Khulna University
Life Science School
Forestry and Wood Technology Discipline

Author(s): Md. Asadul Hasan

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Supervisor(s): Arifa Sharmin, Professor, Forestry and Wood Technology Discipline, Khulna University

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PRACTICE OF AQUASILVICULTURE AT SHYAMNAGAR UPAZILLA IN SATKHIRA DISTRICT

Md. Asadul Hasan

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Supervisor:

5.11.17

Arifa Sharmin
Professor
Forestry and Wood Technology Discipline
Khulna University
Khulna-9208
Bangladesh.

Prepared By:

5.11.17

Md. Asadul Hasan
Student ID: Ms-140513
Forestry and Wood Technology Discipline
Khulna University
Khulna-9208
Bangladesh.

DECLARATION

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Date: ৫.১১.১৮

Name of candidate: Md. Asadul Hasan

Dedicated To

MY BELOVED PARENTS AND MY WELL WISHER

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First of all, I am very grateful to my creator, almighty God, who always encourages me to move forward and to my beloved parents who had brought me into this earth thus become enabling to perform this thesis work and finally write up the outcome leading towards the fulfillment of my M.Sc. (Thesis work) in Forestry.Then, I would like to express my intentness to my respectable teacher and supervisor, **Arifa Sharmin, Professor**, Forestry and Wood Technology Discipline, Khulna University, for her permissions, sympathetic encouragement, overall supervision, valuable guidance, regular advices and constructive analysis during preparing this Thesis.

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To GOD ALMIGHTY are the glory, honor and power forever more.

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ABSTRACT

The livelihoods of a large number of farmers are associated with farming in fish farm (modified rice fields with high, board peripheral dikes) system in southeast Bangladesh. Most farmers integrated prawn with fish and rice in their fish farm and followed extensive methods using low inputs. This paper seeks to explore the status, benefits, management and problems adopting aquasilviculture at shyamnagar upazila management activities, understanding the impact on income and livelihoods, assessing awareness of integrated aquasilviculture-oriented activities that support forest conservation. In this study area 64% respondents are farmers including businessman, service holder, daily labor, fisherman, grocery shop owner who practice aquasilviculture. The respondents practiced aquasilviculture mainly for cash generation. They get timber, fuel wood, fruit, fodder and nutrition also. However, amazing point is that, most of the respondents have no knowledge about aquasilviculture but they have been doing it traditionally as a source of more profit. Respondents practice trees species for example neem, babla, rain tree, guava, goran, geowa, bine etc. About 48% respondents mostly prefer to plant fuel wood species. They practice catla, rui, mrigel, punti, silver crap, common carp, grass crap, tilapas, with most desired crustacean prawn, shrimp known as white gold for their high price.73% farmers are cultivate prawn and white fish during in a same time. They also extract timber, fuel, fruit, fodder and nutrition. Maximum farmers was very much agree to practice aquasilviculture. 54% people was agree and 27% people was strongly agree to practice aquasilviculture. The market demand of the products is well .78% respondents gave their positive opinion about market demand of the products. Although farmers have improved their social and economic conditions through aquasilviculture practice, constraints include high production costs, small land holding, lack of capital, massive morality of fish, high salinity, lack of technical knowledge of farmers and negative environmental impacts.

TABLE OF CONTENT

LIST OF TABLES

LIST OF PHOTOS

LIST OF FIGURE

CHAPTER-ONE

INTRODUCTION

Introduction

1.1.Background of the study:

Bangladesh is now almost devoid of forest land except in a few selected areas of the country. The area under forest is 2.53 million ha(17.5% of the country's total area).About 1.3 million ha of forests are designated as government forest land but in reality only 6% to last 8% of the total area of Bangladesh merits the term "forested" which is far below the desired level. Because of the small area and rapid destruction of forests it is difficult to meet the country's huge demand for timber, fuel, food and fodder. About 50 percent of the destruction of forest has been taken place during the last 20 years. The major causes of deforestation are industrialization, rapid urbanization and high population pressure on existing forestland, both for settlement and shifting cultivation. Other causes include encroachment, grazing, fire, uncontrolled and wasteful commercial logging, illegal felling, fuel wood collection and official transfer of forest land to other sectors i.e. for settlement agriculture and industries. In this way, almost half of the existing forestland is under different types of non-forest use (Anon, 1996).

Aqua-silviculture technology on the other hand is an excellent technology in areas with forest cover. This was introduced as an alternative livelihood option under different project. Although relatively new it is seen as a good alternative and supplementary source of income to fisher groups as it simultaneously caters to the promotion of coastal resource management through mangrove protection conservation as well as income generation. By local farming system small landholding farmer is not capable to meet their diverse need. Contribute to employment, livelihood and income opportunities in mangrove areas, low investment, and high profit, stainable with certain limits for mangrove protection. (Plutomeo et al.2004).

In southern Bangladesh fish farm based production system (transforming formal rice field in to integrated farming system of fresh water prawns, fish, rich and other crops) are expanding rapidly. However due to the lack of well-targeted technical assistance and presence of higher levels of debt, many prawn farmers are in a state of increased vulnerability. Under these circumstances the GOLDA (Greater option for development aquaculture) project was launched by CARE in 1996 founded by DFID with the prime goal of enhancing social economic security for small scale farming households in southern Bangladesh.

The major objectives of the project are to reduce cash cost for fish farming, promote diversified and integrated other farming system and increase financial management skill of male and female members of participating fish farm households.(Krishna,2005).So agroforestry based cultivation system this moment is most wanted and promising to the farmer. The population of Bangladesh is increasing at an alarming rate; the demand of protein is also increasing day by day. Fish species are important from the viewpoint of providing nutrition and supplemental income to the vast majority of the rural people. There is a clear dominancy of small fish varieties getting more income in the homestead pond or ditches (Shafiul et al.2005).To fulfill the demand of protein we can increase combined fish production. The present per capita annual fish consumption in Bangladesh stands at about 14 kg/year against a recommended minimum requirement of 18 kg/year; hence there is still need to improve fish consumption in the country (DOF, 2005).

Aquasilviculture can play an important role to minimize this gap combining several composition decreases the risk of element which agriculture initials. If one component fails the other can provide the critical mass for survival the different component interact in a symbiotic and synergetic manner, enhancing overall production, optimizing resource use and thus providing for the subsistence needs of the household. Trees provide shade for crops and livestock while producing fruit; livestock manure is used as a fertilizer and crop by-products are feed to animals. Smallholder farming systems have evolved over countries. Their technological and socio economic features are part of the indigenous knowledge of the social group for whose basic needs they provide (FAO, 2000).

1.2. Justification:

The selected area is a coastal part of the country where both fresh and brackish water aquaculture is common practice like other coastal region of Bangladesh; a rapidly expanding farming activity plays an important role in the overall silvofisheries development effort in Bangladesh, where shyamnagar has a great opportunity to extract maximum benefit and creating employment opportunity by aquasilviculture practice. This paper also attempts to identify the problems and benefit of practicing aquasliviculture. By considering the above background and justification, this present study aim to identify the status, benefits, prospects and problems of practicing aquasilviculture in shyamnagar upazila and their contribution to sustainable livelihood of the local people of south-western part in Bangladesh.

1.3. Objective of the study:

The objectives of the study are as follows:

- ❖ To know the present status and management technique of the aquasilviculture in shyamnagar upazilla of shatkhira district.
- ❖ To identify the benefits and problems of practicing aquasilviculture in shyamnagar upazilla of shatkhira district.

CHAPTER-TWO

LITERATURE REVIEW

Review of Literature:

2.1. Concept of agroforestry:

Asian agriculture is characterized by mixed farming activities which form the backbone of farming systems (Devendra, 1996). Agroforestry is the art and science of growing woody and non woody plants together on same unit of land for a range of benefits (Hasanuzzaman 2009). The scientific rediscovery of agroforestry dates back of the mid- 1970 but the roots of the agroforestry tradition go much deeper. In order to appreciate what modern agroforestry is and where it is going it might be useful to know something of its history. The main taproot of agroforestry lies embedded in the traditional agroforestry practices of farmers all over the world. In some areas traditional agroforestry practices have declined but in orders they are still going strong. Systematic study and improvement of viable traditional practices is still the best route of entry for those seeking to make a modest contribution to rural development in the short term.

In Bangladesh, because of various factors such as competition for land due to intensified population pressure, rapidly depleting fuel wood resources, time-scale for orchard operations, dispersed distribution of benefits from forestry and seasonal shortage of labor, the growing of trees did not find a suitable place in the rural economy. Due to the high ecological and social costs and land degradation, highly adverse land-man ratio and more pressure on non-renewable land resource great emphasis has now to be given on the research and developmental aspects of the various agro-forestry systems.

However, people's involvement in such programs is very much essential because they know better what species are best adapted to a particular micro-climate and would have the greatest survival. They should alone decide what are their optimum needs and channels of marketing their surplus produce. Then, they will themselves protect these plantations once they have made the decisions themselves and have been involved in their execution.

Agroforestry is a landuse that combines both agriculture and forestry which significantly contribute to fulfill increasing demands of fuel wood, timber, fodder, ash and infrastructure in many developing countries(Solanki, 1998).Agroforestry has been practiced by the farmer for a very long time by applying low level of technology where monocropping system is not profitable.(Shkhwela, 1990).The term "agroforestry" is not familiar with farmers and was primarily developed for the tropical region where existing climatic conditions are mostly harash and be inclined not to support conventional cropping system(Gordon et al, 1997).

According to Nair (1990), agroforestry is a land- use system that involves socially and ecologically acceptable integration of trees whit agricultural crops and animals, simultaneously or sequentially, top get increased total productivity of plant and animal in a sustainable manner from a unit of farm land, especially under conditions of low level of technological inputs and marginal lands.

Agroforestry is a dynamic, ecologically based, natural resource management system that through the integration of trees in farm and ranged land diversifies and\or sustains agricultural production for increased social , economic and\or environment benefits (modified from leaky , 1996).

2.2 Characteristics of Agroforestry

- Multiple plant components, at least one of which must be perennial. Components of the system either economical\ecological.
- A high level of interaction (economic and bio physical) .between the woody and non woody components.
- Usually products, often of different categories (i.e. food, fuel, fodder).
- The cycle of an agroforestry system is always more than one year.
- The most simple agroforestry system is more complex, ecological and ecological and economically than a monoculture system (Hasanuzzaman, 2009).

2.3 Attributes of agroforestry

There are three main attributes which are agro forestry possess, these are-

1. Productivity
2. Sustainability
3. Adoptability

1. Productivity: Most, if not all, agroforestry system aims to maintain or increase production or (preferred commodities) as well as productivity of the land. Agroforestry can improve productivity in many different ways. These include: increased output of tree products, improved yield of associated crops and recreation of cropping input.

2. Sustainability: By conserving production potential of the resource based, mainly through the beneficial effects of woody perennials on soil, agroforestry can achieve and indefinitely maintain conservation and fertility goals.

3. Adoptability: The word "adopt" here means "accept" and it may be distinguished from another commonly used word adopt, which implies modify or "change" the fact that agroforestry relatively new word for an old set practices means that, in some cases agroforestry has already been accepted in farming community. However implication here is that improved or new agroforestry technologies that are introduced in new areas should also conform to local farming practices. (Hasanuzzaman, 2009).

2.4. Advantage of agroforestry

Agroforestry systems have several advantages are given below in short:

2.4.1 Environment/ecological Benefits:

- Better production from crops and lives from environmental hazards such as flood drought, cyclone etc.
- Conserved biodiversity
- Improved microclimate such as reduce soil temperature, reduces evaporation of soil moisture
- Purification of air and water

- Reduce use of chemical fertilizer
- Reduce pressure on forests
- Protect land through reduction of surface run-off and soil erosion
- Increase soil nutrients through of decomposition of litter fall
- More efficient recycling of nutrients by deep rooted trees
- Improve soil structure through the constant addition of organic matter from decomposed litter. (Hasanuzzaman, 2009).

2.4.2. Economic Benefits

- Diversifies the range output a given area
- Increase the value of output from a given area of land
- Reduces incidence of total crop failure, common to single or monocropping system
- Provide productive use of underutilized land, labor and capital
- Increases in level of farm incomes due to improved and sustain productivity (Hasanuzzaman, 2009).
- Year round distribution of employment and income rather than more highly seasonal income from annual monocropping. (Arnold, 1987).

2.4.3. Social Benefits

- Improved in rural living standard from sustained employment incomes
- Improved in nutrition and health due to increased quality and diversity of food outputs
- Estabilization and improvement of upland communities, through elimination o the need of shift of farm activities. (Hasanuzzaman, 2009).

2.4.4. Biological Benefits

- Increase crop productivity
- Sustain crop productivity
- Produce diversified food
- Increase forest productivity
- Increase fruit supply
- Decrease weeds infection. (Hasanuzzaman, 2009).

2.5. Classification of Agroforestry

Arrangements of different types of crops, e.g animals' perennials, trees etc. and the level of interaction between different components are distinct for individual agroforestry system. One system differs from others in respect of structure, composition, age, intensity technology, inputs etc. (dwivedi, 1992). It is different to work out anyone system of classification of agroforestry systems capable of meeting most of the requirements.

The system can be grouped, based on anyone factor or function of the farming system. Nair classified the agroforestry system based on structure, function, socio-economic and ecological status.

The agroforestry system can be classified based on the following factors:

i. Structure
ii. Function
iii. Physiognomy
iv. Floristic
v. Ecological consideration
vi. Socio-economic factors
vii. History
viii. Utility of land (Haque, 1996)

The classification of agroforestry is described below:

2.5.1. Structural Classification

Structure refers to composition, stratification and dimension of crops.On the basis of composition. The agroforestry systems are classified as:

a) Agrosilvocultural system
b) Agrosilvopastur
c) Silvopastural system
d) Multipurpose tree plantation system

The structural agroforestry system may be further classified based on dominance, arrangement and stratification of the components. (Haque, 1996)

A. Classification based on dominance of component

a) Silvo agriculture

b) Agrosilvopasture

c) Silvopasture

d) Pastoralsilviculture

e) Agrosilvopasture

f) Silvoagropasture

B. Classification based on arrangements of components

i. Arrangement in respect of space

- ❖ Mixed dense
- ❖ Mixed sparse
- ❖ Strip plantation

ii. Arrangement in respect of time

- ❖ Coincident
- ❖ Concomitant
- ❖ Intermittent
- ❖ Interpolated
- ❖ Separate

C. Classification based on stratification of components

i. Based on vertical stratification

- ❖ Single layered
- ❖ Double layered
- ❖ Multilayered

ii. Based on spacing

- ❖ Dense
- ❖ Scattered
- ❖ Mixed intercropped

2.5.2. Functional Classification

Our agriculture is known for its multi functionalities of providing employment, livelihood, and food, nutritional and ecological securities. Today our economy is based on mainly in the field of agriculture, for achieving rapid progress in rural area, our strategy must focus on; conserving natural resource, enhancing efficient of resource use, increasing productivity and profitability and improving quality and competitiveness through reduced unit cost of production.

Integrated plant nutrients and protection systems of crop, livestock and aquaculture production are being updated for various agro-ecologies.

Based on various functions; the agroforestry system is classified into following system-

- ❖ Productive agroforestry system
- ❖ Protective agroforestry system
- ❖ Multipurpose agroforestry system (Haque, 1996)

2.5.3. Physiognomic Classification

Physiognomic Classification is based on the characteristics of vegetation in relation to water. This classification includes the following systems:

- ❖ Hydromorphic agroforestry
- ❖ Xeromorphic agroforestry system
- ❖ Mesomorphic agroforestry system (Haque, 1996)

2.5.4. Floristic Classification

For defining agroforestry system on species combination, it is necessary to have an inventory of all existing system along with their component plant species. (Dwivedi, 1992).

