

**POTENTIAL USES OF WATER HYACINTH FOR SUSTAINABLE
ENVIRONMENTAL MANAGEMENT**

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**POTENTIAL USES OF WATER HYACINTH FOR SUSTAINABLE
ENVIRONMENTAL MANAGEMENT**

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CERTIFICATE

*This is to certify that the thesis entitle, "POTENTIAL USES OF WATER HYACINTH FOR SUSTAINABLE ENVIRONMENTAL MANAGEMENT." submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGROFORESTRY AND ENVIRONMENTAL SCIENCE**, embodies the result of a piece of bona fide research work carried out by **AFSANA AKTER**, Registration No. **12-05202** under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: June, 2018
Dhaka, Bangladesh

Dr. Ferzana Islam
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***DEDICATED TO MY
BELOVED PARENTS
AND MY BEST FRIEND
PRODIP KUMAR
SUTRADHAR***

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ABSTRACT

Water hyacinth is an invasive alien aquatic species introduced to our country from tropical South America. This study aims at assessing the local people perception on water hyacinth, its management and sustainable use of water hyacinth in making it environmental friendly. Local people's perceptions are key to sustainable management of water hyacinth because most of the information are relatable to potential use of water hyacinth that is environmental friendly and also can be helpful in case of improving their socio-economic status. To conduct the study properly a structured questionnaire having seven section with seven parameter has been prepared and went to the study area which are nearer to Roa beel. Roa beel is situated in Chandpur union, Katiadi upazila under Kishoregonj district. In rainy season excessive water hyacinth have been found in the study area and people of three village namely Sheker Para, Purbo Para and Modinas Para were interviewed according to the questionnaire. The study assesses local people's perception regarding knowledge and understanding of water hyacinth, their management techniques, advantages and disadvantages of water hyacinth and its practical use in their daily household life and different sectional activities including fishing, livestock, agricultural farming activities especially in floating agricultural practices and in industrial purposes. From the study findings we established that excessive amount of water hyacinth of the beel can be developed into a potential and promising sector for the locality especially by making water hyacinth into low cost and environmental friendly animal feed, bio-fertilizer and biogas. That will definitely help in sustainable environment management and will also create a better income generating opportunity for the local unemployed people.

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LIST OF ABBREVIATION

WH	Water hyacinth
OM	Organic matter

CHAPTER I

INTRODUCTION

Water hyacinth is the deleterious alien invasive species which is one of the World's worst aquatic weeds is originated from Amazon area of South America (Hill *et al.*, 2011). It has been selected in 100 of the World's worst invasive alien species from the global invasive species database because of its nocuous nature (Lowe *et al.*, 2000). Water hyacinth is monocotyledonous aquatic microphyte weed that is belong to the family Pontederiaceae. This is free floating weed and have beautiful clusters of yellow and violet flowers and bulbous green leaves. This weed was mainly introduced to Australia to use as ornamental plants for botanical gardens and embellishment of ornamental plants. It has extended to more than 50 countries on 5 continents till then. Water hyacinth is dominant in Southeast Asia including Bangladesh, the Southeastern United States, Central and Western Africa and Central America (Bartodziej and Weymouth, 1995; Brendonck *et al.*, 2003; Lu *et al.*, 2007; Jimenez and Balandra, 2007).

Water hyacinth is a free floating aquatic plant and it is characterized by rapid vegetative growth. As a single plant it reproduce and colonizes very fast in new areas (Zhang *et al.*, 2010; Williams *et al.*, 2007). This aquatic weed has expanse in many tropic and sub-tropical areas and caused serious impact on the indigenous species and human's livelihood. (FAO, 2002; Patel 2012; Téllez *et al.*, 2008; Villamagna, 2009). Water quality is seriously affected as it increase the sedimentation rate because it has complex root structure and also increase evapotranspiration rate from the leaves and this condition causes water scarcity in many areas when compared to open water even by a factor of 10 (Gopal, 1987).

Excessive presence of water hyacinth has several negative impacts, for example- it has dense impenetrable mats which restrict access to water, fisheries and related commercial activities are also impacted negatively, it also create problems in irrigation canals, navigation, transports, hydroelectric programmes and tourism (Navarro and Phiri, 2000). There are many other problems related

to it, such as during flood, water hyacinth build up against bridges, fences, walls which helps to obstruct flow of water and thus increase flood water level. Water hyacinth has serious impact on community livelihood as their livelihood dependent on commercial food, transport and clean water. Human and animal life also get affected as water hyacinth play as the bearer of disease vectors like cholera, malaria etc. (Harley *et al.*, 1997). Because of rapid growth of water hyacinth, it compete with other native aquatic plants by utilizing available nutrients in water and also compete for space and sunlight (Cilliers, 1991).

Besides these negative impacts, water hyacinth also have many potential uses. For example- water hyacinth is popularly used as animal feed (feed for cow and turkey chicken), fish feed and another important use of it is as fuel in case of cooking purpose in village. It helps in arsenic mitigation and also helps in reduction of water pollution through filtering heavy metals. It is used in preparing organic manure which can be used in crop cultivation in both field and homestead. Water hyacinth is also used as mulching material that helps to maintain moisture in crop production. Nowadays another use water hyacinth is becoming popular in submerged areas, it is being used for preparing floating bed where different vegetable and crop seedling are produced in adverse conditions like flood.

To protect and keep balance on environment, all the waste are trying to recycle and re-use as resources globally. In our country water hyacinth is invasive alien species which is mainly recognise as a waste material, we can convert this waste into resource. We can control and utilize this nuisance weed in different sector by making it environmentally friendly.

There are some potential use of water hyacinth by which we can convert this waste into resources such as-

Livestock and poultry feed: Water hyacinth plays as a high energy source for ruminants as it contains high level of cellulose and hemi-cellulose (Mukherjee and Nandi *et al.*, 2004). For diet purpose of cattle, fresh water hyacinth is using as partial replacement of para grass (Biswas and Mandal *et al.*, 1988). For better

growth of beef cattle, wilted water hyacinth with rice straw based diet has a positive effect (Islam S, Khan MJ and Islam MN *et al.*, 2009). Highly nutritious and low cost poultry feed also can be produced from water hyacinth. Water hyacinth can be used fresh, ensiled or wilted to animals. Whole plants, chopped or ground can be used as feedstuffs for both ruminants and poultry sector.

Bio-fertilizer: Agro-scientists are working for many years to reduce the negative impact of agro-chemicals and pesticides, they are using water hyacinth for the preparation of bio-fertilizer to improve the environment from toxicity of chemicals and also improve the productivity. Composting can be defined as a controlled biological process which helps to convert solid organic materials into humic substance. It is very beneficial as fertilizer and soil amendments (Kulikowska D and Sindrewicz S 2008). Decomposed water hyacinth helps to increase the organic matter content of soil and also promote mineralization of nutrient. It helps to increase soil organic carbon, nitrogen, phosphorus, potassium thus increase crop yields (Parker C.F and Sommers E.L *et al.*, 1983).

Biogas: Biogas is known as an ideal clean energy source. It helps to reduce deforestation of forests and also helps to promote ecological and environmental conditions. Biogas can be used as cooking purpose and generating electricity. Biogas residue includes regular nutrients, trace elements, amino acids and vitamins etc. These contents help to make both slow and quick organic elements fertilizers (Day D.L and Chen T.H *et al.*, 1990). Water hyacinth has the carbon nitrogen ratio about 20:1. Microorganism can conduct their nutrients for anaerobic fermentation of methane under anaerobic conditions (Chen B. 2007). Water hyacinth and other aquatic plants have the ability to degrade easily (Gunnarsson *et al.*, 1986). Large amount of gas can be produced from anaerobic fermentation of water hyacinth that minimize the problems related to breeding and also generate energy by turning waste into valuable resources.

Fish feed: In simple production system, water hyacinth is used as a potential component for farm mixed feed for omnivorous and herbivorous freshwater fish and also it is available in low cost (Hasan *et al.*, 2009a). Many research has been

conducted to investigate the use of water hyacinth as fish feeding (Hasan *et al.*, 2009a). Water hyacinths are fed to fish either fresh, as a dried meal in pelleted diets, or composted as feed and fertilizer. Researches are going on to find other techniques of processing water hyacinth as fish feed.

Waste water treatment: The roots of water hyacinth helps to absorb pollutants and chemical found in water as lead, mercury, strontium90, arsenic, zinc etc. It also helps to absorb some carcinogenic compounds having concentration of approximately 10000 times which is generically found in water. Water hyacinth can be used to treatment of waste water or water purification for industrial waste water or sewer water with other additional techniques. Water hyacinth have such root structure that provide suitable environment for aerobic bacteria to remove various impurities of water.

Floating beds for crop production: Floating agriculture practice is mainly popular in low lying submerged areas or the areas which are mostly affected by flood. One of the main element for the preparation of floating bed is water hyacinth. In this technique, the bed is prepared by the mixture of water hyacinth with other aquatic plants and muds. Different kind of vegetable are produced in those floating beds, even rice seedlings are also produced.

Objectives:

1. To identify the potential uses of water hyacinth
2. To identify the way of managing excessive water hyacinth through their potential use and creating awareness among local people
3. To assess the perception of people in water hyacinth as bio-fertilizer, biogas, livestock poultry and fish feed and inform local people about these use
4. To evaluate local people's perception about the use of water hyacinth

CHAPTER II

REVIEW OF LITERATURE

2.1 Origin and evolution of water hyacinth

According to Mack *et al.*, (2000); IUCN (2000) it is widely acknowledged by conservationists that invasive alien species are one of the biggest threats to biodiversity. Their rapid spread which cause damage to ecosystem and ultimately affects the livelihoods of the people has attracted a lot of concern.

Ojwang (2003) reported that water hyacinth, *Eichornia crassipes*, is one of the worst weeds in the world. It is a free-floating perennial plant native to South America that grow about 3 feet tall as they float on the water's surface, with stems intertwining to form dense mats.

According to Ntiba *et al.*, (2001) water hyacinth has such a high growth rate that, it can double its area in only five days. It produces seeds that remain viable for very long periods and have fairly wide ecological amplitude and exhibit great phenotypic plasticity.

According to Food and Agriculture Organization (FAO) (2000) it is reported that water hyacinth is indigenous to Brazil having first been described from wild plants collected from Francisco River in 1824. In Africa, the water hyacinth was first reported in Egypt between 1879 and 1893. It is considered one of the most notorious weed species in tropical West Africa.

According to MONSANTO (1996) it is widely reported that water hyacinth is indigenous to Brazil having been first described from wild plants collected from the Fransico River in 1824. On the African continent, water hyacinth was first reported in Egypt between 1879 and 1893; in South Africa in 1908; Zimbabwe (1937); Zaire and Sudan (1957); Senegal (1964); Nigeria (1983) and Uganda (1987).

OSIENALA (1990) slated it is now popularly believed that water hyacinth entered Lake Victoria via the Kagera River which drains the Rwanda and Burundi water catchments in 1990.

Gopal (1987) indicates that where the plant produces seeds, the seeds may cause a new outbreak of water hyacinth even after a site is completely cleared of an initial infestation. Water hyacinth grows best in neutral pH, water high in macronutrients, warm temperatures and high light intensities.

According to Kitunda (2006) people have been enticed to carry the weed as an ornament because of its attractive flowers. European explorers had seen and probably carried *Eichhornia Crassipes* from South America to Europe and Africa between the 16th and 17th centuries. Birds and animals too that feed in sites of water-hyacinth infestation transport the seeds over considerable distances on their feet (Gopal, 1987).

Makhanu (1997) reported that water hyacinth is a freshwater weed species. It is a free-floating plant that draws all its nutrients directly from water. Currents and wind help in its distribution and dispersal. It comprises 95% water and 5% percent dry matter of which 50% is silica, 30% potassium, 15% nitrogen and 5% protein. It has been known to thrive well in nutrient-enriched fresh waters in tropical climatic zones. For this purpose it has been used in wastewater treatment facilities.

Mitchell (1976) described that the weed is mainly found in inshore and shallow areas to which it is swept by currents and sometimes in patchy offshore areas. It spreads fast in shallow (< 6m) bays and inlets with mud bed surfaces. Lake Victoria's tropical location, shallow depth and nutrient enrichment provide favorable conditions for its proliferation.

According to International Development Research Centre (IDRC) (2000) in shallow lakes and where plant production is great, complete de-oxygenation of the sediments and deeper water can occur. Such conditions are not compatible for the survival of fishes and invertebrates. Moreover, under anoxic conditions, ammonia, iron, manganese and hydrogen sulphide concentrations can rise to levels deleterious to biota. In addition, phosphate and ammonium are released into the water from anoxic sediments, further enriching the ecosystem.

2.2 Components enhancing the growth and infestation of water hyacinth

Cilliers (2003) observed that the South African River Vaal has experienced an increase in nutrients levels due to run-off which carry along fertilizer from agricultural practices, industrial and mining effluents, and wastewater from settlements. This in turn has caused rapid growth of water hyacinth in the River. Williams *et al.*, (2007) reported that water hyacinth has grown rapidly in Lake Victoria due to run-off and wastewater carrying nutrients from agricultural activities and settlements which find its way into Lake.

Wilson *et al.*, (2007) considered temperature as one of the strongest determinants for the growth and reproduction of water hyacinth. The increase in temperature leads to rapid growth and reproduction of water hyacinth. These physical and chemical parameters will help identify the pollution sources that cause the infestation of water hyacinth in the River.

Villamagna and Murphy (2010) observed that in Zambia, the water hyacinth infested massively freshwater bodies during the early 1960's and rapidly spread in many areas such as Kafue River, Lake Tanganyika, Lake Kariba and Kafubu River. For example, wastewater from the Kafubu and Water Sewerage Company contribute eutrophication of the river and which influences the growth of water hyacinth, which has serious consequences on socio-economic activities around Lake Kariba (Lusaka Voice, 2014).

Harley *et al.*, (1997) reported that the world has experienced rapid population growth, industrialisation, urbanization and land use change for the past years. These anthropogenic activities have often lead to increase in the waste generated and crop production to cater for the growing population. Industrial and domestic wastewater carry along nutrients and eventually find their way into water bodies as run-off (Harley *et al.*, 1997).

Labrada *et al.*, (1996) added that the unpredictable rapid growth rate of the weed is attributed by the eutrophication and absence of natural enemies of the plant in water bodies which cause the weed to bloom.

2.3 Impacts of water hyacinth

Water hyacinth has serious impacts around the communities living near the water bodies and poses an impact to biodiversity, fishing, agriculture and hydropower activities (ITDG, 1999).

2.3.1 Direct water use:

Gopal (1987) indicates that water hyacinth has caused interference with navigation, water flow and recreational use of water body. In several countries, it has invaded newly constructed reservoirs which caused problems for hydroelectric power generation and in irrigation. Water hyacinth has been reported to reduce the water flow by 40% to 95% in irrigation channels (Gopal, 1987). The decrease in light penetration, increase in de-oxygenation and recurrence of algae blooms; increasing lake fly swarms and the rapid invasion of the lake by aquatic weeds such as water hyacinth in Lake Victoria is an just indicator of a “sick lake” undergoing eutrophication from pollution induced by man (Gopal, 1987).

