, 7th, 8th and 9th with PI score of 77, 76, 74, 73, 72, 66 and 62 respectively against a possible range from 36 to 144.

7.4 Problems and Constrains Faced by Female

Table 7.3 and Table 7.4 present the perception index score and ranking of the statements of female and male respondents respectively on the problems and constrains faced by female.

Table 7.3: Perception index on problems and constrains faced by female as per female

Constrains	Very often	Often	Sometimes	Never	Perception Index	Rank
Health hazard	0	6	23	7	71	5
Hindrance from owner	0	1	3	32	41	10
Rain & heat	3	14	9	10	82	4
Natural calamity	2	13	19	2	87	2
Time consuming	0	3	17	16	59	7
Risky at night	0	4	19	13	63	6
Insufficient drainage system	0	5	11	20	57	8
Unavailability of water	4	14	10	8	86	3
Depend on owners will	0	0	2	34	38	11
More Physical labor	0	22	11	3	91	1
Cause of quarrel	0	0	15	21	51	9

Source: Field survey, 2017

a. Total number of female respondents- 36
b. Calculation of perception index score for the problem of health hazard- 0×4+6×3+23×2+7×1=71

From Table 7.3 the computed perception index score of 11 problems and constrains ranged from 38 to 91 (against a possible range from 36 to 144). The perception index score ranked 1st in the 11th statements with a total score of 91 as the majority of female respondents opined that 'more physical labor' was the main problem they faced during water fetching. In the study area, the groundwater level is very low and tube well installation is very costly. For this, majority of the households had no own tube well in their premises. Only 21.7% respondent households had their own tube well and other households depend on BMDA home supply, community tube well and

union parishad tube well for domestic use. Female members were collected water all the way from tube well to home which of course require very hard labor.

'Natural calamity' is another major problem faced by female which in perception index ranked 2nd with a score of 87. Whereas females are primary fetcher of domestic water and they had to do it all the year round not only in a particular season so during rainy season or stormy and sunny weather they suffered more than male for water fetching.

It is already known that groundwater level in NW Bangladesh is declining everyday so 'unavailability of water' is an important constrain for both male and female. 'Unavailability of water' ranked 3rd with a perception index score of 86. Rain and heat statement stood 4th ranked with a score of 82 and 'health hazard' ranked 5th with a PI score of 71.

Females fetch water for domestic use and they prefer fresh water for use, so they also need to fetch water during the night while availability of light is very poor. For this, water fetching in night is always very risky and it ranked 6th with a PI score of 63. In case of community tube well at least 10 to 30 households depend on same tube well even for bathing and BMDA provide one water tap for at least 4 to 5 households. That's why 'time consuming' ranked 7th with PI score 59.

'Insufficient drainage system' and cause of quarrel' considered as problems that ranked 8th and 9th with PI score 57 and 51 respectively.

In the study area not even a single household collect domestic water from neighborhood or any individual owner so 'hindrance from owner' and 'depend on owners will' are certainly not a problem and ranked 10th and 11th with a PI score of 41 and 38 respectively.

Table 7.4: Perception index on problems and constrains faced by female as per male

Constrains	Very often	Often	Sometimes	Never	Perception Index	Rank
Health hazard	0	18	32	9	127	2
Hindrance from owner	0	1	3	55	64	10
Rain & heat	4	16	22	17	125	3
Natural calamity	1	12	38	8	124	4
Time consuming	0	3	28	28	93	7
Risky at night	0	7	24	28	97	6
Insufficient drainage system	0	2	12	45	75	8
Unavailability of water	2	12	29	16	118	5
Depend on owners will	0		3	56	62	11
More Physical labor	3	22	25	9	137	1
Cause of quarrel	0	1	11	47	72	9

Source: Field survey, 2017

a. Total number of male respondents- 59
b. Calculation of PI score for the problem of health hazard- 0×4+18×3+32×2+9×1=127

Male respondents also confess that 'more physical labor' was the greatest problem and constrain faced by female with a score of 137 (against a possible score range from 59 to 236). Alongside this problem there are also some problems that ranked same in male's perception on problems and constrains faced by female compare to female's perception. Risky at night, time consuming, insufficient drainage system, cause of quarrel, hindrance from owner and depend on owners will are those problems and constrains that ranked same.