2.5.5. Ecological Classification

Ecological Classification of agroforestry is based on important ecological parameters (Climate, Edaphic and Physiographic ones). Based on climate it can be classified as-

- ❖ Tropical
- ❖ Sub- tropical
- ❖ Temperate
- ❖ Subalpine
- ❖ Alpine (Dwivedi, 1992).

2.5.6. Socio-economic Classification

Based on socio-economic considerations, the agroforestry system is grouped into:

- ❖ Subsistence agroforestry system
- ❖ Commercial agroforestry system
- ❖ Intermediate agroforestry system (Nair, 1985a)

2.5.7. Classification based on utilization of land

Based on utilization of land, the agroforestry production systems are sometimes classed into the categories:

i. Homestead agroforestry
ii. Forestland agroforestry
iii. Crop-farm forestry
iv. Fish-farm forestry
v. Animal-farm forestry
vi. Integrated farm forestry
vii. Road side agroforestry
viii. Public place forestation (Haque, 1996)

Whichever classification scheme is most appropriate in a given moment depends upon the purpose of the user.

2.5.8. Other Components Present and Special Aspects

i. Apiculture with forestry
ii. Aquasilviculture (trees with fisheries)
iii. Trees in water management
iv. Irrigated agroforestry (Young, 1987).

2.6. Scope of Agroforestry in Bangladesh

Agroforestry is the most effective land use system from sustainable view point and as recognized worldwide as the best productive system from which the rural people can meet their requirement of food fodder, fuel and other necessities. This has been practiced by the farmers of Bangladesh in haphazard manner. The homestead of rural people is a unique feature of combination of trees, shrubs, vegetable, and live-stock animals, duck a poultry birds, in as association of trees of different multipurpose values. Estimated 16.7 million homestead of the country occupy about 0.03 million hectare of land (which is increasing sharply with the increase of population) in now under traditional agroforestry practices.

There is a great scope to manage and develop these homesteads with sound sustainable technologies. Because the homestead are providing of bio-fuel requirement as well as fruit fodder, timber, shelter, for rural people. Beside the homestead, part of our cropper land (net copper land is 8085m ha), 0.39 ha current fallow land, 0.27 m ha cultivable waste land, 3.29 m ha land which is not available for cultivation and encroached forest area in madhupur Sal forest. CHTs forest along with the denuded hills of grater Chittagong region may bring under agroforestry system. Utilizing appropriate agroforestry technologies in these areas the overall production may be increased many folds. (Hasanuzzaman, 2009).

2.7. Definition of aquasilviculture:

Aquasilviculture –An agroforestry system that combines trees with the raising of aquatic animals (Huxley and Houten 1997).Aquasilviculture system coming from the greek word "aqua" means water and "silvos" means tree and is an aquasilviculture management strategy which combines and harmonizes fishery production and vegetation. Again "aquasilviculture is a multiple use system that promotes a harmonious co-existence between fishery and mangrove tree species in a semi enclosed system while providing coastal protection and maintenance to the ecosystem."(Baconguis, 1991).Through the consideration of ecological and socio-economic importance of the mangrove ecosystem, the culture of seaweeds, mollusk and fish in cages in sub tidal mangrove is both compatible with mangrove and amenable to small-scale family level operations, mangrove filters where mangrove are used to absorb effluents from high density-culture ponds.(Troell,2009).

It has been suggested that the technology could be used to facilitate the reversion of abandoned and unproductive or denuded open areas to their productive condition (Baconguis, 1991).This system that integrates fisheries and trees into a production system. Integration can be directly beneficial to farmers either through additional valuable products ,promoting recirculation (improving water quality),preventing diseases ("green water"),habitat conservation (including mangroves),or increasing allowed production volumes through waste reduction (regulations for emissions),usually converted into human settlement and for brackish water aquaculture.

To arrest the massive decrease of mangrove forests, reforestation of mangroves has been done, a system that combines utilization and conservation called silvofisheries has been introduced. (Plutomeo et al.2004)

2.8. Objectives of aquasilviculturte:

Professionals in all aspects of agriculture struggle with improving their efficiencies and output to meet the food demands of the constantly increasing human population. Aquasilviculture is no different, and in fact plays a critical role in this arena.

Most of the people practice aquasilviculture:

- To earn money, get timber, fuel, wood, fruit and fodder.
- To meet family consumption requirement, proper utilization of niche and food, and increase economic return.
- To increase income from the production of both rice and fish.
- To create a reliable source of protein for farmers and their families, countering the decrease in available wild fish in many countries, a reduction is using fertilizer.
- To develop and optimize the special use of degraded or marginal land disused pound through integrated culture.
- To improve the socio-economic conditions through increased incomes and to further protects with principles of sustainable land use and biodiversity conservation.
- To conserve and rehabilitate the mangroves and other lower part of the country from degradation, thus promoting production potential of the subjected land.
- Fishponds and barren land can be used as plantations so that it can be a source of firewood, poles and protect land long term basis.
- To increase employment opportunity round the year.

2.9. Advantages of aquasilviculture:

- Ensure maximum use of land.
- Uplift the socio-economic status of people.
- Provide employment opportunity to the local communities.
- Contribute national economy.
- A reliable source of protein for farmers and their families.
- Benefit to small farmers of limited means.

2.10. Problems of aquasilviculture:

2.10.1. Poor farm management:

A big problem, especially for farmers wanting to start up rice-fish culture, is the initial investment cost. Farmers need to construct a trench and dike, purchase fingerlings and feed for fish. Especially the costs for the dike construction and digging of the trench are high. Most of the respondents felt lack of technical knowledge and lower capital that leads poor farm management (IDRC, 1998).

2.10.2. Acidification of soils:

In the study area due to plenty of brackish water and extensive shrimp culture larger part had gone under salt damage and has become a great threat for fresh water local rice production. Already most rice field kept barren due to excess salt. The normal production of fruits like mange, jackfruit, jam, coconut, betel nut etc. and other crops have droped significantly than before. Acid sulfate soils seriously affect by soil acidification are sulfaquets, this soils have pH less than 3.5. Growth limiting factors in acid sulfate soils for wetland rice are strong acidity, Al toxicity, Fe toxicity, high electrolyte content and deficiency of N and P (Ponnamoeruma, 1983). The acidic water that results from acid sulfate soils destroys food resources, displace biota, relese toxic level of aluminum, precipitates iron that smothers vegetation and alters chemical properties of water (Smmut J et al. 1996).

2.10.3. Crop diseases

Aquasilviculture program includes diverse crop and rice – fish is most important, both rice fish and other crops affected by seasonal pest, or disease. In integrated aquaculture quality and quantity of water is insufficient and fish disease is serious problem for small holding farmer. Massive mortality of shrimp, different viral and bacterial fish disease causes great loss for farm owner.

2.10.4. Poor water quantity and quality

Due to aquasilviculture practice, trees, leaves fall into the water and the may be poisonous. So the quality of water is not good. Sometimes mud also causes poor water quality.

2.10.5. Socio- economic problem (poaching, poisoning)

Primary construction cost is higher to smallholding farmer. Farm owner often face the threat of poaching. Theft risks increase when fishponds or farms are far from farmers' households. Surveillance requires labor inputs for which the returns are not immediate. These constraints have limited the feasibility of fish farming to some extent, especially among households headed by females, who, on their own, are unable to protect their assets against an unfavorable social environment.

2.10.6. Problems due to modern rice cropping and lack of technical skills

As local rice varieties have been replaced by different high yielding HYV verities. Most of the farmer possesses little knowledge to managing new rice varieties so they extract lower yield. (IDRC, 1998).

2.11. Methods of practicing Aquasilviculture

Integrated mangrove- aquaculture systems, or silo- fisheries, have a long tradition dating back many centuries to mangrove fishponds known as "tambaks" in Indonesia. Different forms of silvo – fisheries continue to operate on a large scale today in many countries, especially in Indonesia, Philippines and Vietnam (Fitzgerald, 1997). Aquasilvicultures, e.g. tree- fish- arable crop and tree- fish- livestock systems, are alternatives for land use in the wetlands (Huang, 1997). The concept of aquasilviculture is that mangroves are planted in shallow area covering 70- 80% of selected site, and remaining 20- 30% is used to creat a deeper pond along the dike which is devoted to brackish water aquaculture (Fish, shrimp, or crab). (Stevension, 1997)

Two cultural method "gher" culture and pond dike system is mainly followed by local farmer. Which vary in types of trenches used, stocking rate, fish species used, and supplemental feeding. Crabs spp, some catfishes, tilapias, prawn, etc are being cultured.

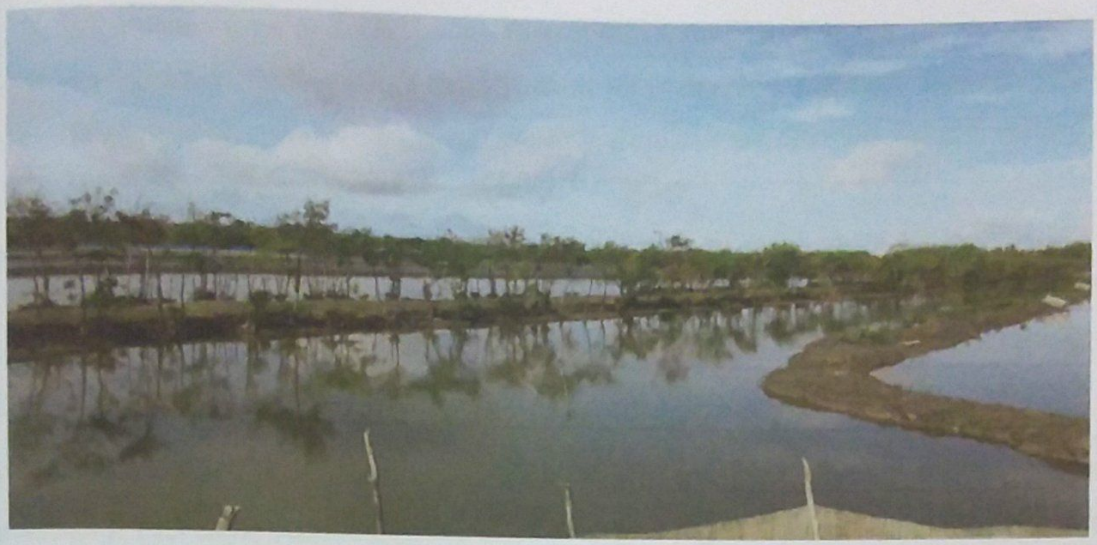

Photo 2.1: Practice of aquasilviculture at shyamnagar uazila in shatkhira

(Field survey, 2016)

Farmers rear prawn in ponds with existing craps to ensure suitability and sustainability of production system. It is started with rice- fish culture then further integrated. To incorporate in a rice paddy field, farmers generally follow this procedure:

- They begin by digging a small pond or trench enclosure made 0.5 to 1 meter deep in a low- lying area of the rice field. This trench becomes a refuge for the fish during planting and harvesting, or when there is little or no water. This is also allows the farmer to keep the fish alive well after the growing season; the excavated soil is used to raise banks around the field locally called bheri for better water control. These banks provide some land above water level, wider bheri and adjacent upper land used for raising some tree species like Mehagony, Sissoo, Koroi, Neem, and Babla, Rain tree, Khejur widely used for border protection, also growing different types of fruit trees, diverse vegetables;at a time rice monoculture was main crop but now rice with shrimp or fish polyculture is given more importance.
- In the trench or cannel different types of fishes are introduced as catla *(Catla catla)*, rui *(Labeo rohita)*, mrigal *(Cirrhinus mrigala)*, Mola *(Ablypharyngodon mola)*, punti (*Puntius chola*), Kholsia (*Colisa fasciatus*), silver carp, common carp, grass carp, some catfishes, tilapias, mud crab, freshwater shrimps, prawns etc.

- After three weeks, once the rice is well established, the fish are let into the rice fields.
- Supplemental feeding varies from none at all to frequent feedings, depending on the farmer and local conditions; at harvest, or if chemicals are used, the water is drained and the fish are collected from the trances.
- In case of tiger prawn it required minimum supply of saline water for 2- 3 months. In rainy season water is available for paddy and other agricultural crops but in dry season it required deep boring machine for irrigation and few farmer possess this opportunity (IDRC 1998)

Today many extensive pond farmers practice different varieties of improved extensive farming techniques. This implies active selection and stocking of targeted species for culture, either from wild- caught or hatchery reared seeds. Choice and combination of species does not only reflect present market situation, but also the underlying biological premise of polyculture i. e. ecological feeding niches are most efficiently utilized when different species are farmed together. This does not only result in diversified and enhanced production, but also in a more efficient utilization of resources.

Polyculture is also practiced in ponds with mangrove stands aiming at protecting an important coastal habitat and simultaneously improving livelihood through aquaculture production.

In case of any mixed culture clear knowledge about each component and better combination for more profit is essential. So aquasilviculture is not far from such consideration. Mixed farming is also known as polyculture or composite culture. The basic principle of mixed farming is to stock and rear together some species of fish in the same water body like ponds, lakes, ditches, etc. typical examples of mixed fish farming in Bangladesh are the culture of Indian major crops, viz. catla *(Catla catla)*, rui *(Labeo rohita)*, mrigal *(Cirrhinus mrigala)*, Mola *(Ablypharyngodon mola)*, punti (*Puntius chola*), Kholsia (*Colisa fasciatus*) etc.

Recently, some exotic ponds to obtain higher production per unit area of water body through mixed farming. (Banglapedia, 2008).

In mixed farming, the improvement of pond oxygen regime occurs due to the presence of silver carp, which consumes excess algae. Concentration of excess algae creates depletion of oxygen in the pond, but consumption of excess algae by silver carp helps to improve pond environment.

Some bottom feeders that feed on organic debris also improve the oxygen condition in the pond. Grass carp cleans the pondweeds and aquatic vegetation by consuming them. Besides, some fish feed on the excreta of other fish, e.g. common carp feed on the excreta of silver carp. Thus, mixed farming of some fish has added advantage of improving the aquatic ecosystem. (Banglapedia, 2010).

Before the practice of mixed fish farming, the food habits of the fish species to be stocked and the amount of the natural food available in the stocking pond must be assessed. The ratios among the different species of fish and their stocking densities are of great importance in polyculture. People used according to Fisheries Research Institute (FRI), Mymensing; seven- species mixed fish farming has recently proved successful.ths includes silver carp, catla, rui, mrigal, grass carp, mirror carp, and sharputi at the stocking rate of 1200, 400, 400, 400, 300, 500, 1500 fish fry/acre respectively, with a size range of 5- 7 cm. (Banglapedia, 2010)

For successful mixed fish farming, there are some pre- conditions such as:

i. Selection of suitable and compatible species of fish,
ii. Appropriate time of releasing fry,
iii. Appropriate number and size of fry,
iv. Adequate natural food,
v. Supply of supplemental feed,
vi. Supply of organic and inorganic fertilizers,
vii. Harvesting and marketing of fish, etc.

The fresh water shrimp tiger prawn has great market value, and in any combined aquaculture this are most preferred to the farmer. Average pond or gher size 0.82 ha average farm size- 1.87 ha in shatkhira shyamnagar, about 97% farmers followed polyclture for family consumption food, and increase economic return, more than 43% farmer followed prawn – fish- paddy culture.