2.3.2 Disruption on fishing and farming activities:

According to Ndimele *et al.*, (2011); Patel, (2012) the ability of the aquatic weed to reproduce rapidly affects socio-economic activities such as hampering fishing as the weed makes it difficult to access open areas, entangles boat propellers and clogs waterways.

Labrada *et al.*, (1996) slated that water hyacinth makes it difficult to transport goods and reduces fish catch on water bodies, and more fuel is consumed when water hyacinth infestation is high.

Twongo and Howard, (1998); Villamagna and Murphy (2010) observed on Lake Victoria, water hyacinth reduces fish stock for Tilapia and young Nile Perch by limiting access to breeding, nursing, and feeding grounds.

According to (ITDG, 1999) fishermen also find it difficult in carrying out fishing activities due to the presence of water hyacinth infestation.

According to National Academy of Sciences (1979) the Chinese grass carp is a fast growing fish which eats aquatic plants. It grows at a tremendous rate and reach sizes of up to 32kg. It is 21 an edible fish with a tasty white meat. It will eat submerged or floating plants and also bank grasses. Water hyacinth has also been used indirectly to feed fish.

Gopal (1987) reported that dehydrated water hyacinth has been added to the diet of channel catfish fingerlings to increase their growth.

2.3.3 Impact on agricultural plants:

Mailu (2001) reported that water hyacinth infestation on Lake Victoria blocks irrigation canals. The aquatic weed blocks irrigation channel and reduces the flow of water by 40% to 95%, which in turn affects and obstruct the amount of water reduced in crop fields (Jones, 2009).

Gopal (1987) indicates that water hyacinth interferes with both the irrigation and crop growth, causing heavy losses in crops such as rice.

According to Mironga (2005) in Lake Naivasha, it was observed that water pipes that get water out of the lake into the farms around the lake regularly get choked by water hyacinth mats. This is common during the rainy season, when the weed spreads all over the shore of the lake. 70.9% of the farmers interviewed reported to have suffered from such blockages quite often.

McVea and Boyd (1975) slated that it also interferes with seed germination and seedling establishment in paddy fields. The outer extracts of fresh and decaying leaves and rhizomes of water hyacinth have been reported to indicate phytotoxicity which inhibits germination and seedling growth.

Desougi and Obeid (1978) reported that water hyacinth also displaces large volumes of water in the reservoirs. The remained buoyant and suspended organic matter just below the mat may result into disappearance of water body through gradual siltation. Population of marine plants and other wild animals are reduced.

2.3.4 Impacts on hydro-power:

ITDG (1999) reported that water hyacinth causes high water losses through evapotranspiration and blocking turbines. The Owen Falls hydropower scheme on Lake Victoria has suffered the impact of the weed, hence plenty of time and money has been invested to clear and prevent the weed from entering the turbines, which may cause damage and power interruptions.

According to Labrada *et al.*, (1996) on Owen Fall's hydropower scheme, the water hyacinth caused damage to water coolers and generators, prompting the power utility company to switch off generators for maintenance, and about 15 Megawatts of electricity were lost causing power cut in an urban area of Uganda.

2.3.5 Spread the infestation of pests and vectors:

According to Minakawa *et al.*, (2008) the mat for water hyacinth maintains organisms that can cause harm to human health. Water hyacinth slows moving water, and increases breeding grounds for the malaria causing anopheles mosquitoes and Lake Kariba is a victim of this.

Chandra *et al.*, (2006); Varshney *et al.*, (2008) reported that the weed acts as a breeding ground for *Mansonioides* mosquitoes, the vectors of human *lymphatic filariasis* causing nematode Brugia.

Borokini and Babalola (2012) observed that vectors for the parasite of *Schistosomiasis* (Bilharzia) such as snails are found in the thick mat, while dangerous snakes habit in the weed mat.

2.3.6 Decreasing water quality and oxygen quantity:

Villamagna and Murphy (2010) reported that water hyacinth limits oxygen diffusion between air and water surface, and decrease oxygen supply by plants.

According to EEA (2012) during decomposition at the bottom of the water body, the weed takes up oxygen and depletes it.

Patel, (2012); Mironga *et al.*, (2011); Ndimele *et al.*, (2011) reported that reduced dissolved oxygen concentration in the water body can negatively affect fish that cannot adapt to new environment, while dead and decayed water hyacinth can deteriorate water quality, and this may increase the cost of treatment for drinking water.

Ndimele *et al.*, (2011) observed that about 75% of Zambians live in poverty, increasing the treatment of potable water entails increase in the water supply price. This will disadvantage the majority of Zambians as they will be unable to afford high price of water. Decrease in water quality has health risks for those who directly depend of the water from the Kafubu River. The main livelihood for the local people who live along the River is fishing and farming; the depletion of dissolved oxygen will reduce fish stock thereby affecting peopl's livelihood and directly increase poverty.

2.3.7 Impact on Biodiversity:

According to Pyšek and Richardson (2010); Vila *et al.*, (2011) biological alien invasions are one of the driving forces of biodiversity loss around the world.

Khanna *et al.*, (2011); Gichuki *et al.*, (2012) reported that water hyacinth has caused serious ecological loss of freshwater water bodies.

According to Patel (2012) the weed out-competes the indigenous species due to its rapid reproductive ability, which poses a threat to aquatic biodiversity.

Gichuki *et al.*, (2012); Villamagna and Murphy (2010) described that due to its colonization, the water hyacinth also prevents the growth of vital phytoplankton, and ultimately affects fisheries and other vital aquatic animals.

2.4 Possible assessment and utilization of water hyacinth:

The Integrated Regional Information Networks IRIN Kenya (2007) says; despite its adverse effects, the water hyacinth has, however, led to the flourishing of other fish species better adapted to less oxygenated water, including cat fish and lung fish. The weed also provides a “closed season”, preventing over-fishing in

the bays it clogs up, allowing for the regeneration of the lake's fish stock as some species hide within the hyacinth.

According to Maine (2006) the plant has high capacity of uptaking heavy metals, such as Cd, Cr, Co, Ni, Pb and Hg etc, which could be utilized for the biocleaning of industrial wastewater.

Ebel (2007) said that not only uptaking the heavy metals, *Eichhornia crassipes* can also remove toxins, such as cyanide, a process which is environmentally beneficial in areas that have endured gold mining operations.

Despite all these benefits, Julien (2001) stresses that these uses seldom develop into sustainable activities and that the cost of water hyacinth to communities far outweighs any benefits derived through utilisation. Therefore, control measures to curb water hyacinth proliferation are important.

According to Lindsey and Hirt (1999) in settlements where water hyacinth has destroyed economy (fishing and river transport) population can reorient to manufacturing of art paper, crafts, ropes, furniture and other things from water hyacinth which will positively influence to reduction of unemployment and increase of income.

Ndimele *et al.* (2011), Patel (2012) reported that as a readily available resource, water hyacinth has been used in several small cottage industries in the Philippines, Indonesia and India for paper, rope, basket, mats, shoes, sandals, bags, wallets, vases, etc.

According to Haider (1989) the House and Building Research Institute in Dhaka has carried out experimental work on the production of fibre boards from water hyacinth fibre and other indigenous materials. Chopped water hyacinth stalks are reduced by boiling and then washed and beaten. The pulp is bleached and mixed with waste paper pulp and a filter agent such as china clay and the pH is balanced. The boards are floated in a vat on water and then finished in a hand press and hung to dry. The physical properties of the board are sufficiently good for use on indoor partition walls and ceilings.

2.5 Control and management of water hyacinth:

2.5.1 Biological control

Chikwenhere & Phiri (1999) indicated that dramatic successes with biological control using weevils, *Neochetina eichhorniae* and *N. bruchi*, have been reported from other parts of Africa and elsewhere in the world, most notably at Lake Chivero, Zimbabwe; Lake Victoria, Kenya (Ochiel *et al.*, 1999); Louisiana, USA (Goyer & Stark, 1984) and Benin (de Groot *et al.*, 2003). Work towards biological control of water hyacinth in Tanzania was started in May 1995 when 418 water hyacinth weevils (*Neochetina eichhorniae* and *N.bruchi*) were imported from Benin into Tanzania and mass-reared at Kibaha National Biological Control Centre (Ndunguru *et al.*, 2001). *Neochetina* weevils were released into Lake Victoria for the first time during 1997 and were followed by subsequent releases covering all the weed-infested bays, gulfs, ponds and satellite lakes Weevil release (Mallya 1999). Observations after 2000 indicated that extents of water hyacinth were less (100 to 200 ha) than those observed in the late 1990s.

2.5.2 Physical and mechanical control:

Julien (2001) reported that historically, physical removal of water hyacinth has been the most widely used form of water hyacinth control. Poor rural communities resort to removal by hand pulling - an extremely labor intensive process and thus largely ineffective for very large weed infestations. Physical removal is useful only on small infestations and in situations such as ports or hydroelectricity plants where high monetary costs can be justified.

Mailu (2001) observed that communities around Lake Victoria practice manual removal in such areas as fish-landing beaches, ports and piers, irrigation canals and water supply points and sources.

According to LVEMP (1999) in Tanzania, communities and non-government organizations are constantly involved in identifying and clearing infested sites. Hand tools and protective gear worth 14.5 million Tanzanian shillings

(US\$20,000) has been provided to the community by the government to enhance manual removal work.

2.5.3 Chemical control:

Labrada *et al.*, (1996) indicates this method uses herbicides such as 2, 4-d, Diquat and Glyphosate to control water hyacinth. It is ideal for small infestation areas not big areas.

ITDG (1999) reported that application is done either on the ground or air with skilled operators. The method has environmental and health concerns as herbicides can be harmful, especially sources used for drinking and washing.

Apart from the three control methods, Harley *et al.* (1997) suggested that if the amount of nutrients entering any water body is decreased, this automatically reduces the infestation and growth of the water hyacinth.

2.5.4 Integrated control:

Cilliers (2003) argues that to sustainably manage and control the spread of the alien species, an integrated control approach is required, where chemical, mechanical and biological controls are used together. Different control methods supplement each other and where possible have an additive effect.

2.5.5 Water hyacinth management through possible practical applications:

Although the water hyacinth has been labelled as a problematic weed in many parts of the world, the plant contains than 95% water content has a fibrous tissue with high energy and protein contents. Therefore, the weed can be used for different applications, which include:

2.5.5.1 Paper

Tacio (2009) reported that water hyacinth fibre blended with waste paper can be used to produce good paper. For example, Bangladesh, Philippines, India and Indonesia have been experimenting with paper production from the water hyacinth and successfully produced paper.

2.5.5.2 Biogas production:

According to Ojeifo *et al.*, (2013) water hyacinth fibre can be converted into biogas where, organic matter of water hyacinth is used to produce methane gas

by anaerobic digestion which can be used directly for energy such as electricity for cooking and lighting in homes.

2.5.5.3 Basket work:

Intermediate Technology Development Group (1999) reported that the weed can be used to make baskets and mats for domestic use and subsistence market such as crafts for tourists. For example, in the Philippines and India water hyacinth is used to make baskets by local people.

2.5.5.4 Purification:

According to Vidya and Girish (2014) water hyacinth has the ability to trap pathogens. This makes it suitable to be used to purify drinking water in treatment plants. Water hyacinth can be used to treat sewage as it can absorb metals such as copper, mercury and lead (Land Development Department, undated).

2.5.5.5 Animal fodder and fertilizers:

Ojeifo *et al.*, (2013) have shown that water hyacinth has nutrients and potential as animal feed. Vidya and Girish (2014) reported that the organic matter from the weed can be used as fertilizer and provides nutrients essential to crop growth. According to ITDG (1999) in China and Malaysia, the water hyacinth is used as pig, duck and fish feed while mixed vegetable waste, salt and rice bran.

CHAPTER III

MATERIALS AND METHOD

3.1 Research Design

This study conducted the descriptive design having both qualitative and quantitative data. To determine the current status of a population, the experiment of collecting data from that population is considered as a survey (Mugenda and Mugenda 1999). This design was occupied to the study as it simplifies the narration of the characteristics and also show the relation between the positive and negative impact of water hyacinth and its sustainable management on the livelihood of the communities in the study area. According to Best and Khan (1993), descriptive study describe 'what is' and is concerned with conditions or relationship that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing. Descriptive studies are planned to obtain relevant and appropriate information concerning the status of the occurrence and whenever possible to draw indisputable general conclusion from the facts that discovered. Therefore the design directed the study in seeking to find out the impact of water hyacinth and their sustainable management on the economic activities of the communities around the study area.

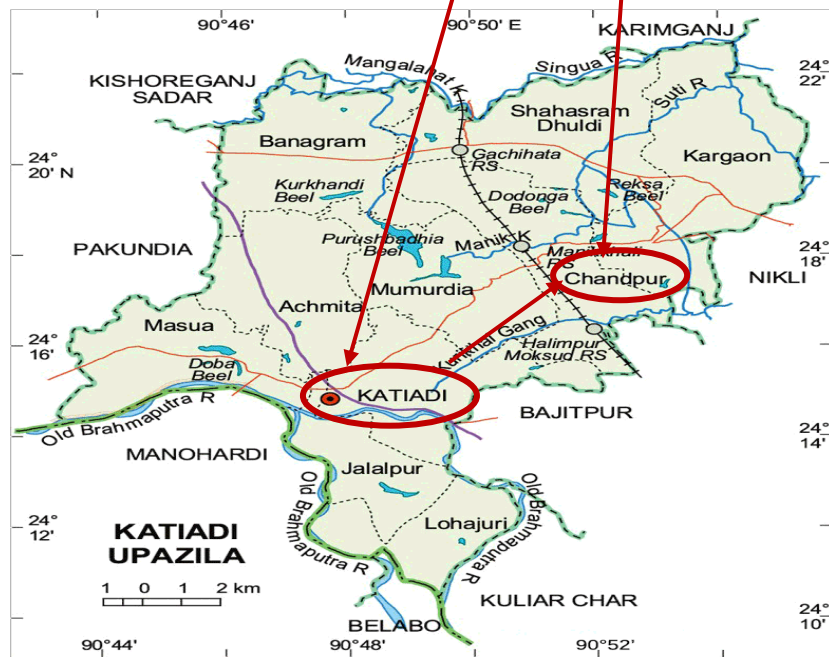
3.2 Location of the study area

This study was conducted in three villages of Chandpur Union of Katiadi upazila of Kishoregonj district. The district kishoregonj include an area of 2731.21 sq km, located in between 24°02' and 24°39' north latitudes and in between 90°35' and 91°15' east longitudes. The total area of katiadi upazila is 219.22 sq km. which is located between 24°10' and 24°22' north latitudes and in between 90°43' and 90°55' east longitudes. There are 10 union in Katiadi upazila and Chandpur is one of them. The total area of Chandpur is about 6152 acre. The study area is situated in Chandpur union and the name of three villages of the study area are Sheker para, Purbo para and Modinas para. (Source- Banglapedia)



(a)

(b)



(c)

Plate 1: Step wise location of study area where (a) Bangladesh (b) Kishoregonj District (c) Katiadi Upazila and Chandpur Union

3.3 Selection of the study area

The selection of the Roa beel is based on the facts that, it is near to our village home and it is well-known to our Upazilla, there are 3 village around the beel having vast of agricultural land also, this area is situated near to the main road of Manikkhali bazar from where it is easy to communicate with Upazilla, Katiadi. In rainy season there can be seen huge amount of water hyacinth in that water body that definitely affect the livelihood nearer to the beel through hampering their agricultural activities, fish farming, navigation and so on. On the other hand water hyacinth is also using in different ways by the localities of the area.