Other problems and constrains like health hazard, rain and heat, natural calamity and unavailability of water ranked 2nd, 3rd, 4th and 5th with PI score of 127, 125, 124 and 118 respectively.

7.5 Other Problems and Constrains

Listed 11 problems and constrains mentioned in perception index were set by the researcher for measuring perceptions of the respondents but beside these problems each respondents were asked about the major problems and constrains in water collection regarding to both domestic water and irrigation water.

Problems and constrains regarding to domestic water collection:

- Insufficient water supply;
- Unavailability of water/mitigated water flow;
- Tube well run almost dry during winter season;
- The place of water collection is slippery and thus water collection is risky;
- Load-shedding;
- Require hard labor;
- Only one tube well for many families;
- Sometimes need to wait and maintain serial; and
- Time consuming.

Problems and constrains regarding to irrigation water:

- Need to maintain serial;
- Too much time consuming;
- Unavailability of water during emergency and mitigated water flow;
- Load-shedding;
- Water collection at night is risky;
- Farmer bears repairing cost of deep tube well and repairing cost is high;
- Insufficient drainage system;
- The system is corrupted and biased;
- The deep tube well driver do not follow rules properly;
- Irrigation cost is high; and
- Sometimes it starts quarrel among farmers and deep tube well operator.

7.6 Proposed Solution by the Respondents

Bottom up approach is always better than top down approach because those who are living with the problems know the best solution than that of others. Keeping this view in mind, at the end of every interview, each respondent was requested to mention some solutions based on the problems and constrains they mentioned before. For better understanding these proposed solutions were categorized into two subgroups namely proposed solution relating to groundwater and other problems. Proposed solutions are presented in Table 7.5 and Table 7.6 respectively with frequency and rank.

Table 7.5: Proposed solutions on groundwater related constraints

Proposed solution	Frequency	Rank
Manage alternative water source for irrigation	26	1
Full time electricity supply during irrigation period	22	2
Implementation of more tube well for domestic use	22	3
Implementation of more water pump/deep tube well for irrigation purpose	17	4
Ensure adequate water supply	16	5
Water cost must be low	3	6
Manage surface water/water from river for irrigation	2	7
Need to repair deep tube well	1	8

Source: Field survey, 2017

The prime demand of the people in the study area was to manage alternative water source for irrigation purpose only so that the pressure on groundwater can be minimize. The second most prioritized demand was full time electricity supply during irrigation period at least for irrigation pump. The third and fourth demand was for implementation of more tube wells and irrigation water pump to reduce pressure and also to save valuable time.

Table 7.6: Proposed solutions for other problems

Proposed solution	Frequency	Rank
Supply of quality and adequate seed and fertilizer	28	1
Government help and support	28	2
Soft agricultural loan	15	3
Agricultural insurance	12	4
Soil test	8	5
Expert advice and monitoring from BMDA	7	6
Proper price system for agricultural commodity	5	7
Equal partnership and right	4	8
Training	3	9
Labor crisis need to solve	3	10
Technology and information support	2	11
Communication system need to improve	1	12
Decentralization of power	1	13
Land ownership of female	1	13
Middlemen in agriculture should be remove	1	13

Source: Field survey, 2017

Except water problem there are many more problems people faced every day and for the solution of that problems the most important proposed solutions were- supply of quality and adequate seed and fertilizer, government help and support, soft agricultural loan, agricultural insurance, soil testing provision etc.

Some of the proposed solutions require immediate implementations before too late otherwise, the problem will be forever. Some problems can be solved within a day, just need willingness and cooperation and others need more preparation and time and are more realistic and reasonable in medium to long-term action depends on other variables like geography and effectiveness of the area, availability of resources, willingness and capabilities of the government authorities and most importantly to understand the problems depth and future impact.

7.7 Conclusion

The role and contribution of male and female in groundwater utilization are never be the same and also not the genre and impacts of problems and constrains but both male and female face almost similar types of problems and constrains during water collection and utilization. For male some problems were found severe but for female other problems and both male and female were well concern about the problems they faced and also their partner face. For mitigation and prevention of the problems and constrains, respondents suggested some solutions which are crucial for future intervention.

CHAPTER 8

SUMMARY AND CONCLUSION

8.1 Introduction

This is the final chapter of the study and it presents the concluding remarks of the whole study along with summary of the major findings as well as some recommendations to address the challenges in connection to groundwater utilization by gender.