Few years ago, prawn culture was fully dependent on wild PLs (Ahmed , 2003). Due to shortage supply and hogh price, many farmers currently dependent on hatchery produced PL. in different cultural system by gher/ pond by prawn monoculture then prawn 22436 no per hactre, in case of prawn- carp polyculture then prawn is 3145 and fish is 16921. Prawn – carp – shrimp polyculture then prawn 24462 fish, 3050 and shrimp 15346 average stocking density per no/ ha if followed. Rice bran, wheat barn, boiled vegetables and other ingredients in fixed proportion Commercial feeds, Homemade feeds, (Snail meat (28%) combining oil cakes, fish meal, Most preferred feed in some farmers also used oil cakes, boiled wheat and boiled rice directly. (Asaduzzaman et al, 2005).

Parasitic infection in Bangladesh fishes is on the increase with the increase of culture fisheries; the parasites recorded so far exceed 130 species. The common protozoan diseases include: Ichthyyobodiasis,Ichthyophthiriasis,Chilodoneliasis,Trichodiniasis,Myxosporidiasis,Dactylogyri asis, and Gyrodactyliasis etc. there is no report of viral disease. Common bacterial diseases are: Columnar is disease, Haemorrhagic septicaemia (Dropsy), Scale protrusion disease, and Bacterial gill rot disease. Known fungal diseases are: Saprolegniasis, Branchiomycosis, and Epizootic Ulcerative Syndrome (EUS). (Banglapedia, 2010).

Fish develop Lordosis or spinal curvature a nutritional disease found in carps and clarias with stunted growth and deformity; and cracked/ broken head disease due to failure of ossification in head and necros of the skull. Environmental diseases, like Gas- bubble disease, are associated with the super saturation of nitrogen or oxygen. The gas- bubbles are found in yolk sac, eye, skin, gills and mouth and even in swim bladder. In 1988 a wide variety of freshwater and estuarine fish species were affected by disease called epizootic ulcerative syndrome (EUS), an infectious disease characterized by large necrotizing ulcers extending deep into the tissues, leading to death.(Banglapedia, 2010).

2.11.1. Paddy cum fish culture

The origin and development of aquaculture practices in Bangladesh are not well documented; historically the country's natural water bodies were stocked during the monsoon season through natural spawning.

However, along with the ongoing rapid development of modern aquaculture, involving diverse high-rech methods (both on land and more recently also in off- shore environments) the need for developing low- cost, low polluting, energy- saving, and resource efficient systems been stressed.

Cultivating rice and fish together has been a 2000 year old tradition in some parts of Southeast Asia. However, this beneficial cultivation system was gradually abandoned due to population pressures, decreasing stocks of wild fish and the "Green Revolution" which emphasized high – input monoculture using high – yield rice varieties, pesticides, and herbicides (which are toxic to fish) (IDRC, 1998).

During the 1980s and early 1990s, rice- fish culture as managed cultivation systems experienced a revival, as concerns over the widespread use of pesticides emerged. In several Southeast Asian countries, rice fields as natural fisheries are more important than as places where cultured fish are raised. Rice fields are deliberately stocked with fish in the culture system. Fish farming in rice fields can be broadly classified as concurrent (integrated) and rational (alternate). In the concurrent system, rice and fish are grown together, while in the rational system they are grown alternately. According to the survey, 70% of farmers practiced concurrent rice – fish farming and the rest (30%) cultured rotationally. In general, the concurrent rice- fish culture system is practiced in plain – lands and medium lowlands, while the rotational system is performed in deeply flooded lowlands.

The average farm size was found to be 0.33 ha and 0.29 ha in the concurrent and rotational system, receptively. Two types of rice crops are cultivated in the concurrent system: boro and aman. Farmers cultivate boro rice during the dry season from January to April, and the monsoon season aman rice during June to October. The aman rice culture takes place in either deep or flooded water conditions with fish, and with a fish culture period of around 4 months. In the rotational system, farmers produce fish during the monsoon.

Fish fingerslings are stocked in May to June and are harvested primarily from November to December, a culture period of around 5 to 8 months. Rotational farmers avoid cultivation of aman rice with fish due to high water levels. On the other hand, farmers avoid fish culture with boro rice because of water scarcity and lower availability of fingerlings. A wide range of fish species are cultured in rice fields.

The selection of species depends on farming systems.according to the survey; concurrent farmer's mainly stocked common carp (*Cycrinus carpio*), silver barb (*Barbonymus gonionotus*), nile tilapia (*Oreochromis niloticus*) and silver carp (*Hypophthalmichthys molitrix*).

In rotational culture, on the other hand, the most common fish species were stocked catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhina cirrhosis*), silver carp (*H. molitrix*), grass carp (*Ctenopharyngodon idella*) and bighead carp (*Aristichthys nobilis*). The average annual stocking density of fingerlings were 2857 per ha in the concurrent system, while it was 4917 per ha in the rotational system. The average size of fingerlings stocked varied between 4 and 8 cm in the concurrent system and 6 to 10 cm in the rotational system.

Although small- scale fish farming in rice fields is an extensive aquaculture system that relies on the natural food (phytoplankton, zooplankton, periphyton, benthos), supplemental feeds are used by most respondents. In the concurrent system, farmers mainly use on- farm inputs, such as rice bran, wheat bran and mustard oilcake. On the other hand, a few rotational farmers apply fishmeal and industrially manufactured pelleted feeds, in addition to on- farm inputs. Farmers reported higher fish yields when feeding pelleted feed rather than on farm inputs. The most common feeding frequency in the rotational system was once per day, while it was once or twice a week in the concurrent system. There was substantial difference in feeding rate among culture system. In order to increase rice and fish production, a variety of fertilizers such as urea, triple super phosphate (TSP) and muriate of potash (MP) are used by the farmers.

The fertilizer quantity used is related to farming system concurrent farmers with two rice crops used fewer fertilizers on an annual basis than did rational farmers of one rice crop because the presence of fish increased soil fertility. The average annual yield of rice was higher in concurrent farming compared to rational farming, because of two rice crops.

Shows that concurrent farmers had a higher aman rice yield than boro rice as the stocking of fish affected the aman rice yield possibility. Never the less, boro rice yield was slightly higher in rotational farming than that of concurrent farming. The average annual yield of fish reported by respondents was 259kg/ha in concurrent farming, while 1,108kg/ha in rotational farming.

The yield of fish was higher in rational farming due to higher inputs of fish seed, feed and fertilizer. In addition, rotational farmers stocked larger fingerlings which could have a positive effect on survival and growth, and thus also the yield.

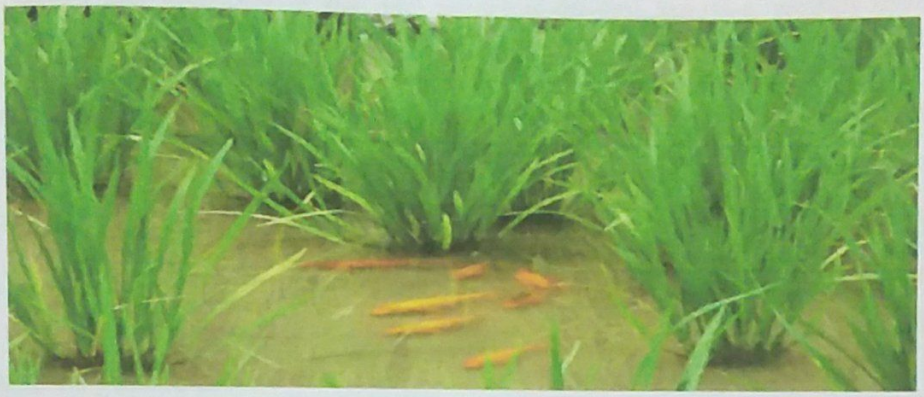

Photo 2.2: Fish culture in paddy field

As rice is main staple, fish is in all cases the secondary crops. The rice prawn gher farming system has significant impacts on land for modern varieties (MV) paddy production. The yield of MV paddy production under rice prawn gher farming system is almost the same as the yield in other parts of Bangladesh where the farmers usually produce only year-round MV paddy. The rice prawn gher farming system is providing a sufficient amount of rice, fish and vegetables to marginal and landless farmer.

In the farm *cocos nucifera*, date plam (Khejur) with *acacia nilotica* (babla) widely planted as cluster to reduce runoff and for land stabilization. From contiguous homestead various fruit trees including timber trees are planted to meet their diverse need. Betel leaf, dike crop including vegetables extensively cultured for more profit round the year. Due to late rain doughtiness the fish culture is retracted but cocos, betel nut with local vegetables grown small-scale for family consumption.

During growth period, the farmers give supplementary feed to the prawn. Traditionally, only mud snail meat was used as prawn feed, but now a day farmers use a wide range of homemade and commercial supplementary feeds. Rap fish fingerlings are released into gher in May/June and cultured for nine months as long as sufficient water is retain in gher. Usually, no specific supplementary feed is provided for the fish.

Fish share the feed to the prawns. Rice dominates the cropping pattern throughout Bangladesh. It has been broadly divided into three classes viz,aman (grouop of rice verities gown in the monsoon season and harvested in the post monsoon season),Aus.(rice verities sown in pre monsoon season and harvested in the monsoon season) and boro (growth in dry season),according to the season these are harvested in December-January, March-May and July-August respectively. Among, this transplanted aman is most important and covers and about 46.30%of the paddy area, followed by boro (26.85%), aus (17.59%) and broadcast aman (9.26%). Bangladesh is a country dominated by wetlands having more than 50 percent of its territory under fresh water marshes, swamps, river estuaries and the world's largest contiguous mangrove forest sundarbans.

The inland open water fishery resources have been playing a significant role in the economy, culture, tradition and food habits of the people. Fish have been an integral part of the life of the people of Bangladesh from time immemorial. Fisheries, second only to agriculture in overall economy of Bangladesh, contribute nearly 5 percent to the gross domestic product (GDP), 23 percent of gross agriculture products and 5.71 percent to the total export earnings (DOF, 2008).It accounts for about 63 percent of animal protein intake in the diet of the people of Bangladesh (DOE, 2005).Native fish species are favored over species which are generally cultured like the common crap,tilapia and silver crap. Bangladesh has six largest aquaculture producing country with its estimated production of 856-956 tones in 2003(FAO, 2005).Fisheries in Bangladesh is diverse: there are about 795 native species of fish and shrimp in the fresh and marine waters of Bangladesh and 12 exotic species that have been introduced.

Rice –fish culture can increase rice yields (up to 10% in some cases) while providing farmers with an important source of protein and extra income .Implementation is relatively inexpensive and low –risk.

The ministry of fisheries and livestock (MoFL), Department of fisheries (DoF), Bangladesh fisheries development corporation (BFDC) and the Bangladesh fisheries research institute (BFRI) are the main organizations responsible for aquaculture and its development. Universities, organization within other ministries and local and international NGOs are also involved in this area (Ahmed, 2003).

2.11.2. Brackish –water fisheries:

Brackish water aquaculture, also known as coastal aquaculture, is a rapidly expanding farming activity and plays an important role in the overall fisheries development effort in Bangladesh. Marine and estuarine shrimpfish and carbs are the farm products. Bagda shrimp (black tiger shrimp, *penaeus monodon*) is the primary target culture species, while fish, heterogeneous shrimp and carbs are the by-products, among the coastal districts, brackish water aquaculture activities are most success in, shatkhira shyamnagar coastal part. The open brakish water culture fisheries generally deal with black tiger shrimp, the main target commodity for high value of frozen food from in Bangladesh.

Though brackish water fisheries contribute a fraction of marine fish land in Bangladesh, the area is important for breeding and nursing ground of many marine and freshwater species. A vast number of marine species utilize the brakish – water region as nursing ground.

The giant fresh water prawn ,more popular known as (*Macrobrachium rosembergi),* migrates toward brackish-water from a freshwater habitat for breeding and returns when young individuals attain post-larva stages, similarly many marine species spend part of their life in brakish-water area and juveniles back to the open sea(Banglapedia,2008).1982-1983 there were 51,8365 ha of brackish water ponds in Bangladesh. In 1984-85, the brackish water farming area was estimated at 70,3314 ha (Aquatic Farms Ltd, Hawai USA, engaged by the Asian Development Bank).The brackish water aquaculture area thereafter further expanded and reached 108,280 ha in 1988(DOF estimated).

It is estimated that 29% total fisheries production in Bangladesh comes from seawater. Further 101-15% of total marine production is from brakish water region. Total production of fisheries in Bangladesh during 1997-98 was 1.21 million m tom. Besides, the brakish water region also supplies roughly 3.0-3.5 billion post larvae of the black tiger shrimp, penaeus monodon, annually. Bangladesh produces roughly 50,000 to 60,000 m tons of "head on" brakish-water shirmps annually. It is estimated that 150,000 ha of coastal aquaculture produce approximately 70,000 m tons of mixed fishes, carbs and small shrimp annually non target species. (Banglapedia, 2008).

Though brackish water shrimp is highly preferred to the farmer for highest profit than any other monocrop. It required 2-3 month saline water for one crop but for double crop it requires year round saline water, which though increase shrimp yield but greatly hamper fresh water rice production. Many respondents claim that larger farm owner allows entrance of saline water round the year for the betterment of their farm that hamper the small farm holder or only rice field. They demand at least a single deep boring machine for each union; so that they can continue their farm activities during drought season otherwise they have to wait for rain water is also uncertain. Some of them blamed to the authority that due to lack of proper attention the high productive potentiality of the area are being underestimated. (Field survey, 2011).This is by far the most common culture practice. However, tidal inundation in the greater part of the farming area in February, which marks the beginning of culture season, is quite inadequate.

The land is relatively high compared to the tidal height. Most of the farming areas in shatkhira shyamnagar, nearly three-fourths of the area cannot be tidally inundated under even 50 cm of water at the beginning of the culture season. Yet, the farms depend upon tide alone, but they are amongst the worst from the point of view of tidal inundation. Supplemental pumping could significantly here, but it is not used. Brackish water organism may be classified into two categories resident and migratory. Resident species include mullets, threat fins, saiendaes, perches, ribbon fish, clupied shirmps are also resident.

Rakish water aquaculture in Bangladesh however, has not yet developed as total system dealing with production of finfish and shellfish for domestic consumption and for export maintaining a sound ecological balance. (Banglapedia, 2008).

In rice fish integration as shown in, crop residues(brans and straw) can be used as feed to fish(bran) and livestock(bran and straw);pond mud can be used as manure in rice fields and vegetable plots and livestock manure can be used for fertilizing fish ponds and rice fields. Coastal saline soil occupies an estimated 2.8 m ha in southern part of the country which receives tidal saline water and hold for few months. Kharif paddy varieties are widely cultivated in these areas.

After the tidal water enters in march, tiger shrimo(*p.monodon*) and mullet (*Liza parsia*) are stocked at a density of 100,000/ha and cultured up to June and harvested. Subsequently, saline water is drained off before monsoon and after washing out the land with monsoon water, kharif paddy cultivation with freshwater fish is under broken. The fish cultivation for three months gives a yield of 0.25-0.30 tons/ha of which 40% is contributed by *M., rosenbergii* and the rest by craps. Culture of freshwater and marine fish, shrimp and other crustacean species are highly important as they can be easily integrated with water activities such as agriculture and livestock rearing. Bangladesh has extremely favorable conditions for shrimp culture, not least because of the low production costs. In 1982-1983, there were only 5200 ha of land under shrimp culture: by 1996,110,000 ha had been brought under shrimp cultivation, 70% being located in the khulna region. By contrast, mud crab (*S. serrata*) has been an incidental product arising from the culture of shrimp, prawn, milkfish and other finfishes in Southeast Asia (Krishna, 2005).