3.4 Target population

Target population can be defined as that population to which a researcher wants to generalize the results of the study (Mugenda and Mugenda 1999). According to Singleton (1993), the ideal arrangement of research study is one that directly satisfies the researcher's interest and should be accessible to the researcher. The target population of the study comprised all the household of the three village nearer to the Roa beel namely Sheikh para, Mojider para and Purbo para whose are situated in Chandpur Union of Katiadi Upazilla. According to 2011 census there are 280 male and 314 female with a total of 594 population in Sheker para, 1723 male and 1805 female with a total of 3528 population in Purbo para and 598 male and 644 female with a total of 1242 population in Modinas para. (Sources-BBS 2011) The target population of the study included all the household of three villages having around 943 households. A list of these households are provided by the Chandpur Union parishad. These can be considered as a sampling frame from which a representative sample was selected for the study.

3.5 Economic activities

People having different habitants have been living in the study area for years. Among them almost 70% people of that area are associated with agricultural activities coupled with livestock keeping. There are also others professionals like labours, rickshaw pullers, fishermen, businessman, Govt. and private job

holders, doctors, teachers etc. About 8-10% people deals with fishing seasonally mainly at rainy season.

About 98% of the fishing activities takes place in Roa beel at rainy season. Main species found in the beel are Taki, Puti, Boyal, Magur etc. that are popularly consumed in that areas. Water hyacinth proliferation causes problems like blockage in case of navigation, fish collection in the daily activities of those fisherman.

An idea of using these water hyacinth into processed nutritious fish feed create interest among the people of that area. If it is possible, then excessive water hyacinth can be used and controlled without causing any negative impact on environment and peoples of that area will be benefited also.

3.6 Sample size and frame

A sample size can be defined as a definite plan that is ascertained before data is actually collected for obtaining a sample from a given population. (Orodho 2005) The sampling frame of this study included three villages alongside of the Roa beel which is situated in Chandpur Union of Katiadi Upazilla of Kishoregonj District. This villages were listed from the North end of the beel to the South side. The three villages are- Sheikh para, Purbo para and Mojider para having around 943 households

Three villages were sampled or selected for representatives according to some criteria-

1. These three villages are situated alongside the Roa beel.
2. These three villages are mostly affected by the excessive water hyacinth during the monsoon period.
3. Potential use of water hyacinth in economic activity of locality is possible.

3.7 Sampling procedure

By sorting some part of a totality on the basis of which a conclusion or decision is made from that totality is known as sampling. In other words, it is a process

by which inquiry are made from a part of an entire population and obtain information or result from that population (Kothari, 2004).

From the starting point, cluster sampling were adopted where the study area were clustered into 3 location according to 3 villages namely Sheker para, Purbo para and Modinas para. All the three locations were alongside the Roa beel where excessive water hyacinth were found in monsoon period. Cluster sampling is most appropriate where there is an attempt to study characteristics in their natural settings or to ensure geographic representation of intact groups whose distinct characteristics are of interest in a research. The next step included the selection of study subjects that is done through simple random sampling to ensure that each number of the population had an equal and independent chances of being selected. Random list of number that coincided to the number of households represented in the locations were generated. Then the participating households picked at random from each list.

3.8 Data collection

3.8.1 Data Sources

Both primary and secondary data were collected and used in this study.

3.8.1.1 Primary Data

The primary data were collected on the basis of direct field data, survey questionnaire and key informants of the field. This portion included the general knowledge of community about water hyacinth, their origin, nature and their impacts on environment, socio-economic condition, demographic distribution etc. It also included information on the indigenous management of excessive water hyacinth and is there any introduced modern techniques were involved or not.

3.8.1.2 Secondary Data

The secondary data were collected from reviews of other findings on problem related to water hyacinth and their sustainable management, other Govt. and NGO's publications, different journals, internet etc.

3.8.2 Questionnaire

A questionnaire is a method of gathering information from respondents. For the purpose of this study, a questionnaire was designed to gather information about the identification of uses and problems related to excessive water hyacinth in daily life, how it is hampering our environment, solutions by which the problems can be solved through their sustainable use that must be environmental friendly etc. The order in which the questions were asked, was also carefully considered to avoid influencing the participant's answers to subsequent questions. The time required to complete the questionnaire was kept as short as possible to avoid fatigue of the participant which could lead to invalid and unreliable data. A number of open-ended questions were asked to allow participants to give their own answers. The questionnaire was compiled in English, and translated into Bangla to enable participants to answer questions in their first language.



(a)



(b)



(c)



(d)

Plate 2: Above pictures (a), (b), (c) and (d) showing data collection from the respondents by using questionnaire.

3.9 Data analysis Technique

After collecting data all interviewed, questionnaires were checked for its completeness, correctness. Both qualitative and quantitative data were collected in the field. Questionnaires were coded by the researcher and information obtained through the questionnaire was analysed by Microsoft Excel Worksheet. Both open-ended and close-ended data were analysed through this program. These data were collected based on the respondent's general information including name, age, gender, educational qualification, marital status, family size and so on. Moreover data were taken on the basis of the respondent's knowledge on water hyacinth, fishing activities, household activities, farming activities and water hyacinth based business initiatives. These themes or points were counted and then entered into the computer for analysis.

CHAPTER IV

RESULT AND DISCUSSION

The result of the study has been discussed and presented in this chapter. The experiment was conducted to check the response of the people about water hyacinth, their positive and negative reviews and overall use of excessive water hyacinth that should be environment friendly and will help to progress in socio-economic condition of the people living nearer the water hyacinth affected areas.

4.1 General Information

4.1.1 Gender and Age Distribution

In general, in this study, more respondents who were interviewed through questionnaire were found male. Highest number of male found in Purbo para while the lowest number noted in Modinas para. Extra 5 male were interviewed whose were involved in fertilizer and animal feed related business. On the other hand, highest number of female found in Modinas para and lowest in Purbo para. In case of the age distribution of the respondents we divide it in 4 ranges as 20-30 years, 30-40 years, 40-50 years and >50 years. Highest number of respondents found having age range of 30-40 years and lowest number found in the range of >50 years in Sheker para.

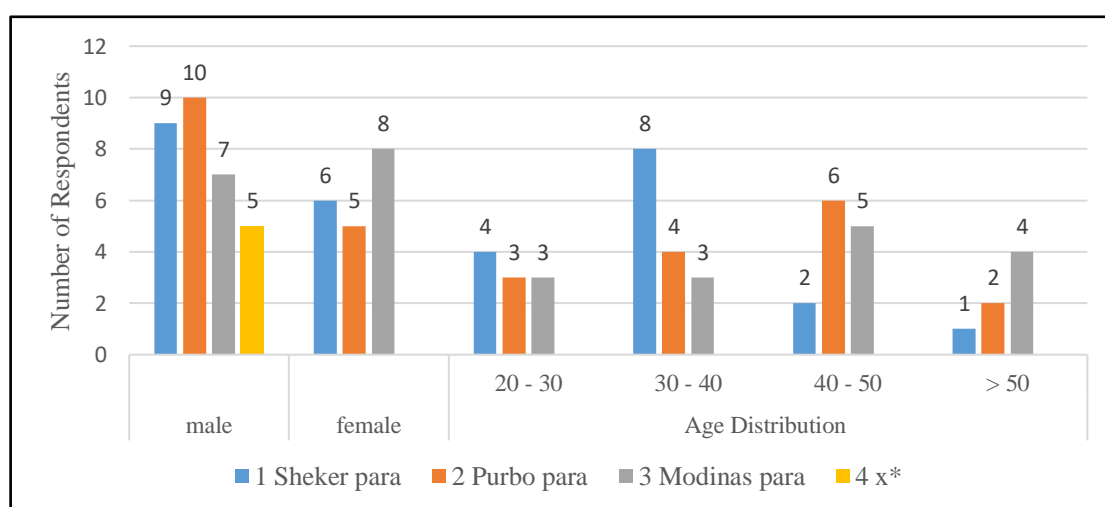


Figure-1: Gender and age distribution of the respondents in study area
X*→ Extra 5 male interviewer

4.1.2 Educational Qualification and Marital Status of Respondents

Educational qualification of the respondents have been divided into four categories for example- can sign only, primary, secondary and above secondary. According to the information gathered by the questionnaire, highest number of respondents found who can sign only in Modinas para and lowest in Purbo para. Again highest number of respondents found with primary level educational qualification in Purbo para and lowest in Modinas para. Respondent with secondary educational qualification found highest in both Sheker para and Modinas para and lowest in Purbo para. Meanwhile respondents with above secondary qualification have found highest in Purbo para and Modinas para where lowest in Sheker para.

Marital status of the respondents also divided in four categories as single, married, divorced and widow. Information collected by using questionnaire indicate that most of the respondents were married where highest number found in Modinas para and lowest found in Purbo para. Then majority found having single marital status where highest in Purbo para and lowest in Modinas para. There found no respondents having divorced marital status but a little number found having widow marital status highest in Purbo para and lowest in both Sheker para and Modinas para.

Extra 5 male were interviewed whose were involved in fertilizer and animal feed related business having highest in above secondary educational level and married in marital status and lowest found having secondary educational qualification and single marital status.

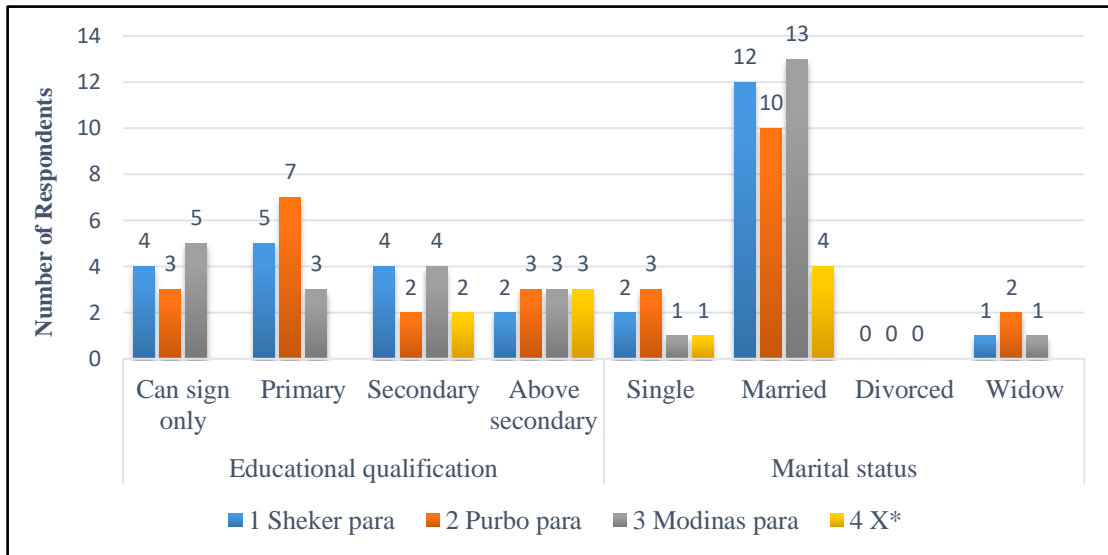


Figure-2: Educational qualification & marital status of respondents

X* → Extra 5 male interviewer

4.1.3 Family Size and Earning Member of Respondents

Here family size was counted in numbers and divided it in two range as 1-4 and >4. According to the information most of the family found >4 members where highest was in Modinas para and lowest in Purbo para. Comparably there were lower number in family size having 1-4 members but here lowest was in Modinas para and highest was in Purbo para.

Again earning member of those family was counted in to range for example 1 earning member in a family and > 1 earning member in a family. According to the information, most of the family found having only 1 earning member per family where highest was in Purbo para and lowest was in Modinas para. And there was a little number of family having >1 earning members where highest was in Modinas Para and lowest was in Purbo para.

Extra 5 male interviewee found having highest in the >4 family size range and 1 earning member. Again lowest in the 1-4 family size range and >2 earning members.

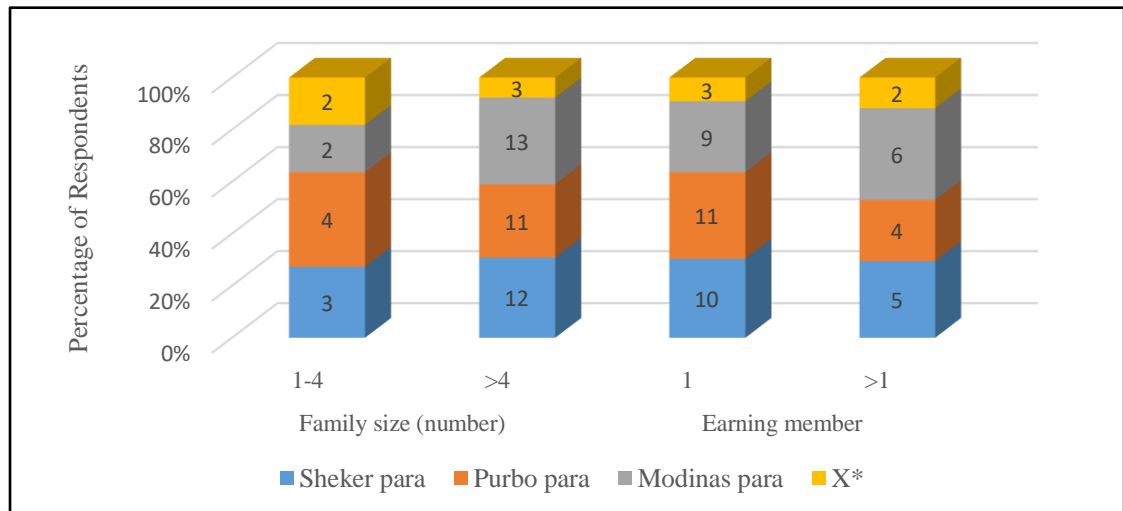


Figure-3: Family size & earning members of the respondent's family

X* → Extra 5 male interviewer

4.1.4 Occupation of the respondents

Different type of people having different profession or occupation living in those three villages nearer the Roa beel. From upper class to lower class people lived here for example doctors, engineers, teachers, rickshaw-pullers, labors, fishermen, farmers, businessmen and so on.

To know about the occupation of the respondents, it was divided into five categories for example farmer, fishermen, businessman, labor and others. After sorting out the information of the questionnaire it is found that there were equal number of fishermen in each village. Most of the respondents were farmer where highest number found in Purbo para and lowest was in Modinas para. In case of business profession there were highest in Modinas para and lowest in both Sheker para and Purbo para. Again in labor profession there were highest in Sheker para and lowest was in both Purbo and Modinas para. There were a little number of other professional people out there.