8.2 Summary

Gender specific involvement in groundwater utilization was the main focus of this study where the intension was to unearth the roles and responsibilities of different gender for different activities. The factors that influence decision making process and perceptions on different problems and constrains faced in groundwater utilization were estimated. Involvement of gender in different cropping scenario and household labor distribution was also addressed.

Summary of the findings has been stated below:

1. The very first finding of this study was on land holding discrimination between male and female. About 91% land possessed by male in the study area, on the other hand only 9% land possessed by the female;
2. In case of agricultural decision making, based in main respondent's view, about 62% decisions were solely taken by male and 37% took by both male and female, and only 1.7% took by female solely. On the contrary, based on spouse views, about 71% decisions took by male and female jointly and only 29% agriculture decisions were taken by male;
3. Crop specific decision making process, for rice, maize, lentil and vegetable cultivation, male decided 57, 79, 75 and 56%; female decided 3, 0, 1 and 2%; male and female jointly decided 40, 21, 24 and 42% decisions, respectively according to main respondent's opinion. Similarly, based on spouse's opinion,

male decided 30, 30 and 0%; female 2, 0 and 0% and jointly decided 68%, 70% and 100% for rice, lentil and vegetable cultivation respectively;

4. For agriculture labor force in rice, maize, lentil and vegetable cultivation male performed 79, 81, 83 and 80% of total work and female performed 21, 19, 17 and 20% of total work respectively from the view of main respondent and in case of spouse, 79, 77, and 71% work done by male and 21, 23, and 29 % work done by female for rice, lentil and vegetable cultivation respectively;
5. Most of the household related task were done by female, on an average 3.95 hours spent for cooking only where male spent only 0.12 hours. An average of 1.13, 1.09, 1.61, 1.56 and 0.41 hours for collecting fuel, collecting water, cleaning & washing, child caring and looking after elderly where male spend 0.89, 0.13, 0.02, 0.09 and 0.29 hours for respective works;
6. The main source of collecting household water in the study area were BMDA home supply (39%), community tube well (33%), own/personal (23%) and union parishad tube well (5%) while for irrigation, BMDA contributed 87% and others 13%;
7. About 97% of households' water were collected by female alone and only 3% water was collected by male. On the other hand, about 91% irrigation water was collected by male where only 9% water was collected by female. Similar results were found in the study of Faisal and Kabir (2005), where about 96% domestic water was collected by female in Rajshahi;
8. In case of water requirement for different agricultural crops, boro rice required the highest amount of water followed by vegetable, wheat, maize, aman rice, lentil and orchard. Water requirement in household activities, cleaning and washing required highest amount of water followed by cooking, drinking, bathing, sanitation and livestock rearing. Similar results were found into the study of Faisal and Kabir (2005) and Maiunddin *et. al* (2014);
9. Linear regression result shows that age of the respondents, year of schooling, working members in agriculture, farm experience, time spend for water collection were found to be negatively associated with water utilization. On the other hand, farm size, training on water management, domestic water

utilization found to be positively associated with decision making process regarding groundwater utilization for irrigation;

10. As per male perception, the top three problems and constrains faced by male were unavailability of water, time consuming and rain & heat in contrast more physical labor, health hazard and rain and heat were reported top three problems and constrains faced by female. As per female perception, the top three problems and constrains faced by female were more physical labor, natural calamity and unavailability of water and unavailability of water, time consuming and risky at night were the top three problems and constrains faced by male.

8.3 Conclusion

Present study has centered on gender involvement in groundwater utilization; gendered roles and responsibilities toward using groundwater, factors influencing decision making process in using groundwater, groundwater utilization related problems and constrains and gender specific workloads in agriculture and household activities in NW Bangladesh.

To meet the objectives of the study, both male and female from selected households (main respondent and spouse) were interviewed. Respondent's perception about male and female were asked and the results became very interesting where male perceived that they solely done most of the work and took decisions. In contrast, female perceived that both male and female contributed equally.