2.11.3. Criteria For appropriate farming technology:

In view of the countries depressed socioeconomic status, low technological base, private ownership of most of the suitable land, short-term leasing system, lack of infrastructure, diversified environment in terms of land elevation, tidal inundation and hydrological characteristics, a production technology can be called appropriate only if it satisfies all or most of the following criteria:

- Requires low capital;
- Cab be applied to land taken on short-and medium-term lease;
- General farmers can easily adopt with short- term training;
- Can be applied in existing farms without substantial topographic changes;

- Production is much higher with relatively low financial risk, compared to the traditional methods;
- Little or no dependence on machinery that require electricity apply(which is not available in most of the coastal areas or ,where available ,is seldom stable and dependable);
- Can create new employment opportunities;
- Can benefit all or most of the farmers in an ecological area for which the technology is intended;
- Does not pollute, upset or degrade the ecosystem or cause disease (Bangladesh shrimp is still disease-free and of population for free origin. The shrimp is raised completely on natural food rather than artificial products and so antibiotics or any prophylactic chemicals are used in the farms. As a result, the Bangladesh shrimp enjoys an advantage in the international market.);
- The farming system can be sustained on a profitable basis year after year; and
- Keep production cost low, thus allowing easy survival of the product in the competitive international market. (Bangladesh can more effectively attract a foreign market by offering a lower price than by attractive presentation of its products).From all this consideration aquasilviculture could a highly potential productive system through well management of water resource. (Badre et al.1997).

2.11.4. Aquasilviculture as a strategy for rural development

The country is facing the problems of fast growing population, low rate of development, depletion of the natural resource base, natural calamities and environmental degradation. Less and less available resources are unable to meet the demands of multiplying development problems. Agriculture is the mainstay of the economy where 85% people live in the villages and are dependent on agriculture. So to accelerate development mission it prior need to develop socio-economic condition of villagers still below poverty level that is acute problem. Agriculture land is being reduced to meet the rapidly growing demand for non-agricultural needs. There is an immediate need for innovative land use practices for maximizing output and income from the limited resource.

Aquasilviculture is considered to be a very significant tool for optimizing land use, maximizing output and integrating the production of crops woody perennial, fish, fodder and livestock into farming system. In the face of its limited resource base, Bangladesh is compelled to devise appropriate strategies to meet its development needs. Adoption of sustainable land use system and practices can be a very effective way of achieving the overall development objectives. Practice of agroforestry is one of the most effective ways for a sustainable conservation and utilization of the land.

As a land use practice, aquasilviculture that combines integrated trees, agricultural crops-rice mainly with aquatic organism like shrimp-fish polyculture by this taking care of the best land use, soil fertility and farmers needs for food, fuel. Timber and fodder. I simultaneously help to sustain rural economy and environment. Many village people are now able to afford household needs very easily than any time before. It augments the food crops and the tree resources. Depletion of forest and tree resources is leading to environmental degradation and pauperization of the rural economy.

Practice of integrated aquasilviculture can help in a very important way to ameliorate the environment and rural economy of Bangladesh. In rural areas of poorer countries, agronomy, water management, aquaculture and wild aquatic resource harvesting are often physically and functionally integrated. Thus aquasilviculture in an integral and indivisible part of forest and aquatic resources.

From the farmers perspective, agroforestry can be a way to increase crop yields and the diversity of products grown, but an additional benefit is the creation of a carbon sink that removes carbon dioxide from the atmosphere, and therefore has implications for climate change, In land and coastal areas, improved aquatic resources management, including aquasilviculture into existing farming system, therefore has the potential to enhance livelihood to sustainable development.

2.12. Aqua-culture Practiced at shyamnagar Upazilla:

The susequent section describes different existing integrated practices that were developed by farmers from their own experience. The numerous type of existing integrated aquasilviculture systems are distinguished from each other by the choice of species and design. The main purpose of such integration is to increase total productivity of smaller pieces of land and make a cash beside meeting need for family consumption. They practice agri-aqua culture,agri horti-aqua culture,agri-horti-aqua-silvi-culture,agri-horti-aqua-silvi-pasture-culture.

In agri-aqua-culture system agricultural crops, fish, prawns are practiced specially rice-fish cultured extensively. In land area, rice is cultivated in the middle portion and in the canal which is inside around the dike fish is cultivated. In canal Golda is also grown with fish. Farmers cultivated mainly IRRI paddy and other high yielding rice. In agri horti-aqua culture system rice, fruit trees, vegetables, fish are more practiced. This is most common practice in the study area where the fish farm dike is as wide as before. People cultivate annual crops (vegetables) in the dike. In the canal, fish and Golda is cultivated and in middle rice is cultivated. The leaves of annual crops are used as fish food and the roots control soil erosion. In agri-horti-aqua-silvi-culture system rice, vegetables, fruit trees, fish, trees (such as Neem, Babla, Koroi etc.) are more practiced. But in the study area most of the respondent are not interested to grow such type of trees. Because leaf falling is a major problem which pollute water. In agri-horti-aqua-silvi-pasture-culture system rice, vegetables, fruit trees, fish, trees are practiced and with this cattle are also rearing.

2.13. Starting and Rising Time of Aqua Practice:

In the study area, in May or June the respondents' starts practice fresh water fish and they also raise fish after every two or three months. The respondents' starts practice tiger prawn or golda in January or February and they also raise it in September or November. Doughtiness is a great problem and now for starting, they completely depend on rain water. It require change internal water to allow slight saline water 2-3 months for bagda and irrigation for paddy, some of them possess deep boring machine but maximum people have not possess such expensive equipment. Due to late rain or doughtiness farmer fallen in great problem otherwise in presence of required water both agricultural and fishing program can going on round the year.

Table-2.1: Local and Scientific names of fish species that practiced at Shyamnagar Upazilla:

Local Name	**Scientific name**
Silver carp	*Hypophthalmicthys molitrix*
Grass carp	*Ctenopharyngodon idella*
Common carp	*Cyprinus carpio*
Rui	*Labeo rohita*
Catla	*Catla catla*
Mrigal	*Cirrhinus mrigal*
Punti	*Puntius chola*
Mola fish	*Amblypharyngodon mola*
Fresh water prawn	*Macrobrachium rosenbergii*
Golda	*Macrobrachium rosenbergii*

(Source: Field survey 2016)

2.14. Common Tree & Agricultural Species Practiced at Shyamnagar Upazilla:

In Shyamnagar Upazilla, most of the respondents practice various types of cereals, timber or fuel trees, vegetables, spices and fish, crab species in paddy field as gher system or pond-dike system. The main purpose of such integration is to increase total productivity of smaller pices of land and make a cash beside meeting need for family consumption. The importance and benefits of integrated systems are discussed, involving animals with annual and perennial tree crops, integration with aquaculture, the significance of crop-animal interactions, stratification of the systems, production options, improved use of forages and legumes, potential for enhanced productivity, implications for improved livelihoods of the rural poor and the stability of farm households.

Table-2.2: Local and Scientific names of annual crops that practiced at Shyamnagar Upazilla:

Local name	Scientific name
Ada	*Zingiber officinale* Rosc.
Brinjal	*Solanum melongena L.*
Cucumber	*Cucumis sativus* Linn.
Dharosh	*Hibiscus esculentus* (L.) Moench.
Holud	*Curcuma longa* Linn.
Kochu	*Calocasia esculenta* (L.) Schott
Kumra	*Cucumbrita maxima* Duch.
Karolla	*Momordica charantea* Linn.
Morich	*Capsicum frutecans* Linn.
Olkochu	*Amorphophallus campanulatus* Bl.
Pui	*Baselle alba* Linn.

(Source: Field survey 2016)

Table-2.3: Local and scientific names of tree/fruit tree species that practiced at Shyamnagar Upazilla:

Local Name	Scientific name
Babla	*Acacia nilotica* Linn
Ghora neem	*Melia azadirach* Linn
Rain tree	*Samania saman* (Jacq.) Merr
Koroi	*Albizia procera* (Roxb.) Benth
Neem	*Azadirachta indica* A. juss
Mehagani	*Swietenia mcrophylla* king
Sissoo	*Dalbergia sissoo* Roxb.
Kazi Guava	*Psidium guajava* linn
Lemon	*Cytrus spp*
papaya	*Carica papaya* L.
Banana	*Musa spp.*

(Source: Field survey 2016)

2.15. Benefits from Aquasilviculture Practice:

Aquasilviculture Practice is an integrated operational unit in where a number of crops including timber trees or fruit trees are grown with fish production mainly for the purpose of satisfying the farmer's basic needs . It is the most prospective form of production site may far or along with the seat/shelter of the family. Homestead farm fulfill the basic needs of the family such cash, food, shelter etc and high species diversity help to reduce the environmental deterioration commonly associated with monoculture production system.

2.15.1. Cash:

The aim of integrated agroforestry system is to improve the income base of people living in rural Bangladesh. This is possible through producing and selling variety of crops as timber, fuel wood, different hybrid fruits, local vegetables, fresh water fish, shrimp (called white gold),Rice, according to household and farm size all the year round.

2.15.2. Fuel wood:

A wide variety of trees usually induce at intensive rice monoculture systems such trees like babla, neem, raintree, coconut for producing fuel woods and for generating cash. Lops and tops, producing during pruning and thinning, are used as fuel wood. Dry Leaves, small twigs, tree trunk supply fuel wood for most houses hold cooking.

2.15.3. Timber:

Another important product from integrated agro forestry system is supply of household timber. Trees e.g neem, gewa, babla, acacia, and rain tree are commonly planted in the study area for producing timber production.

2.15.4. Others benefits:

2.15.4.1. Fruit:

High value crops such as coconuts, mango, guava, banana, and citrus and other fruit trees are grown primarily for sale. They earn a good profit from selling seasonal fruits and vegetables from their farm.

2.15.4.2. Fodder:

Aquasilviculture is also an important source of fodder for rearing livestock. Tree species, such as babla (*Acacia ilotica*), sissoo (*Dalbergia sissoo*), rain tree *(Albizia saman),* ipil-ipil (*Leucaena lucocephala*) produce pod, green leaf and fodder. This is the main source of fodder for livestock.

2.15.4.3. Increased Employment Opportunity:

Aquasilviculture practice integrates diverse crops and aquatic organism so there is an opportunity to work round the year. Aquasilviculture practice offers diverse livelihood opportunities for operators and employees of hatcheries and seed nurseries, and for seed traders and other intermediaries. Labor is needed for field or dike construction, repairs, and fish harvesting. So this practice increased employment opportunity very much.

2.15.4.4. Utilization of Waste and Degraded Land:

The specific objective of the integrated agroforestry is to provide a tool for bringing the marginal and fragile land under integrated agroforestry. Integrated production system decreases the risk element which agriculture entails. If one component fails, the other can provide the critical mass for survival; the different components interact in a symbiotic and synergetic manner, enhancing overall production, optimizing resource use and thus providing for the subsistence needs of the household.

2.15.4.5. Environmental benefits:

Some fish species not only eat rice pests but also disease carrying organisms of human health importance, such as mosquito larvae or snails. When appropriate fish species are stocked in rice fields, the feeding of the fish on weeds and algae, and their subsequent excretion, not only reduces the need for herbicides but also increases phosphorus and nitrogen levels in the water. This therefore reduces the requirement for chemical fertilizers.

2.16. Effects of Annual Crops on Fish Production:

According to the farmers of the study area it was that fish production is hampered by annual crops. The leaves of annual crops may causes poisonous to the water. Sometimes it is very severe. The shade of crops is beneficial in the summer season because in that time the water is very hot but in the shady places the fish can stay. Sometimes it creates physical obstruction to the farmers when the catch fish. On the other hand, when the farmers give food to the fishes is also an obstacle to fall the food into the water.

2.17. Effects of Trees on Fish Production:

The farmers of Shyamnagar Upazilla practices aquasilviculture traditionally within fish production. They perceived that the practice is done for their own satisfaction and household consumption and to earn money. They perceived that trees has more or less important role in terms of production. Though in this area there is no natural forests so, the villagers meet their demands of wood, firewood and other forest products from their village forests as well as traditional agroforestry products. In conclusion we can summarize that farmers perceive that trees moderately affect their agricultural crops. They perceived that the aquasilviculture does not hamper their traditional agroforestry system and it has a great role in managing, space utilization and water holding capacity.

CHAPTER –THREE

MATERIALS & METHODS

3.1. Materials and Methods

An exploratory survey was conducted over a period of three months from April to June 2016 at shyamnagar upazila in shatkhira district to explore information regarding the socioeconomic condition of the farmers, status, benefits and management techniques of aquasilviculture practice.

3.1.1. Description of the study Area:

Shyamnagar is located at 22.3306°N 89.1028°E . It has 46,592 households and a total area of 1968.24 km².Shyamnagar Upazila is bordered by Kaliganj (Satkhira) and Assasuni upazilas to the north, the Sundarbans and Bay of Bengal to the south, Koyra and Assasuni upazilas to the east and Hingalganj (community development block) in North 24 Parganas district in the Indian state of West Bengal to the west. The main rivers here are: Raymangal, Kalindi, Kobadak, Kholpetua, Arpangachhia, Malancha, Hariabhanga and Chuna. South Talpatti Island at the estuary of the Hariabhanga is notable.

Shyamnagar Thana was turned into an upazila in 1982. It consists of 12 union parishads, 127 mouzas and 216 villages. The average literacy in the entire upazila is 28.1%, comprising 38% among males and 17.4% among females. There are five colleges, 28 high schools, 98 madrasas and 96 government primary schools. The main occupation of the people is agriculture, 32.93% of whom are engaged with this work. The main exports are Paddy, jute and shrimp. Shyamnagar is the largest thana of Bangladesh.As of the 1991 Bangladesh census, Shyamnagar has a population of 265004. Males constitute 50.46% of the population, and females 49.54%. This Upazila's eighteen up population is 132516. Shyamnagar has an average literacy rate of 28.2% (7+ years), and the national average of 32.4% literate. Shyamnagar has 12 Unions/Wards, 127 Mauzas/Mahallas, and 216 villages. ("Population Census Wing, BBS.". Archived from the original on 2005-03-27. Retrieved November 10, 2006).

The unions are:

1. Vurulia (Bhurulia)
2. Kashimari
3. Shyamnagar Sadar
4. Ishwaripur
5. Burigowalini
6. Koikhali
7. Munsigong
8. Nurnagar
9. Podmopukur
10. Ramjan nagor
11. Atulia
12. Gabura, which was the most severely affected union of Satkhira district by cyclone Aila(Banglapedia2013).

3.1.2. Selection of the study area & Respondents:

The study was contdcted in shyamnagar upazilla in shatkhira district of Bangladesh through two month from March 2016 to April 2016. The sampling design for the survey was purposive sampling because of the uneven and discrete distribution of aquasilviculture land in the region. In my field survey, the sampling units were selected by some stages (purposive multistage sampling). During the reconnaissance survey the area selected where aquasilviculture practices are predominant. This had been done by the information collected from personnel of GO's and NGO's at district levels and Upazilla levels who are involved in aquasilviculture and forestry extension. Besides public representative such as Upazills chairmen and locals were consulted. Based on this secondary information a physical verification of the secondary information about aquasilviculture practices were done by travelling into the aquasilviculture fields of the Upazillas.In these way five unions from the Upazillas was indentified for sampling. Form these five unions, two villages from each union, were selected according to the procedure followed above for union selection. Here, in addition to GO's and NGO's personnel, union council members, local farmers and key personnel of the area were consulted for information on aquasilviculture about the respective unions.

From ten villages 103 farmers/respondents were selected by snow ball sampling method, where the aquasilviculture practices were most predominant. Five unions named Burigowalini, Munshiganj, Koikhali, Ishwaripur and Ramjan nagor.