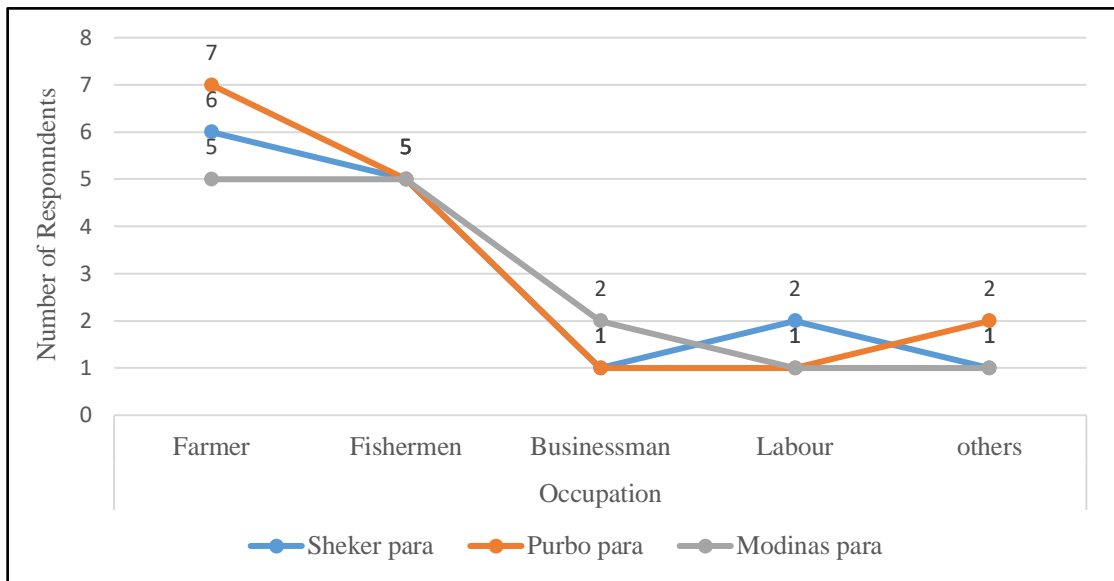


Figure-4: Occupation of the respondents

4.1.5 Duration of Business

Most people of the study areas were involved in their profession or business for a long period of time. Many of them got their profession or business from their family practices. Mainly most of the farmers, fishermen, labors were followed their family profession. Again many people were aware of education and change their fate into higher profession.

According to the questionnaire, duration of business are categorized in five ranges as <2 years, 2-4 years, 5-7 years, 8-10 years and >10 years. In comparison of the respondents from the three study areas, most of the respondents were involved in their business activities for more than 10 years where highest respondents found in Purbo para and lowest was in Modinas para. Thereafter highest respondents found in the range of 8-10 years and lowest respondents found in <2 years.

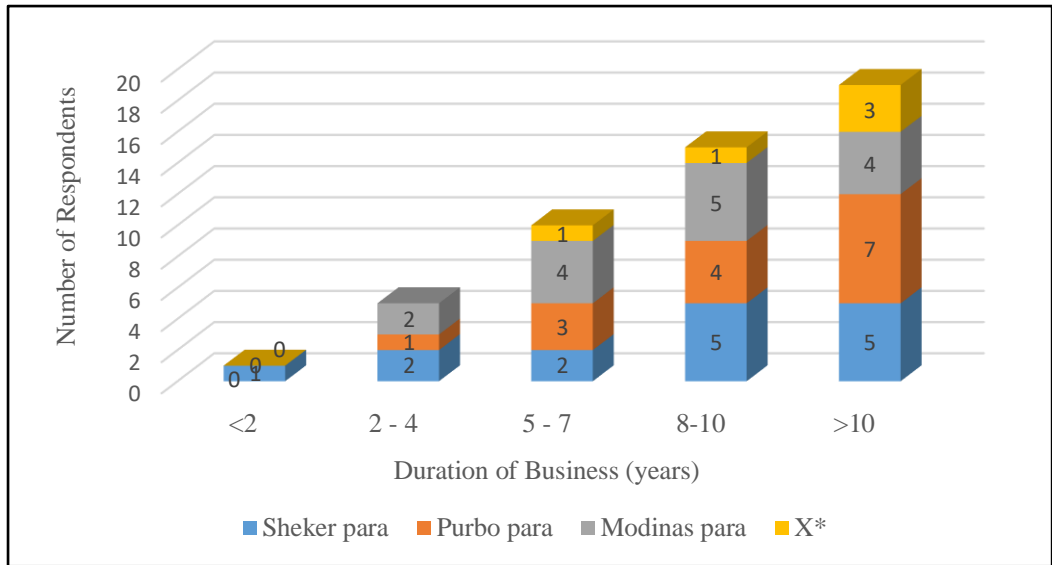


Figure-5: Duration of the respondent’s business involvement

X*→ Extra 5 male interviewer

4.2 Respondents knowledge on water hyacinth

4.2.1 General Knowledge and Growing Area of Water Hyacinth

Generally the survey indicate that all the respondents of the three study areas were acquainted with water hyacinth and its nature in their village. And also aware about the growing area where water hyacinth grow most in their villages. According to the respondent’s opinion, water hyacinth mostly grows in beel in their villages.

According to MONSANTO (1996) it is widely reported that water hyacinth is indigenous to Brazil having been first described from wild plants collected from the Fransico River in 1824. But in our findings, we found all the respondents indicating Roa beel as the growing area in their villages.

Table-1: Respondent’s general knowledge on water hyacinth and it’s growing area

SL	Village	General knowledge		Growing area			
		Yes	No	Ponds	Beels	Lakes	River
1	Sheker para	15	0	0	15	0	0
2	Purbo para	15	0	0	15	0	0
3	Modinas para	15	0	0	15	0	0
4	X*	5	0	0	5	0	0

X*→ Extra 5 male interviewer

4.2.2 Duration of Water Hyacinth Existence and Water Hyacinth Proliferation Season

There were some variation among the respondent’s perception on the water hyacinth existence. It had been divided in 5 ranges like 0-5 years, 6-10 years, 11-15 years, 16-20 years and more than 20 years. Most of the respondents said that water hyacinth exist in their village from more than 20 years, they were watching this aquatic plant since they grew up and some of them added that it existed in their village before their grandfathers ages. Here highest number of respondents gave their response in more than 20 years range in Modinas para and lowest in Sheker para. Successively from higher to lower response found in 16-20 years, 11-15 years, 6-10 years ranges and no one’s response found in 0-5 years ranges.

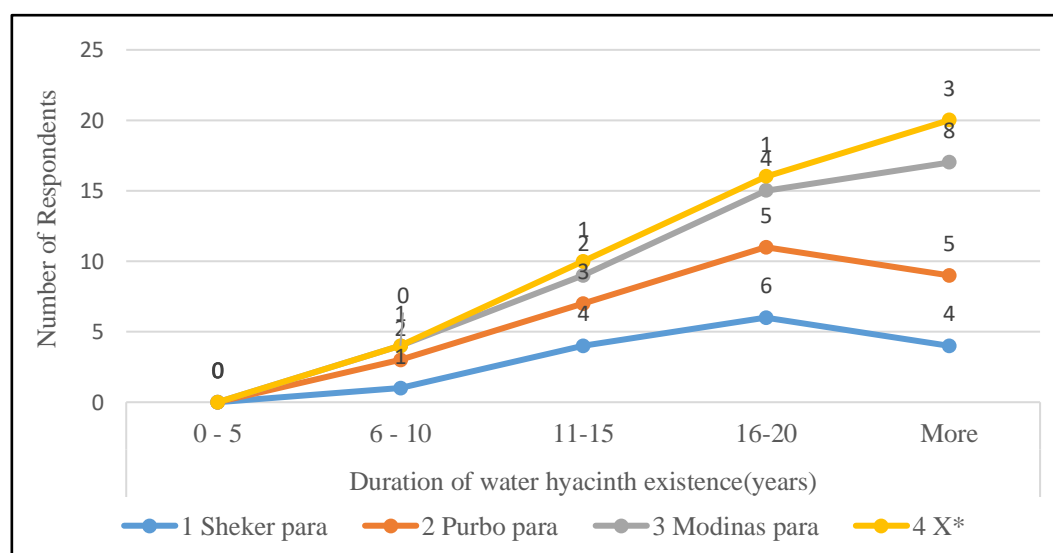


Figure-6: Duration of Water Hyacinth Existence. X*→ Extra 5 male interviewer

Again, to know the water hyacinth proliferation season, it was divided into three season for example dry season, rainy season and winter season. All of the respondents gave their opinion as water hyacinth extensively grown in rainy season. Clear perceptions of water hyacinth proliferation by the respondents in all the three villages, indicated that they had long and permanently stayed in their areas.

Extra 5 interviewee also gave their response mostly in more than 20 years and all of them agreed as rainy season is the season where water hyacinth extend most.

All the respondents participated in this interview program said that water hyacinth mostly found in rainy season in their areas as in rainy season water logging condition creates because of heavy rainfall.

Table-2: Water Hyacinth Proliferation Season

SL	Village	Water hyacinth proliferation season		
		Dry season	Rainy season	Winter season
1	Sheker para	0	15	0
2	Purbo para	0	15	0
3	Modinas para	0	15	0
4	X*	0	5	0

X*→ Extra 5 male interviewer

4.2.3 Advantage of Water Hyacinth

Respondents gave their opinion whether there is any advantages of water hyacinth or not. To get the information, it was divided in two answer as yes or

no. All the respondents including extra 5 interviewee agreed to yes option that means everyone replied that water hyacinth have advantages.

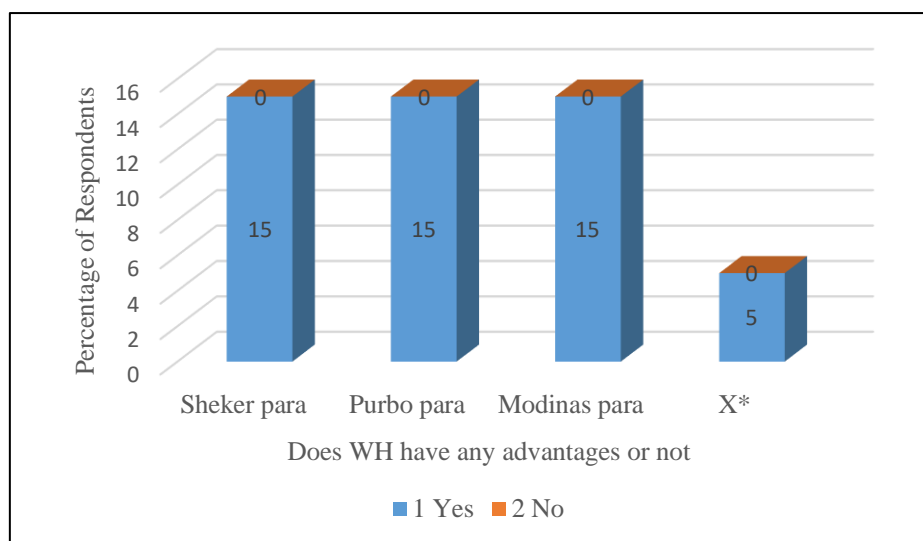


Figure-7: Whether there is any advantage of water hyacinth or not

X* → Extra 5 male interviewer

In addition, respondents were asked to give their views on the possible uses of water hyacinth in their area. All of them gave their own views and opinions but after sorting their views and opinions we found that majority of the respondents said water hyacinth use as mainly fuel in their villages. They also added some more uses for example manure, mulching materials, animal feed and fish feed consequently. Again a very few respondents said about the use water hyacinth as floating seedbed preparation.

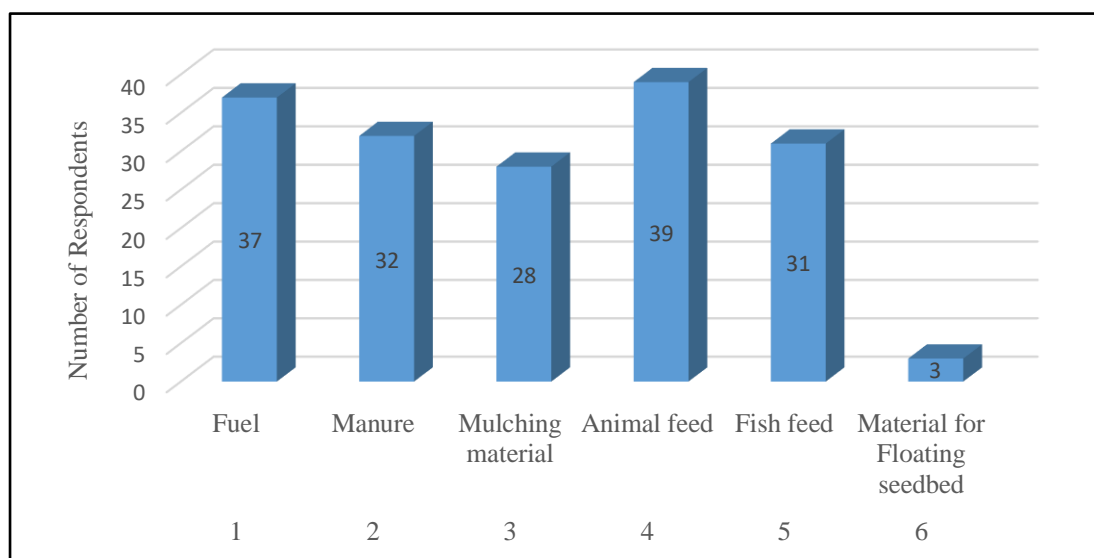


Figure-8: Advantages of Water Hyacinth

We found several uses of water hyacinth in our study areas where 39 respondents said the use of water hyacinth as animal feed.

Water hyacinth is popularly using as fuel and mulching materials in the study areas. People of those areas collect water hyacinth and dried under sunlight and keep these making heap and use these as fuel. They also use these dry water hyacinth as mulching material for other crops like potato and tomato.



Plate-3: Use of water hyacinth as mulching material and fuel

4.2.4 Disadvantage of Water Hyacinth

Respondents were also asked about their perceptions if at all there is any disadvantage of water hyacinth to them. Answer were again divided as two option like yes or no. Majority came up with the answer yes where highest response in yes option found in Sheker para and lowest was in Purbo para including extra 5 interviewee. A few had given no answer where highest negative option was chosen by the respondents of Purbo para and lowest in Sheker para.

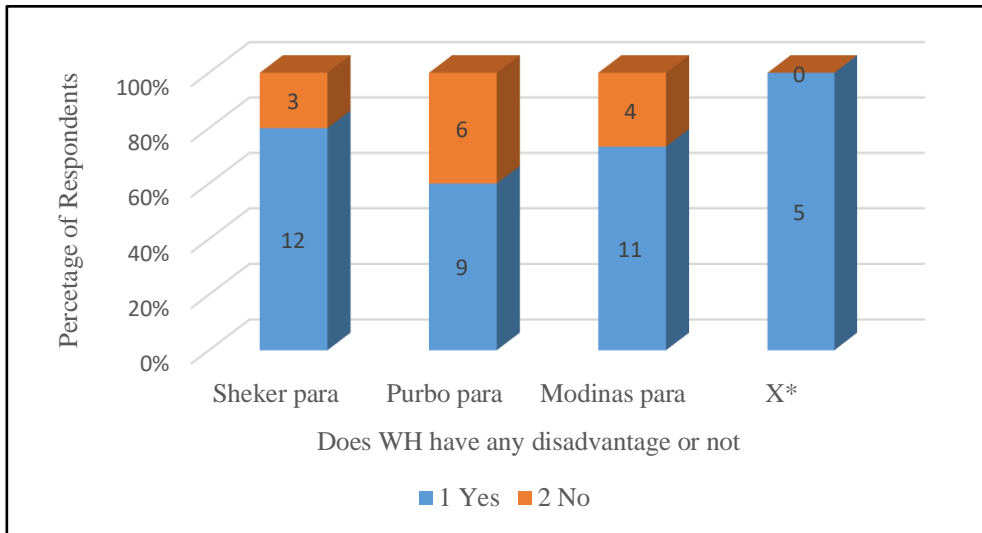


Figure-9: Whether there is any disadvantage of water hyacinth or not

X* → Extra 5 male interviewer

Respondents perceived water hyacinth as a problematic plant with invasive characteristics. The majority of them perceived it as an obstacle to their different socio-economic activities such as create problems in crop and fish production. They also added water transport or navigation problems, difficulties in catching fish and a few said about water pollution because of water hyacinth consequently.

We found several disadvantages of water hyacinth in our study areas where 36 respondents said that water hyacinth create problems in crop and fish production which found as a major problem in those areas.

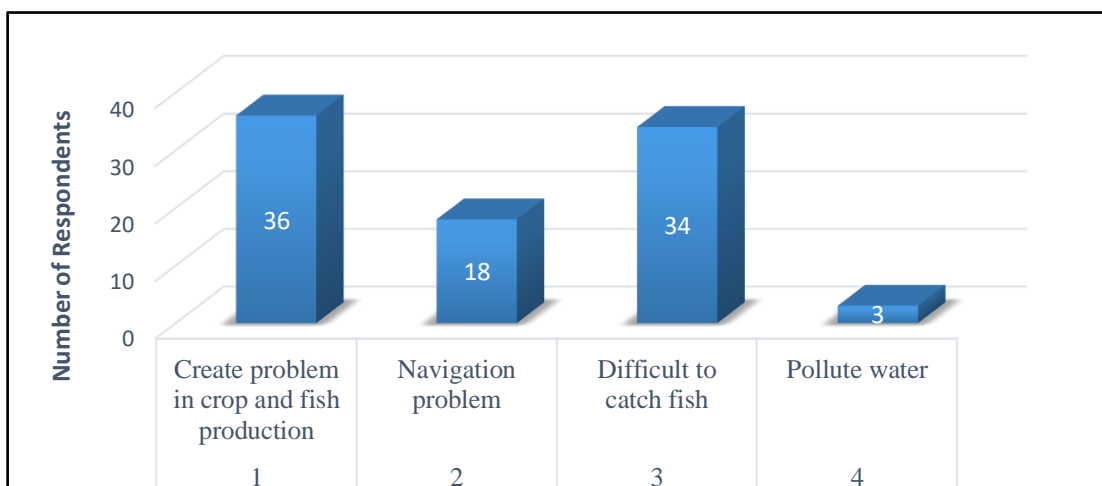


Figure-10: Disadvantages of water hyacinth

4.2.5 Management System of Water Hyacinth

To know about the management system of water hyacinth in study areas, it is divided into two options for example indigenous method and modern method of water hyacinth management. All the respondents including extra 5 interviewees selected the option of indigenous method while none of the respondents had any idea about modern technology. They also added that water hyacinth is mostly managed in their villages by using bamboo sticks and ropes, even some of them indicated about the use of small hand net for the management of water hyacinth in their areas.

Table-3: Management of water hyacinth in the study areas

SL	Village	Management system of water hyacinth	
		Indigenous system	Modern system
1	Sheker para	15	0
2	Purbo para	15	0
3	Modinas para	15	0
4	X*	5	0

X* → Extra 5 male interviewer

Although this local peoples' knowledge may be inexact and qualitative, it is however valuable because it is based on observations over long periods of time. The combination of scientific and local monitoring methods can make partnership with ecologists, researchers and build a community unanimity. According to The Ramsar Convention Bureau (1999), local inhabitants' ecological knowledge can make significant contributions to wetland management strategies, especially when blended with the best science.

4.3 Water hyacinth and fishing activities

4.3.1 Water Hyacinth Affecting Fishing Activities

This section was interviewed only for respondents of the occupation with fishermen. Equal number of respondents of fishermen were selected in each

villages that were surveyed. Respondents perceived water hyacinth as an obstacle which affect fishing activities in many ways. All the fishermen were agreed in one point that is water hyacinth create a huge problem in catching fish. That means it is hard to catch fish when there are excessive amount of water hyacinth in the Roa beel. Then majority indicated that excessive present of water hyacinth create navigation problems in their areas and decrease fish production in Roa beel and also in other water bodies. A few respondents hinted that excessive water hyacinth decrease oxygen and light under the water and also pollute water of the Roa beel.

According to Ndimele *et al.* (2011), Patel (2012) and Labrada *et al.* (1996) water hyacinth creates problems in fishing activities and also clog water. In our finding we also found 15 fishermen saying water hyacinth hampers them in fish catching and 14 fishermen said that these water hyacinth creates navigation problems.

Villamagna and Murphy (2010) reported that water hyacinth limits oxygen diffusion between air and water surface, and decrease oxygen supply by plants. In our study we found a fewer respondents saying water hyacinth decrease oxygen and light under water which affect fish growth and quality.

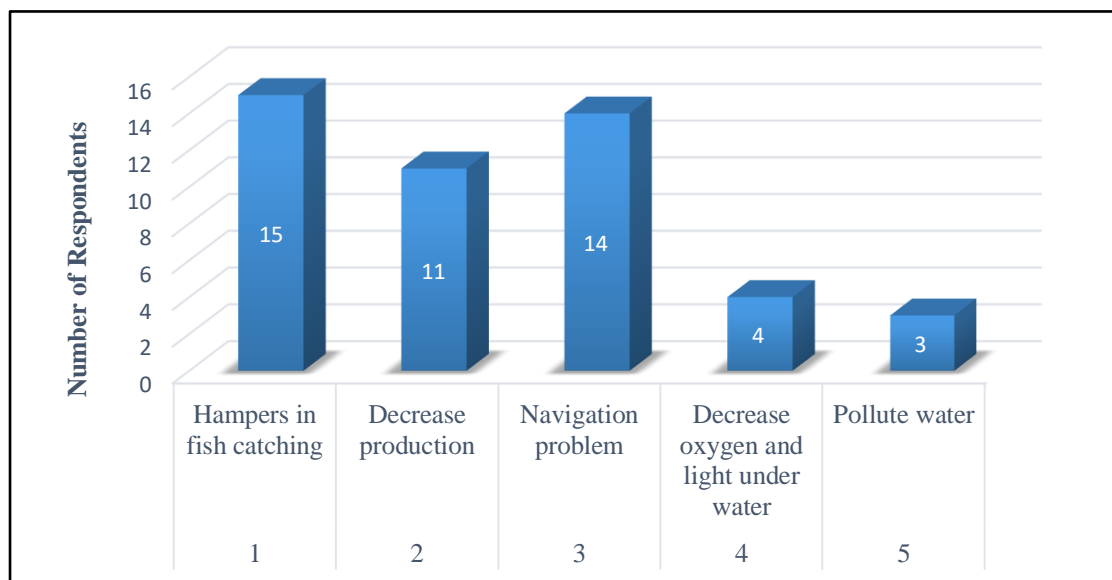


Figure-11: How water hyacinth affect fishing activities

4.3.2 Effect of Water Hyacinth in Fish Quantity and Impact on Fish Price

To know the information whether water hyacinth have any effect in fish growth or fish quantity, this portion was divided into two answer as yes or no. Majority of the respondent gave positive answer where number found in Modinas para and lowest in Sheker para. Comparably a lesser number gave negative answer where maximum negative answer found in Sheker para and minimum in Modinas para.

Again, to know whether water hyacinth have any impact on fish price or not, it was divided into yes or no answer. Here majority came up with the negative option where highest number was found in Modinas para and lowest was in Purbo para. Comparably a lesser number gave the positive answer where maximum found in Purbo para and there was none found in Modinas para.

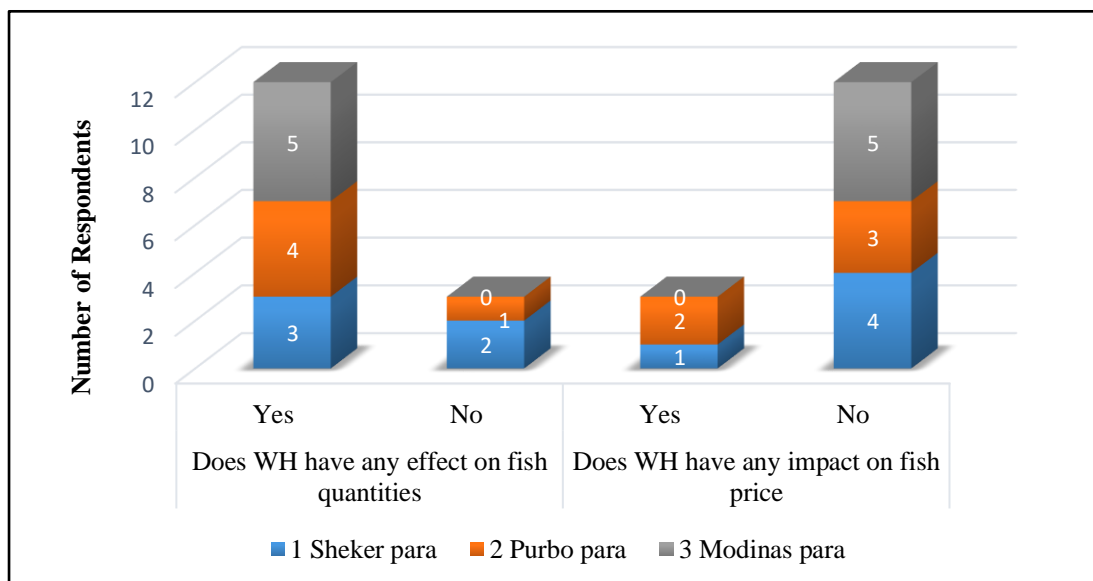


Figure-12: Effect of water hyacinth in fish quantity and its impact on fish price

4.3.3 Use of Water Hyacinth as Fish Feed and Respondent's Interest in Using Nutritious Fish Feed Made by Water Hyacinth

According to the questionnaire, there were two option yes or no that given to the respondents to know whether water hyacinth use as fish feed in their area or not.

All of the respondents came up with the positive option that water hyacinth use as fish feed in their area.

Table-4: Use of water hyacinth as fish feed in study area

SL	Villages	Does WH used as fish feed in your area?	
		Yes	No
1	Sheker para	5	0
2	Purbo para	5	0
3	Modinas para	5	0

Again respondents views were taken if nutritious fish feed made by water hyacinth will they use it or not by giving yes or no option. All the respondents came up with positive option, there was none with negative option. They had shown their highest interest about use of nutritious fish feed made by water hyacinth.

Table-5: Respondent's Interest in Using Nutritious Fish Feed Made by Water Hyacinth

SL	Villages	If Nutritious fish feed made of WH, will you use it?	
		Yes	No
1	Sheker para	5	0
2	Purbo para	5	0
3	Modinas para	5	0

According to Hasan *et al.* (2009a), in simple production system, water hyacinth is used as a potential component for farm mixed feed for omnivorous and herbivorous freshwater fish and also it is available in low cost. Many research has been conducted to investigate the use of water hyacinth as fish feeding.

In our findings we found most of the respondents know about the use of water hyacinth as fish feed. They mainly use water hyacinth's fresh leaves for cows and goats.

4.4 Water Hyacinth and Livestock Activities

4.4.1 Respondents Involvement in Livestock and Poultry Rearing

To know the respondents involvement in livestock and poultry rearing there were four categories as cattle, poultry, both and none. Majority of the respondents having poultry like duck, chicken, pigeon etc. in their house where maximum number found in Sheker para and minimum in Modinas para. After that, maximum respondent having cattle as cow, goat, sheep etc. in their house where highest number found in Sheker para and lowest in Modinas para. Many respondent have both cattle and poultry while some of them have none of these two. Maximum number of respondents having both cattle and poultry found in Purbo para and minimum found in Sheker para. Again maximum respondents having none of them found in Modinas para and minimum in both Sheker para and Purbo para.

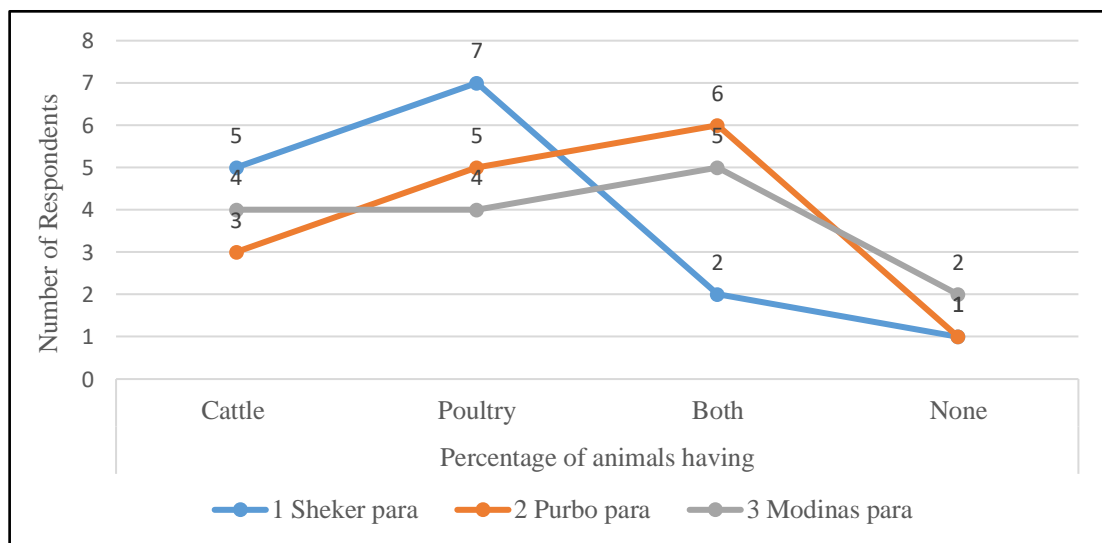


Figure-13: Respondents Involvement in Livestock and Poultry Rearing

4.4.2 Use of Water Hyacinth as Animal Feed and Main Problem related to Animal Feed

Water hyacinth is a popular animal feed in many areas. To know whether water hyacinth used as animal feed in those study areas or not, we gave them two option

as yes or no. Most of the respondents gave positive answer where highest number of respondents found in Purbo para and lowest in Modinas para. There were some respondents with negative answer too where maximum negative answer found in Modinas para and minimum in Purbo para.

To know about the main problems related to water hyacinth as animal in those areas, we have divided it in four categories as high price, low price, available and not available. Most of the respondents indicated in high price where highest respondent number found in Modinas para and lowest in Sheker para and a little found in not available problem where maximum respondents found in Sheker para and minimum in Modinas para but there were none found indicating low price or available options. That means in those study areas, price of animal feed is very high and also not so available.

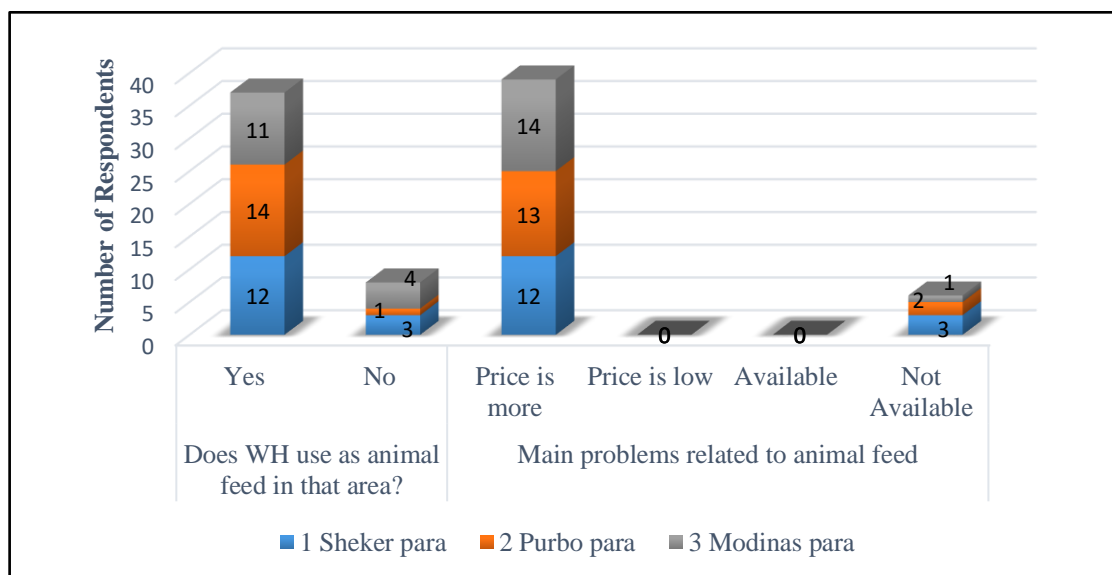


Figure-14: Use of Water Hyacinth as Animal Feed and Main Problem related to Animal Feed

4.4.3 Checking the Interest of Respondents in Using Low Cost Livestock and Poultry Feed Prepared by Using Water Hyacinth

Highly nutritious and low cost poultry feed also can be prepared from water hyacinth. Water hyacinth can also be used fresh, ensiled or wilted to animals.

Whole plants, chopped or ground can be used as feedstuffs for both livestock and poultry sectors. To know about the response of the respondents if low cost livestock and poultry feed are produced from water hyacinth, will they use these on their livestock or poultry feeding or not, we gave them again two options of yes and no. In this case, majority had given positive answers where full response was found in Purbo para and minimum response was found in Sheker para. And a very few respondents gave negative answers because they didn't have any interest in this issue and they have better financial conditions than others, here maximum negative response was found in Sheker para and minimum in Modinas para but there were no negative responses from the respondents of Purbo para at this point.

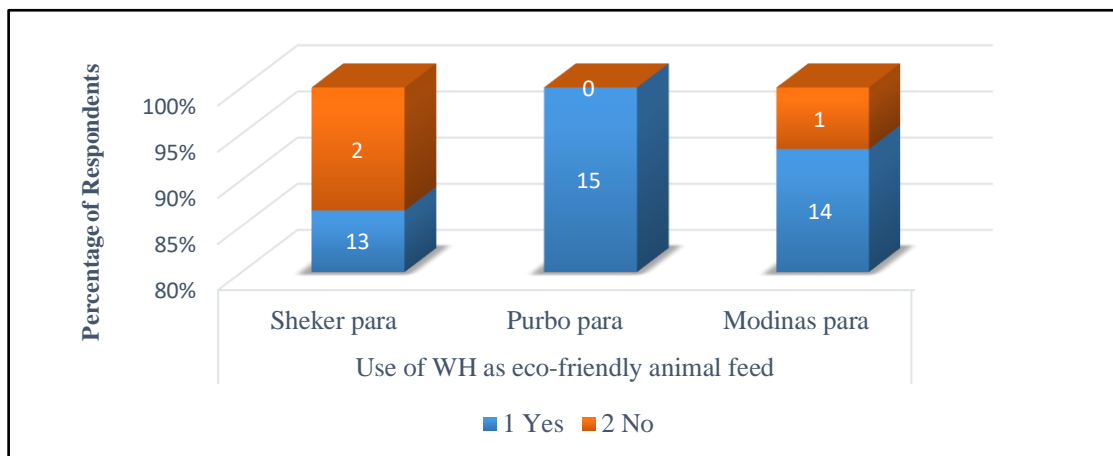


Figure-15: Checking the Interest of Respondents in Using Low Cost Livestock and Poultry Feed Prepared by Using Water Hyacinth

4.4.4 Water Hyacinth can be a Potential and Promising Sector on Agricultural Activities

In an ambition to establish the influence of water hyacinth on agricultural activities around the beel region, respondents were asked several questions about their interest and knowledge of use of excessive water hyacinth in their area and make vast portions of the unusable part of water hyacinth as resources related to agricultural activities around the beel.

We tried to check, if Govt. body or any private organization provide them water hyacinth based machine through which they can produce nutritious livestock and poultry feed easily, whether they are interested to take it and use it or not. In this case we gave them three option of yes, no and not sure. Major portion of the respondent showed their interest in this service where all the respondent came up with positive reaction in Purbo para, then found highest positive reaction in Modinas para and then in Sheker para. Comparably a very few respondents were found with negative reaction and some of them confused to take the service because of a little knowledge and some had no interest because of their high financial support.

Table-6: Respondents interest on taking water hyacinth based machine to prepare animal feed

SL	Villages	If Govt./others provide WH based machine to prepare animal feed, will you take it to use		
		Yes	No	Not sure
1	Sheker para	13	1	1
2	Purbo para	15	0	0
3	Modinas para	14	1	0

Again to know the opinion of the respondents about the fact that- this animal feeds are highly demandable and by using this machine, the price of animal feeds will become affordable and cheaper, we gave them again three option of yes, no and not sure. Majority gave positive reaction where maximum number equally found in both Purbo para and Modinas para, minimum number found in Sheker para. In this case none of the respondents found with direct negative reaction but some of them were confused because of lack of proper knowledge or other problems.

Table-7: Conception of respondents on getting affordable & cheaper animal feed by using water hyacinth based machine

SL	Villages	If yes, Animal feed will be affordable & cheaper, agree?		
		Yes	No	Not sure
1	Sheker para	12	0	3
2	Purbo para	14	0	1
3	Modinas para	14	0	1

If they were agreed with all the above opinions, then it can be an income generating opportunity for them and others too. To know about reaction of respondents on this point, we gave them again three option of yes, no and not sure. In this point all of the respondents gave positive reaction where none them found with any negative reaction or confusion.

Table-8: Conception of respondents on water hyacinth based machine can be an income generating activity

SL	Villages	It can be an income generating opportunity, agree?		
		Yes	No	Not sure
1	Sheker para	15	0	0
2	Purbo para	15	0	0
3	Modinas para	15	0	0

According to Mukherjee and Nandi *et al.* 2004, water hyacinth plays as a high energy source for ruminants as it contains high level of cellulose and hemicellulose. Highly nutritious and low cost poultry feed also can be produced from water hyacinth. Water hyacinth can be used fresh, ensiled or wilted to animals. Whole plants, chopped or ground can used as feedstuffs for both ruminants and poultry sector. In our study we all the respondent know about the use of water hyacinth as livestock and poultry feed and they are interested in using processed water hyacinth.

4.5 Water Hyacinth and Household Activities

4.5.1 Use of Water Hyacinth in Household Activities

To know whether water hyacinth use in household activities, we ask respondents question about it and gave them three option of yes, no and not sure. All most all the respondents gave positive reaction on this point and a very negligible respondents gave negative reaction.

Table-9: Perception of respondents on using water hyacinth in household activities

SL	Villages	Does WH use in household activities?		
		yes	no	not sure
1	Sheker para	15	0	0
2	Purbo para	15	0	0
3	Modinas para	14	1	0

In addition, respondents were asked to give their views on the possible uses of water hyacinth in their household activities where all of them gave their own views and opinions. By sorting their views and opinions, we found that majority of them responded by saying that water hyacinth was used mostly as fuel for their household activities. They also added that in off season they gather water hyacinth and dried them under sunlight and kept them in heap and later on used them as fuel when they needed. They also responded by saying water hyacinth used as animal feed like cow and turkey chicken in their house. A few respondents said that water hyacinth helps to maintain water retaining capacity of plants, thus they used them as mulching material in their homestead gardening areas.

In our study we found maximum 43 respondent saying the use of water hyacinth as fuel that means maximum people of the study area use water hyacinth as fuel.

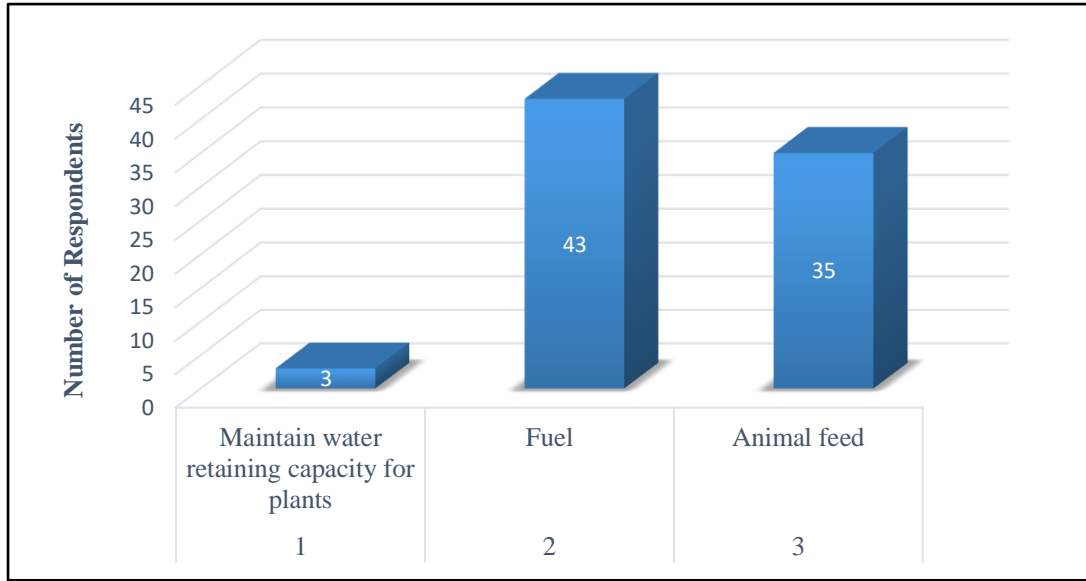


Figure-16: Uses of water hyacinth in household activities

4.5.2 Use of Water Hyacinth as Handicraft and Biogas

Nowadays excessive water hyacinth that were considered as waste material are using as resources in many sector. In many developing countries water hyacinth are used in making handicrafts like hand bags, baskets, mats, furniture, papers and many other things. To know whether water hyacinth is used as handicraft in the study area or not, we asked them question on it and gave them yes and no option to answer. Majority of them came up with negative reaction saying that they did not know about it. Very few respondents said that they had heard about it but it was not found in those areas.

Table-10: Conception of respondents on use of water hyacinth as handicraft

SL	Villages	Does WH use as handicraft?	
		yes	no
1	Sheker para	1	14
2	Purbo para	2	13
3	Modinas para	0	15

Respondents were also asked about their perceptions if low cost eco-friendly biogas prepared by using water hyacinth, would they use it in their daily household fire activities or not and gave them two option of yes and no. All most all of the respondents gave positive reaction by saying yes where a very negligible number of respondents did not show their interest in using it as biogas for their household.

Table-11: Respondents interest on using eco-friendly biogas prepared from water hyacinth

SL	Villages	If low cost eco-friendly biogas is prepared, will you use?	
		Yes	No
1	Sheker para	14	1
2	Purbo para	15	0
3	Modinas para	15	0

Again they were asked whether it would be beneficial for them or not. All of the respondents gave their positive reaction in this point.

Table-12: Conception of respondents whether biogas made by water hyacinth is beneficial or not

SL	Villages	It will be beneficial, agree?	
		Yes	No
1	Sheker para	15	0
2	Purbo para	15	0
3	Modinas para	15	0

4.5.3 Water Hyacinth can be a Potential for Household Activities

According to the report made by The Daily Star (2019), sustainability usually rely on socio-economic improvement and availability and consumption of energy. As a lavishly available source of biomass, the plant can be used as feedstock for local energy production as well as a resource input for many important products with environmental and socio-economic benefits. Biogas produced from water hyacinth is similar to that from cow dung. The easily biodegradable matter, particularly hemi-cellulose, is higher in water hyacinth than in cow dung.

To access the opinions of the respondents we asked question that- if Govt. body or any private organization provide them water hyacinth based biogas-plant through which they can produce biogas easily, would they take it to use it or not and gave them three option as yes, no and not sure. All most all of them agreed with positive reaction where a very rare number of respondents gave negative reaction.

Table-13: Respondents interest on taking water hyacinth based machine to prepare biogas

SL	Villages	If Govt. /others provide WH based machine to prepare biogas will you take it to use?		
		Yes	No	Not sure
1	Sheker para	14	0	1
2	Purbo para	15	0	0
3	Modinas para	15	0	0

Again we check the response of the respondents whether they were agreed to the idea or not that-biogas is highly demandable and also by using biogas-plant, the price of biogas will become affordable. All most all of the respondents from the three villages were agreed to this opinion where a very few were confused by saying not sure because of their lack of knowledge in this point.

Table-14: Conception of respondents on getting affordable & demandable biogas by using water hyacinth based machine

SL	Villages	If yes, biogas will be affordable & demandable, agree?		
		Yes	No	Not sure
1	Sheker para	13	0	2
2	Purbo para	14	0	1
3	Modinas para	14	0	1

If they were agreed with all the above opinions, then it can be an income generating opportunity for them and others too. To know about reaction of respondents on this point, we gave them again three option of yes, no and not sure. In this point all of the respondents gave positive reaction where none them found with any negative reaction or confusion.

Table-15: Conception of respondents on water hyacinth based machine that produce biogas can be an income generating activity

SL	Villages	It can be an income generating opportunity, agree?		
		Yes	No	Not sure
1	Sheker para	15	0	0
2	Purbo para	15	0	0
3	Modinas para	15	0	0

According to Ojeifo *et al.* (2013) water hyacinth fibre can be converted into biogas where, organic matter of water hyacinth is used to produce methane gas by anaerobic digestion which can be used directly for energy such as electricity for cooking and lighting in homes. In our study we all the respondent know about the use of water hyacinth as biogas and they are interested in using it as biogas from processed water hyacinth which maintain sustainability of environment and related income generating activities to improve their socio-economic condition as well.

4.6 Water Hyacinth and Farming Activities

4.6.1 Main Crops Grown in those Study Areas

It is also necessary to establish how the water hyacinth was used in the farm, and therefore the respondents were asked several questions. Respondents gave their opinion about the major crops grown in their villages. To get the information, we categorize the answer into five categories as cereals, pulses, oil seeds, vegetables and cash crops. Most of the respondents were associated with cereal production where highest number of respondents found equally in both Purbo para and Modinas para and lowest in Sheker para. Then consequently came from higher to lower production in vegetables, pulse crops, cash crops and then oil seeds. In our study area we found most of the farmer are involve in cereal production.

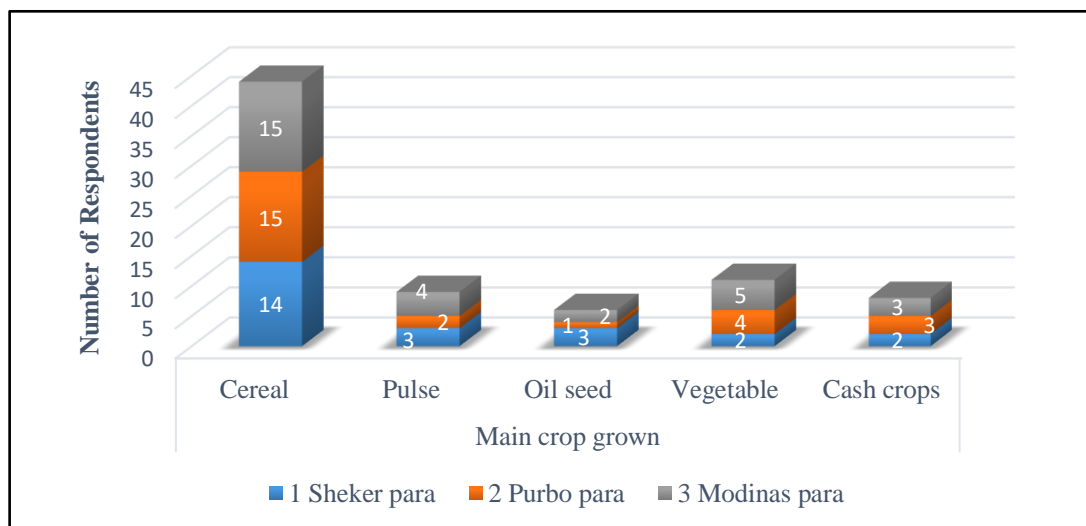


Figure-17: Response of Respondents on major crop grown in the study areas

4.6.2 Effect of Water Hyacinth on Water for Irrigation Purpose

According to Jones, (2009); Ndimele *et al.*, (2011); Patel (2012), water hyacinth laggards water flowing into irrigation channels and restricts access to water for irrigation, which may become reason for severe flooding. To know about the effect of water hyacinth on water for irrigation purpose we asked some question to the respondents whether the water of the beel used for irrigation purpose or not and gave them three options to answer as yes, no and not sure. All the

respondents from the three villages gave positive reaction by saying yes. That means water of that beel used for irrigation purpose.

Table-16: Respondents opinion whether water of the beel use for irrigation purpose or not

SL	Villages	Does the water of the beel use for irrigation purpose?		
		Yes	No	Not sure
1	Sheker para	15	0	0
2	Purbo para	15	0	0
3	Modinas para	15	0	0

Again we sought their response in whether there was any problem occurred in irrigation for water hyacinth or not and gave them three option of yes, no and not sure to answer. Majority of them agreed to this opinion by saying yes where highest respondent number found in Purbo para and lowest was in Modinas para. Then highest respondent found with negative reaction by saying no in Modinas para and lowest was in Purbo para. Other respondents were not sure about this fact because of lack of knowledge.

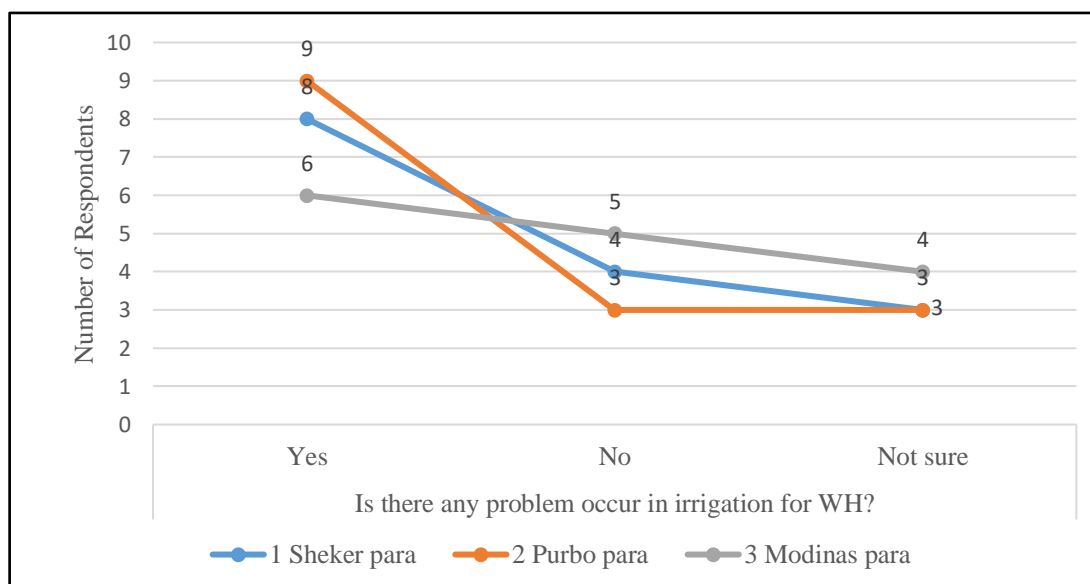


Figure- 18: Conception of the respondents on Effect of Water Hyacinth on Water for Irrigation Purpose

4.6.3 Water Hyacinth as a Prospect for Floating Agriculture

Some parts of Bangladesh are mostly affected by flood where water remains for a prolonged period of time. In those areas, farmers are using their submerged lands for crop production by adopting scientific methods which are similar to hydroponic agriculture practices, i.e. floating agriculture, whereby plants can be grown on the water in a bio-land or floating bed of water hyacinth, algae or other plant residues.

As water remain for a long time in the study area with excessive water hyacinth and to know about the information whether water hyacinth used in floating agricultural practices or not we asked them question on it and gave them two option of yes and no. Majority of the respondents came up with negative option by saying no, where highest number negative response found in Purbo para and lowest negative response was in Modinas para. Very few respondents agreed to the question by saying they had tried this several time to make rice seed bed production and highest number of positive reaction found in Modinas para and lowest was in Purbo para.

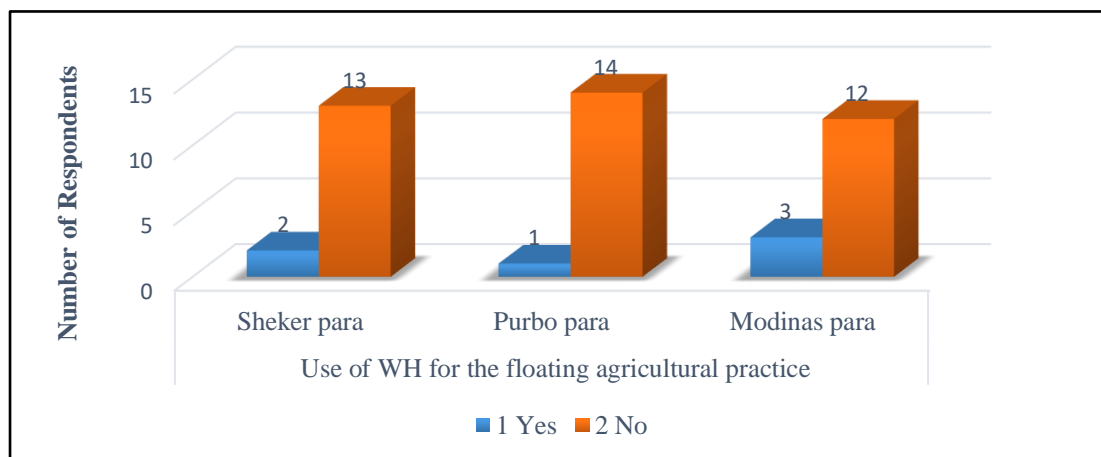


Figure-19: Conception of respondents on the prospect of water hyacinth as floating agriculture

To access the opinions of the respondents we asked question that-If they get training from Govt. or from other organization about floating agriculture practice, would they practice it in their nearest beel by using water hyacinth or

not and again gave them three option to answer as yes, no and not sure. All most all the respondents showed their interest by saying yes where all the respondents from Purbo para were highly interested and all most all of the respondents of other villages were also showed their interest in it. Only a very few respondents gave negative reaction and confusion because of their social status.

Table-17: Respondents interest on getting training about floating agriculture practice

SL	Villages	If Govt. /others give training on it, will you practice it?		
		Yes	No	Not sure
1	Sheker para	14	0	1
2	Purbo para	15	0	0
3	Modinas para	14	1	0

We know that Floating agriculture practice is mainly popular in low lying submerged areas or the areas which are mostly affected by flood. Although very few respondents in the study area are involve in this practice but it can be a potential method of water hyacinth management by utilizing these waste properly in production system by providing them necessary help and training.

4.6.4 Use of Water Hyacinth as Farm Input

It is essential to imbedded how the water hyacinth was used in the farm, and therefore the respondents were asked several questions. Whether water hyacinth used as a farm input or not- to know this information we offered them two option of yes and no, where most of the respondents gave response by saying yes and highest response found in Purbo para and lowest was in Modinas para. Very respondents gave negative answer where highest found in Modinas para and lowest was in Purbo para. They mainly use water hyacinth as manure, mulching material, animal feed etc.

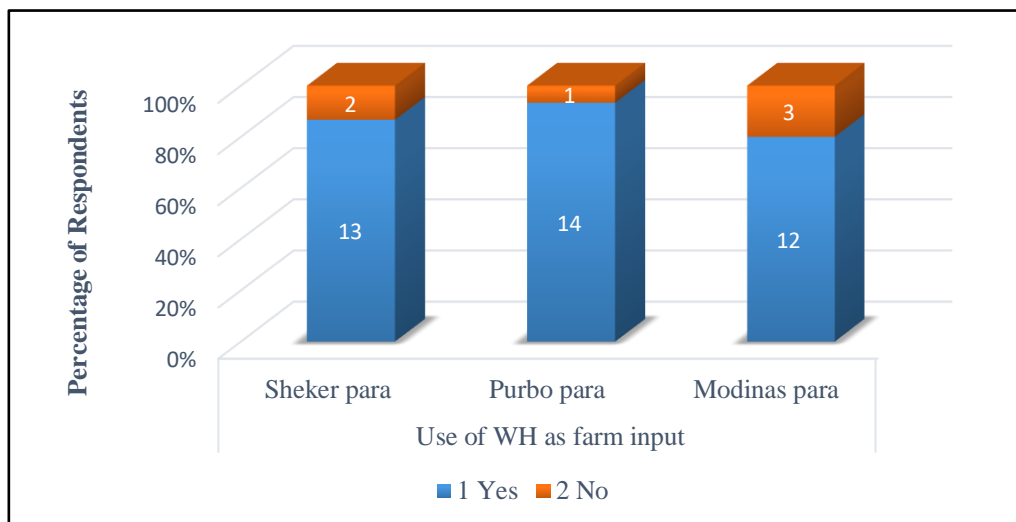


Figure-20: Conception of respondents on the Use of Water Hyacinth as Farm Input

We also sought information whether water hyacinth helps to increase or decrease organic matter content of soil or not and gave them three option of yes, no and not sure. All the respondents indicated in positive reaction by saying yes and none of the respondent found with negative reaction.

Table- 18: Conception of respondents on water hyacinth maintain OM content of soil

SL	Villages	WH maintain OM content of soil, agree?		
		Yes	No	Not sure
1	Sheker para	15	0	0
2	Purbo para	15	0	0
3	Modinas para	15	0	0

Respondents were also asked about their perceptions if low cost eco-friendly bio fertilizer prepared by using water hyacinth, would they use it in their farming activities or not and gave them three option of yes, no and not sure. All most all of the respondents gave positive reaction by saying yes where a very negligible number of respondents did not show their interest in using it as bio-fertilizer.

Table-19: Respondents interest on using eco-friendly bio-fertilizer prepared from water hyacinth

SL	Villages	If low cost eco-friendly bio-fertilizer is prepared, will you use?		
		Yes	No	Not sure
1	Sheker para	14	1	0
2	Purbo para	15	0	0
3	Modinas para	15	0	0

4.6.5 Water Hyacinth can be a Potential Sector in Farming Activities

Although water hyacinth is noxious weed having rapid proliferation rate, it is nowadays using as bio-fertilizer and other environmental friendly resources which will maintain the sustainability of the environment and also help to improve socio-economic condition.

To know the opinions of the respondents we asked question that- if Govt. body or any private organization provide them water hyacinth based compost-plant through which they can produce compost and bio-fertilizer easily, would they take it to use it or not and gave them three option as yes, no and not sure. All most all of them agreed with positive reaction where a very rare number of respondents gave negative reaction.

Table-20: Respondents interest on taking water hyacinth based machine to prepare bio-fertilizer

SL	Villages	If Govt. /others provide WH based machine to prepare bio-fertilizer, will you take it to use?		
		Yes	No	Not sure
1	Sheker para	14	0	1
2	Purbo para	15	0	0
3	Modinas para	15	0	0

Respondents were also asked about their perceptions if low cost eco-friendly bio-fertilizer prepared by using water hyacinth, would they use it in their farming activities or not and gave them three option of yes, no and not sure. All most all of the respondents gave positive reaction by saying yes where a very negligible number of respondents gave negative reaction with confusion by saying not sure.

Table-21: Conception of respondents on getting affordable & demandable bio-fertilizer by using water hyacinth based machine

SL	Villages	If yes, bio-fertilizer will be affordable & demandable, agree?		
		Yes	No	Not sure
1	Sheker para	13	0	2
2	Purbo para	14	0	1
3	Modinas para	14	0	1

If they were agreed with all the above opinions, then it can be an income generating opportunity for them and others too. To know about reaction of respondents on this point, we gave them again three option of yes, no and not sure. In this point all of the respondents gave positive reaction where none them found with any negative reaction or confusion.

Table-22: Conception of respondents on water hyacinth based machine that produce bio-fertilizer can be an income generating activity

SL	Villages	It can be an income generating opportunity, agree?		
		Yes	No	Not sure
1	Sheker para	15	0	0
2	Purbo para	15	0	0
3	Modinas para	15	0	0

According to Parker C.F and Sommers E.L *et al.* (1983), decomposed water hyacinth helps to increase the organic matter content of soil and also promote mineralization of nutrient. It helps to increase soil organic carbon, nitrogen, phosphorus, potassium thus increase crop yields. Most of the respondents from our study have known to the use of water hyacinth as bio-fertilizer which helps crop production in organic way and also maintain sustainability of environment. They are interested in using water hyacinth as bio-fertilizer and related income generating activities to improve their socio-economic condition as well.

4.7 Water Hyacinth and Business Initiatives

4.7.1 Use of Water Hyacinth for Industrial Purpose

Extra 5 male were interviewed whose were involved in fertilizer and animal feed related business. We asked the respondents whether water hyacinth can be as any kind of business purpose or not and gave them two option of yes and not sure. Here 60% of the respondents gave positive answer by saying yes while 40% gave negative answer saying not sure.

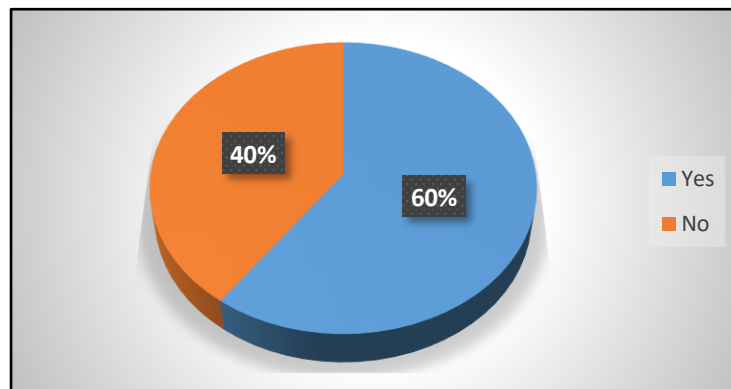


Figure-21: Percentage of respondents on whether water hyacinth can be used as industrial purpose or not

In addition, respondents were asked to give their views on the possible uses of water hyacinth in their area. All of them gave their own views and opinions but after sorting their views and opinions we found that majority of the respondents said water hyacinth can be used as manure or compost for industrial purpose.

Thereafter more response found by saying as fish feed and then as turkey chicken feed.

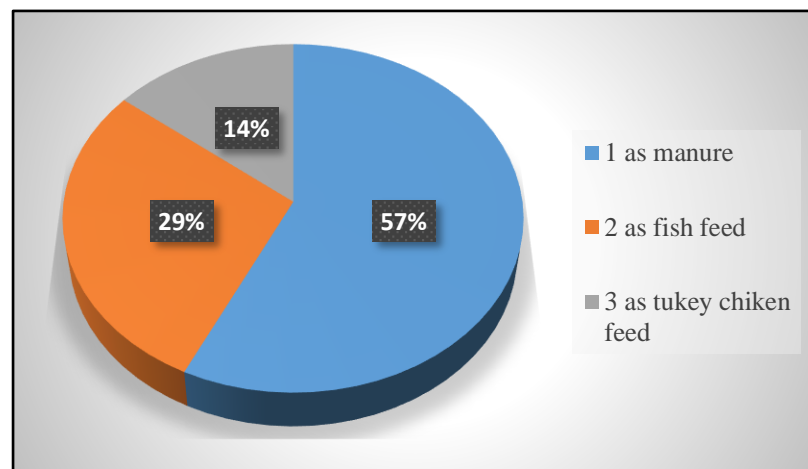


Figure-22: Use of water hyacinth for industrial purpose

4.7.2 Water Hyacinth can be a Potential and Promising Sector in Industrial Purpose

To know the interest of the respondents on water hyacinth based business, we asked them- if water hyacinth is used to prepare low cost eco-friendly livestock and poultry feed, would they use it for their business purpose or not. 80% of the respondents gave positive opinion by saying yes while 20% respondent gave negative response.

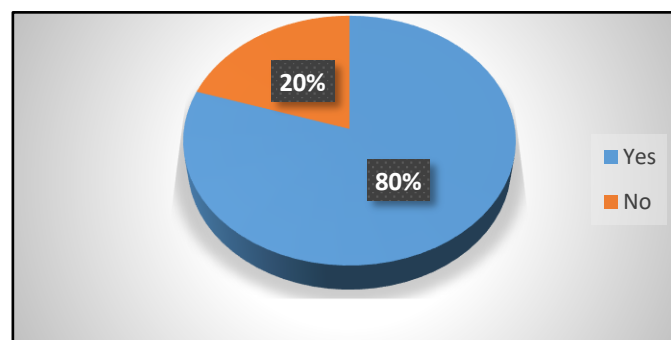


Figure- 23: Percentage of respondent's interest in animal feed made from water hyacinth related business

Respondents were also asked to express their opinion about-if biogas and bio-fertilizer (manure and compost) prepared from water hyacinth, it can be a

profitable business or not. Again 80% gave positive opinion by saying yes while 20% gave negative opinion.

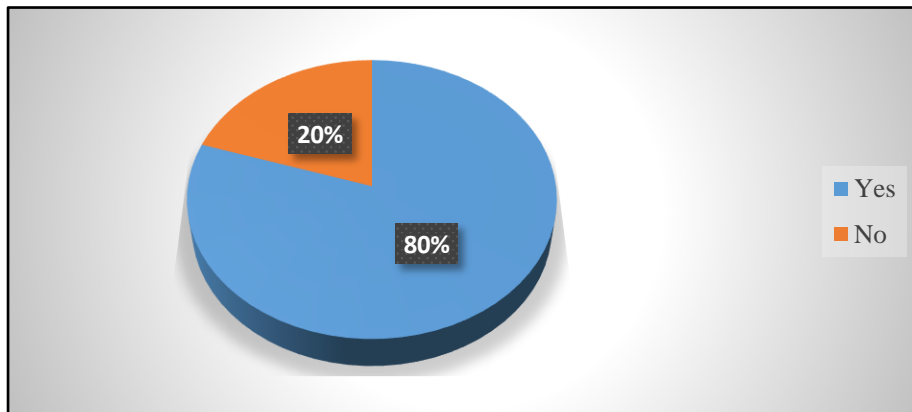


Figure-24: Percentage of respondent having interest on biogas and bio-fertilizer prepared by water hyacinth related business

Finally respondents were asked to know their clear perception whether they were interested in these kind of water hyacinth related business or not. Again 80% respondents gave positive view by saying yes and 20% respondents gave negative answer by saying no.

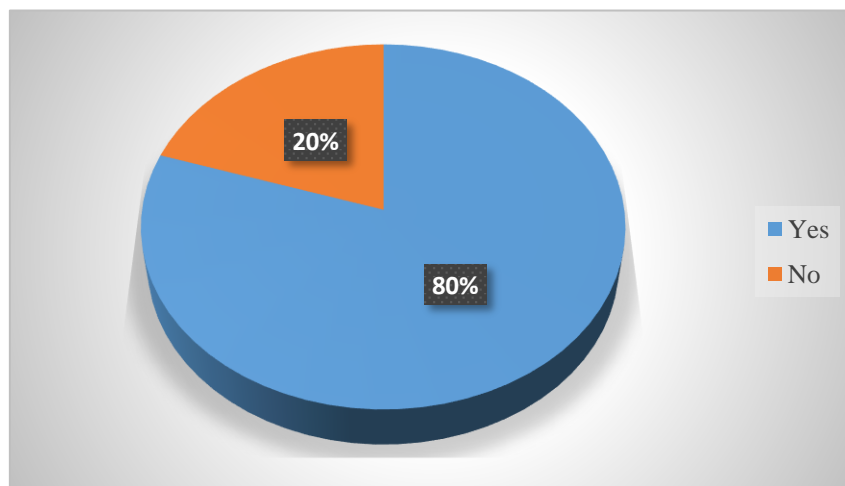


Figure-25: Percentage of respondent's interest on water hyacinth based business

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Local people have different perception on excessive water hyacinth on their local beel having many advantages and disadvantages. They unraveled their knowledge on the advantages and disadvantages of this obnoxious species.

The study revealed that communities living around the Roa beel were concerned about the proliferation season of this invasive weed and they use local method in their management. But they have no idea about any kind of modern technology in the management of these excessive water hyacinth.

The study established that the water hyacinth has a great impact on fishing activities on the beel. According to their opinion, they faced problem in fish catchability and cultivating, rowing boats but they had no idea about the impact of this weed on fish growth and fish price. But according to respondent's opinion, they are highly interested in floating agricultural practices if they are taught properly about this.

The study also showed local people's interest on using low cost eco-friendly and nutritious fish feed made by water hyacinth.

Nowadays water hyacinth is used to make different handicrafts like papers, baskets, bags, mats etc. but local people had a very little knowledge on it. The study also showed local people's interest on this discussible point.

According to this study we found a very little response on having knowledge about floating agricultural practices and noted their interest on it; if any kind Govt. /NGO give them training to learn and apply this practice, they would definitely apply this method and it would be an important and sustainable method in managing these excessive water hyacinth of those areas.

From the study findings we established that excessive amount of water hyacinth of the beel can be developed into a potential and promising sector for the locality especially by making water hyacinth into low cost and environmental friendly animal feed, bio-fertilizer and biogas; that will definitely help in sustainable environment management and will also create a better income generating opportunity for the local unemployed people. This study revealed local people's huge interest on these discussible subject.

Again the study expressed that excessive water hyacinth by which animal feed, bio-fertilizer and biogas can be made is also can be used for industrial purpose.

5.2 RECOMMENDATION

Local people does not have much knowledge on use of water hyacinth in floating agricultural practices and also in preparing bio-fertilizer, biogas and animal feed. There should be Govt. / NGO or any other organization's involvement to teach them about these facts and give them training and provide them necessary resources including technical and financial resources for macro level usage of water hyacinth. This will definitely help to our national economy by creating employment opportunities and also keep the environment calm without doing any kind of destruction.

CHAPTER VI

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APPENDIX: QUESTIONNAIRE

Section 1: General Information

1. Name of the Respondent-

Gender: Male Female

Present age:-

2. Educational qualification:-

- Can't read and write
- Can sign only
- Primary
- Secondary
- More.....

3. Marital status:

- Single
- Married
- Divorced
- Widow

4. Family size:

- a) How many members in your family.....
- b) Earning members.....

5. Occupation:

- Farmer
- Fishermen
- Businessmen
- Labours
- Others.....

6. How long have you been in this business?

- Less than 2 years
- 2-4 years
- 5-7 years
- 8-10 years
- More than 10 years

Section 2: Respondents knowledge on water hyacinth

1. Do you know water hyacinth plant?

- Yes No

2. If yes, where they grow more in your village?

- Ponds Beels Lakes River

3. Do you know how water hyacinth spread over the water bodies?

- Yes No Not sure

4. If yes, please mention

.....

5. When did you first notice water hyacinth on the lake?

Month..... Year.....

6. For how long have they been in your village area?

- 0-5 years
 6-10 years
 11-15 years
 16-20 years
 More.....

7. In which season do you think water hyacinth proliferation is more severe?

- Dry season
 Rainy season
 Winter season

8. Do you think water hyacinth have any advantages?

- Yes No

9. If yes, please mention

.....

10. Do you think water hyacinth have any disadvantage?

- Yes No

11. If yes, please mention

.....

12. What are the indigenous management system through which you manage excessive water hyacinth in your nearest swampy areas?

.....

13. Do you know any introduced modern management systems that are used to manage water hyacinth?

.....

.....

Section 3: Water hyacinth and fishing activities:

1. How does the water hyacinth affect your fishing activities on the river?

.....

2. In your own opinion, do you think water hyacinth has an effect on the fish quantities?

Yes

No

3. Do you think water hyacinth have impact on the increase or decrease of fish price?

Yes

No

4. Does water hyacinth used as fish feed in your area?

Yes

No

5. If water hyacinth is processed into nutritious fish feed, do you think it will be beneficial for fish farming or will you use it as fish feed?

Yes

No

Section 4: Water hyacinth and livestock activities:

1. Which animals are kept?

Cows

Goats

Chickens

Ducks

Others.....

2. What is the percentage/number of animals?
- Cattle
 - Poultry
3. Do you think water hyacinth have any effect on livestock and poultry farming?
- Yes No
4. If yes, please mention how does it affect?
-
-
5. Does it use as livestock and poultry feed in your area?
- Yes No
6. What are the main problems of livestock and poultry feed in your area?
- Price is more
 - Price is less
 - Availability is more
 - Availability is less
 - Not sure
7. If low cost eco-friendly livestock and poultry feed are prepared by using water hyacinth, will you use these for your livestock and poultry feeding?
- Yes No
8. (a). If Govt. body or any private organization provide you water hyacinth based machine through which you can produce nutritious livestock and poultry feed easily, will you take it to use it?
- Yes No Not sure
- (b). If yes, this animal feeds are highly demandable and by using this machine, the price of animal feeds will become affordable and cheaper, are you agree with these opinion?
- Yes No Not sure

(c). Do you think it can be an income generating opportunity for you and others too?

- Yes No Not sure

Section 5: Water hyacinth and household activities:

1. According to your opinion, do you think water hyacinth have any use on household activities?

- Yes No Not sure

2. If yes, how does it use in your household activities?

.....
.....

3. Do you know about the use of water hyacinth use as handicraft like hand bag, baskets, mats or other things?

- Yes No Not sure

4. If low cost eco-friendly biogas is prepared by using water hyacinth, will you use it for your daily household fire activities?

- Yes No

5. Do you think it will be beneficial for you and your family?

- Yes No

6. (a). If Govt. body or any private organization provide you water hyacinth based biogas-plant through which you can produce biogas easily, will you take it to use it?

- Yes No Not sure

(b). If yes, this biogas is highly demandable and also by using biogas-plant, the price of biogas will become affordable, are you agree with these idea?

- Yes No Not sure

(c). Do you think it can be an income generating opportunity for you and others too?

- Yes No Not sure

Section 6: Water hyacinth and farming activities:

1. What is the percentage of crop growing in your areas?

- Cereal crops
- Pulse crops
- Oil seeds
- Vegetables
- Cash crops

2. Because of water hyacinth is there any effect on the price or production of livestock and agricultural products?

- Yes No Not sure

3. Have you used water hyacinth for the floating agricultural practice?

- Yes No Not sure

4. If you get training from Govt. or from other organization about floating agriculture practice, will you practice it in your nearest beel when amount of water is less in the beel by using water hyacinth?

- Yes No Not sure

5. According to your opinion, does the water of the beel use for irrigation purpose?

- Yes No Not sure

6. Is there any problem occur in irrigation for water hyacinth?

- Yes No Not sure

(a). If yes, it can create problem by decreasing crop production (quantity based), are you agree with this opinion?

- Yes No Not sure

7. Is Water Hyacinth used as an input in the farm?

- Yes No

(a). If yes, how is it used?

- Manure
- Mulching
- Animal feed
- Not sure

(b). If yes, do you think water hyacinth helps to increase or decrease the organic matter content of soil?

- Yes No Not sure

8. If low cost eco-friendly bio-fertilizer like manure or compost are prepared by using water hyacinth, will you use these for your farming activities?

- Yes No

9. (a). If Govt. body or any private organization provide you water hyacinth based compost-plant through which you can produce compost easily, will you take it to use it?

- Yes No Not sure

(b). If yes, these composts are highly demandable and also by using compost-plant, the price of these products will become affordable, are you agree with these idea?

- Yes No Not sure

(c). Do you think it can be an income generating opportunity for you and others too?

- Yes No Not sure

Section 7: Water hyacinth and Business initiatives:

1. In your opinion, do you think water hyacinth can be used as any kind of industrial purpose?

- Yes No

2. If yes, please mention some

.....

3. If water hyacinth is used to prepare as low cost eco-friendly livestock and poultry feed will you use it for your business purpose?

- Yes No

4. Do you think biogas and bio-fertilizer (manure and compost) prepared from water hyacinth can be a profitable business?

- Yes No

5. Are you interested in these kind of business related to water hyacinth?

- Yes No