Based on study findings it can be concluded that-

1. In patriarchal society like ours, females have very low access and ownership as 'right to land'. Where the constitution of Bangladesh emphasized on equality of both gender but in case of land holding they lag far behind of male. Study findings documented that only 9% land was possessed by female whereas it was 91% for male implied clear discrimination on land ownership;

2. For agriculture labor force in rice, maize, lentil and vegetable cultivation male performed 79, 81, 83 and 80% of total work and female performed 21, 19, 17 and 20% of total work respectively from the view of main respondent and in case of spouse, 79, 77 and 71 % work done by male and 21, 23, and 29 % work done by female for rice, lentil and vegetable cultivation respectively;
3. In agriculture decision making process, the result re-confirmed that male do not recognized the contribution of female's contribution to agriculture as they reported most of the works done by male solely however, female recognized both contributions (decisions were taken jointly);
4. Tube well installation is expensive in NW Bangladesh, thus few people got the ability to install tube well. The dependency on other tube wells found to be higher which lead to time constraints. This study also justify that irrigation water were mostly collected by male and household water were collected by female.

Male and female faced similar type of problems and constrains but their impacts were found to be different as the purpose of collecting water is different by gender.

8.4 Limitations of the Study

This kind of study requires extensive time to fully capture the experiences and perspectives of the issue but for MS thesis time allocation is for 6 months which can be considered as time constraint. Completion of all tasks within these short period of time, it is hard to claim for the best results. For gender study, it would be nice to have 50-50 participants from each gender but it could not happen due to gender barrier in the community. Data collected from the respondents may not ensure cent percent authentication as respondent provides response based on their memories. From researcher point of view, if research had get enough time and fund to adopt observational method the outcome would be more valid and realistic. However, present study has brought some interesting findings on groundwater utilization by gender that can guide further research in this field.

8.5 Recommendations

Based on study findings following recommendation proposes-

- Water scarcity is a common problem in the study area and during dry season the scarcity became severe, thus dry season cultivation hampered. For resolving the problems, alternative water sources like river water can be brought through channel for irrigation use. Therefore, specific project on expansion of surface water irrigation could help to overcome the water crisis;
- For domestic use of water there need to implement more tube wells in the study area through public private partnership which will reduce extra burden of women in fetching water;
- Full time electricity supply should be provided in dry seasons so that irrigation pump can run smoothly and fulfil the water requirement. Alternatively, introduction to solar panel into pump irrigation could help to solve the problem;
- More training for both male and female for agriculture activities and water management should be provided as training has found positive effect on groundwater utilization;
- Women's contribution to agriculture and household activities particularly on groundwater utilization should be popularized so that women's can have social recognition for their contribution; and
- Proper monitoring from BMDA should be provided so that pump operator treats every water buyer equally.

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APPENDICES

Assessment of Gender Involvement in Groundwater Utilization in Northwestern Bangladesh

PART-I

Questionnaire Number: Date:

Mobile No. (optional):

1 Information about the respondent:

1.1 Respondent name: 1.2 Age: 1.3 Sex (M/F):

1.4 Education: 1.5 Occupation*: 1.6 Farm Experience (Yrs):

1.7 Marital status: 1.8 Village: 1.9 Union:

1.10 Upazila: 1.10 District:

Note: 1-Farming; 2-Labor selling; 3-Business; 4-Job; 5-Housewife; 6-Student; 7-Others

2 Family information:

2.1 Total No. of family members: 2.2 Male: 2.3 Female:

2.4 Working members (Directly involve): 2.5 Male: 2.6 Female:

2.7 Working members (in Agriculture): 2.8 Male: 2.9 Female:

2.10 School going: 2.11 Male: 2.12 Female

3 Land holding and tenure:

3.1 Total farm size cultivated by the household (dec):

3.2 Total farm size owned by the household (dec):

3.3 Information on land holding including cropping pattern:

Plot No.	Plot size (dec)	Ownership		Irrigated			Cropping pattern (16 March-15 March)
		Male	Female	Y/N	GW	Surface	
1							
2							
3							
4							
5							
6							
7							
8							

4 Decision Making

4.1 Who mainly takes the agriculture related decision: Male: Female:

4.2 Decision making process. Who takes the following decision?

Decision type	Rice			Maize			Lentil			Vegetable		
	Man	Woman	Both	Man	Woman	Both	Man	Woman	Both	Man	Woman	Both
4.2.1 Selection of land												
4.2.2 Time of tillage/ land preparation												
4.2.3 Time of planting												
4.2.4 Time of weeding												
4.2.5 Selection of fertilizer												
4.2.6 Time of application												
4.2.7 Selection of pesticides												
4.2.8 Time of application												
4.2.9 Time of irrigation												
4.2.10 Method of irrigation												
4.2.11 No. of irrigation												
4.2.12 Time of harvesting												
4.2.13 Method of threshing												
4.2.14 Consumption												
4.2.15 Storage												
4.2.16 Selling												
4.2.17 Others (If any)												

Note:

5 Agricultural workloads

5.1 Who do the following works? **Hours spend**

Works type	Rice (boro)		Maize		Lentil		Vegetable	
	Man	Woman	Man	Woman	Man	Woman	Man	Woman
5.1.1 Preparation of seedbed								
5.1.2 Growing seedlings								
5.1.3 Collection of seedlings								
5.1.4 Preparation of land/Tillage								
5.1.5 Planting								
5.1.6 Weeding								

5.1.7 Fertilizing								
5.1.8 Application of pesticide								
5.1.9 Irrigation								
5.1.10 Harvesting								
5.1.11 Preparing threshing floor								
5.1.12 Threshing								
5.1.13 Drying								
5.1.14 Storage								
5.1.15 Seed selection & storage								
5.1.16 Managing by-products								
5.1.17 Selling								
5.1.18 Others (if any)								

Note:

6 Other workloads

Works type	Spending hours		
	Man	Woman	Total
Household work			
6.1 Cooking food			
6.2 Collecting fuel			
6.3 Collecting water			
6.4 Cleaning and washing			
6.5 Child caring (feeding, bathing, preparing for school etc.)			
6.6 Looking after elderly			
Livestock rearing			
6.7 Preparing food for them			
6.8 Cleaning waste and bathing			
6.9 Managing shed			
6.10 Grazing			
Others			
6.11 Leisure			
6.12 Social/Community work			
6.13 Others (if any)			

Note:

7 Participation on different training programme

Training	Participant		Duration (days)
	Man	Woman	
7.1 Agriculture			
7.2 Water management			
7.3 Irrigation			

Note:

8 Water Management

Items	Tube well	Irrigation pump	Irrigation organization
8.1 Do you have own			
8.2 Do you collect water			
8.3 Who mainly collect water			
8.4 Do the female members contract for water			
8.5 From where you collect water			
8.6 Relation with the owner			
8.7 Priority for member selection			
8.8 Do you get water according to your demand			
8.9 Do they do any biasness			
8.10 Rich get more priority than poor			
8.11 Reasons of collecting water	i) ii) iii)	i) ii) iii)	i) ii) iii)
8.12 Payment method			
8.13 Cost/ acre			
8.14 Constrains	i) ii) iii)	i) ii) iii)	i) ii) iii)

Note:

9 Groundwater utilization:

9.1 Most water use sector: Irrigation Domestic:

9.2 Major uses of groundwater:

Utilization	Very often_4	Often_3	Sometimes_2	Never_1
Irrigation				
9.2.1 Boro rice				
9.2.2 Maize				
9.2.3 Lentil				
9.2.4 Vegetable				
9.2.5 Wheat				
9.2.6 Aus/Aman				
9.2.7 Livestock				

9.2.8 Fisheries				
9.2.9 Orchard				
Domestic				
9.2.10 Drinking				
9.2.11 Cooking				
9.2.12 Washing and cleaning				
9.2.13 Bathing				
9.2.14 Sanitation				
9.2.15 others (if any)				

Note:

10 Household Assets/Capital & Income

Household Income (Yearly)

Sl. No.	Source of Income	Amount (Tk)
10.1	Income from crop selling	
10.2	Income from livestock & poultry	
10.3	Income from fisheries/ponds	
10.4	Income from wages & salaries	
10.5	Income from remittance	
10.6	Govt. support or grants	
10.7	Others (Specify)…….	

11 Problems and Constrains

11.1Who faces more problems & constrains: Male Female

11.2Major problems & constrains

Constrains	Man	Woman
11.2.1 Health hazard		
11.2.2 Hindrance from owner		
11.2.3 Rain & heat		
11.2.4 Natural calamity		
11.2.5 Time consuming		
11.2.6 Risky at night		
11.2.7 Insufficient drainage system		
11.2.8 Unavailability of water		
11.2.9 Depend on owners will		
11.2.10 More Physical labor		
11.2.11 Cause of quarrel		
11.2.12 other (if any)		

Note: Very often-4: Often-3; Sometimes-2; Never-1

12 Proposed solutions

12.1.....

12.2.....

12.3.....

12.4.....

12.5…….

Thanks

Signature of the Enumerator:

Name: Cell:

Assessment of Gender Involvement in Groundwater Utilization in Northwestern Bangladesh

PART-II

Questionnaire Number: Date:

Mobile No. (optional):

2 Information about the respondent:

2.1 Respondent name: 1.2 Age: 1.3 Sex (M/F):

1.5 Education: 1.5 Occupation*: 1.6 Farm Experience (Yrs):

1.7 Marital status: 1.8 Relation with other respondent:

Note: 1-Farming; 2-Labor selling; 3-Business; 4-Job; 5-Housewife; 6-Student; 7-Others

2 **Decision Making**

2.1 Who mainly takes the agriculture related decision: Male: Female:

2.2 Decision making process. Who takes the following decision?

Decision type	Rice			Maize			Lentil			Vegetable		
	Man	Woman	Both	Man	Woman	Both	Man	Woman	Both	Man	Woman	Both
2.2.1 Selection of land												
2.2.2 Time of tillage/ land preparation												
2.2.3 Time of planting												
2.2.4 Time of weeding												
2.2.5 Selection of fertilizer												
2.2.6 Time of application												
2.2.7 Selection of pesticides												
2.2.8 Time of application												
2.2.9 Time of irrigation												
2.2.10 Method of irrigation												
2.2.11 No. of irrigation												
2.2.12 Time of harvesting												
2.2.13 Method of threshing												
2.2.14 Consumption												
2.2.15 Storage												
2.2.16 Selling												
2.2.17 Others (If any)												

Note:

3 Agricultural workloads

3.1 Who do the following works? **Hours spend**

Works type	Rice (boro)		Maize		Lentil		Vegetable	
	Man	Woman	Man	Woman	Man	Woman	Man	Woman
3.1.1 Preparation of seedbed								
3.1.2 Growing seedlings								
3.1.3 Collection of seedlings								
3.1.4 Preparation of land/Tillage								
3.1.5 Planting								
3.1.6 Weeding								
3.1.7 Fertilizing								
3.1.8 Application of pesticide								
3.1.9 Irrigation								
3.1.10 Harvesting								
3.1.11 Preparing threshing floor								
3.1.12 Threshing								
3.1.13 Drying								
3.1.14 Storage								
3.1.15 Seed selection & storage								
3.1.16 Managing by-products								
3.1.17 Selling								
3.1.18 Others (if any)								

Note:

4 Other workloads

Works type	Spending hours		
	Man	Woman	Total
Household work			
4.1 Cooking food			
4.2 Collecting fuel			
4.3 Collecting water			
4.4 Cleaning and washing			
4.5 Child caring (feeding, bathing, preparing for school etc.)			
4.6 Looking after elderly			
Livestock rearing			
4.7 Preparing food for them			
4.8 Cleaning waste and bathing			
4.9 Managing shed			

4.10 Grazing			
Others			
4.11 Leisure			
4.12 Social/Community work			
4.13 Others (if any)			

Note:

5 Participation on different training programme

Training	Participant		Duration (days)
	Man	Woman	
5.1 Agriculture			
5.2 Water management			
5.3 Irrigation			

Note:

6 Water Management

Items	Tube well	Irrigation pump	Irrigation organization
6.1 Do you have own			
6.2 Do you collect water			
6.3 Who mainly collect water			
6.4 Do the female members contract for water			
6.5 From where you collect water			
6.6 Relation with the owner			
6.7 Priority for member selection			
6.8 Do you get water according to your demand			
6.9 Do they do any biasness			
6.10 Rich get more priority than poor			
6.11 Reasons of collecting water	i) ii) iii)	i) ii) iii)	i) ii) iii)
6.12 Payment method			
6.13 Cost/ acre			
6.14 Constrains	i) ii) iii)	i) ii) iii)	i) ii) iii)

Note:

7 Groundwater utilization:

7.1 Most water use sector: Irrigation Domestic:

7.2 Major uses of groundwater:

Utilization	Very often_4	Often_3	Sometimes_2	Never_1
Irrigation				
7.2.1 Boro rice				
7.2.2 Maize				
7.2.3 Lentil				
7.2.4 Vegetable				
7.2.5 Wheat				
7.2.6 Aus/Aman				
7.2.7 Livestock				
7.2.8 Fisheries				
7.2.9 Orchard				
Domestic				
7.2.10 Drinking				
7.2.11 Cooking				
7.2.12 Washing and cleaning				
7.2.13 Bathing				
7.2.14 Sanitation				
7.2.15 others (if any)				

Note:

8 Income

8.1 Yearly Income (amount):

8.2 Total land owned (dec):

8.3 Do you have any bank account/saving account (Y/N):

8.4 Do you have full control what you owned (Y/N):

9 Problems and Constrains

9.1 Who faces more problems & constrains: Male Female

9.2 Major problems & constrains

Constrains	Man	Woman
9.2.1 Health hazard		
9.2.2 Hindrance from owner		
9.2.3 Rain & heat		
9.2.4 Natural calamity		
9.2.5 Time consuming		
9.2.6 Risky at night		
9.2.7 Insufficient drainage system		
9.2.8 Unavailability of water		
9.2.9 Depend on owners will		
9.2.10 More Physical labor		
9.2.11 Cause of quarrel		

9.2.12 other (if any)		

Note: Very often-4: Often-3; Sometimes-2; Never-1

10 Proposed solutions

10.1.....

10.2.....

10.3.....

10.4.....

Thanks

Signature of the Enumerator:

Name:

Cell:

Assessment of Gender Involvement in Groundwater Utilization in Northwestern Bangladesh

Checklist for conducting Focus Group Discussions (FGD)

Village: Upazila:

District:

SL. No.	Name of the FGD participants	Age	Occupation
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

I: Introductory questions

(number of population and HH in this village, male female ratio, access to education, health and sanitation, access to market, major cropping pattern, sources of irrigation, number of irrigation pump)

II Focused Questions:

2.1 What is the role of women in crop production in this village:

2.2 In which crop production women get involved more and why?

2.3 Provide rough estimation of women participation in crop production

i). Planting of crops (%)- Female: Male:

ii). Intercultural operation (%)- Female: Male:

iii) Irrigation management (%) Female: Male:

iii) Harvesting crops (%) Female: Male:

iii) Post harvest operation (%) Female: Male:

2.3: Do the women of this village participate in Groundwater irrigation management? If yes, then how this change evolved:

2.3: Women involvement in Groundwater utilization based on the following aspects:

a) Resource agency:
   - Access to land ownership:
   - Control over land ownership:

b) Social views:

c) Women participation on groundwater management:
   - Domestic purpose:
   - Irrigation purpose:

d) Membership in irrigation organization
   - General member:
   - Committee member:

e) Institutional agency and time
   - NGO membership:
   - Capacity to speak in public:
   - Use of time:

f) Sense of individualism
   - Sense of self-reliance:
   - Sense of equal right compared to men:
   - Voice against deprivation:

Date: Name & Signature of the facilitator

Assessment of Gender Involvement in Groundwater Utilization in Northwestern Bangladesh

Checklist for conducting Key Information Interviews (KII)

Name of the key informant:

Age: Sex (M/F): Profession:

Village: Upzila: District:

Q 1: Request to brief agriculture production systems in this village or locality

Q2: Ask about cropping pattern in this village/locality

At present:

Before10 years:

Before20 years:

Q3: Ask about groundwater and surface water availability

At present:	Groundwater:	Surface water:
Before10 years:	Groundwater:	Surface water:
Before20 years:	Groundwater:	Surface water:

Q4: What is the role of women in this village in crop production:

Q5: Do the women's role and contribution is changed over the period? If so, what are the important factors that make this happen?

Q 6: Do the women of this village participate in Groundwater irrigation management? If yes, then how this change evolved:

Q 7: Women involvement in Groundwater utilization based on the following aspects:

g) Resource agency:
   - Access to land ownership:
   - Control over land ownership:

h) Social views:

i) Women participation on groundwater management:
   - Domestic purpose:
   - Irrigation purpose:

j) Membership in irrigation organization
   - General member:
   - Committee member:

k) Institutional agency and time
   - NGO membership:
   - Capacity to speak in public:
   - Use of time:

l) Sense of individualism
   - Sense of self-reliance:
   - Sense of equal right compared to men:
   - Voice against deprivation:

Date: Name & Signature of the facilitator