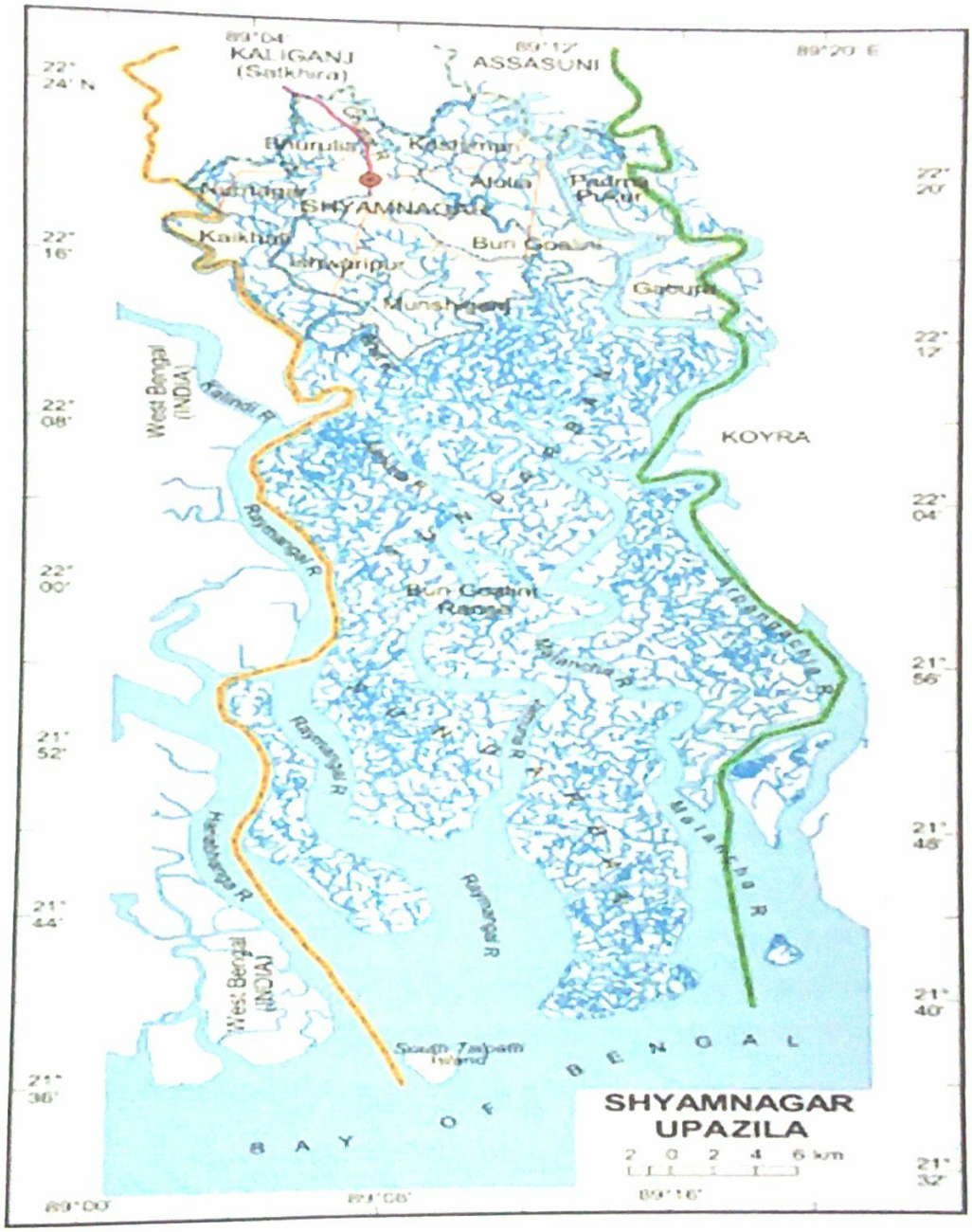

Fig-3.1: Map of the study area (intobd.wordpress.com).

3.1.3. Reconnaissance Survey

After collecting preliminary information, reconnaissance survey was carried out to know about the existing aquasiviculture of the study area to prepare a set of questionnaire to fulfill the study.

3.1.4. Questionnaire survey

In order to obtain relevant information, the interview schedule was carefully designed keeping in mind the objectives of the study. The formal survey of each union was carried out by using the semi-structured questionnaire, and data was collected from both primary and secondary sources. The questionnaire were asked in Bengli language but written in English language. The questionnaire covered on:

- Information about the respondents
- About their income sources
- Information about aquasilviculture practice land
- Infomtion about fish and vegetation preferred for aquasilviculture,
- Mnagement strategy
- Problem of practicing aquaslviculture
- Recommendation from respondent

3.1.5. Likert Scale:

A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. The scale is named after its inventor, psychologist Rensis Likert. Likert distinguished between a scale proper, which emerges from collective responses to a set of items (usually eight or more), and the format in which responses are scored along a range.The format of a typical five-level Likert item, for example, could be:1.Strongly disagree 2. Disagree 3. Neither agree nor disagree or neutral 4. Agree 5. Strongly agree.

Strongly Disagree(1)	Disagree(2)	Neutral(3)	Agree(4)	Strongly Agree(5)

3.1.6. Procedure of data collection

In order to fulfill the objectives set out for this study, relevant information and literature were collected from the following two sources:

3.1.6.1. Primary sources

The primary data has been collected by conducting a survey work with a well-prepared structured questionnaire. For this reason, interview was conducted with randomly selected respondents, done by physical visit to the study area. The information discussion with the participants and villagers of the target areas also conducted.

3.1.6.2. Secondary sources

Secondary information was collected from the following sources:

- Khulna University Library, Bangladesh.
- Seminar Library, Forestry and Wood technology Discipline, Khulna University.
- Different Web Sites.

3.1.7. Data processing and Analysis

After collecting information from primary and secondary sources, data are processed and analyzed in IBM SPSS statistics (version 20).

3.1.8. Report Writing

After successful completion of primary data analysis and arrangement all primary and secondary information, a draft report was fully finalized after some corrections.

CHAPTER FOUR

RESULTS

And

DISCUSSION

4.1. Demographic and socio-economic content of the respondent

Now at this time aquasilviculture is a common practice in our country. For these point of view most of the village in our country people are already practice aquasilviculture. At shyamnagar upazila most of the people are already involve about aquasilviculture. They also develop their income level and change their livelihood strategies to practice aquasilviculture. A total 103 respondents were interviewed from various places like house, field, market and other several places. A semi-structured questionnaire was used to collect essential information from the respondents. The different social and economic indicator was educational status, land pattern, ownership status, previous land use etc.

4.1.1 Percentage of respondents according to their sex:

In the field survey, it is found that about 100% respondents are male and directly involved where as female are indirectly involved in such activities at shayamnagar upazilla.

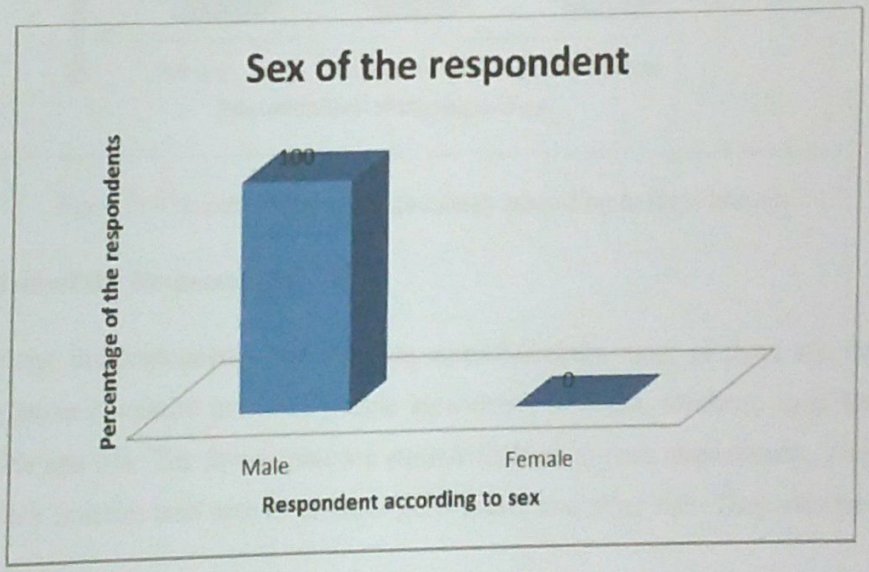

Fig -4.1: percentage of respondent according to sex

4.1.2. Educational Status of the Respondents:

Education is considered as a crucial factor for progressive attitude of the respondents towards the adoption of modern technology. The respondents who practice aquasilviculture about 59% have primary education. They have very little education scope and 26% of respondents have secondary education and 15% had higher secondary educations who are practicing aquasilviculture for their extra income.

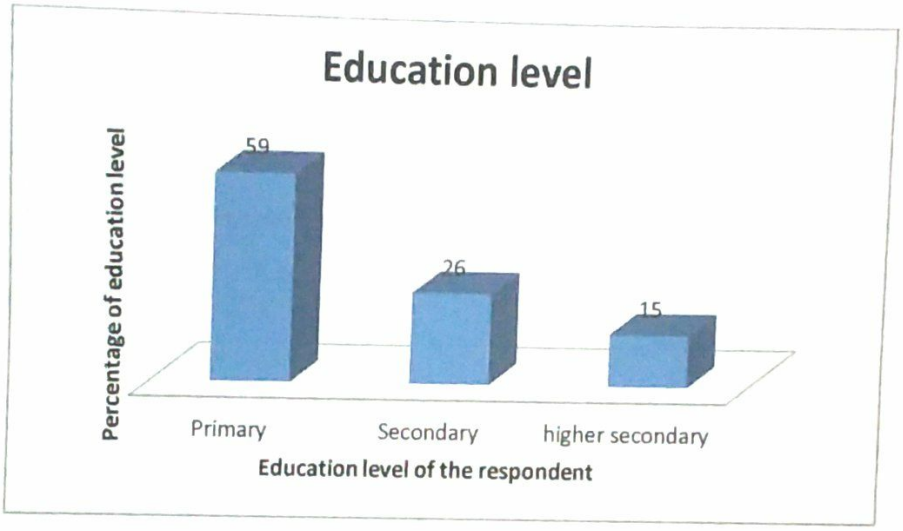

Fig-4.2: The percentage of respondents according to their literacy.

4.1.3. Occupation of the Respondents:

In the area among the respondents who practice aquasilviculture most of them are farmers (64%). Among aquasilviculture practiced people agriculture, business, teaching, shop keeping are 18%, 5%, 7% and 6%. The farmer practice aquasilviculture to earn more money. They use this money in their practice land area to produce good prawn and other fish. They also buy fish food from this money..

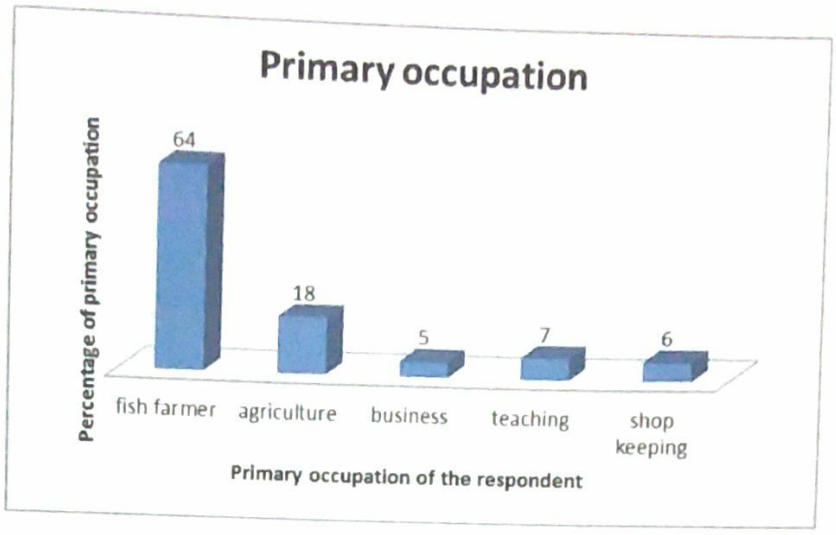

Fig-4.3: The percentage Primary and secondary occupation of the respondents

4.1.4. Income of the Respondents:

Aquasilviculture practice is not very new technology in our country. By practicing aquasilviculture farmers can achieve their livelihood security as well as conserve the biodiversity. In Shymnagar Upazilla, most of the farmers practice aquasilviculture for their livelihood. The annual incomes of the respondents are categorized into three types. About 27% respondents practiced aquasilviculture whose income is (50000-150000 lakh) taka and about 4 % is (150001 lakh-250000 lakh) taka and 25% respondents income is about 250001-3000000 lakh taka per year. Above 44% people earn above 300000 lakh taka per year only practice aquasilviculture.

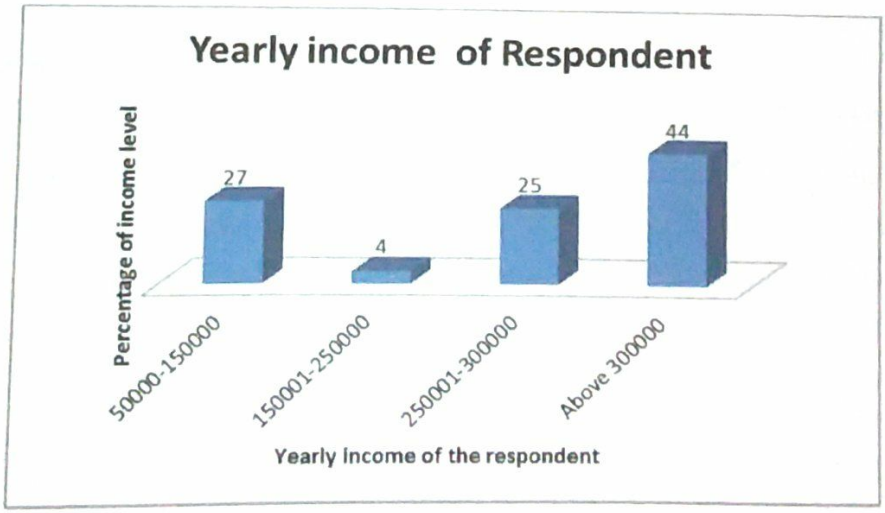

Fig-4.4: The percentage of Yearly income of the respondent

4.2. About aquasilviculture practiced land at shyamnagar Upazilla:

4.2.1. Total area of fish farm of the respondents:

Total 103 people in my survey where 30% farmer have 1-10 bigha fish farmand 44% of people have 11-20 bigha fish farm. Here also show that about 26% people have above 25 bigha fish farm in my area.

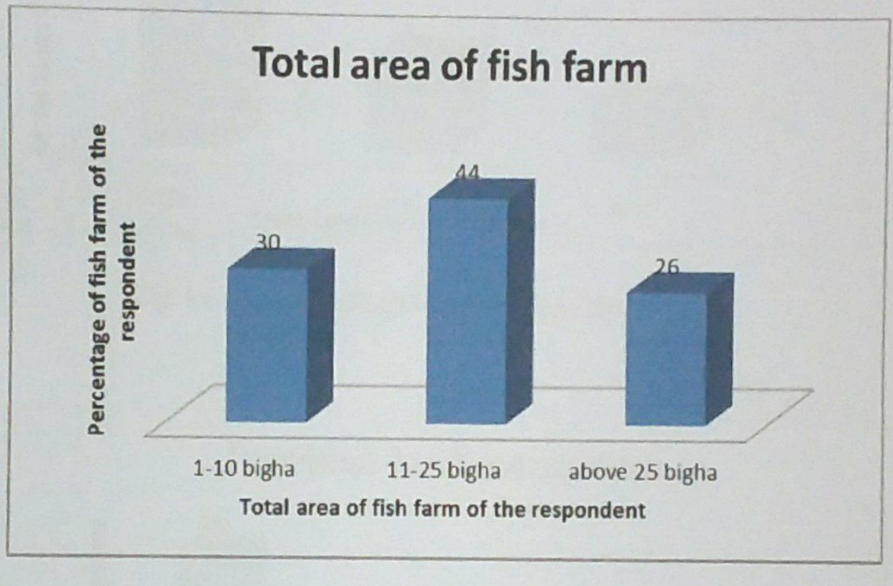

Fig-4.5: The percentage of total area of fish farm

4.2.2. Ownership Status & previous land use system of the Respondents:

Among the respondent about 70% use their land singly. Because of land scarcity they lease land and have to pay a certain amount of money according to the productivity of land, about 19% done only with joint land and a small part of respondent 11% use leased land with own land to increase farm size. Generally farmer has to maintain a positive relation with adjacent land owner to avoid conflict and to secure their farm stability.

It was found that 70% respondent for aquasilviculture use the land which was previously used for paddy cultivation. Only 19% and 4% and 7% respondents used fallow land, unused land and old fish pond respectively for practicing aquasilviculture.

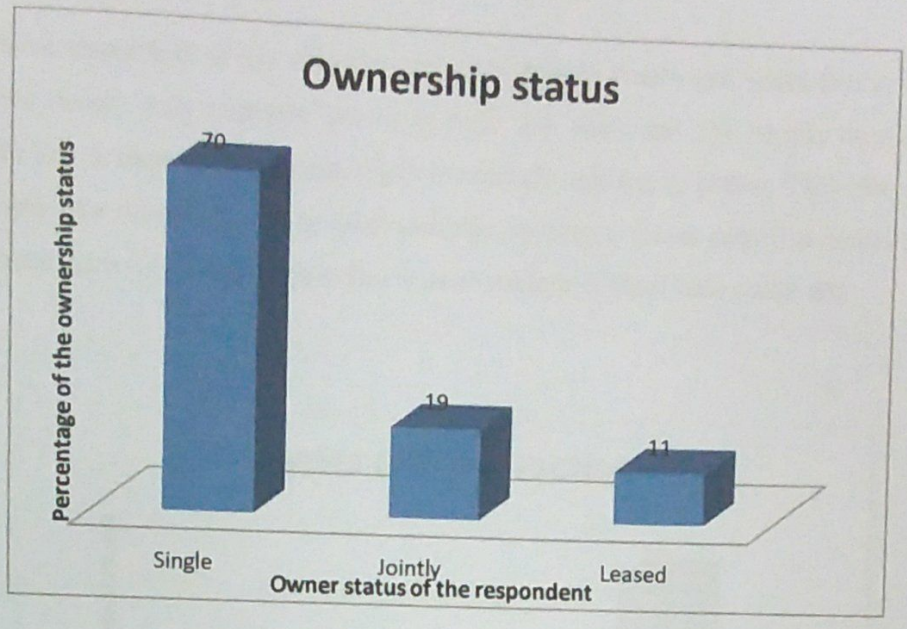

Fig-4.6: The percentage of ownership status

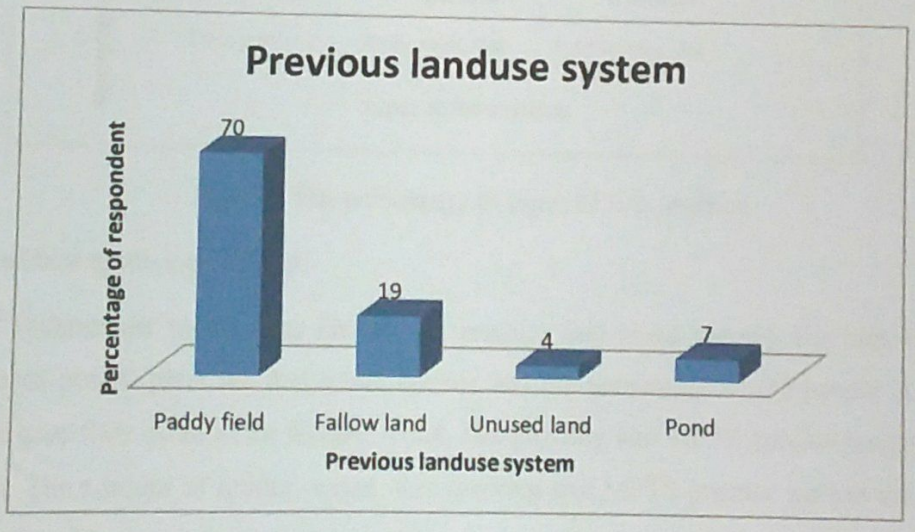

Fig-4.7: The percentage of previous land use system at shayamnagar upazila

4.2.3: Types of fish practice:

73% of the total respondent in my area that are practice both prawn and white fish at the same time and 26% people only cultivate prawn in their fish farm and 1% people they can only practice white fish in their fish farm area. They are mainly cultivating prawn. They also cultivate fresh water fish like Silver carp (*Hypophthalmicthys molitrix)*, Grass carp (*Ctenopharyngodon idella)*, Common carp (*Cyprinus carpio)*,Rui (*Labeo rohita)*, Catla (*Catla catla)* etc.

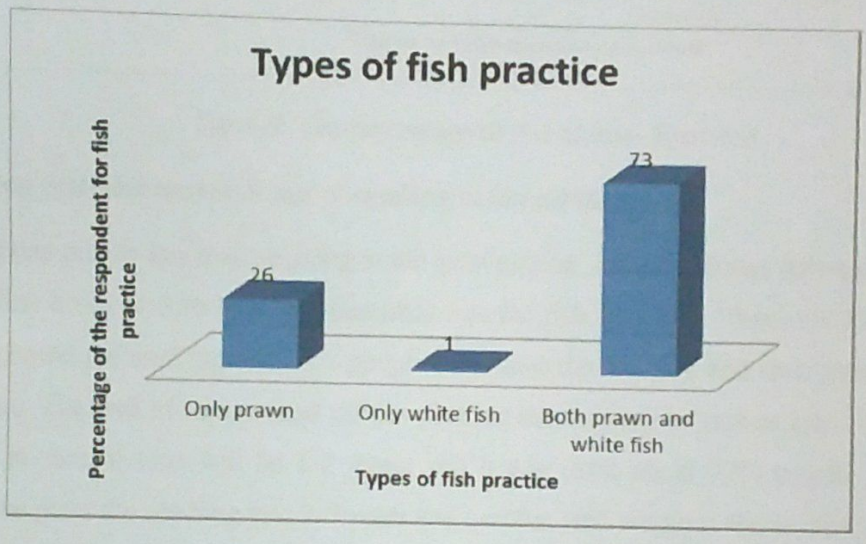

Fig-4.8: The percentage of types of fish practice

4.2.4: Types of tree species practiced:

In the area of shyamnagar most of the farmers are practice fuel wood species. For their choice most of the cases people plant the fuel wood species and the percentage of the people is 48%, another people give their opinion for fodder, wood, fast growing and MPTS species practiced in their gher area. The amount of fodder, wood, fast growing and MPTS practice people are 21%, 17%, 8% and 6%. They mainly plant koroi *(Albizia procera)*, Babla *(Acacia nilotica)*, Neem *(Azadirachta indica)*, Guyava *(Psidium guajava)*, Lemon *(Cytrus spp)*, Banana *(Musa spp)*, Gewoa and so on to get fuel, fodder and kinds of benefits.

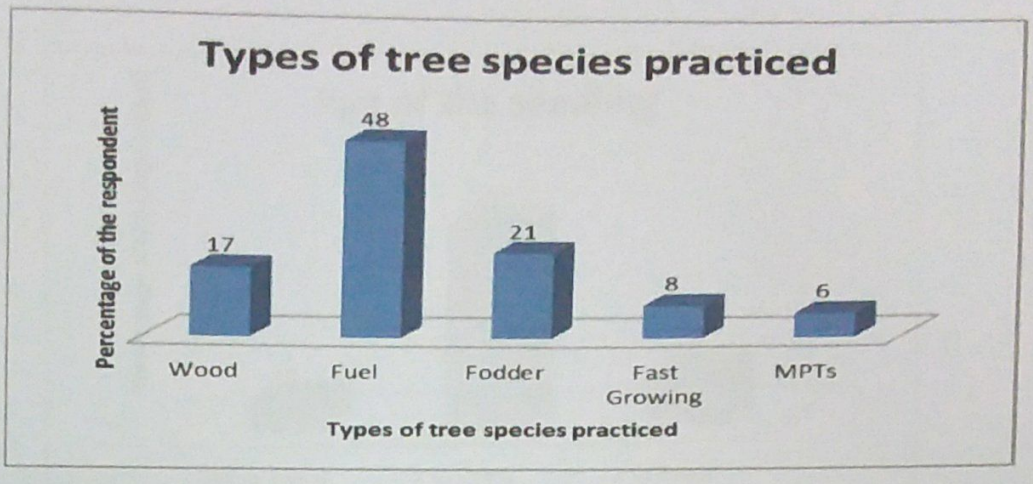

Fig-4.9: The percentage of tree species practiced

4.2.5: Planting material source & age of seedling at the planting time:

Most of the cases people buy their seedling in the local market. And sometimes they can raise the seedling in their home or own land and then plant into the fish farm side. There are 85% people who are purchased the seedling and 15% people they raise the seedling and then plant into the fish farm dyke. The area of shyamnagar people planting the seedling in june or july. The age of the seedling in several time will be 1-2 years, and it was done about 72% people, and 18% people who are plant the seedling into 2-3 years and another 10% are plant the seedling bellow 1 year. And it may be vary at 7-10 months.

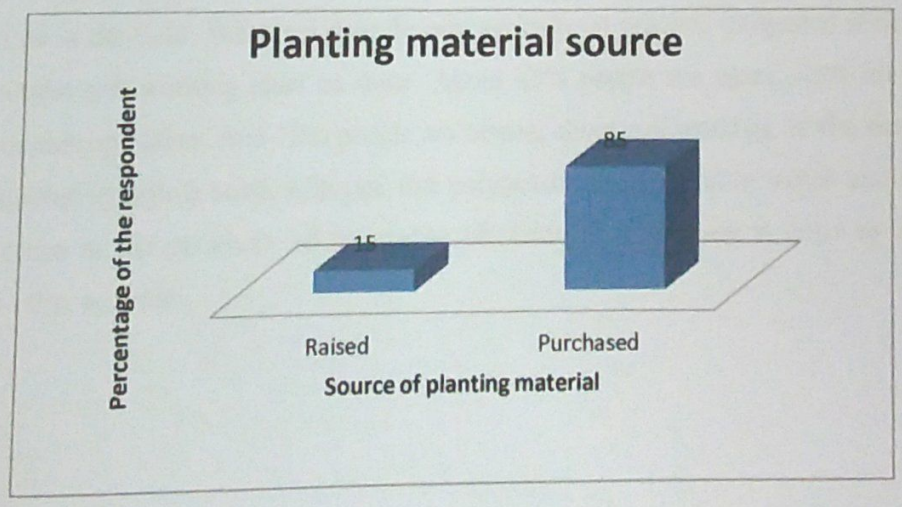

Fig-4.10: Percentage of planting material source

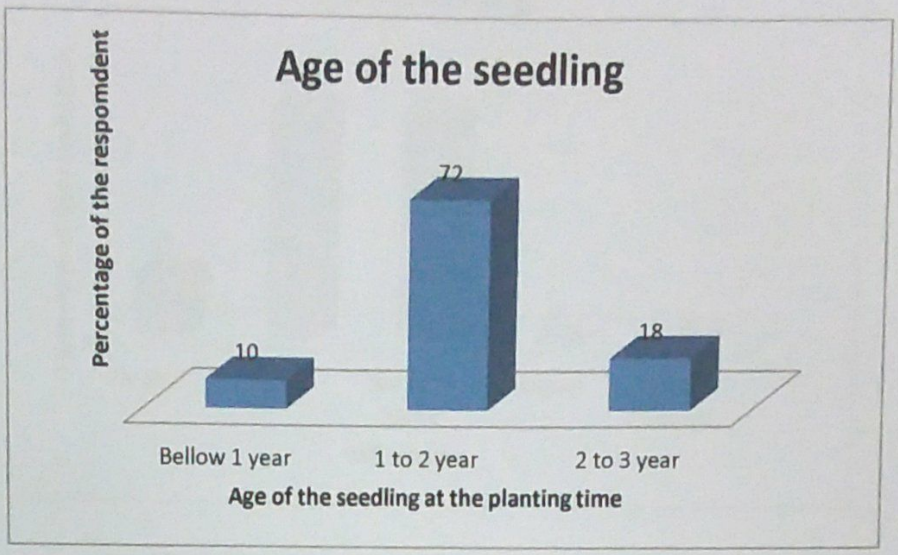

Fig-4.11: Percentage of the age of seedling

4.3: Management strategies:

4.3.1: Soil working

One of the most conspicuous characteristics of traditional agricultural technology is the diversity of crops employs. It is typical for a subsistence household to employ a number of cropping system and variety of crops within each of those cropping system, including the inter planting of different crops in the field. Whatever they do any agricultural practice integrated with fish and other component soil working must be done. About 45% people are agree, 43% are strongly agree to done this operation. And 12% people are neutral about soil working. In the study area a general integrated system is starts with rice fish polyculture in the pond or trench and trees and other dike crops in the periphery of the paddy platform. Soil working is done by plugging, digging and other activities.

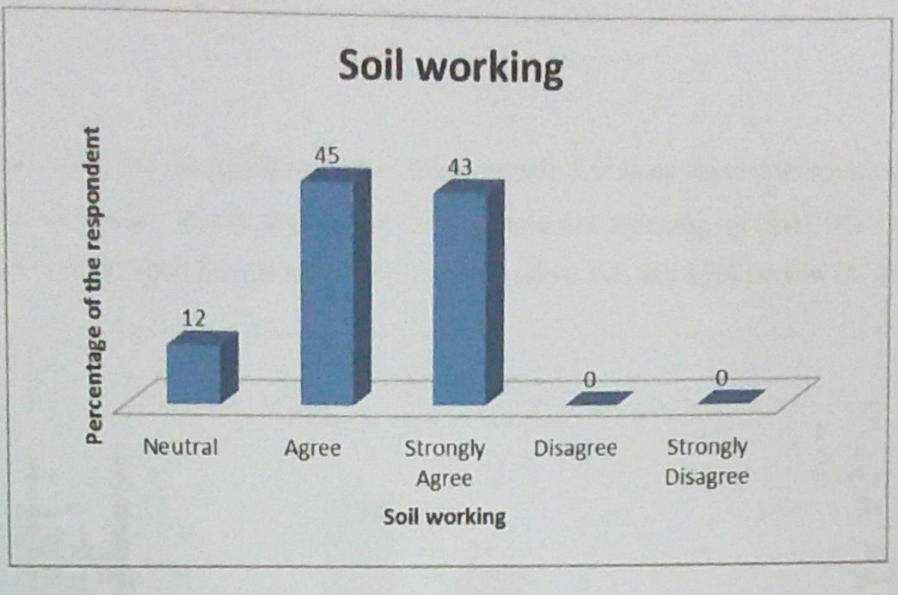

Fig-4.12: Percentage of soil working

4.3.2: Weeding

Weeding is done by cutting back all weeds that will complete with crops for food and nutrition in the same land. So it required for well growth of crops and free movement of fish as well as to increase yield. Weeding is done during making seed bed, transplanting of seedlings, after two or here month of sowing when seems to be need. It is practiced most of the people.45% people are agree about these operation, 39% people are strongly agree and 11% people are neutral.

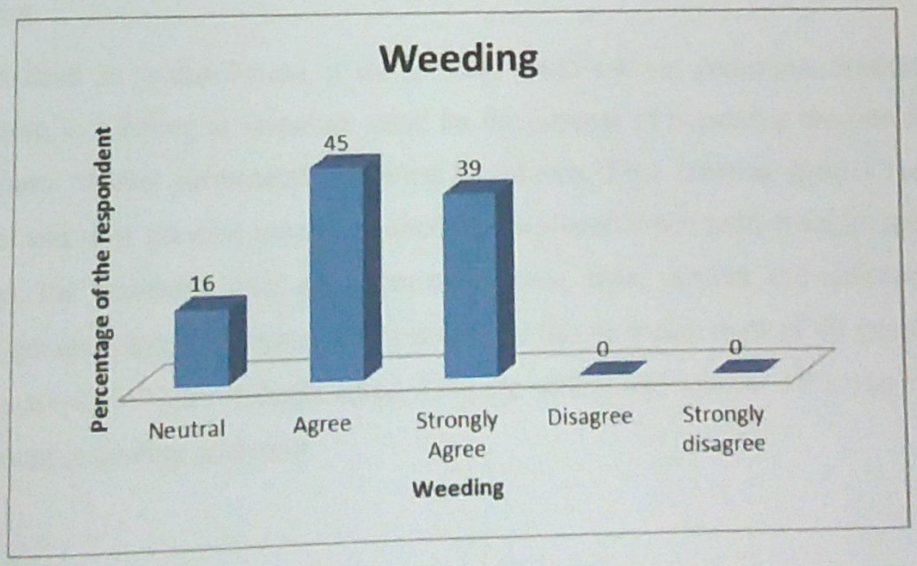

Fig-4.13: Percentage of weeding

4.3.3: Pruning

Pruning is mainly done for the improvement of trees growth. For done these operation trees can be grow as well as better. In my area about 51% people are agreeing to done his types of operation and 34% of the total people are strongly agreed about this and 15% people are neutral.

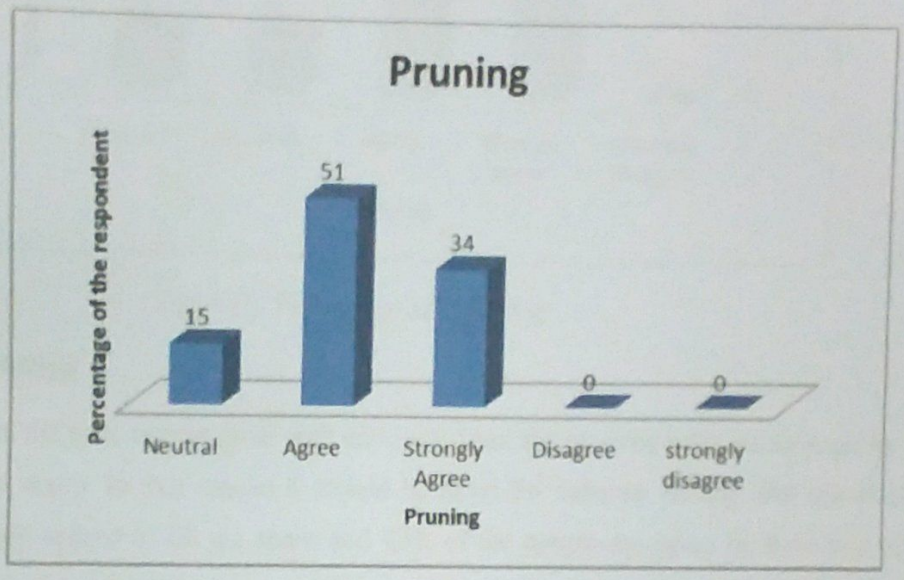

Fig-4.14: Percentage of pruning

4.3.4: Thinning

Thinning is defined as re-distribution of the growing space without permanent breaking the canopy. Thinning is a felling in immature stand for the purpose of improving the growth and stem of the trees without permanently breaking the canopy. First growing species required thinning earlier and slow growing species required thinning later. When some trees are removed from the stand, the remaining trees are given more space, light, nutrient and moisture thus affecting their general physical process. In my area done this operation most of the people and about 44% are agree, 34% are strongly agree, 11% are neutral and another 11% who are not involve to done these tending operation.

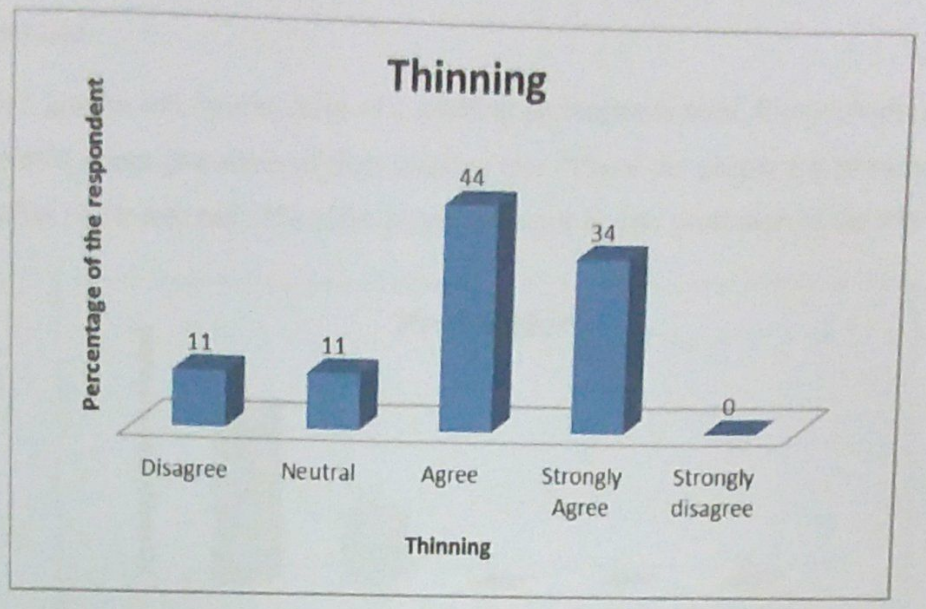

Fig-4.15: Percentage of Thinning

4.3.5: Vacancy felling

Some of the cases the trees cannot grow well and sometimes the planting trees are damage by the animal and other ways. In that reason it should be done for vacancy felling. But about 38% people are strongly agreed to fill the space and 40% of the people are agree to done this work and11% people are neutral to give their opinion. Another 11% people who are disagreeing to do this work during the lack of some technical assistance. Mostly they have done this operation in june-july.

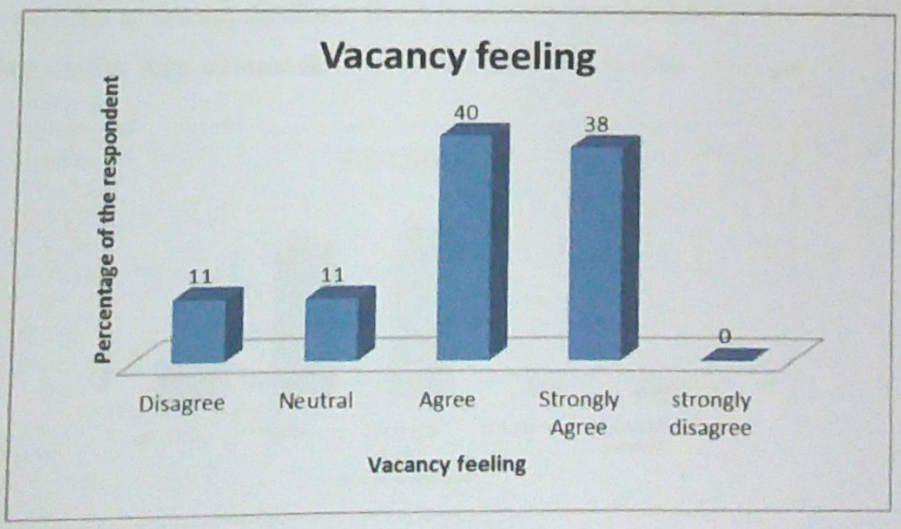

Fig-4.16: Percentage of vacancy felling

4.3.6: Protection

For the good growth and development of a seedling protection is need. Every people give their positive opinion about protection of their planting tree.71% of the people are strongly agree to give protection of the tree and 29% of the people are agree to give protection of the tree.

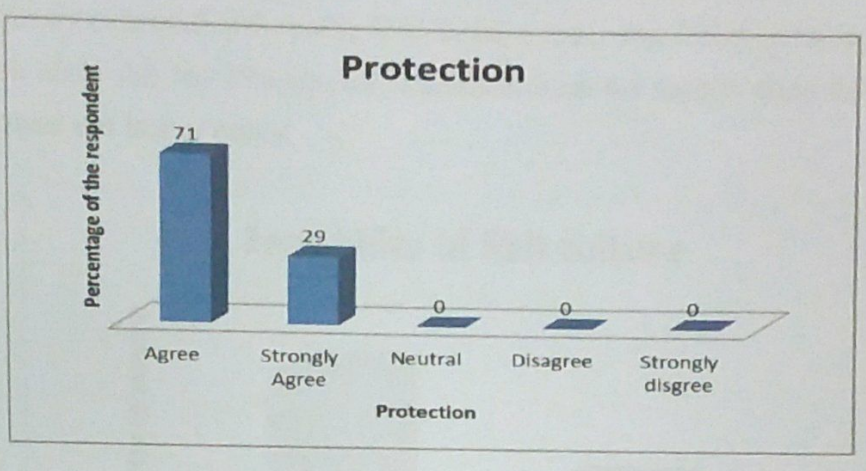

Fig-4.17: Percentage of protection of seedling

4.3.7: Fertilizer

It is observed that about 46% respondent are strongly agree to use both organic and inorganic fertilizer. Respondents use urea and cow dung as fertilizer. Outer fertilizer is urgent need as crop residues and animal dung are not kept in the field; this are collected for by poor people for making cooking fuel.42% people are agree to use these fertilizer in the seedling but about 12% respondents who are not to use any fertilizer. But it is mention that fertilizer is normally applied twice per cropping season, they increase dosages if they think land is tried.

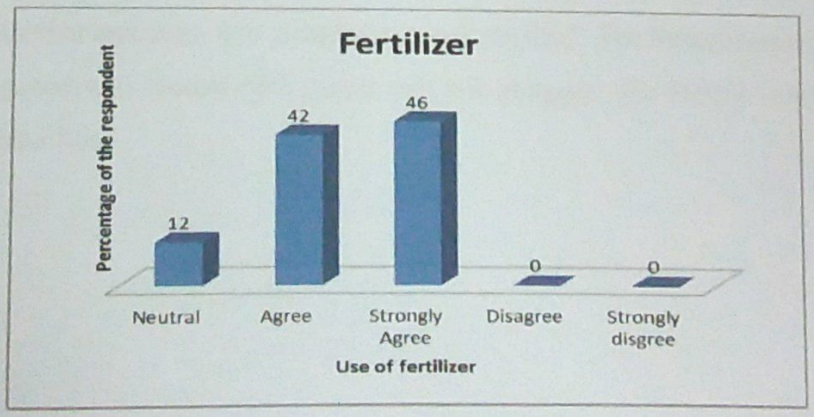

Fig-4.18: Percentage of use fertilizer

4.4. Feasibility of fish culture

Aquasilviculture is a good technique where many types of fish and tree or crops are cultivated in a same time. But many people cannot do this work for proper management and lack of proper education of these. In that case some people cannot support these types of practice where fresh water fish, prawn are cultivated in the paddy field during a same time.72% respondent give their positive opinion about this but 28% percent respondent doses not support those thing during proper management and lack of capital.

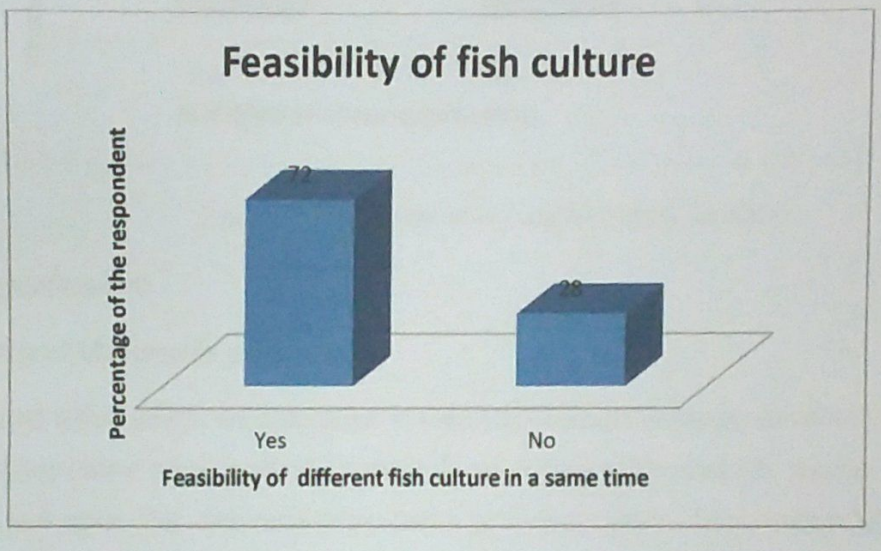

Fig-4.19: Percentage of feasibility of fish culture

4.5. The infrastructural facilities

Lack of good infrastructure facilities people cannot severally practice aquasilviculture and this reason fish production and crop, tree production is not satisfied. The infrastructure facilities are good said 70% people and another 30% people said it is not good. But overall view they are not totally agreed about this.

Fig-4.20: Percentage of the infrastructural facilities

4.6. Market preference

4.6.1. Availability of Marketable products

All of the products which people are cultivating in their land the marketable products are good. 34% of the total respondent are strongly agree about the good marketable products, another 46% respondent are said agree. But 20% respondent cannot give their opinion because they are not satisfied to sell their product in the market.

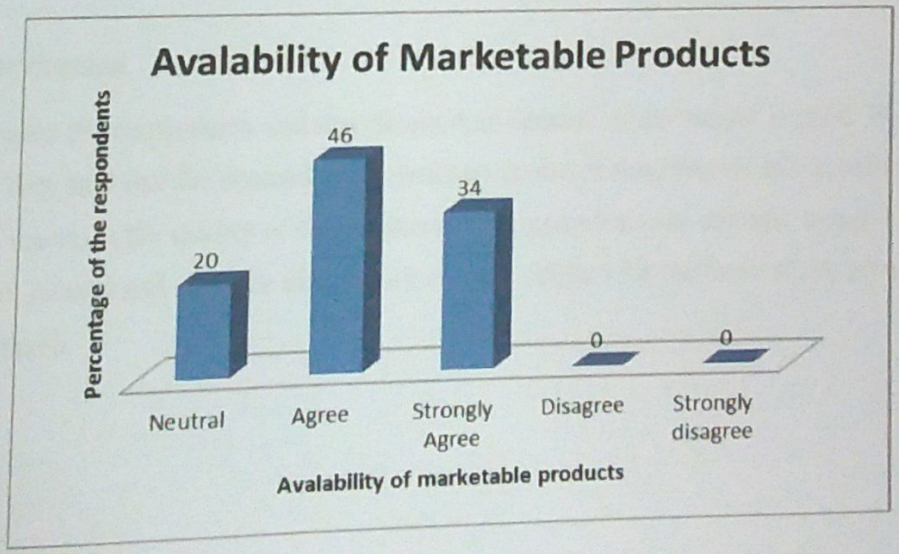

Fig-4.21: Percentage of the marketable products

4.6.2. Market facilities

The product value ability is depending on the market facilities. At shyamnagar upazila farmers products facilities in the market is moderate.44% respondents are agree about good facilities of the market, 32% are strongly agree, 11% are neutral, 11% of the respondents are disagree about the market facilities and only 1% respondents are strongly disagree. And they think that if the market facilities will be develop than the product demand are prize also increase.

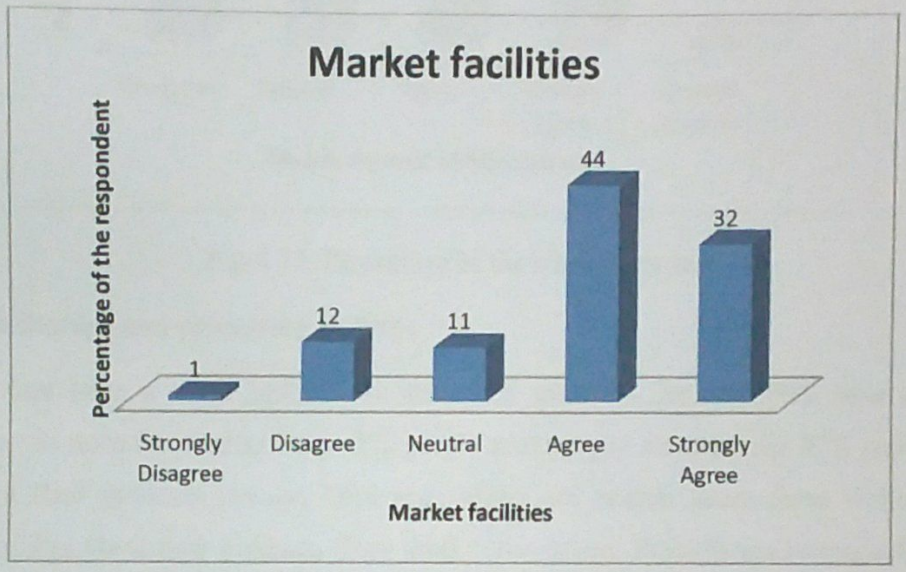

Fig-4.22: Percentage of the market facilities of the product

4.6.3. Market demand

Most of the cases the respondents said that the product demand in the market is good. But some of the people they said that the demand of the products is now at this time are fall in before time. And its main reason is the quality of the products.36% respondents are strongly agree, 42% are agree, 12% are neutral and 10% are disagree about their opinion for the basis of the products in the market demand.

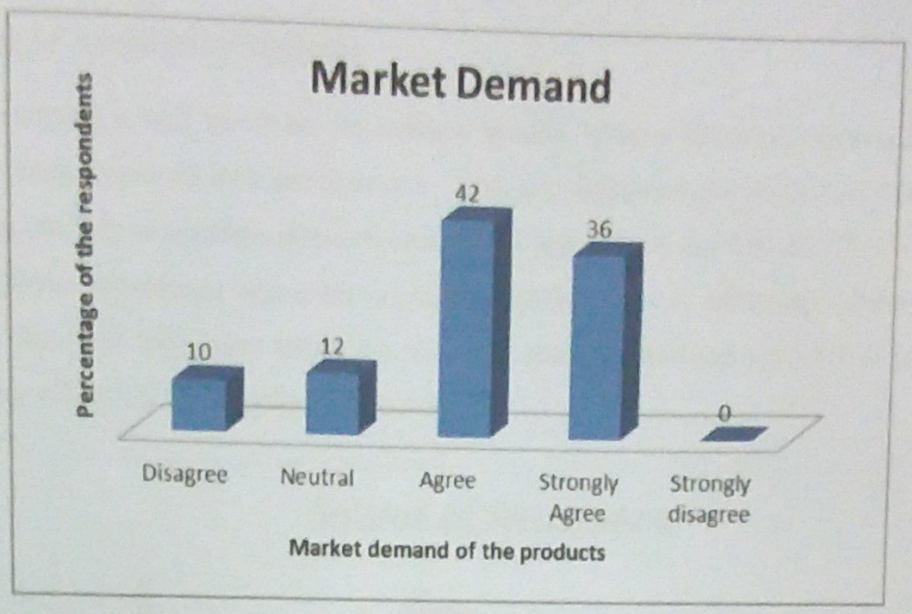

Fig-4.23: Percentage of the market demand

4.6.4. Market Storage and processing facilities

Every respondent have a major problem to store their products. Because they have no any alternative way to store the products and 45% people are strongly disagree and 37% people are disagree about their products storage. 18% respondents are neutral about these storage and processing facilities about their products. They think if the storage facilities are increase than the products demand also increase and they get more profit about this.

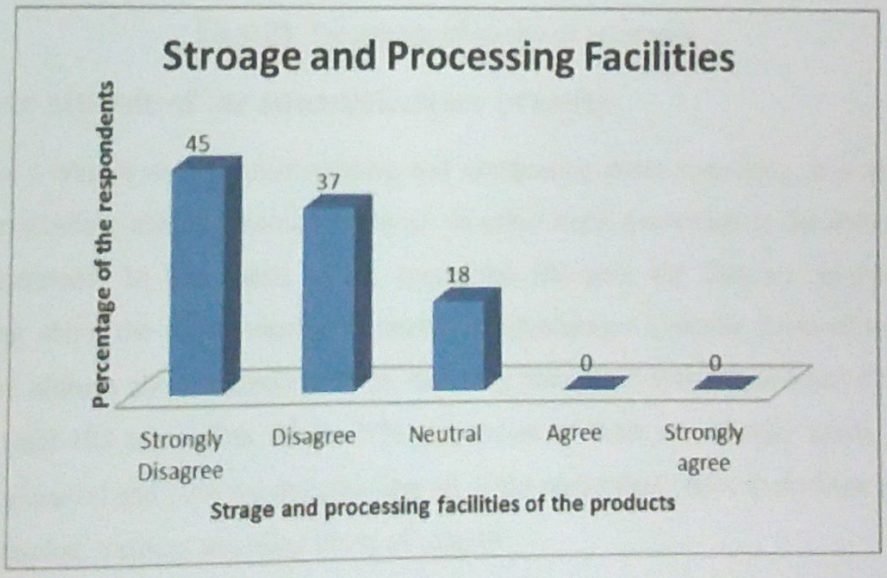

Fig-4.24: Percentage of the storage and processing facilities

4.7. Source of Assistance/Support

The NGO is playing a vital role in the shyamnagar upazila. Most of the respondents said that the NGO is the main source of their development. They got different types of benefit like capital, seed etc. that are help to practice aquasilviculture. 48% respondents got help into the NGO, 17% people said forest department help them to practice aquasilviculture, 14% respondents get help many ways like bank loan, local samiti etc. and 21% people cannot get any kind of help. And those are very effect full for aquasilviculture practice.

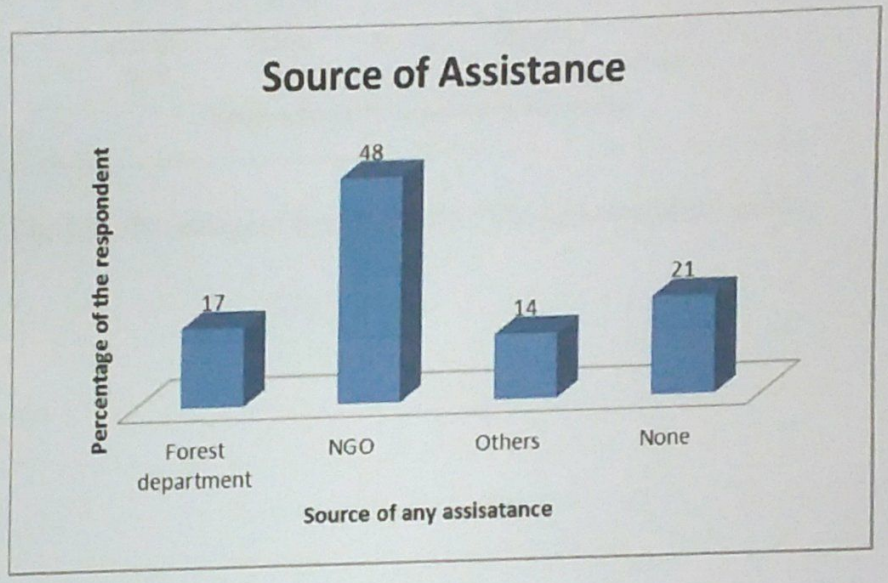

Fig-4.25: Percentage of source of assistance

4.8. Farmer attitude of the aquasilviculture practice

Perception is a way of seeing, understanding and interpreting about something, it is the deeper natural understanding and awareness than usual. In other word, perception is the ability to see, hear or understand. In this thesis paper, perception indicates the farmer's awareness and understanding about the aquasilviculture systems at Shyamnagar Upazilla. Most of the person has a positive attitude about aquasilviculture. And they have to do about these types of practice. In my area total 103 respondent where 27% respondent of them are strongly agree, 54% are agree, 9% are neutral and 10% are disagree. But all of the respondents want to do those practices, if they get a capital, training and other kinds of support.

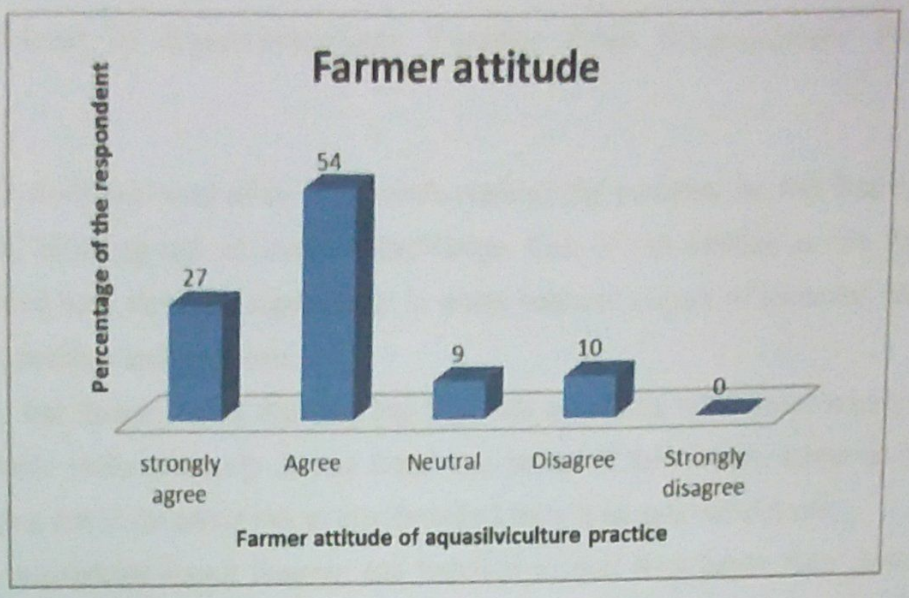

Fig-4.26: Percentage of farmer attitude of the aquasilviculture practice

4.15. Problems of Aquasilviculture Practice from Respondents' Points of View:

- In the study area most of the respondents reported that problems for fish farming in rice fields, including lack of technical knowledge. Cost of fish farming in rice fields was reported have increased significantly in recent years as a result of increased fish, seed, feed, fertilizer and labor cost.
- Very few farmers noted that they had high fish mortalities when their neighbors used pesticide indiscriminately .It was found that better-off farmers are active in rice-fish farming due to the taking risk as they described there is no gain without risk.
- The respondents expect financial and technical support from larger farm owner, both fisheries and forestry extension officer so that they are able to handle farm effectively and aquasilviculture could be the most wanted and promising cropping system.
- Preventing fish escape is very difficult during the flood.
- Especially for small farmers who are reluctant to raise their low and narrow dikes.
- During aquasilviculture practice fish harvesting also very difficult to the farmer.
- Doughtiness causes low water levels and high water temperature, all farmers also reported higher fish mortality occurred due to virus and it is single most damaging factors hampers production also our national economy.

CHAPTER-FIVE

CONCLUSION & RECOMMENDATION

5.1. Recommendations:

- Government should establish training center for developing aquasilviculture practices at the Upazilla level of the study area so that Local people can take training and technical advice.
- Financial assistance should be given to the local people who are interested in aquasilviculture practices.
- The suitable plant species, good quality seed, seedlings and good quality Fish fry and Golda fry which are appropriate for the area should be supply to the poor farmers. Storage facilities also are increased.
- Various NGO's, bank and other organizations that provide soft loan to the farmers should be given with low interest.
- The governmental policies, strategies, and plans for farm management should be formulated and implemented.

5.2. Conclusion:

Aquasilviculture is the fairly complex technology. The biological merits of integrated cropping make it an important conservation farming practice for small holders and resource poor farmers. Aquasilviculture is the combination of fishes, trees and annual crops which provides alternative livelihood options for the local poor peoples and farmers. In local farming system farmers can not capable to fulfill their needs. In that case they practice aquasilviculture for their alternative source of income that is provide rice, fishes, trees and crops at the same time. Some of the cases trees and crops have some effects on fish production by falling leaf and small brunches (28% of the total respondents). But most of the farmers (72%) think that there are no effects on the fish production. On the other hand, there are good market facilities for shrimp and excellent for annual crops. The market types of annual crops and shrimp and fish are fully competitive with poor storage and processing facilities (82% of the total respondents) .During the natural calamity, different crop disease and massive mortality of fish causes serious loss. But all of the problems people considered and very much interested to practice aquasilviculture at shyamnagar upazila in shatkhira district.

CHAPTER –SIX

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6.2. Appendix

Appendix-one

(Practice of Aquasilviculture at Shyamnagar Upazila in Shatkhira District)

Field Survey Questionnaire

Date:

Survey No:

A. General information of the Respondent:

1. Name of the owner of the aquasilviculture practice land:

Name	Sex		Literacy			Occupation		Total income/year
	Male	female	Primary	Secondary	Higher Secondary	Primary	Secondary	

B .About aquasilviculture practice land:

2. Location of the aquasilviculture practice land:

3. Ownership status: a) jointly b) Leased

If leased, how much money have to pay per year for ha/bigha?

4. Ownership pattern: a) jointly b) single

If jointly, for why?

5. Previous land use system:

6. Area of the aquasilviculture practiced land (ha):

7. Which type of land is preferred for aquasilviculture practice?

8. Which type of fishes is practiced?

9. Time of rising fish:

10. Treatment for fish: a) Yes b) No

11. Types of tree species is practiced

Wood	Fuel	Fodder	Fast Growing	MPTS	Fruit

13. Source of planning material/seedling: a) Raised **b)** Purchased

If raised, then source of the seed:

14. Age of the seedling at the planting time:

15. Height of the seedling at the planting time:

16. Species preference

Highly planting tree species	Moderately planting tree species	Less planting tree species

C). **Management Strategies**

Mgt. strategies	Mgt. Schedule	Strongly Disagree(1)	Disagree(2)	Neutral(3)	Agree(4)	Strongly Agree(5)
Soil working						
Weeding						
Pruning						
Thinning						
Vacancy feeling						
Protection						
Fertilizer						

17. In paddy field is it feasible for shrimp, prawn and fresh water fish culture at a same time:

18. The infrastructural facilities (shrimp hatcheries, grow out and nursery ponds) are available or not:

19. **Products preference**

Marketable products	a)Timber b)Fuel c)Vegetables d)Fish e)Prawn f)others	1	2	3	4	5
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Market facilities	1	2	3	4	5	
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Market demand	1	2	3	4	5	
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Storage and processing facilities	1	2	3	4	5	
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	

20. Source of any help?

a) Forest Department b) NGO c) Others d) None

D) Problems of aquasilviculture:

E) Recommendation from respondent:

F) Recommendation from researcher: