Impacts of commercial drugs and chemicals on aquaculture in north-east Bangladesh

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ABSTRACT

Bangladesh has a lot of water bodies which are very suitable for fish cultivation. Fish farming is increasing every year in Bangladesh. With increasing aquaculture, the use of various chemicals and drugs are also increasing day by day. This study was designed to find out the chemicals and aqua drugs used in aquaculture and their impacts on fish production in north-east part of Bangladesh. It is rich in natural and farmed fishes. The study was conducted between March 2018 and April 2019 using prearranged questionnaire. Data was collected from administer to operations of many farms groups, such as markets survey, focus group discussion with nursery and culture farmers, farm managers, fish hatchery owners, fisheries professionals, retailers and whole sellers of aqua products and representative of pharmaceutical companies. Fish farmer's usually used a variety of aqua products to solve various problems. These drugs and chemicals included a variety of disinfectants, natural food enhancers, and harmful insecticides, various parasite, harmful gas remover, artificial oxygen releasing products, predatory fish killer, and fish control products etc. The Study observed that168 types of different aqua products were commonly used for various purposes such as, pond preparation, water quality management products, fish poisoning or disinfectant, water and soil probiotics ,insect killer, Stress reducer, digestively enhancer, chemicals use as disinfectant, gas remover, growth promoters, oxygen supplier, algae killer, predator killer and fish disease recovery or antibiotics in this region. Lime, salt, zeolite and probiotics were used common products for pond preparation and water quality management. Rotenone, aluminium phosphate toxin tablet and bleaching powder were used to clean the pond when fish toxicant of which rotenone was broadly used in the nursery and grow out ponds. Though aluminum phosphate endrin and phostoxin were forbidden fish toxicant but these were frequently used in this region. Farmers were using more these products to culture fish in more density in less space. Beneficial aspects such as increased in production help to prevent feed wastage and maintain a good pond environment. There were some harmful aspects in farmers such as increasing the cost of production by using more drugs. Some drugs were harmful to human health. Excessive use of some chemicals including potash reduces the growth of fish, destroying the natural food etc. The study observed that 80% farmers were followed

in poly culture systems. The study indicated that 88% and 90% of the farmers use the liming and drying process for culture pond preparation respectively. The study found that 98% farmers eradicated the predatory fish and insects from the pond. The study found that 90% of the farmers collected their fish seed from hatcheries where only 10% collected them from the wild. In the management process of the ponds, 98% of the farmers used fertilizers. The study found that 99%, 90% and 95% of the farmers stated that they regularly monitor their pond, check the water quality of the pond and feed the fishes. Most of the farmers received FCR 1.5 that indicated feed cost was too much higher and overall production cost also high. Farmers in the north-east were aware of the FCR of their used feed. According to them the average FCR is 1 to 1.5 but different feed companies' referred to their FCR as 1.2. 98% farmers used some kind of banned chemicals which are very harmful for culture pond and bad impacts on its productions. The study showed that 80% farmers were benefitted to use chemicals/ drugs and got high production. They used a variety of chemicals, even antibiotics to prevent and cure fish diseases. Farmers collected all these chemicals, medicines and feed from various companies. But the best part is that the farmers of this region were becoming more and more aware day by day. They were collecting good quality fry and feed .In the study area 98% of the farmers were regularly taking care of their ponds and fish health. The study found that 90% of farmers had no water exchange facilities and they apply feed two to three times per day. The used of impure chemicals is high due to the rapid degradation of the water environment due to excess feed waste. Due to these reasons the farmers were economically disadvantaged. The study indicated that 98% of farmers said they were interested to use various drugs and chemicals. Only 2% of farmers did not use any types of drugs. In the study area 85% of farmers responded that the use of drugs and chemicals increase their fish production which had a huge impact on high production. In the study area 90% of farmers answered that their production has increased more than before in modern fish farming using drugs and various chemicals. At the time of data collection, it was observed that farmers using regular chemicals, probiotics and drugs to keep their pond environments were good. The color, smells and the presence of natural food were much better. Those that were regularly using variety of chemicals and probiotics did not have any bad smell at the bottom of the pond which was conducive to fish production. Farmers thought that

regular use of drugs reduces the incidence of the diseases. Examination of various parameters during data collection showed that regular use of probiotics and chemicals in all ponds had a good pH, ammonia and oxygen which lead to higher fish production. The study showed that they are generally unaware of the use of chemicals, appropriate dose, application method, and proper products knowledge and health hazard use of chemicals is the main problems in north- east region. The study observed that Feed, fry and aqua products price were so high and on the other hand fish selling price was very low. The study also observed that the farmers were suffered by low quality feed, seed and drugs which had adverse impact on the aquaculture production as well as environment. Government should take some step to reduce the feed, seed and aqua inputs price and ensuring quality. Aqua farmers required awareness training program about adverse and benefits of drugs and chemicals of modern culture technique. Aqua culturists and environmentalist require raising their awareness of the implications of the use of these products. Users should be aware of the health consequences of chemical misapplication

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Chapter-One

1. Introduction

1.1 Background

Aquaculture is an important and one of the rapid growing sectors in the world. Aquaculture in Bangladesh has been expanding rapidly in the last two decades. Contribution of Bangladesh fisheries sector is 3.635 % to the gross domestic and contributes one fourth or 23.81% of the agriculture GDP (DoF, 2016). Bangladesh is in an important position in the world in fish farming which is in the fifth position (FAO, 2016) with a total production of more than 1.85 lakh M tons compare to 2012–2013 year(DoF, 2014). The total production was 38.78 lakh ton in the year of (2015-2016) on the other hand 36.84 lakh ton was produced in the year of (2014-2015). Growth rate of production was 5.27 %. The majority of the fish production in Bangladesh comes from in freshwater culture 56.82%, capture 27.03% and marine 16.15% (DoF, 2016).

The north- east part of Bangladesh is a dynamic aquaculture zone. A number of fin fish hatcheries and aquaculture farm has been recognized in this region. It is of boundless importance to classify the quantities of aqua products those are being applied in the north- eastern region of Bangladesh to safeguard and hygienic aqua cultural products of international standard. Aquaculture production is increasing rapidly in Bangladesh day by day through intensification (Al Mahmud et al., 2012; Ahmed et al., 2012). Aquaculture has been playing an important role in the economy of the country for so long and its contribution to the economy is much higher

and it eliminates unemployment. Aquaculture is being considered as one of the sources of animal protein, food security and income of foreign exchange (Siddiq et al., 2013). Regular animal protein intake level of fish supplements to about 60%. Directly and indirectly is dependent on the fisheries for their living about 11% of the population (DoF, 2016). With the development of fish farming in Bangladesh, the use of chemicals and drugs is increasing rapidly. Drugs included different types of antibiotics, growth promoters, disinfectants and different types of predatory fish killers. The poor livelihood of many people has been eliminated through fish farming and cheap sources of healthy food for the population of the country (Ali et al., 2014).There is now a much wider variety, extended in fish farming than in the past decade, and with these has come a massive development of technology. Along with the development of technology, the use of various chemicals and drugs has increased. More fish are being produced in less space than before and chemicals are playing an important role in fish farming in a short time. These chemicals are available in different forms in the market. From the beginning to the end of fish farming, the use of chemicals is regular at different levels. There are different uses of different chemicals, especially in the health management of fish (Subasinghe et al., 1996). Chemicals and antibiotics are significant modules in health management of aquatic animal, pond construction, soil and water management, progress natural aquatic productivity, conveyance of live fish, feed formulation, manipulation of reproduction, growth promotion and processing and value addition of the final product (GESAMP, 1997; Subasinghe, et al., 1996).

Aquaculture has become a vital financial enterprise in the world. Farming of aquatic organisms has been practiced through the ages (GESAMP, 1997). As a growth of human food demand, it is now measured as a countless matter of concern. So the

progression of aquaculture is now growing at a boundless rate. The use of aquaculture through intensive and semi-intensive progression hints to the increase of fish production .The extent of recent growth in fish production is massive, yearly fish production has more than triple with in the span 15 years, from 16.8 million tons in 1990 to 52.9 million tons in 2005 (FAO and Fisheries Information Data and Statistics Unit 2005). Currently fish production of Bangladesh is 38.78laces tons whereas closed water (culture) backs 56.82% to the entire production and fifth place of world aquaculture production (FAO, 2016). The complete development performance from inland aquaculture displays a sensible increased trend, due to usage the probiotics, chemicals, drugs and new technology of increasing consciousness of the farmers (DoF 2017). For the purpose of higher production, aquaculture implementation has been shifted from the old-style to modernized or semi-intensive system. There has been growing tendency in using aqua products in aquatic animal health management with the extension and escalation of aquaculture in Bangladesh. Chemicals and drugs are vital apparatus in aquatic environment and health management of aquatic animals, pond preparation, soil and water management, advances aquatic productivity, carriage of live fish, feed formulation and nutrition, manipulation of reproduction, growth promotion (Subasinghe et al., 1996, Gesamp, 1997). Antibiotics have been used against bacterial infections for the past 50 years. Sodium chloride is a former treatment used in various range of diseases of fish. It is especial type of effective chemical that is commonly used in some fungal and parasitic diseases in fish. For all the organophosphates, effects on non-target organisms, mostly crustaceans are foremost concerned. Potential effects on health of fish farm staffs are also health hazardous chemical because of extraordinary neurotoxicity of organophosphates, (Alderman et al. 1994).

1.2 Present status of aquaculture in Bangladesh

Bangladesh is considered as a golden land of fish farming in the world. Very few fish producing countries with a total production of 42.77 lakh MT in FY 2017-18 are as prominent as Bangladesh. Bangladesh has contributed 56.24 percent of the total fish production. Average growth performance of this sector is 5.26 percent for last 10 years. Bangladesh ranked 3rd in inland open water capture production and 5th in world aquaculture production (FAO, 2018). In 2017-18, this sector contributes 3.57 percent to the national GDP and more than one-fourth (25.30 %) to the agricultural GDP. More than 11 percent of total population of Bangladesh earns their livelihoods by involving in this fisheries sector on full time and part time basis. This sector also has made a great contribution for the perspective of economic development of the country and will continue to do so in the future (DOF, 2018). Aquaculture indicates a study and consistent growth rate, standard growth rate is almost 10% during the same time frame. After 49 years of independence Bangladesh becomes a self sufficient country in fish production with a per capita fish consumption of 62.58% g/day against set target of 60g/day. Due to dissemination of adaptive technologies the production from closed water bodies is increasing very rapidly. Total closed water body (culture based) is 797851 ha and total hatchery 926 among government hatchery 102 and private hatchery 824. The north-east region plays a significant role in fish farming in Bangladesh. This area has ample low land and one crop land. Fish farming is spreading rapidly in this region day by day .If we look at the data for 2017-2018, fish farming has increased many times compared to 2015-2016. Of the four districts in the north-east region, Habigang district produced 3.55 MT per hectare, Moulvibazar 3.63MT, Sylhet district 3.19 MT tons and Sunamgong 3.6 MT

of fish. A total of 62858 ponds have been used for fish production including 16330 in Habigang and 18903 in Moulvibazar, 17571 in Sylhet and 10054 in Sunamgong district. A total of 20150 ha lands have been farmed out of which 4603 ha in Habigang, 7073 ha in Moulvibazar, 5515 ha in sylhet and 2938 ha in Sunamgong. Out of total land, Extensive culture has been5737 in one place semi intensive and intensive has been in 20150 ha place where it was 3429 ha in extensive and intensive in 15387 in the year of 2017-2018 (DoF, 2019).

In addition to the rapid increase in fish farming in the region, various types of chemicals and drugs are being used. Farmers are using all chemicals and drugs for pond preparation at regular rates to increase the health management and production of fish. The trend of drug use among them is increasing day by day. Past reports have shown that they are using approved and prohibited drugs and chemicals at regular rates in a variety of situations that have both advantages and disadvantages in fish farming. The cultivation of different species of fish including pabda, gulsha,,shing, magur is increasing rapidly in the region and the use of drugs for the growth and maintenance of these fishes is increasing rapidly. It may or may not be helpful for fish farming. Although main fish farming in the region is a mixed farming system of Tilapia with carps.

To rise the production and controlling disease organism massive number of chemical and biological products are used throughout the world and the amounts increasing day by day. Besides, several people are unconscious of the overwhelming effect of these chemical compound and they thought that the spending of chemicals is the only way to control pathogens and disease-organisms (Moullac, 2000). Numerous

chemicals, drugs and other materials are commonly used in the fish farming to improve soil and water quality and for adjusting biological systems such as phytoplankton blooms, aquatic plant infestation, disease vectors, and explosion of wild fish (Boyd 1995, Boyd and Tucker., 1998). For example, four separate tilapia fish processors advanced health complications subsequent to infection with Streptococcus inane, a fish pathogen not previously testified to be a root of diseases in human (WHO, 1998).

1.3 Scope of the study

The scope of the study raises concerns about toxic and environmental problems as a result of the widespread use of chemicals and drugs in aquatic environment, particularly the potential toxic effects on humans and animals (Mazid, 2005). Bangladesh is fortunate enough to have vast and lot of water resources across the country. Fisheries resources in our country are extremely diverse. Inland fisheries resources include rivers, canals, and floodplains, lakes of oxbow and available and adequate resources. Bangladesh offers a unique opportunity to produce enough fish and shrimp for export and domestic consumption. But, there are serious barriers to population pressure, industrial and agricultural activities that degrade the aquatic ecosystem beyond environmental tolerance to natural disasters. Natural disasters and man-made disturbances are also considered as major barriers in accelerating development process of the fisheries sector.

Therefore an appropriate and well thought-out research plan with a long-term vision is needed for the sustainable development of the fisheries sector. The aquaculture industry in Bangladesh has started to expand from mid 80's. The result of the expansion, the use of chemicals and drugs has been increased as a part of management. It is known that in

commercial fish farming in the country, the farmers practice higher stocking density which in turn requires greater use of fertilizers and supplementary feeds. Thus, the water quality of the farms and the aquatic environment are deteriorated which make the fish more susceptible to diseases. The outbreak of this disease in aquaculture sometimes leads to mass mortalities and economic loses of the farmers. SO the farmers /entrepreneurs indiscriminately use of chemicals and drugs, feed additives, growth enhancer's etc. Farmers use aqua drugs in order to increase fish/shrimp production and to control diseases. These are also used to improve water quality, kill unwanted fish and increase high production. In Bangladesh, as in many other developing countries, chemicals and drugs are widely used for the treatment of bacterial diseases of fish and shrimp in commercial aquaculture. Especially, the aquaculture industry has started to expand in the after mid 80's country when usage of toxic chemicals and drugs has also been increased. Thus, the toxic chemicals and drugs subsequently get access in aquatic biota, particularly in fish and shrimp, and in turn, human health through food chain, which is very much detrimental for the consumers (Rahman M. K., 2013). This toxic waste can cause serious damage to the next generation. In addition, the toxic chemicals can hamper long-term water quality and pond fertility. It can also damage the microbial community of the water body. The above overall cumulative impact ultimately hampers the total fish production in the country, which is the serious concern for the nation.

1.4 Problem statement

Aquaculture is a dynamic contributor to the agriculture economy which offers as a source of income to the community who depends on it entirely to their social-economic livelihood. Fisheries sector is an important part the activity of aquaculture for the production of fish for food consumption in Bangladesh. As in all food

production areas, one of the outer inputs need to massive fish production is chemicals and drugs. Aquaculture should be conscious of the risks connected to handling chemicals, their likely impacts on the environment and food safety. The use of chemicals should have a suitable regulatory system in place. In aquaculture, chemicals and drugs which are used uncontrollably may lead to antimicrobial resistant organism's development. Chemical is a separate mixture or pure ingredient which is consisting of matter that has been artificially purified or organized or produced by or used in a chemical method (Primavera et al.1993).

Chemicals and drugs have numerous applications in aquaculture, the types of chemicals used to rely the culture system on the nature and the classes such as health management, culture structure preparation, conveyance of live fish, pest control, soil and or water quality management, feed and supplements, breeding, disease treatment and control. The welfares of chemical usage are numerous. Chemicals are performances as a disinfectants, stress reducers, organic and inorganic fertilizers, herbicides, growth enhancers, feed additives, antibiotics, anesthetics etc. They are also assisted to increasing oxygen content, dropping toxic gases, fry treatment. They are used to diminish transport stress and to control pathogens to prevent disease, treat animals and control pests, among some other applications.

For successful aquaculture chemicals are really an important which has been popularly used in numerous form for element to successful aquaculture, which has been used in numerous forms for century's chemicals of aquaculture can be categorized by the aim of use, the life cycle stage, the kind of organisms under culture for which they are used, the culture structure and intensity of culture and for

the people who practice them. Several types of aqua drugs and chemicals counting antibiotics are used by farmers for fish health management and growing production. To continue proper health condition of fish, drugs and chemicals play a dynamic role. Increasing production in aquaculture day by day by applying chemicals in aquatic animal health management as well as intensification make farmed animals vulnerable to a unlike type of health difficulties and diseases. For the effective farming and high production in aquaculture the use of chemicals and drugs has turn out crucial input. There are numerous reasons of using drugs in aquaculture which include reducing the appearance of pathogenic organisms in culture area, reducing the multiplication of pathogenic organisms, reducing the stressful condition on fish health, reducing or defend the outbreak of disease and treatment of the disease (FDA, 2001). Drugs obtain from many different types of sources like plant origin, animal source, chemical substances, marine plants and animal etc. Different kinds of drugs are a used for health management of fish separately from antibiotics in aquaculture. The different types of chemicals are applied in aquaculture for controlling aquatic environment and fish health management. According to Food and Drug Administration (FDA) law, a drug is any compound which has a physiological conclusion on the animal. There are three major options for legal use of drugs to treat animals including fish. For regulating medicated feeds, drugs as well as other fish products responsibility should be taken by the related authority. They will support products, set tolerance levels for drug residues in edible tissues and govern specifically how drugs are to be used (FDA, 2001).Uses and misuses of aquaculture chemicals is also a matter of concern. The amount of material on chemical use in aquaculture and its meaning for human health assurance, environmental shield and sustainable development of the sector, has been growing throughout the last two

decade (FAO/NACA, 1995; Plumb, 1995). Due to extraordinary neurotoxicity of organophosphates, possible effects on health of fish farm workers are also health hazardous chemical (Alderman et al., 1994). Application of chemical by aqua culturists, either for anticipatory or treatment purposes, a certain portion of the applied material is released directly to the environment (Cravedi et al., 1987) stated that the vast majority of Oxy tetracycline and oxolinic acid provided is likely to leave the farm as particulate wastes because of feed wastage and poor digestive captivation of these drugs. By the releasing of these polluted feeds and faces is about to arise continually at low attention but can be better at definite periods of the growth circle for example pond or tank clean up. It is now broadly acknowledged that this intensive development of the industry has been convoyed by an increase in environmental impacts (Brown, 1989). Now days a lot of antibiotics are being used in different farm and hatcheries trough out Bangladesh. Antibiotics were used to avert and treat Vibrio infections. For handling bacterial infection in fish, antibiotics have been applied in aquaculture for over 50 years. The factor affecting the uses of chemicals are educational background, price of inorganic chemicals, farmer' awareness of the production processes, farmers' awareness of the harmful effects of inorganic chemicals, training policies for extensions, support policies for extensions, cooperative groups. (America Academy of Microbiology, 1999. Wegener et al, 1999. Inglis, 2000)

There are many significant problems for the use of chemicals in aquaculture. Such as human health related concerns connected to the use of feed additives, antibiotics, hormones, disinfectants and vaccines. Using chemical in fish farming depends on two categories such as hygiene products (for environmental control and

disinfections) and medicinal products. Some chemicals pretend a danger to farmers through as fire and outburst hazards, or potential toxicity and residues of certain chemicals may poison aquaculture products and present a food protection concern. Generally farmers have absence the effects of knowledge concerning and their residues and fates of chemicals and within itself by the aquaculture method.

Growth of highly specific targeted chemicals that have reduced side effects and environmental implicates is needed. The accessibility of affordable treatments suitable for aquaculture systems raising low-value species needs to be enhanced. In the FAO code of conduct for responsible fisheries has reflected that human health and environmental concerns are regarded in the use of chemicals in aquaculture (FAO, 1995). Chemical inputs should be controlled in aquaculture because it is dangerous for both human health and the environment.

1.5 Rationale

In Bangladesh, aquaculture is labeled to commercialization and intensification. For this advanced production, aquaculture practices are changing day by day for surplus and adequate production, turning from traditional to semi intensive and intensive culture. With the change in farming methods, the use of aqua products is also increasing day by day. Several kinds of commercial drugs and chemicals turn into fundamental section for successful aquaculture production. The numerous purposes for using commercial drugs and chemicals in aquaculture are spaciously identified. The happenings of aquaculture are gripped by different types of chemical in Bangladesh. Animal health management is the management structures which are scheduled to prevent to animal disease. Appling disallowed drugs animal displays

human health hazard. So, need for better understanding in health management. Drugs and chemicals are very important ingredient for fish health management of aquatic environment. It plays an important role in pond preparation, improving soil and water quality natural food production, improve aquatic productivity, conveyance of live fish, feed formulation, manipulation of reproduction, growth promotion etc (Subasinghe et al, 1996.,Gesamp, 1997). Chemical can be used as a growth organizer, stress reducer, toxic gas reducer, oxygen supplier, disinfectants, insecticides and ectoparasiticides north-eastern Bangladesh. Some of aquaculture chemical demote rapidly in aquatic system (Example Formalin,Furazolidone). But by exhausting chemicals and drugs, some difficulties have been observed which are absence of information about accessorial effect and expire date, random uses of chemicals, apply high doses drugs without recommendation. But in most cases the farmers have no knowledge or poor knowledge about the use of these suitable chemicals and dosage they should use. Only few studies (Faruk et al, 2004., Uddin and Kader, 2006., Khan et al, 2011) conducted on the usages of profitable drugs and biological products in aquaculture in northeast Bangladesh (Ali et al, 2015).

Faruk et al, (2004) stated that the status of fish health management practices in rural freshwater aquaculture of Bangladesh principally from Mymensingh region which is the part of north-east region. Uddin and Kader, (2006) determined their study only on the application of antibiotics in shrimp hatcheries. There is no proper exploration work in this region. North- east region is very significant for aquaculture. It has a lot of land and enclosed by several hoar and boar. As a consequence, there is a lack of information regarding the present status of aqua drugs used in north- east region of Bangladesh. Consequently, the present study has assumed to identify the categories

of aqua drugs used in fish health management and to recognize the purpose, dose, price and method of their application with problems associated with their uses highlighting the economic and environmental issues in Greater north- east region of Bangladesh. In aquaculture, fish production is growing day by day and plays a dynamic role in socio economic, industrial expansion. Actually, successful aquaculture depends on chemicals which have been use in numerous ways. Altered types of aqua products are applied in aquaculture for fish health management. Two classes of animal drugs that can be used for fish production contingent on situation are conditionally permitted animal drugs and indexed animal drugs.

For feed additive and water treatment compound as like altered types of biological product are used to get high production in aquaculture. In Bangladesh, fish culture is transferred progressively around commercial practice with the increase in stocking densities and feeding of commercial feeds. Nowadays farmers are interested in using chemicals in feeding to keep up water quality, disease free and increase production.
The direct dealing people in aquaculture business are in four wide is four wide groups such as traders, farmers, consumers and chemicals manufacturers. The seller should inform the farmers about the correct dose and usage rules. Manufacturer's have a responsibility to ensure that the product contains accurate information. The representatives of different companies should use all products properly. On effective work has been done on the influence of use of chemicals in aquaculture. Farmers should be worked to know about proper farm management and use of chemical. They should be also advised themselves of the advantages and disadvantages of chemical use in each specific situation. It is very important to increase their awareness about this. The light of private and government institutions should work well in product

development. In aquaculture, chemicals used in numerous ways and depending on the nature, the use of drugs is usually higher in all culture system and the species being cultured chemicals have to be used. The issues of water quality are temperature, transparency pH, alkalinity and organic matter content can regularly have a containing on the toxicity of a chemical. So, depending of water quality chemical can be countered in unlike ways. Take on exact labeling of drugs and chemical and taking responsibilities for settling claims on product. If there are many other forms of chemical, farmer should select drugs for both rely on efficacy data but also on the basis of common information regarding effects on non-target organisms, affinity to stimulate microbial resistance and rate of residual elimination, environmental subsistence. Aqua culturists need to broaden their awareness of the short-, medium- and long-term implications for the use of drugs and chosen chemicals. Awareness should be built by the users for health hazards of chemicals and drugs misapplication. Benefit and health hazards should be notified by them and arising of chemical use should lookout against undue effects by criticisms against aquaculture which is mainly founded on emotional controversy that have little basis in scientific fact. Nevertheless, where indication strongly indicates the need for constructive change within the aquaculture industry, consumers should care advocacy groups working towards this goal. Policy makers, researchers, and scientists should work organized in addressing the issues of chemical use, with the view to cut the adverse impacts. The problems which are related to the use of chemicals are needed to focus on providing response by requiring more research. More research efforts should be made towards finding non-chemotherapeutic answers to disease control and health management. It is needed to require the

difference between perceived issues and potential threats which can be pre-determined and evaluated scientifically.

In the past, farmers used some of the old chemicals as they are now using them as well as various new products and getting acquainted with new technologies is playing an important role (Hasan and Ahmed, 2002., and Plumb, 1992) Lime, salt, rotenone, various inorganic and organic fertilizers, dipterax, antimicrobials, potassium permanganate, copper sulphate, formalin, sumithion, melatoxin etc are the most commonly used chemicals in aquaculture in Bangladesh (Phillips, 1996; Hasan and Ahmed, 2002; Brown and Brooks, 2002; DoF, 2002. Faruk et al., 2005).

It is very unfortunate that there is very little information is known about these drugs and chemicals in our country. As a result, the department of fisheries lacks information on current conditions and outcomes, especially in the use of chemicals and antibiotics in aquatic animal health management, and thus the current study means the types of chemicals and antibiotics used in aquatic health management. The present study therefore reflected on the identification of types of chemical and antibiotic used in management of aquatic animal health which suggests their application, purpose, dose and systems with problems related with their uses.

1.6 Objectives of the study

The overall objective of the present study was to find out the impacts of commercial drugs and chemicals on aquaculture in north -east Bangladesh.

The specific objectives were:

1. To find out the commercial chemical products /drugs used for aquaculture system in the north-east region of Bangladesh?
2. To recognize the banned/prohibited chemicals which are being used in aquaculture in the north-east region of Bangladesh?
3. To evaluate the impact of chemical use in farm emphasizing the economic and environmental issues?
4. To analyze the production trends before and after the use of chemicals

Chapter-Two

REVIEW OF LITERATURE

The Fisheries sector of Bangladesh is a dynamic and more productive sector. Besides, the aquaculture sector of Bangladesh is contributing a progressively vital role in the national economy for the long period. Bangladesh has made significant improvement in the sector since in 1971.The fisheries sector has been making a very significant contribution to the socio-economic development of the people of Bangladesh. This sector gains 3.57 percent to our national GDP and around 25.30 percent to the agricultural GDP. The fisheries sector has been provided 60% share of animal protein (DOF, 2018).

Pathmalal (2018) studied that a lot of use of antibiotics on aquaculture and discussed the problems that humans and animals face with these antibiotics. A review and identified that the coming out of antibiotic-resistant bacteria spreads in the environments and eventually to the human body through various ways. So, all these antibiotics promote proper application in aquaculture as gathering evidence indicates that unlimited are needed to apply in detrimental to fish, terrestrial animals and human health the global efforts.

Shoaibe (2018) studied at shrimp aquaculture in Bangladesh and found different types of probiotcs use which was increasing day by day. The use of probiotcis in Bangladesh is not long, it is a new concept but its use is increasing day by day due to its eco-friendly nature. Different probiotics compounds originated from various

types of species of beneficiary bacteria and yeast are commercially available used in aquaculture of Bangladesh. These bacteria were important for aquaculture and protect against various diseases and help to stop the use of antibiotics.

Rasul (2017) found that aqua-products used in freshwater aquaculture of greater Sylhet district of Bangladesh and found that a variety of drugs and chemicals including antibiotics were got a large volume in the local market and being applied in the fresh water aquaculture. Various types of chemicals were commonly applied in fish heath management traditionally. These types of chemicals were Lime, salt, potassium permanganate, melathion, malachite green, bleaching powder, methylene blue formalin, and sumithion.

Faruk et al, (2008) studied variety of chemicals and drugs including disinfectants and antibiotics applied in fisheries sector for health and stress management of fish. Along with commonly used traditional chemicals, they found a variety of some new products with different trade names like Goelite gold, Geotox, Mega zeo plus, Geo master, Green zeolite, Fish vita plus,Oxy flow, Oxymax and oxy gold were the most widely applied products.14 branded antibiotics with various ingredients were found with different trade names for disease treatments of aquatic animal. Major active ingredients of these antibiotics were doxy tetracycline, Oxy tetracycline, Chloro tetracycline, Amoxicillin, Erythromycin, Sulpha diazine and Sulpha methoxazole. Fourteen branded antibiotics were found with various business names for disease treatments of aquatic animal. They reported thirty three animal health companies were seen active for producing and marketing of these aqua products. Some of these animal health products have been marketed by different trading companies from the

various countries such as Malaysia, India, Vietnam, China, Thailand, Taiwan, Indonesia, Spain and USA.

Parimal et al, (2006) tested on the sensitivity of Aeromonas hydrophila and concluded that bacterium was susceptible to gentamicin, ciprofloxacin, chloramphenicol and oxyteracline but resistant to erythromycin, nitrofurantion and penicillin.

Faruk et al, (2005) found that chemicals used in aquaculture are mainly potassium permanganate, lime, salt, triple super phosphate (TSP), urea, geolite, disinfectant, vitamins, antibiotics (mainly oxy tetracycline and chloro tetracycline), rotenone, ivermectin, phostoxin, sumithion and some hormones for their cultivation area. Most of the farmers applied a lot of aqua drugs without knowing their mode of action, doses and appropriate procedures of application, benefits indiscriminately.

Yucel et al. (2005) studied that different types of chemicals such as A. hydrophila, A. caviae showed resistance to ampicillin, cephalothin and trimethoprim but susceptible to ciptofloxacin and ceftriaxone.

Sultana (2004) investigated that frequently applied chemicals in aquaculture which were salt, geolite, lime, oxygen, , urea, triple super phosphate (TSP), $KMNO_4$, vitamins and minerals, antibiotics (mainly amoxyciline, oxytetracycline, doxycycline and chlorotetracycline), rotenone, phostoxin, sumithion, melathion and some hormones of their culture.

Chowdhury et al, (2003) found that antibiotic such as renamycin ,oxytetracycline had good results against bacterial disease at a dose of 50 mg/kg body wt/day applying for 7 days and 80-90% fish were rapid cured under laboratory environment.

Brown and Brooks (2002) observed that about 52% fish farmers in Bangladesh applied potassium permanganate, while 40% used lime, 11% used salt as treatment of disease and water modification, such as disinfectants, banana leaves, fertilizer, oil cake, and water exchange.

Singh and Singh (1997) obtained seven isolatets of Edwardsiella tarda and showed that all the isolates were resistant to calistin and gentamicin, but sensitive to ciprofloxacin, chloramphenicol, nalidixic acid, nitrifurantoin, ofloxacin and streptomycin.

Inglis (1996) reported that anti-bacterial chemotherapy has been used in aquaculture for over 50 years, with early attempts to apply sulphonamides in the treatment of furunclosis.

Chowdhury et al, (1996) found that lime and salt treatment of 250 kg/ha respectively were most effective to suppress the ulcer disease through pond treatment.

Prasad et al, (1996) found the effect of five various antibiotics on EUS affected fish and found that chloramphenicol and pxytetracycline would be effective drugs in curing the EUS lesion, tetracycline and streptomycin were found to be less effective in curing the ulcers.

Smith et al, (1994) reported that oxy tetracycline is the most widely used anti bacterial in aquaculture in the world. The majority of oxy tetracycline is relatively low price used in mediated feed found in hatchery effluent at concentrations that explanation for nearly the entire drug supplied.

Alderman (1992) stated that malachite green is an organic product that has been treated against parasitic, algaecide, and fungicide on fish. It is very used in hatcheries rather than culture systems subsequently. Long-lasting withdrawal time is essential following application because of persistent residues.

Baticados and Paclaibare (1992) applied formalin and potassium permanganate in treating the velvet disease caused by Piscinodinium, a protozoan flagellate in aquarium fish.

Plumb (1992) found that potassium permanganate works well for treating external protozoa and bacterial infections. He further described that Sodium chloride is an old treatment procedure applied in various diseases of fish especially some fungal and parasitic diseases

Bhaumik et al, (1991) carried out investigation in the West Bengal on the effect of epizootic ulcerative syndrome (EUS) and showed that application of lime in ponds gave 68% positive result.

According to Rydlo (1989) for controlling the protozoan parasites Costia necatrix, Chilodonella cyprini, Ichthyophthirius multifilis and Trichodina sp., and the crustaceans Argulus foliaceus parasitizing Salmo gairdneri or Cyprinus carpio, the suitable preparations were sodium chloride, potassium permanganate, slaked lime at pH 10, calcium hypochloride, formaldehyde, malachite green and masoten.

Limsuwan (1987) observed that the acute toxicity of malachite green to silver barb (Puntius gonionotus), Nile tilapia (Tilapia nilotica), Gunther's walking catfish (Clarias macrocephalus), carp (Cyprinus carpio) and snakehead fish (Ophicephalus striatus). Gunther's walking catfish was the most sensitive to malachite green (96-h LC50, 0.066 mg/litre) and Nile tilapia was the most resistant (96-h LC50, 0,425 mg/litre). It was concluded that malachite green was highly toxic to fish and use of malachite green at 0. 10 - 0. 15 mg/L He also found that a 5 to 10 min bath of potassium permanganate at 100 mg /L was enough to kill sea lice e for therapeutic treatment of fungal infections and external parasites of fish could be toxic to some species during culture period.

Anonymous (1986) observed that early cases of columnaris disease could be successfully treated with surfactant bath or prolonged immersion in potassium permanganate or copper sulfate. However, they suggested the use of antibiotic such as oxytetracycline or nifurpirinol for successful treatment of columnarles diseases.

Kabata (1985) suggested the use of formalin, malachite green, formalin-malachite green combination and potassium permanganate in controlling the white spot disease

caused by the protozoan lchthyopthirius multififlis. He also found that a 5 to 10 min bath of potassium permanganate at 100 mg /L was enough to kill sea lice.

Boyd (1979) stated that the lowest concentration of potassium permanganate in which the pink hue remains after 15 min was considered the endpoint for the treatment of ectoparasites and skin and gill bacterial infections in freshwater fish.

Plumb (1979) warned that the level of potassium permanganate may be safe for fish if exceed the level approximately 2 mg/L of active ingredient.

Chapter-three

3. Materials and methods of the study

3.1 Study area

Study area is an important part of aquaculture production in Bangladesh. It is the north- eastern part of Bangladesh, on the bank of Surma and Kushiara River. It's famous for its Sufi shrines, like the ornate tomb and mosque of 14th-century saint Hazrat Shah Jalal, now a most important pilgrimage site close to Dargah Gate. The small Museum of Rajas contains belongings of the local folk poet Hasan Raja. This region is covered by the pictures queue of Surma valley amidst scenic tea plantations and lush green tropical forests. Greater north- east is a prime charm for all tourists for visiting Bangladesh. The valley has good number of haors and baors which are large

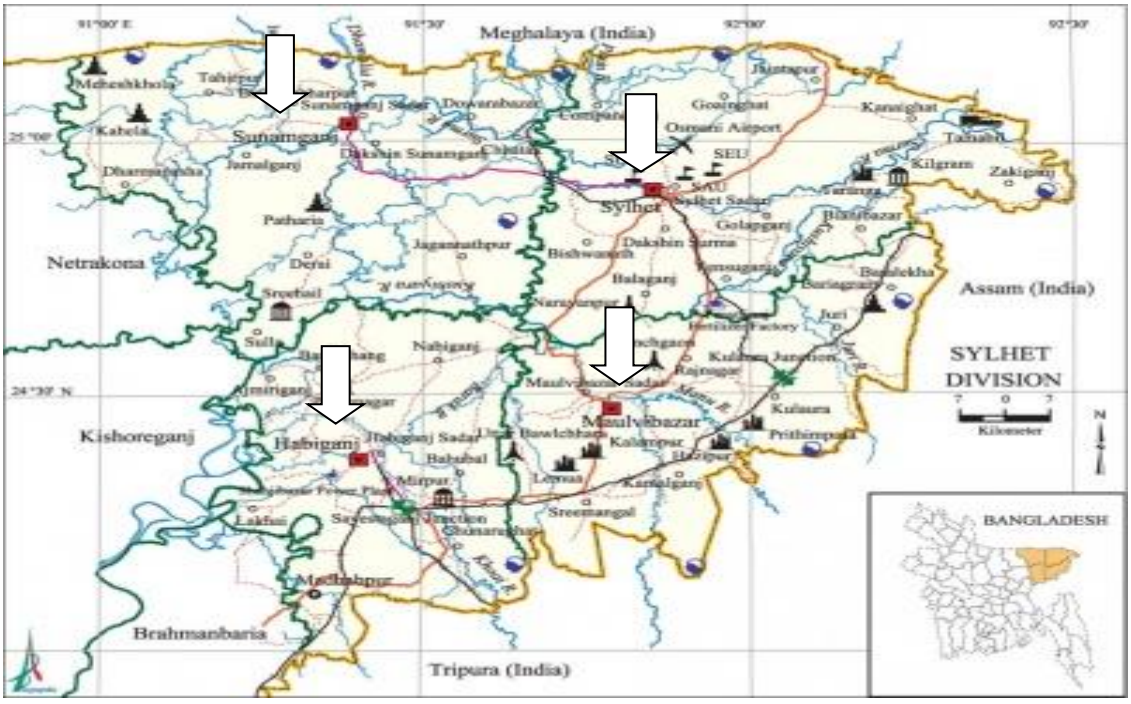

Fig 1: Geographical location of the study area (north-east)

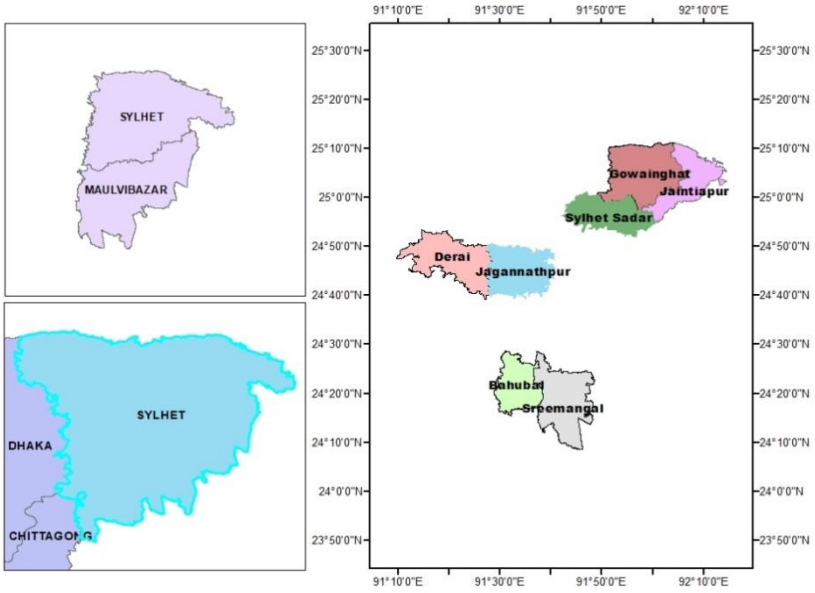

Figure 2: Geographical location of the study area

natural fish ground. In winter these haors turn into green lands in large quantities, but in the rainy season they turn into rough seas. The region was covered by 4 organizational districts. The study included four districts of Bangladesh such as Sylhet, Hobigang, Moulvibazar and Sunamgong. These areas were selected because of contributing significantly to fresh water aquaculture production of the country. It is bordered by tea estates, sub-tropical hills, rain forests and river valleys, a lot of hoar and boar. Aquaculture system is increasing day by day rapidly because of available land and money.

Climate of this region is categorized as tropical. Rainfall is significant most of the months of the year and the short dry season has little effect. The average annual temperature is 24.8 °C in Sylhet. The average yearly rainfall is 3876 mm. Rainfall is the lowest in December, with an average of 8 mm. Most of the precipitation here falls in June, averaging 780 mm. At an average temperature of 28.1 °C, August is the

warmest month of the year. January is the coldest month, with temperatures averaging 18.5 °C. 79 fish species are reported in Sylhet among which 17 species are endangered (21.51%), 13 are vulnerable (16.46%), 8 are critically endangered (10.13%), 6 are exotic (7.59%), 27 are near threatened (34.17%), 3 are not evaluated (3.81%) and 5 species are not threatened (6.32%). Among them, 38 were threatened which comprises 48.10% on the individual's basis. Among 28 endangered fish species in Bangladesh, 17 are encountered in the study area. The Shannon-Weaver diversity index is found to be oscillated from 2.09 to 2.48 with mean of 2.3±0.16. Highest value for Margalef's richness index is 1.53 and lowest 1.25 with mean of 1.42±0.12. The peak evenness value is 0.9 ranges between 0.79-09 occupying averages of 0.84±0.05. The evenness values represent the uneven distribution of the endangered fish species in the study area. The maximum dominance value is 0.88 and minimum 0.84 with mean value of 0.87±0.02. Among the 17 documented endangered fish species in the study area 12 species are rarely available and rest 5 species are found to be available.

Aquaculture is conducted widely in Sylhet. Almost 9.10 percent pond of whole country is in Sylhet.

3.2 Duration

Data were collected from March 2018 to April 2019. During this period 200 fish farms of north- east region were investigated.

3.3 Target groups set up

To find the expected achievement from the study 200, questionnaires were analysed to obtain accurate data during the investigation. They were 180 fish farmers, 10 technical

people of different animal health products producing companies, fisheries officers and 10 traders were also interviewed during the period of study.

3.4 Collection of data

Data were gathered by the combination of the following survey techniques:

3.4.1 Primary data collection

Primary data is the first-hand sources data that is composed by a researcher using methods similar to surveys, interviews, or experiments. Data was collected with the research project in mind, in a straight line from primary sources. Data collected by the investigator himself for a specific purpose. This investigation was performed as the part of the north-east in Bangladesh. The study worked in four geographical "hubs "covering most of the major aquaculture producing sub districts of north-east part of Bangladesh.The chemicals and aqua products use survey was conducted between March 2018 and April 2019. A total number of 200 farms were surveyed with interviews being conducted with farms owners, farms managers, farms technicians and farms assistance

3.4.2 Secondary data collection

Secondary data indicates to data that is composed by someone other than the user. Familiar sources of secondary data for social science comprise censuses, information gathered by government departments, organizational records and data that was originally collected for other research purposes. Secondary data was consisted of published material for example journals, textbooks, newspaper etc. Furthermore, proper government and non-government organizations as like as Fish Inspection and Quality Control (FIQC) office.

3.4.3 Questionnaire survey

Questionnaire survey was conducted to individual aqua farmer, fish hatchery and nursery owner, aqua farm workers and chemical retailers. The study was completed a set of preliminary questionnaire based on the objectives. Data was gathered using a structured questionnaire covering detailed information on chemical and aquaculture inputs used in aquaculture productions. Most important topic of questionnaire were the culture systems, pond area, culture species, feeds, name of chemical , active ingredients, perseverance of use, land, feed conversion ratio, benefits of aqua products, method of application and dose, time, cause, effects on environment, price, impact on health and production etc. In adding data on farming practices, general farm management, health and disease problems, seasonality, mortality etc. were also gathered. For the interview, simple random sampling methods were followed during interview.

3.4.4 Personal Contact

Data were gathered from person to person from the study area. Personal contact refers to the telephone, mail, personal in home surveys and online surveys.

3.4.5 Market Survey

Data were collected from Market Survey from diverse location of north-east region. “A market survey is an objective and systematic collection, recording, analysis and interpretation of data about existing markets for a product.”

3.4.6 Participatory Rural Appraisal (PRA)

Data were gathered by Participatory rural appraisal (PRA) tools from side to side target people to get an overview of particular issues on use of chemicals. Through discussion with a selected group of people following a set of full guidelines designed to generate discussion on a particular set of topic. The surveyed chemicals and aqua

drugs products were classified into categories 1.water and soil treatment compound 2.fertilizers 3.lime and geolite 4.disinfectants 5.gas removal, oxygen supplier 7.feed additives 8.vitamins and minerals 9.pesticides 10.parasiticidae 11. fungicitidae 12.antibiotics 13. Predatory fish killer 14.probiotics.

The main ingredients of surveyed chemicals and aqua drugs were recorded based on the products labels, if the data was absent from the products level, the ingredients was gathered by searching the products name during the key informants interviews, or by cross checking the products name with published leaflets or bruisers.

3.4.7 Focus Group Discussion (FGD)

Focus group discussion meetings were organized at bazaar level to identified the main disease symptoms, impacts of production problems faced by each of the different farms groups, water parameters checked every farms such ph, temperature, ammonia, dissolved oxygen etc Every farms fish health checked by the Authors in physical conditions by eyes observation. Physical observations some diseases were identified by checking characteristics of infectious fishes and using some chemicals and drugs for recovering the diseases. Respondents were asked to report the disease symptoms that they had observed during the last two production cycles.

Data were composed from hatcheries or farm owners, chemical sellers and medical representatives of Pharmaceuticals Company fish farmers through PRA tool such as Focus Group Discussion (FGD). In this survey, FGD was used to obtain an overview of particular issues for example the existing problems attendant with the use of aquaculture drugs. Then, a total of 7 FGD sessions was conducted where each group size of FGD was 8-10 people. FGD session was held in front of Govt fisheries officers, hatchery or farm, representative offices, chemical sellers shop etc.

3.4.8 Crosscheck interviews

After gathering the information through form interviews and FGD, crosscheck interviews were conducted with Upazila Fisheries Officer, Assistant Fisheries Officer, relevant nongovernmental organization staff, private aqua practitioner, place owner, chemical marketer and medical representative of Pharmaceuticals Company at their offices. In order to know an inventory of products name and the principal ingredients, doses, purposes of using, price contained in such products.

3.4.9 Impact and recovery assessment of aqua inputs

The impact and recovery of aqua drugs and chemicals were measured through the fish farm and hatchery operator's observations and various published Research papers.

3.4.10 Preparation of awareness leaflets

During the collection of information, various types of awareness leaflets were prepared to make the users aware about merits and demerits of using of chemicals and drugs.

3.4.11 Data processing and analysis

Data processing and analysis are also important part of a research. So all data were collected and stand in Microsoft excel sheet. Different types of analysis were performed to identify statistical significant difference. SPSS software (Statistical Package for the Social Science, Chicago, IL, USA) was used to perform different statistical analysis. Differences were considered to be statistically significant when $P \leq 0.05$.

Chapter-4

Results

4.1 Aquaculture type and cultivable species

Different types of culture systems have been observed in the study area, including Monosex tilapia culture Thai pangas and carps poly culture etc. Carp poly culture was done by semi-intensive and intensive method and the use of various aqua products was increasing rapidly to increase the production of what is intensive culture method. Fish disease usually affected the production and the farmers were severely affected economically due to the disease. In order to overcome these problems, they were becoming addicted to use various aqua drugs day by day cultivated fish species generally mean fish variety which is already introduced into the obtainable culture system in Bangladesh. Different types of species were currently now being cultivated which were both native and exotic in environment. Native or well known as indigenous fish species included different species of major and minor carps and exotic species includes different Chinese carps, catfishes, pangas, and tilapia which were cultivated in different culture systems. Different types of exotic fish species were usually introduced into aquaculture system in north-east region. Tilapia was the major culture species in the study area.

Maximum numbers of farmers in north-east Bangladesh were practicing poly culture (82%). Tilapia mixed culture; mixed culture, semi intensive and carp culture were also done by the native farmers. Most of the ponds for aquaculture were less than 5 acres. Majority of the farmers conducted aquaculture in their own pond and follow both drying and liming process to prepare the pond for the purpose of eradication of

predatory fish and insects. They also used fertilizer as a source of nutrient. Naturally the farmers collected their fries for aquaculture from an established hatchery nearby. Cultivating ponds were under regular monitoring of the farmers. Feeding process and water monitoring were done on a regular basis. Most of the feed were handmade. Water exchange facilities were not present in almost 90% of the ponds. Bata, catla, kalbaus, mrigal, rui, different types of carps, nilotica, tilapia, pangas, shing, pabda, gulsha etc were the most cultivated fish species in north-east region.

4.2 Different Culture system

4.2.1 Culture types of the study area

In the study area, farmers were practiced different types of culture systems like Tilapia mixed culture, mixed culture; semi intensive and carp culture etc were practiced by 10%, 4%, 2% and 2% farmers respectively (Figure 3). Most of the ponds were less than 5 acres (82%) while only 12% and 6% ponds are between 5-10 acre and < 10 acre, respectively (Figure 4). Almost 88% of the fish farmers had their own pond where the other 12% leases ponds to finish culture (Figure 5)

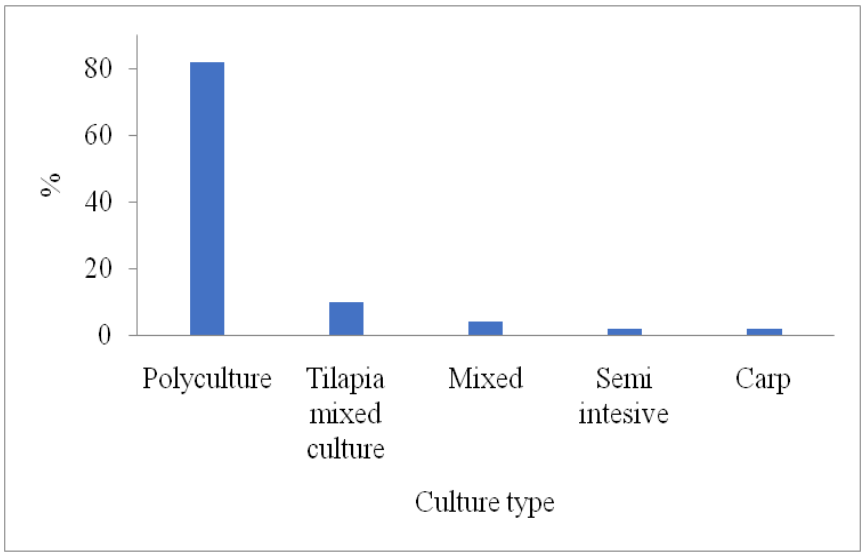

Figure 3: Culture system practiced in the study area

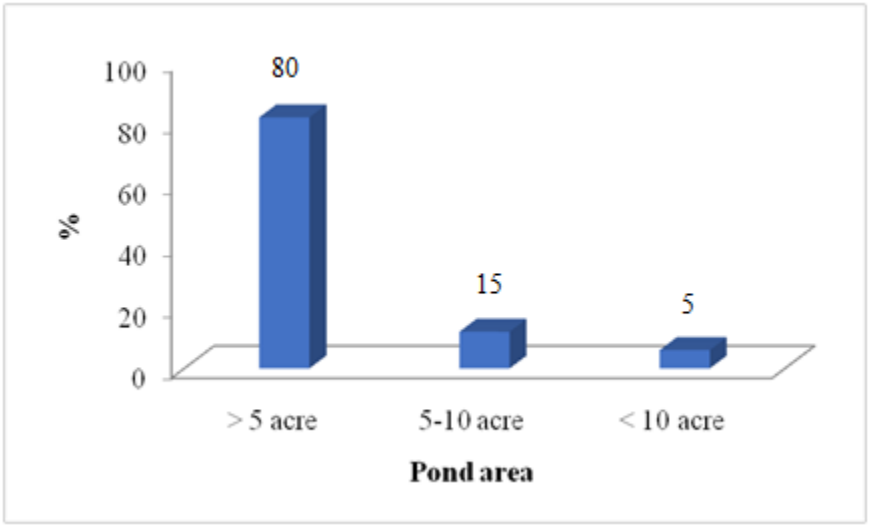

Figure 4: Pond area in the study area

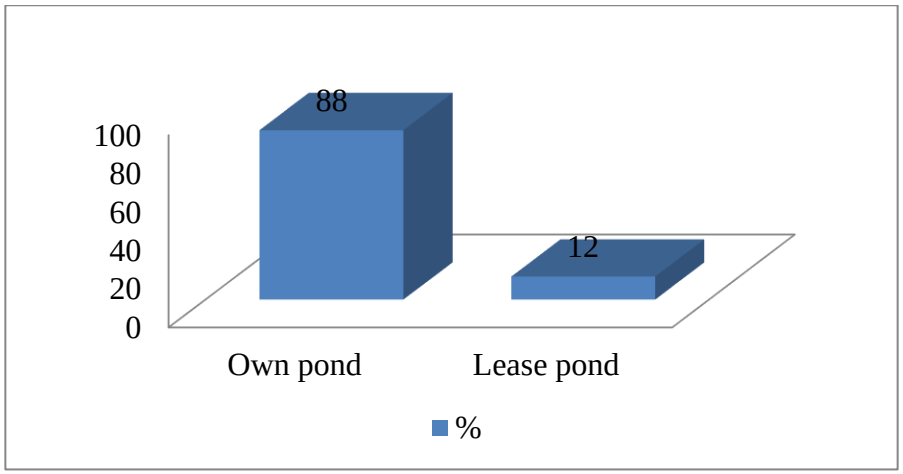

Figure 5: Ownership of the pond in the study area

4.1.2 Preparation for culture in north-east region

Pond preparation was an important issue for fish farming. Farmers were asked about pond preparation and how they prepared ponds. 88 percent fish farmers replied that they prepare the pond well by drying it and 12 percent farmers did not follow drying process while on the other hand 90 % farmers applied lime in pond preparation and only 10% did not apply lime in pond preparation (Figure 6). Farmers stated that they used sunlight to dry the fish farm and usually taking out the water from the pond and

dry the solar energy. Farmers also practiced liming procedure for pond preparation. For liming procedure farmers usually stock water before and then used the lime and predatory killer to eradicate insects and predatory organism and check the water quality for example central ph and soil ph etc.

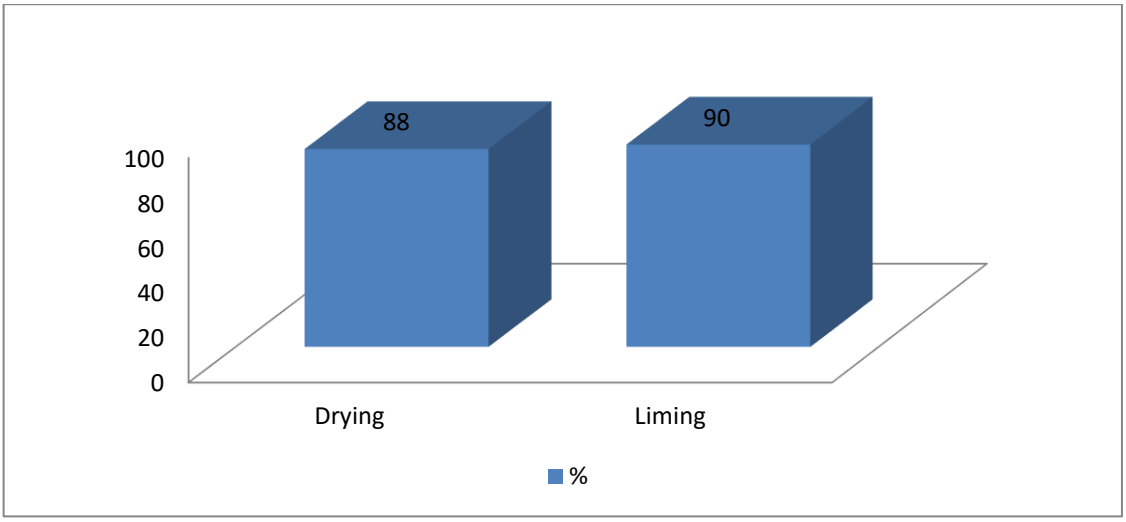

Figure 6: Farmers perceptions about the pond preparation in the study area

Table no1: ANOVA table to observe the statistical difference among different variables

	DF	F value	P value
Error type			
Culture type	1	16.32	0.03
Pond area	1	18.24	0.002
Ownership of the pond	1	25.36	0.01
Pond preparation type	1	18.24	0.02
Residuals	12		

One way ANOVA showed that (Table 1) culture type, pond area, ownership of the pond and pond preparation type were significant difference among the farmers (as the p values of were less than 0.05).

4.2.3 Eradications of predatory fishes in the study area

During the survey farmers were asked if they eradicate the predatory fishes or insects (Figure 7). Predatory fish or insects were harmful for fish culture; predatory fish eat the other commercial important culture species that's had to economic loss of the farmers and insects also similar cause of losses. Therefore it was importance to eradicate the predatory fish and insects from the culture ponds. The study reacted that are 98% farmers eradicate the predatory fish and insects from the pond. However only 2% farmers did not perform to measure eradicate the culture pond.

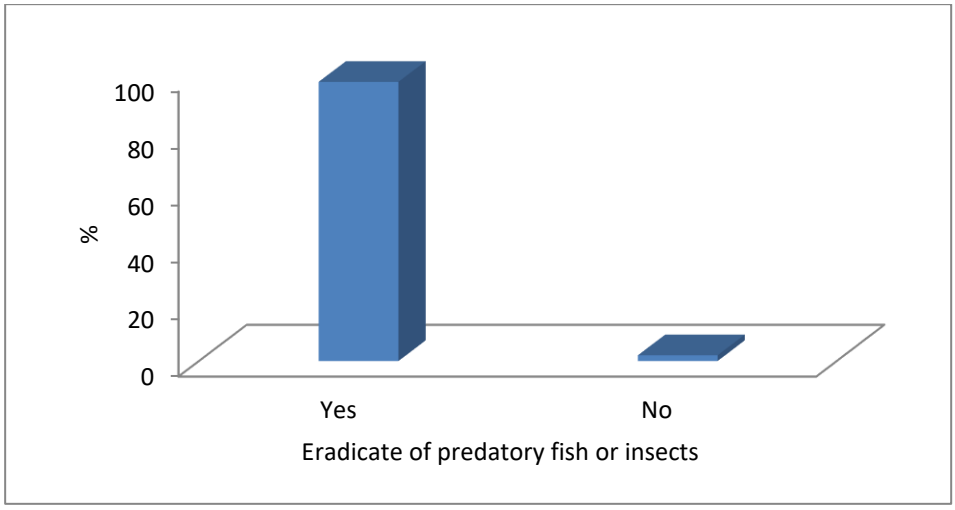

Figure 7: Eradications of predatory fish or insects by farmers

4.2.4 Use of fertilizer in the study area

Fertilizer played an important role in the pond preparation. Fertilizers usually helped in making natural food. If adequate amount of natural food is not produced in the pond then the expected results are not obtained. Farmer's perceptions about the use of fertilizer were shown in figure 8. Findings showed that only 2% of the farmers did not use any kind of fertilizers in their pond where majority of them use some kind of fertilizer.

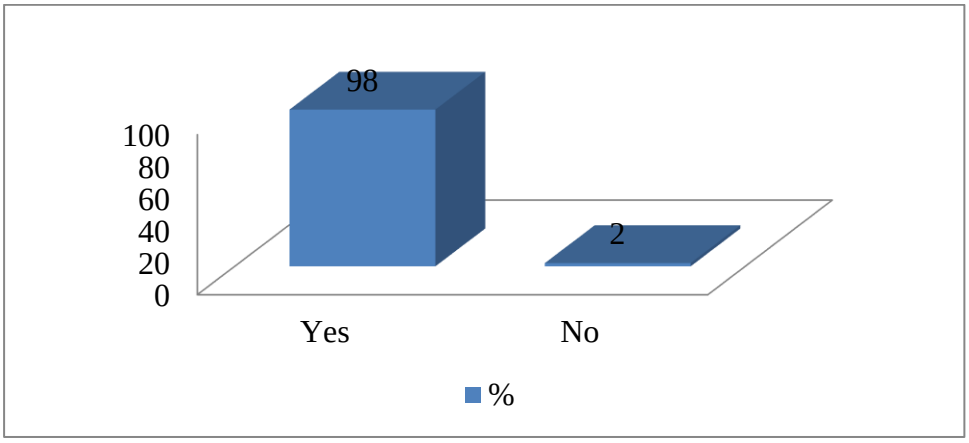

Figure 8: Use of fertilizer by fish farmers in their pond

4.2.5 Fry collection source in the study

Farmers' perceptions about the fries were shown in figure 9. 90% of the farmers collected their fries from hatcheries where only 10% collected them from the wild. Conscious fish farmers usually cultivated fish with good quality from branded companies. The respondent said that if you cultivate fish with, the yield is usually good. Fish farmers informed that low quality fry at low prices had a huge negative impact on fish farming and many times the farms were financially damaged. From the time of data collection showed that those who used good quality products have a much better immune system than low quality ones and they were very satisfied. It was a good indicator that 90% farmers collected their fries from hatchery. Hatchery

fries had positive impacts on aquaculture production. Source of fry collection are shown in figure no 9.

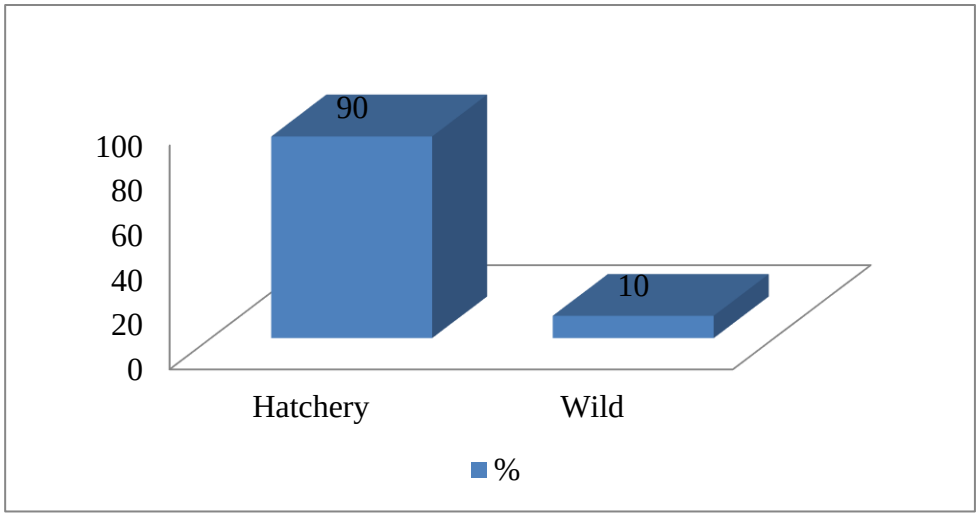

Figure 9: fry collection source in the study area

Table 2: ANOVA table to observe the statistical difference among different variables

Error type	DF	F value	P value
Eradication of predatory fish	1	25.12	0.04
Fertilizer use	1	21.32	0.001
Source of fry	1	29.34	0.002
Residuals	25	25.24	

Statistical analysis(table 2) shows that there was significant differece among eradication methods,fertilizers and sources of fry.

4.2.6 Fry collection from different sources

The study indicated that 85% of the farmers usually collect their fries from establish hatcheries where only 10% was collected locally and only 5% from patil who sell fry (Figure 10). However, few fish farmers collected fry from local hatchery and patil. It was very good sign that maximum farmers collected their fries from branded hatcheries. According to farmers survival rate, growth rate were very good from collecting fries from established hatcheries.

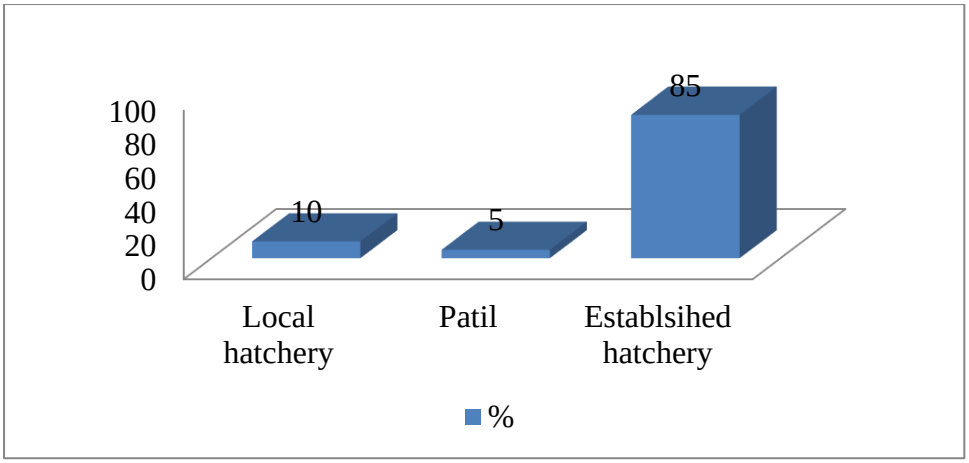

Figure 10: Fry sources from hatchery used in the study area

Table 3: ANOVA table to observe the statistical difference among different variables

	DF	F value	P value
Error type			
Local Hatchery	1	36.21	0.01
Patil	1	25.36	0.02
Established hatchery	1	34.21	0.002
Residuals	54		

Statistical analysis (table no 3) shows that local hatchery, patil and established hatchery varies significantly among the fish farmers. It showed that, even though the fish species were collected from the same sources, they were quite different.

4.2.7 Stocking dencity of culture pond

Density was usually an important factor in fish farming. Fish farming in high density was taken a long time for fish to grow and usually many food wastes and even more and more diseases. 75 % of the ponds in study area had a stocking density of 200 to600 fishes/dec. Where the other 5%, 15% and 5% had <50 fishes/dec, 50-200 fishes/dec and >600 fishes/dec (Figure 11). The study area found that the density of carp fish with tilapia is usually 200 pcs/dec. On the other, carp fish had a density 50/deci or more. Catfish density was 600 /deci or more than 600.

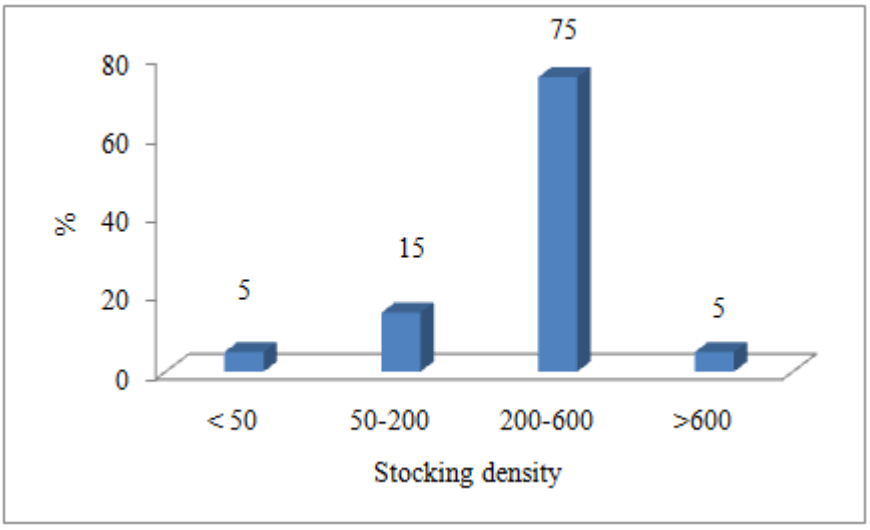

Figure 11: Stocking density of fish in the pond

4.2.8 Regular monitoring for good fish farming

In the management process of the ponds, 99%, 90% and 95% of the farmers stated that they regularly monitor their pond, check the water quality of the pond and feed the fishes (Figure 12).Regular feeding, water quality check and monitoring are good practice for aquaculture production. 99% of the farmers in the north-east Region regularly monitor their projects and seek advice from various fisheries related professionals. 90% of farmers perform management based on water quality. On the other hand, 95% farmers provide regular fish feed to only 10% of the farmers who do not provide regular fish feed.

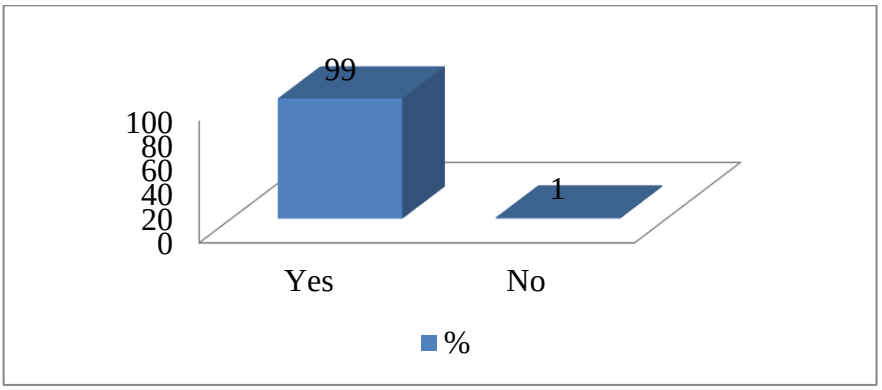

Fig 12.1: Regular monitoring

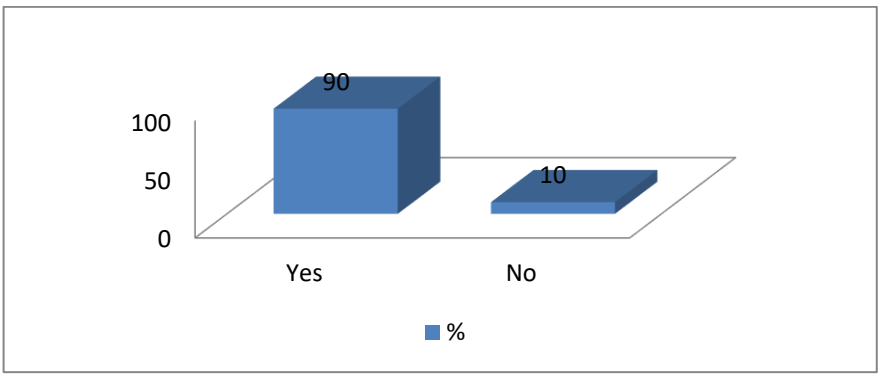

Fig 12.2: Regular water quality check

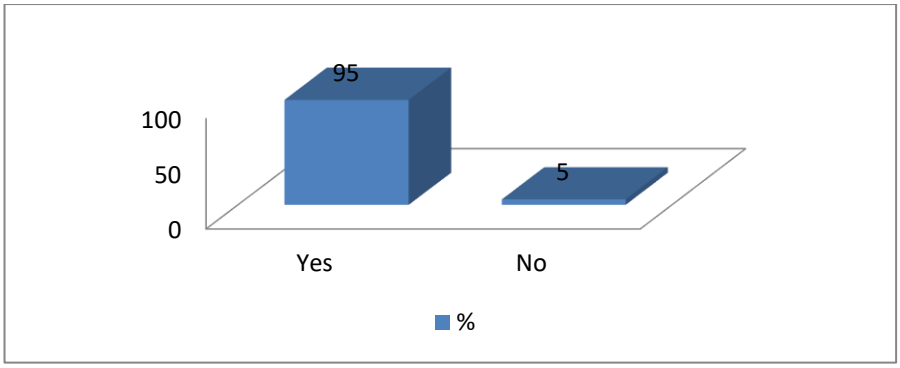

Fig 12.3: Regular feeding

Figure 12: Monitoring status of fish pond in the study area

4.2.9 Various types of feed using by aqua farmers

It was observed that the feeding rate was almost same after the nursery stage 95% (Fig 13). Finisher stage had the highest feeding rate 100%. 8% of the foods they fed the fishes were handmade foods where the other 90% Ready feed but most of the farmers did not know about feed ingredients.

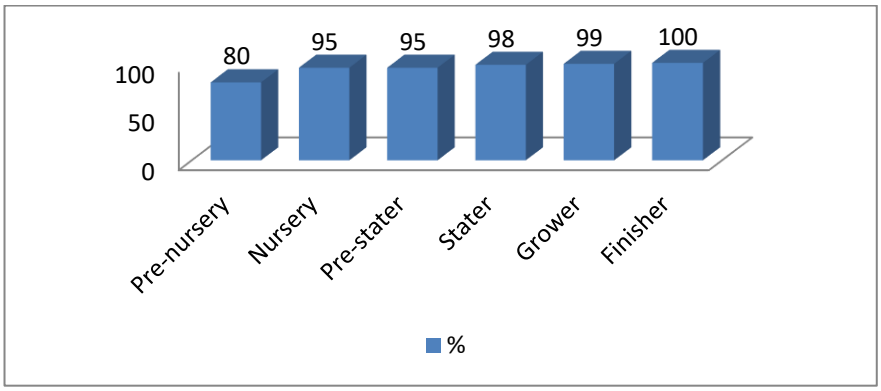

Fig 13: Variation of feed used in the pond in the study area

4.2.10 Feed and feeding practiced using by farmers

During the study period the farmers were applied feed about 90% market sources, 8% handmade and 2% from nature sources. The feeding types were representation graphically bellow figure 14.

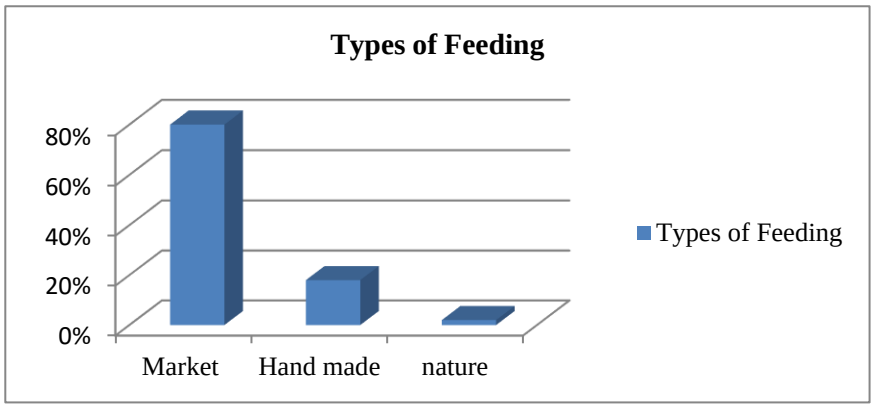

Fig 14: Feed type used in the fish pond in the study area

Table no 4: ANOVA table to observe the statistical difference among different variables

Error type	DF	F value	P value
Stocking density	1	36.21	0.001
Regular monitoring	1	12.35	0.02
Water quality check	1	32.54	0.005
Regular feeding	1	28.32	0.001
Feed type	1	24.23	0.001
Ingredients	1	29.63	0.001
Residuals	32		

Stocking density, regular monitoring, water quality check, regular feeding, feed type and ingredients varied significantly among the fish farmers (table 4).The table also showed the statistical difference between the farmers who regularly monitor the pond, check water quality, fed the fishes regularly and who didn't do so($p<0.05$).

4.2.11 Water exchanges facilities of the study area

Water exchanges were an important way for good fish farming. Changing the water of the pond in the regularly increased the production and reduces the disease. 90% of the farmers in the study area had no water exchange facilities in their pond where the other 10% had any kind of water exchange facility (Figure 15). 90% farmers had no water exchange facilities which were not very good indicator for the best aquaculture practice. When there was no opportunity to change the water, the water environment deteriorates rapidly and the use of various chemicals to maintain the water environment increases. Water change was a major problem in the region. Water was not readily available here. Farmers in the region cultivated fish based on the main natural water.

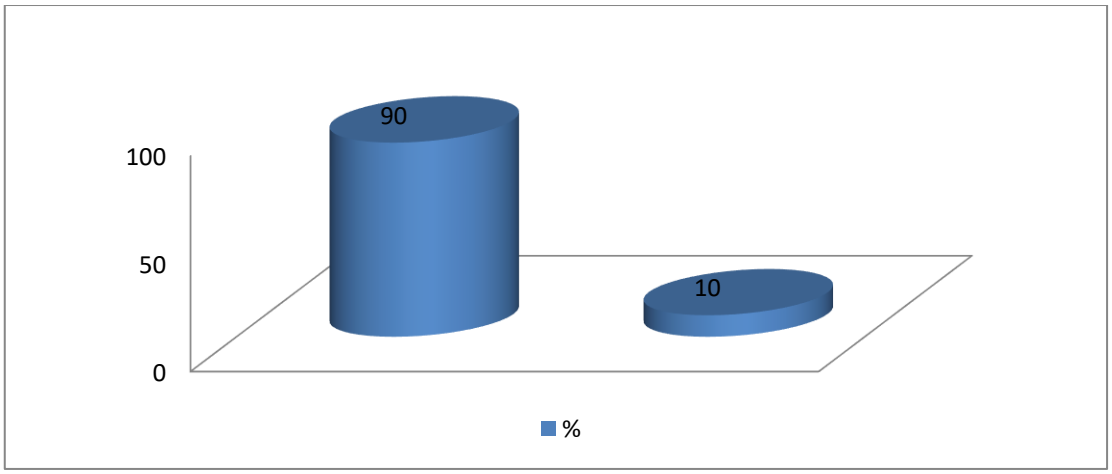

Figure 15: Water exchange facilities in the fish pond in the study area

4.2.12 Feeding frequency in the study area

The study revealed that around 60% farmers give feed 2 times per day and 25 % farmers give 3 times/day on the other hand only 15% farmers give their feed only I time. For good results fishes had need three times feeding/day by satiation feed rate. Feed frequency is shown in figure 16.

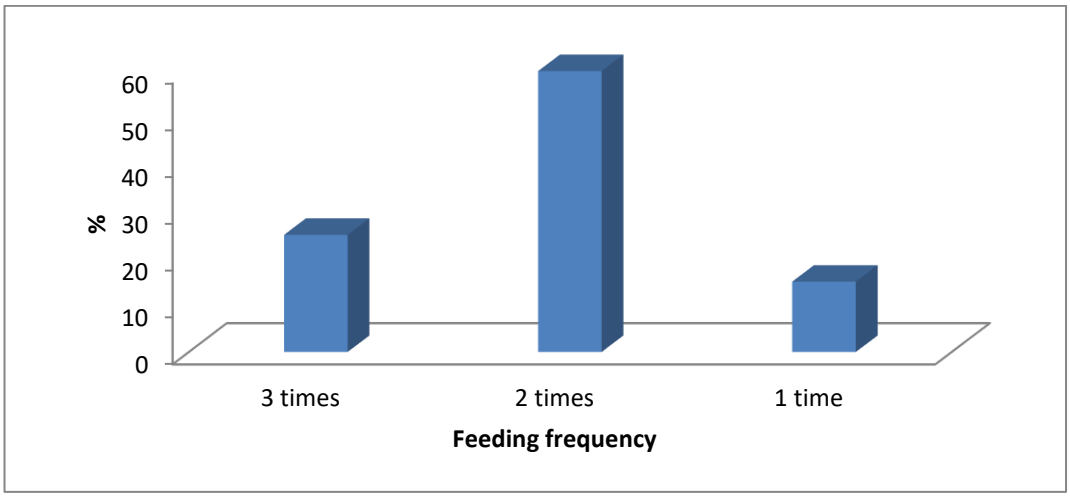

Fig 16: Feeding frequency in the study area

4.2.13 Feeding rate practiced by farmers

Data showed that 50% fish farmers adopted 15% feeding rate while 25% farmers adopted 5% feeding rate, 20% farmers adopted 10% feeding rate,10% farmers adopted 25% feeding rate, 5 % farmers adopted 35% feed rate. Feedingrate is shown in figure 17.

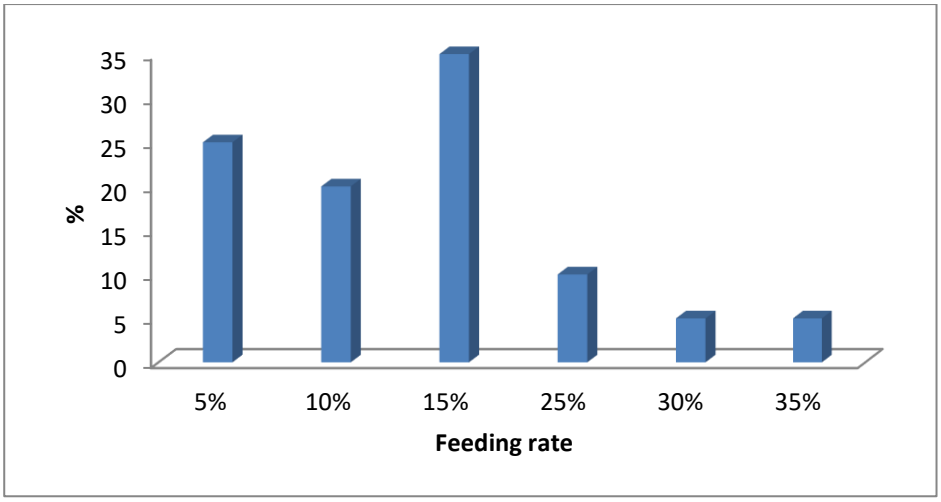

Fig 17: Feeding rate used in the pond in the study area

4.2.14 Feed conversion ratio found in the study

Most of the farmers had got FCR 1.5 that's indicated feed cost is too much high and overall production cost also high. On the other hand most of the feed producing companies indicated their feed conversion ratio is 1.2. When feed FCR will increase than water quality will be deteriorated and water management cost will increase Overall aquaculture production will decrease day by day due to high production cost. Excessive wastage of feed destroyed the pond environment and creates excessive toxic plankton in the pond. Adequate amount of chemicals were used to improve the environment of the pond, on the one hand for feed export and on the other hand due to the use of excess chemicals, fish farming suffers financially and psychologically. So good quality feed was essential for fish farming. Feed conversion ratios shown in figure no 18.

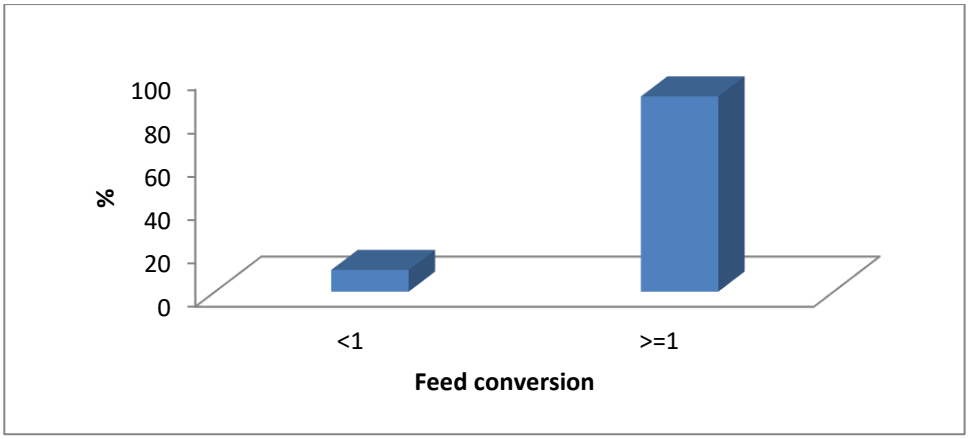

Fig 18.1: Feed conversion ratio found in the study area

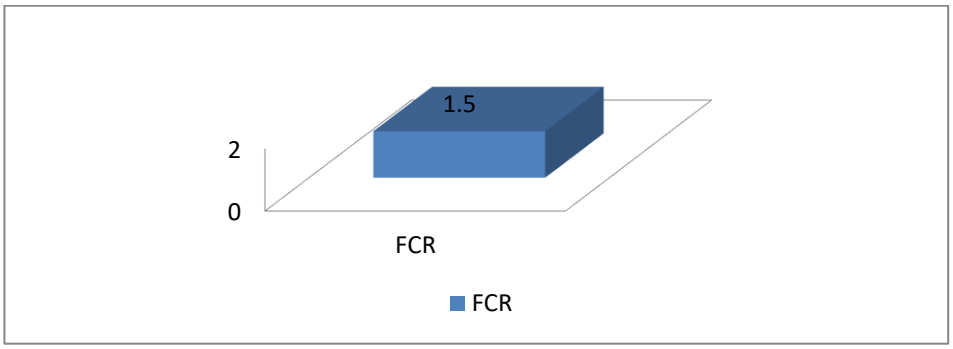

Fig 18.2: Feed conversion rate in the study area

4.2.15 Using chemicals or not in the study area

In the study area, 98% farmers responded that they used chemicals in the aqua farms while only 2% farmers did not use chemicals in the pond. Results on using chemicals or not shown in figure no 19.

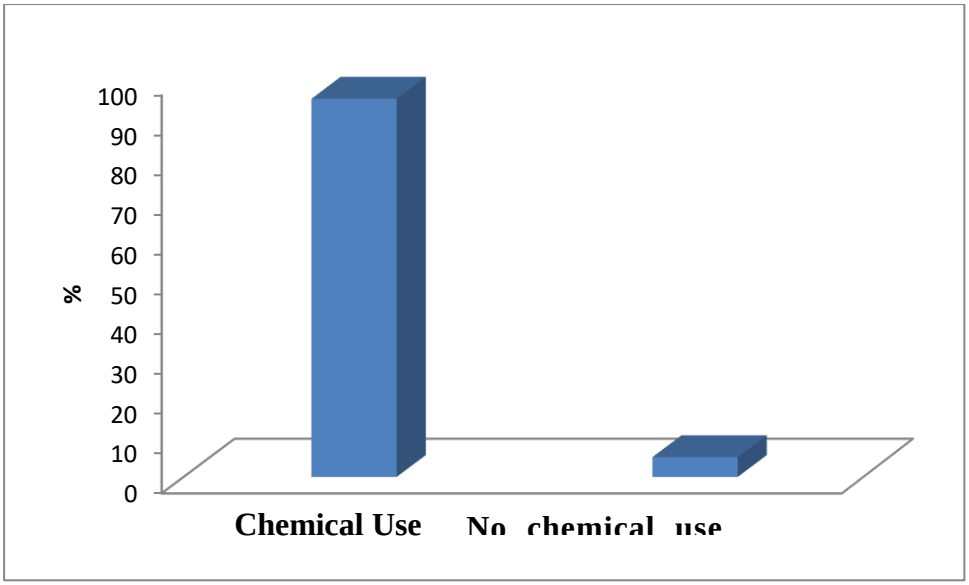

Fig 19: Chemical use or not in the study area

Table 5: ANOVA table to observe the statistical difference among different variables

Error type	DF	F value	P value
Water exchange facilities	1	54.32	0.04
Feeding frequency	1	15.65	0.03
Feeding rate	1	49.32	0.05
Feed conversion	1	15.23	0.01
Use of chemicals	1	16.32	0.001
Residuals	24		

The statistical result of water exchange facilities, feeding frequency, feed conversion, and use of chemicals is shown in table 5.

4.3 Classification of chemicals used in aquaculture for health management

There are different classes of aqua-drugs and chemicals were found to apply regularly by aqua farmers in their cultivation activities and are interested in using drugs by representatives of different companies. These can be classified into different categories e.g.1. Zeolite 2. Disinfectants 3.Oxygen supplier 4. Growth promoters 5. Soil and water probiotics 6. Gas remover 7. Digestivity enhancer 8. Algae killer 9. Stress reducer 10.Insect killer 11. Antibiotics 12. Predatory killer etc. Different types of aqua drugs and chemicals were commonly applied in pond preparation to get good FCR for rapid growth of fish and below all to keep the pond environment good like pond preparation, natural feed enhancing, harmful organisms destroying, supply of oxygen, toxic gas removing, growth promotion, disinfectant, probiotics, digestion, and fish disease treatment have been composed and compiled. These drugs and chemicals were most commonly used in areas where fish diseases are more prevalent. The local animal feed and chemical traders were the main sources of such products from where farmers usually bought these types of products.

4.3.1 Chemicals applied for soil and water quality management

During the search for information, various types of products as well as new products were observed in the study area to apply for pond preparation and improving water quality of the pond. On the impact these products were also called health mineral. They were combined of some inorganic compound like, potassium, silicon, sodium, titanium, aluminum, iron, lithium, calcium, magnesium etc which together form very minute pore and sponge like configuration. These products were characterized by the fact that the smallest germs in the pond are trapped in toxic gases, which improves the heath of the bottom of the pond and the water environment, creating a favorable

environment for aquatic life. Some products also seen in the chemical traders applied mainly for enhancing primary productivity in the fish pond. These products controlled the pH of the water and play an effective role in increasing the alkalinity of the water by suppressing other harmful gases including ammonia, nitrate and hydrogen sulfide in the pond and eliminating soil and water odor. Specially these types of products used as a good source of mineral. The record of such chemicals with their major ingredients, prescribed dose, source, marketing by, pack size and approximate price are shown in table no 6.

Table 6: List of chemicals used for fish farming as minerals

No	Product brand name	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	Doses
1	Zeolite Gold	FISHTECH	Sitto, Vietnam	10 kg	N/A	410	Spread with water (4-5) feet depth 200gm/dec
2	Mega Zeo	ACI	Indonesia	10kg	320	500	For (4-5) feet deep water body 25kg/100 dec
3	Zeo Fresh	Square	Indonesia	10kg	280	440	For (4-5) feet deep water body 60-70 kg/acre.
4	ZeoPel	SK+F	Indonesia	10kg	270	620	200 gm/ decimal
5.	J V zeolite	EON	Indonesia	10kg	270	565	For pond preparation 10kg/33 dec. for

							culture 6 kg/33 dec. every 15 days.
6	Nava Zeolite	Navana	--	10kg	320	400	(4-5) feet deep water body 30kg/100 dec.
7	Zeoprime	SK+F	-	10kg	300	510	300 gm/ decimal
8	Zeorich	Opsonin	Indonesia	10kg	270	460	250gm/ decimal
9	Zeotox	Elanco	India	10kg	560	720	For 4-5 feet deep water body 20-25kg/100 decimal.
10	Acme Zeolite	ACME	Indonesia	10kg	285	450	Time of pond preparation 300gm/dec.
11	Zeo Ren	Renata	Indonesia	10kg	290	420	20-30 kg/acre
12	Zeo star	Star Agro	Indonesia	10kg	280	550	350 gm/ decimal
13	Zeomaster	Nutri Health	Indonesia	10kg	350	550	Time of pond preparation 15-20 kg/100 dec. During culture.

4.3.2 Disinfectants found in the study area

There were various types of disinfectants available in the market. BKC (Benzyl khromium chloride) was the most widely used disinfectants. It was used extensively once a month. It worked well for different bacterial and fungal diseases. Fourteen types of disinfectants from many diverse sources were found to use by the farms. Farmers used a variety of chemicals to keep their pond environment good and free of pathogens. Their trade name, composition, dose, price and source are revealed in table no 7.

Table no 7. List of disinfectant (BKC group) used in the study area

No.	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	doses
1	Pond Safe	BKC 80%	FISHTECH	Biopharmacheme, Vietnam	500 ml	N/A	1045	7ml/dec in5 feet water.
2	Pathonil Plus	BKC 80%	ACI	ACI	500ml	1050	1220	100 ml/30 dec
3	Microbite	BKC 80%	NutriHealth	India	500ml	1120	1600	5ml/dec
4	Bactonill	BKC 80%	General Agro.	India	500ml	1200	1600	100 ml/30 dec
5	Micronil	BKC 80%	SKF	SKF	500m	1150	1345	(6-

					l			7)ml/dec
6	Aquaxide Plus	BKC 80%	Advance	Vietnam	500ml	1250	1450	5ml/dec
7	Aqua Sol	BKC 80%	Navana	Navana	500ml	960	1150	7ml/dec
8	Maktisol	BKC 80%	Makdistribution	China	500ml	1120	1200	4-5gm/dec
9	Protector	BKC 80%	KRF agro	Vivo bio. India	100ml	260	320	(5-6)ml/dec
10	Sansure	BKC 80%	Opsonin	Europe	100ml	184	285	5ml/dec
11	Timsen	BKC 40%	EON	USA	50gm	232	261	50gm/33dec
12	Virocef	BKC 80%	Safe & Save	Napha,Vietnam	125ml	315	360	6ml/dem
13	Aqua kleen	BKC	Square	Square	100ml	342	468	2L/100 dec
14	Virokil Aqua	BKC 80%	Advance	Vietnam	100 ml	245	290	7ml/dec

Table no 8: List of chemicals used as disinfectant and sanitizer in the study area (non BKC group)

Sl. No.	Trade name	Ingredients	Dose	Source	price
1	Emsen	n-alkyl dimethyl benzyl ammonium chloride+stabilized urea	70 g/33dec spread over water surface	SK+F Bangladesh Ltd	240 tk/50g
02	formalin	38% formaldehyde	3-4 ppm	Chemical seller	100/ kg
03	Bleaching	Clorine(35%)	10gm/dec	Chemical seller	80-100/kg
04	Polgard plus	3-methyl,4alkyl two chain brominated halogen compound	5ml/dec in 3-4 feet depth	Fishtech BD Ltd	1095tk/ 500ml
05	Omicide	Benzyl ammonium chloride+urea	250ml/33dec.	Lion overseas trading company	120tk/100ml
06	Water clear	Sodium thiosulphate	In case of 5-6 feet deep water body 3 L/100 dec	Organic pharmaceuticals Ltd	350/L
07	Salt	NaCL using as sanitizer.	500 gn/decimal(4-5)depth of	Chemical seller	8-10/kg

			water.		
08	Lime	CaO, $Ca(OH)_2$		Chemical seller and importers	12-13/kg
09	Potash	$KMnO_4$		Chemical seller	380-400/kg
10	Viusid aqua	Monoglyceraldyhide(use as antiviral and develop immune systems)		Fishtech bd ltd	3800/L

According to the leaflets of various companies, the disinfectant was a powerful sanitizer which was effective against viruses, bacteria, fungi and scaly scabs. Formalin was also control protozoan disease and preservative. BKC used for controlling bacterial disease and water clear can be used as stress reducer. Disinfectant destroyed bactericidal germs and keeps the skin clean by removing zoothumnium and stains deposited on the body of fish and shrimp.

4.3.3 Oxygen supplier found in the study area

Farmers used different kinds of oxygen supplier when dissolved oxygen shortage occurs. The main component of all these oxygen supplies was sodium per carbonate 90%. Oxygen was usually applied in cloudy sky; fish concentration was high in the pond, lack of adequate sunlight, continuous rainfall and the amount of toxic gas at the bottom of the pond increases with increasing temperature. About major 15 oxygen suppliers with various trade name were found to use by the fish farmers in the study area. Several products were found in the market under the same name but their doses were different in price and usage. Oxidizing agent, price, source and doses and the major active ingredients of such chemicals are shown in table 9.

Table 9: List of chemicals used as oxygen supplier in the study area

No.	Product brand name	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	Doses and Composition
1	Oxy Gold	FISHTECH	ANOVA Vietnam	1 kg	N/A	635	Sodium per Carbonate 90%, Oxygen release 13.5%
2	Oxy Ren	Renata	Vietnam	1kg	400	680	Sodium per Carbonate13%
3	Oxy Flow	Novartis	India	1kg=(250x4)	770	880	Sodium per Carbonate (13%)
4	Oxy	General	Thailand	1kg	480	650	Sodium per

	Aqua	agro.					Carbonate 15%
5	Oxy More	SKF	Vietnam	1kg	360	500	Sodium per Carbonate Per oxihydrate 90% , Oxygen release 12%
6	Oxy Top	Nutri health	China	1kg	350	620	Sodium per Carbonate 13%
7	Oxy Rich	Opsonin	Korea	1kg	500	650	Sodium per Carbonate
8	Oxy Mix	Save & Safe	Anvet,Vietnam	1kg	450	550	Sodium per Carbonate
9	Oxy life	Square	Square	1kg	413	635	Sodium per Carbonate
10	ACI-Ox	ACI	Vietnam	1kg	480	632	Sodium per Carbonate 14%
11	Oxy A	Acme	Shanghai,China	1kg	380	520	Sodium per Carbonate
12	OXY-SOS	Advance	-	1kg=(250x4)	610	705	Sodium per Carbonate14%
13	Bio-Ox	ACI	Thailand	1 kg	-	500	Sodium per Carbonate(14%)
14	OXY MAX	EON	China	1kg=(250x4)	580	700	Sodium per Carbonate

15	Miracle O_2	One Pharma	-	1kg=(250x4)	330	590	Sodium per Carbonate 12%

From the above products it was known that some of the products were also using to remove hardness and toxic gases i.e. oxy gold, Ox flow Oxymore and Quick oxygen. Oxygen usually ensured an abundance of dissolved oxygen thus preventing oxygen deficiency mortality, controlling excessive levels of phytoplankton, controls the pond environment and maintains the quality of water by maintaining the supply of oxygen in the absence of photosynthesis. Farmers applied these chemicals for treating a diversity of fish disease such as oxygen deficiency, removing toxics gases with different doses. No information on the leaflet was available about the dose and methods of application of such products. No aqua products trading companies were dealing with their basic running product rather they were engaging in producing new products. In the present investigation it was observed that oxy gold and Oxy-A was vastly used followed by farmers. Sodium per carbonate, Sodium lorile, ether sulphate, Sodium carbonate, H_2O_2 was used in drugs to be used as oxidizing agents.

4.3.4 Growth Promoter applied by aqua farmers in the study area

Most of the products which were identified in the study area used as growth promoter as well as increase the body weight of fish. These chemicals were commonly used for the rapid growth of fish and easy digestion of food. Growth promoter helped to improve FCR. Growth promoters helped prevent stress during cultivation and build strong resistance against disease transmission. It contains ß-glucan, immunostimulant, which improve non-antibiotic and-non-specific immunity in fish. According to farmers' opinion and the chemical's leaflet, these chemicals

helped to increase the immunity of fish. Farmers in the study area named eleven different types of chemicals used as growth promoters of their fish. Their name, dose, price, and source are given in (Table no 9).

Table no 10: List of active ingredient with dose, source and price of growth promoters

No.	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	doses
1	Rapid Grow	Beta grucans, Mannan Oligosaccharide, vitamins,min	FISHTECH	Growel Formulation, India	1 kg	N/A	1000	(2-3)gm/kg
2	Growth care	Multivitamin	Nutri Health	India	1 liter	540	650	5gm/kg
3	Growth Master	Multivitami	Save & Safe	Napha,Vietnam	1 kg	900	1050	6gm/kg
4	GP Fish	Multivitami	ACI		1 kg	950	1060	5 gm/kg
5	Multi Grow	Multivitami	Advanced agrotech	Anova pharma, Vietnam	1 kg	850	950	5 gm/kg
6	Power boost	Multivitami	Plorexagro	USA	1 kg	800	1080	8gm/kg

7	Fish Grow	Multivitami	KRF agro	Implex,India	500ml	350	420	(5-6)gm/kg
8	EON Fish Grower	Vitamin, Mineral, Premix	EON	Netherlands	1 kg	210	270	3gm/kg
9	Multimix	Vitamin, Mineral	Science Tech	Thailand	1 kg	560	675	7 gm/kg
10	Aminosol	Vitamin, Mineral	Al-Madina	Italy	1 liter	1200	1500	5gm/kg
11	Eskalina	Vitamin, Mineral, Protein	SK+F	-	100 gm	236	300	5gm/kg

All growth promoters took part in important role for rapid growth of fish but some products caused a lot of damage for fishes. According to farmers, adding too many chemicals caused the fish to grow faster but suddenly increases the mortality rate which was then stabilized after using many antibiotics. Although the death rate of fish was reduced after feeding with antibiotics for a long time, the normal speed of the fish was disrupted. Some of these chemicals such as Rapid grow, Aqua mix, fish vita plus, vita power, vita max also improved disease preventing capacity of fish. Vita power, Exorich, Megavit aqua, organic aqua also added to hatching rate and, Aqua min helpful in developing bone of fishes.

4.3.5 Soil and water probiotics used by aqua farmers

There had been increasing concentration in the use of probiotics in aquaculture with the requirement to make it friendly environment. In the current era, probiotics were important ingredients which were essential for fish farming. Its use was increasing day by day. It had been observed that those who cultivate fish in a modern way use probiotics regularly every month. According to farmers probiotics usually dissociated the organic matter from the bottom of the pond and provide inorganic elements like carbon,nitrogen,sulfur,phosphorus etc. So that the pond water was cleaner, safer and healthier and ensures higher yields. In the present study some farmers were found to apply a variety of probiotic products to control various harmful Virbiosis and other lunimiscent bacteria, improving water and soil quality, control dissolved oxygen, and pH, ammonia, hydrogen sulfide more toxic gases.(Table no10). The probiotic containd mainly different attention of beneficial bacteria which include Bacillus sp, Aspergillusoryzae, Saccharomyces, Rodobacter sp, Rodococcus sp, Streptococcus faecalis etc. Percentage of dissimilar probiotics applied by fish farmers is shown in (table 11and 12).

Table no 11: List of active ingredient with dose, source and price of soil Probiotics

No.	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	doses
1	Ecotoxnil	*Bacillus sp.* ABPL 142- (5 x 10^9) 5.0 g *Bacillus sp.* ABPL 144- (5 x 10^9) 5.0 g Bacillus thermodenitrificans ABPL 140- (5 x 10^9) 9.5 g	FISHTECH	TIL Bioscience, India	1 kg	N/A	2620	600 gm/ acre
2	Aqua life S	Bacillus sp.,Lactobacillus sp., Saccharomyces etc	SAVE & SAFE	Napha, Vietnam	1 kg	1150	1310	300gm/acroes
3	Aqua Prob	Bacillus sp.,Lactobacillus sp., Saccharomyces etc	ACI	Thailand	1 liter	480	579	1 liter/acre
4	Pond Care	Probiotic: 22×10^9 cfu/gm	SKF	Spain	50 gm	400	495	200 gm/

								acre
5	Vivo Prob	Bacillus sp.,Lactobacillus sp., Saccharomyces etc	NUTRI HEALTH	India	100 gm	294	350	500gm/acre
6	Profs	Bacillus sp.,Lactobacillus sp., Saccharomyces etc	EON	India	100 gm	558	660	200 gm/ acre
7	Aqua Prob S	Bacillus sp.,Lactobacillus sp., Saccharomyces etc	KRF agro	Vivo bio. India	100 gm	515	595	400gm/acres
8	Pond Bact	Probiotics + Enzymes	Naafco	Singapore	130 gm	385	500	500gm/acres
9	Aqua Star Pond	Probiotics	Renata	Indonesia	500 gm	865	1005	500 gm/ acre
10	Ultipro	Probiotics	Renata	Indonesia	5 Liter	1500	1765	5 Liter/ acre

Table no 12: List of zeolite with probiotics found in the study area

No.	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	doses
1	Aqua Magic Plus	*Saccharomyces cerevisiae* 1.5×10^9 CFU *Bacillus subtilis* 1.5×10^9 CFU *Aspergillus oryzae* 1.5×10^9 CFU MgO---0.8%, K_2O SiO_2,Al_2O_3,CaO, Na_2O, Fe_2O_3	FISHTECH	Biopharmacheme, Vietnam	5 kg bucket	N/A	790	5kg/acres
2	Ecorich	Zeolite+Probiotics	Opsonin		5 kg bag	680	800	10/kg acres
3	Biopond	Zeolite+Probiotics	SKF	Japan	5 kg bag	700	990	5kg/acres
4	Pond Life	Zeolite+Probiotics	ACI	Thailand	5 kg bag	625	790	7kg/acres
5	Aqua Pure	Zeolite+Probiotics	SQUARE	SQUARE	5 kg bag	470	570	10kg/acres
6	Bio Gold	Zeolite+Probiotics	SAVE &	Napha,Vietna	5 kg	155	1850	5kg/a

			SAFE	m	bag	0		cres
7	Matrix	Zeolite+Probiotics	EON	Biostad,India	5 kg bag	625	790	10kg/ acres
8	Eco Charger	Zeolite+Probiotics	KRF	India	5 kg bag	650	1200	5 kg/ac res
9	MLime	Zeolite+Probiotics	ACME	Thailand	5 kg bag	600	700	10kg/ acres
10	Pond Guard	Zeolite+Probiotics	ACI	Thailand	5 kg bag	590	790	7kg/a cres

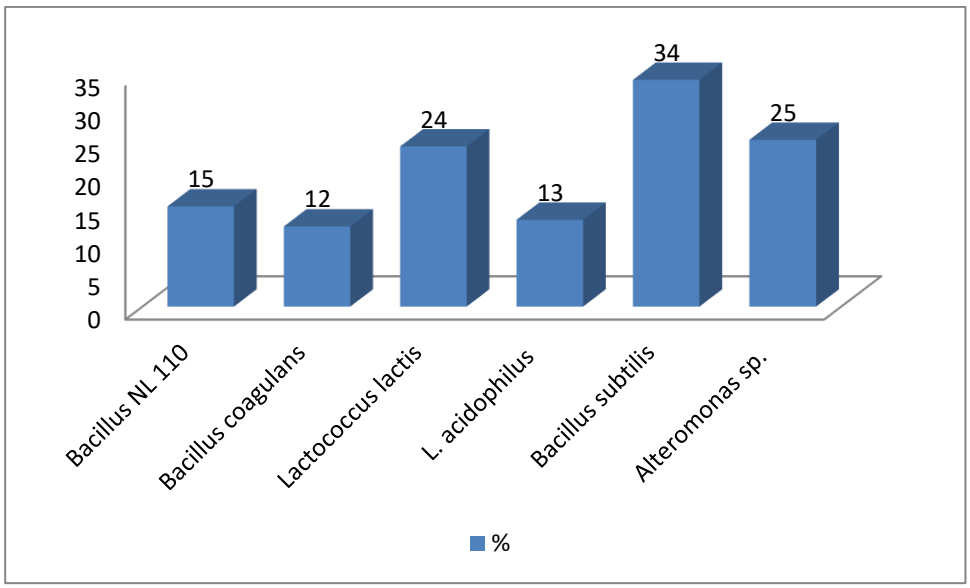

Fig 20: different types of probiotics were used in the study area

Table no 13: ANOVA table to observe the statistical difference among different parameters related to probiotics

Error type	DF	F value	P value
Compositions	1	15.32	0.02
Purpose	1	16.24	0.001
Dose	1	22.36	0.001
Source	1	11.24	0.002
Price	1	13.52	0.04
Species	1	12.35	0.03
Residual	15		

One way ANOVA table 13, shown the statistical result among different parameters related to probiotics such as compositions, purpose, dose, source, price, species varies significantly among the fish farmers.

4.3.6 Gas removal used in the study area

During the study period it was found that farmers used gas removal to their culture pond. Ensuring proper water quality management and adequate oxygen supply was of utmost importance for good health and rapid growth of fish. But irregular water change and application of less excessive lime, excessive application of feed residues and excessive application of organic and inorganic fertilizers make the water quality unsuitable for fish farming and a large number of different harmful gases were

produced. Farmers usually used regular gas to protect the farms from these harmful gases. Around 14 gas removals with various trade names were found to different farm. Their brand name, dose, price and sources are given in (Table no 14). Several aqua-drugs were described to be used as toxic gas reducer in different farms exposed by the respondents.

Table no14: List of toxic gas reducer used by aqua farmers in the study area

No	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)
1	Gasonex+Y	Each gram contains- Pseudomonas florecium-$1x10^9$ Bacillus subtilis-$1x10^9$ Rhodospirillum-$8x10^8$ Bacillus megaterium-$8x10^8$ *Thiothrix*-$6x10^{8,}$ *Nitrococcus*-$4x10^8$ CFU in inactivated yeast and inert base.	FISHTECH	Growel Formulation, India	200 gm	N/A	840
2	Bio Aqua-50	Extract of Yucca Schidegera	EON	Spain	500 ml	960	1100
3	Yuca Plus	Yucca	KRF agro	Vivo	100	230	300

	L	Schidegera,Aloevera, *Bacillussubtillus, B. poliryxin,*Nitrobacter enzyme	care	bioscience, India	ml		
4	Ammo check	Extract of Yucca Schidegera,Aloevera	Navana	India	100 ml	250	315
5	Bio Aqua	Extract of Yucca Schidegera	Nutri Health	Mexico	500 ml	1120	1575
6	Gas Trap	Enzyme,Probiotic,Yucca	Square	Square	100 gm	166	326
7	Gasonil	Probiotic 8×10^9,Yucca 30%	SKF	Japan	100 gm	370	495
8	Gas safe aqua	Yucca schidegera 70gm Lactobacillus 30000m cfu, Bacillus 3000m cfu Saccharomyces 25000m cfu	Save & Safe	Napha,Vietnam	200 gm	580	680
9	Yucca gold	Extract of Yucca Schidegera	ACI	ACI	500 ml	1700	1850
10	Yuca	Extract of Yucca Schidegera	Opsonin	Mexico	500 ml	1034	1320
11	Ammonil	Probiotics	Elanco	India	200	605	720

					gm		
12	Gastonil	Yucca+Enzyme+Probiotics	Nutrihealth	Korea	200 gm	460	650
13	Gas Pro Plus	Probiotics	Advance	Abode, India	200 gm	640	800
14	Yukasol	Extract of Yucca Schidegera	SK+F	India	100 ml	245	290

4.3.7 Enzyme found in the study area as digestive enhancer

Enzymes were an important ingredient that aids in the digestion of fish feed and plays a vital role in the growth of fish. Enzymes were easily digested by fish. According to farmers and products leaflets enzymes used eliminates reluctance to eat feed and improves fish growth which means less feed can be more produced. The existing probiotics and enzymes of the enzymes ensured maximum utilization of food and increase the immunity of fish and shrimps and maintain the balance of the pond environment. Major 14 types of enzyme were applied by the aqua farmers in the study area. The dose of enzyme was 5-10gm/ kg feed. The pharmaceutical business Fishtech afforded the enzyme to the farmer's mainly.

Table no 15: List of enzymes shown in Table found in the study area

No.	Product brand name	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	Doses
1	Biozyme	FISHTECH	Biopharmacheme, Vietnam	500 gm	N/A	560	5gm/kgfeed
2	Aquazyme plus	EON	India	500gm	275	335	5gm/kg
3	Safegut	SK+F	Sanzyme,Japan	500gm	285	330	4gm/kg feed
4	Superzyme	Save & Safe	Napha,Vietnam	500gm	500	650	5gm/kg
5	Ecozyme	Advanced agrotech	Anova pharma, Vietnam	500gm	510	590	5gm/kg
6	GPA	Opsonin	-	500gm	350	490	6gm/kg feed
8	AcmeZyme	ACME	India	500 gm	500	600	10gm/kg
9	EskaZyme Plus	SK+F	India	500 gm	360	418	5gm/kg feed
10	Fast Zyme	Fast Tech	India	100 gm	95	130	10gm/kg
11	RenaZyme	Renata	USA	100 gm	100	125	10gm/kg
12	NaafZyme	Naafco	Vietnam	100 gm	65	90	10gm/kg
13	SuperZyme	Save & Safe	Vietnam	100 gm	150	180	5gm/kg
14	Glucane plus	KRF agro	India	1kg	1180	1290	5gm/kg

4.3.8 Algae killer used by aqua farmers

Algae killer was an important ingredient for algae suppression.It helped in controlling poisonous aquatic plants and excessive phytoplankton. The main ingredients of algae killer were elemental copper 5%. According to products information's and farmers opinion Algae killer usually acts as an antidote to various diseases and removes germs from the bottom of its pond such as tail and antennal flagellum, rot disease, black gill disease and vibrio sp, pseudomonas sp also areomononas sp. Algae killer were used by the fish farmers when abundant of algae during the culture area. They usually used it at a dose of 2-4 liter/acre. The pharmaceutical company Fishtech delivers the Seaweed to the farmers. To remove or control toxic algae and phytoplankton growth the algae killer was used shown in table no16.

Table no16: List of algae killer found in the study area

Sl no	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)
01	Algaenil	Elemental copper 5%	FISHTECH	Vemedim Vietnam	1 liter	N/A	595
02	Algae Killer	Copper and inert ingredients	ACI	Taiwan	1 Liter	440	570
03	Algae Nill	Elemental copper	Advance Agrotech	India	1 Liter	420	610
04	Seaweed	Elemental	FISHTECH	Growel,India	1		400

		copper 5%			liter		

4.3.9 Vitamins-c (stress reducer) found in the study area

Vitamin-C was used basically a good stress reliever, it helps to get rid of menstrual cramps and prevent diseases. It was mainly made from a combination of ascorbic and citric acid. The main function of stress reducer was to increase the appetite rate, change the shell and use it to keep the disease in check and in the recovery period. Fourteen types of vitamins-c with various brand names were found to use by the farmers to increase disease resistance power and sometime to treat diseases of their cultured fish. Their brand name, dose, price and source are given in table no 17.

Table no 17.List of Vitamins-c (stress reducer) found in the study area

No	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)
1	Antistress	L-Ascorbate Poly phosphate 10 gm, Citric acid 20 gm	FISHTECH	Vemedim Vietnam	100 gm	N/A	145
2	Vitax C	Vitamin C 99%	EON	--	100gm	98	142
3	ASCO C	Vitamin C 100%	Nutrihealth	China	100 gm	196	275
4	Rena C	Ascorbic Acid 99%	RENATA	Renata, BD	100 gm	110	135
5	Cevit Aqua	Vitamin C 99%	SQUARE	SQUARE, BD	100 gm	100	139

6	Safe C	Vitamin C 99%	SAVE & SAFE	Napha,Vietnam	100 gm	140	160
7	Revit C	Vitamin C 99%	OPSONIN	OPSONIN, BD	100 gm	130	150
8	Quality C	Vitamin C 99%	KRF agro	Italy	100 gm	70	160
9	Vitamix C	Ascorbic Acid 99%	ACME	ACME, BD	100 gm	90	120
10	SKVit C	Vitamin C 99%	SK+F	SK+F, BD	100 gm	120	180
11	Vitasol C	Ascorbic Acid 99%	Advance	Vietnam	100 gm	235	275
12	Asvit C	Vitamin C 99%	Al-Madina	Al-Madina, BD	100 gm	155	195
13	C-Aqua	Vitamin C 99%	ACI	ACI	1kg	700	900
14	Ascavet C	Nova Pharma	Nova Pharma		500 gm	450	800

4.3.10 Insect killer used by aqua farmers in the study area

It was observed that fish were often attacked by parasites such as ticks, lice, mites' maggots, flies, anchor worm etc. All these parasites live in host's body and absorb blood from the host. These parasites not only caused anemia in the body of fish, but also endanger their immune system and cause various health problems. During the data collection, it had been observed that many people apply pesticides on agricultural land to control external parasites in fish farming. This disrupts the respiratory process of the fish and caused shortness of breath in the fish. Moreover, these pesticides were not very effective in pond water. These products were generally approved for agriculture but they were not approved for fish culture. The

latest and most effective solution to all these problems was deltamethrin but many other groups of drugs including cypermethrin, permethrin were used in the market. The farmers in their pond to kill different types of harmful insects removed they used Sumithion and Deletixwere the two insect killer. The recommended dose of Sumithion was 5-10ml/day/3ft depth and Deletix was 70 ml/acre for 4 feet water depth respectfully. There were ten companies who are provided the chemicals to the farmers shown in table no 18

Table no 18.List of insect killer found in the study area

No	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)	doses
1	Deletix	Deltamethrin 2.8% EC	FISHTECH	Growel Formulation, India	100 ml	N/A	885	75 ml/acre
2	Angreb	Cypermethrin	EON	--	100ml	81	125	100 ml/acre
3	Deltacin	Deltramethrin 2.8%	SAVE and SAFE	India	100ml	360	405	75 ml/acre
4	Aquacide Plus	Deltramethrin 1.5% Cypermethrin 3.5%	KRF agro	Vivo bio. India	100ml	350	420	

5	Ivatin	Ivermectin 2%	NUTRI HEALTH	India	1 lit	900	1000	
6	Acimec 1%	Ivermectin 1.5%	ACI	--	100ml	94	107	300 ml/acre
7	Shrimp killer	Ivermectin 5% Cypermethrin 10%	Somvabonar deshagro	--	100ml	70	180	
8	Paratics	Deltramethrin 1.75%	Advance	India	50 ml		270	50 ml/acre
9	Terminate	Deltramethrin 1.75%	Ultimate	Royal Bioscience	50 ml	220	270	50 ml/acre
10	Sumithion	Fenitrothion	Setu Corporation		100 ml	113	162	300 ml/acre

4.3.11 Farmers overall responded about aquaculture production in present situation in study area

SLno	Opinions of the fish farmers
1	Feed and fry cost was very high
2	Medicine cost was very high
3	Feed and medicine cost were very high but fish market not increase
4	Fry quality was not satisfactory

5	Government training program should be arranged
6	Feed price should be less, and good quality feed required
7	Feed and fry cost was very high. Govt should take some step to reduce the feed price
8	Fish price was very low need to subsidiary
9	Fry quality was not good enough and need to proper monitoring
10	Fish should be exported and not imported
11	Benefited by catfish culture
12	Unavailable raw materials
13	Service was not adequate from government office and lack of fisheries professional
14	Production was very high but sales volume was very low
15	Not getting expecting price in wholesale market
16	Quality assurance of available drugs and chemical also feed
17	We don't get any support from government

The most highlighted response by the fish farmers in the study area was ‘high price of feed and low price of fish. Most of the farmers claimed that the quality of fry and feed is not satisfactory, where the costs of these are much higher than their accord. They are also not quite sure about the quality and price of the medicines used in the process. Even after the high cost of fry, feed and medicine, the farmers weren’t getting expected price of fish in the wholesale market with the low sale volume. The farmers were profited by cat fish culture. According to the farmers, the governments were not creating any kind of support for them and it’d be beneficial for them if the government arrange training programs on aquaculture

and give them a clear concept of the process. Though low price of fish caused by the high production is disadvantageous for the farmers, it's beneficial for the general public as they're getting a larger quantity of product at a lower price.

4.4 Banned chemicals used in the study area

The study investigated that 98% farmers use any kind of banned chemicals which are very harmful for culture pond and bad impacts on its productions (Figure 21). Banned chemicals or any kind of insecticides were not allowed of good aquaculture practice only 2% farmers were very conscious about banned chemicals. They did not use any banned chemicals. Any kinds of banned chemicals are not approval for good aquaculture practice. It was also very harmful for aquaculture production for example radar, ivatin, ivarmectin, sumithion, aluminium phosphate, aldrin, and coper sulphate etc.

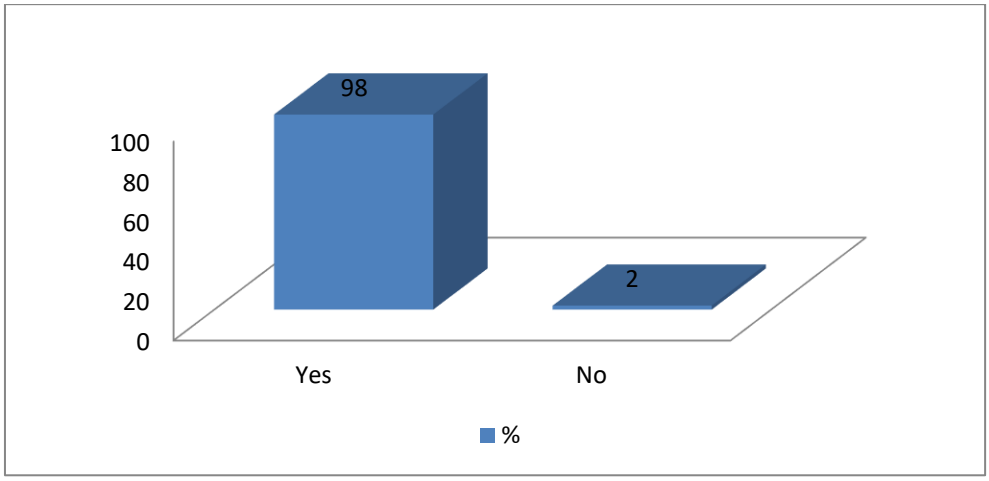

Figure 21: Farmers response to use any banned chemicals

4.4.1 Antibiotics used in the study area

In the study area, aqua farmers were applying antibiotics to prevent mass mortality of fish. Moreover, the slightest problem was that they take antibiotic advice from the representatives of different companies. Most of the farmers had no idea about the negative aspects of the use of antibiotics. During data collection, it was observed that farmers use different types of antibiotics. They even used high- potency new-generation antibiotics such as agithromycin, erythromycin etc. In the present study about 14 recognized antibiotics with different brand name were seen in the market as well as applied by the fish farmers which are shown in table 18.The vigorous ingredients of such antibiotics were mostly oxytetracyclin, chlorotetracycline,amoxicillin,co-trimoxazole,sulphadiazine,Erythromycin, methroprion and sulphamethaoxazole. Varying opinion was made by the farmers about the efficiency of particular products. The price seemed quite reasonable by the profitable fish farmers.

Table no 19: List of active ingredient with dose, source and price present using antibiotics.

SL no	Brand Name	Active ingredient	Dose	Source	Price (TK)
1	Acimox(vet) powder	Amoxicillin trihydrate	Normaly3 gm/1kg feed in emergency cases 5 gm /kg feed	ACI animal health ltd	80-100/100gm
2	Novamix-104	Sulpherdiazine, Erythromycin,	2 gm/kg feed	Fishtech (BD)ltd	415/100gm

		methroprion			
3	Chlorasteclin	Chlortetracycline	300-400gm/100kg feed (5-7 days)	Alanco pharmaceuticals ltd	3000-3200 tk/kg
4	Contrim (vet) bolus	Cotrimoxazole Inert ingredients	Mixed with 2-3gm /kg feed	Square pharmaceuticals ltd.	70-80/100gm
5	Cotrim-vet	Sulphamethoxazole + trimethoprim+ inert	normally2mg/kg fed in the body weight	Square pharmaceuticals ltd.	90-100/100gm
6	Micronid	Sulpherdiazine, Erythromycin, methroprion	2-3 gm/kg feed in emergency 5gm/kg	Renata animal healthlimited	360/100gm
7	Orgacycline 15%	Chlortetracycline+ inert ingredients	300-400gm/100kg feed 7 days	Organic pharmaceuticals ltd.	320/100gm
8	Urocode(175vet)	Sulpherdiazine, Erythromycin, methroprion	3-4gm/kg feed. Or 200 gm/1 tons feed.	Ophsonin Agrovet	380-400/100gm
9	Otetra (vet) powder 50	Ox tetracycline+ inert	Mixed with feed 10gm/100kg body weight	Square pharmaceuticals ltd.	156-170/100gm

		ingredients			
10	Oxin WS	Ox tetracycline 20%	100mg/kg body weight(1 ton)	Navana limited	100/100gm
11	Oxygenating 20%	Ox tetracycline HCL BP	300gm/100kg feed, 7days	Novartis pharmaceuticals ltd.	1700/kg
12	Renamox	Amoxicillin trihydrate	35-40gm/100bd of fish, 10 days	Renata pharmaceuticals ltd.	150/100gm
13	Renamicin	Ox tetracycline+inert ingredients	40gm/100kg feed, 7 days	Renata pharmaceuticals ltd.	85/100gm
14	Sulphatrim	Sulphadiazine and methioprion	4gm/kg feed (5-7) days	Square pharmaceuticals ltd.	80-85/100gm

From the leaflet information all of those antibiotics were useful against bacterial, fungal and viral disease. Some of above antibiotics like Eurocode, Micronid, Novamix-104, oxysentin 20% and orgacycline-15% was also helpful against EUS. Antibiotics played very important role against growth promotion as well as effective against some of disease like antenna rot, viscous gills ,yellow gills, dropsy, parasitical, tail and fin rot, gill rot black gill of fish etc

4.4.2 Predator killer found in the study area

Currently predatory killer was an important ingredient used in pond preparation for fish farming as it often contains predatory fishes. Suppression of predatory fish in nursing ponds was an important issue because the presence of nursery ponderous causes numerous damage to the character which later leads to damage to the culture. Nowadays conscious fish farmers' regularly suppress giant fish in their ponds. In this case they usually used rotenone the most and not as those who use aluminum phosphate. Rotenone with a brand name was provided by many pharmaceutical companies. So, 15gm/dec/1 ft depth water body recommended dose of Accurate Gold shown in table 20.

Table no 20: List of gas tablet (Aluminum phosphide) used by farmers in the study area

No.	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)
1	Magic Fos	Aluminium phosphide 56%	FISHTECH	Excel crop care, India	1 kg	N/A	970
2	E-Phos	Aluminium phosphide 56%,	EON	China	1kg	650	1130
3	Rajtox	Aluminium phosphide 56%	Sandhya organic chemicals	India	1kg	520	1020

4	Fumitox	Aluminium phosphide 57%	National agro	China	1kg	750	1275
5	Insecticide	Aluminium phosphide 56%	MacDonald BD Ltd	Singapore	1kg	830	1200
6.	Sumicox	Aluminium phosphide 56%	Bangladesh national agro care	China	1kg	911	1225
7	Royal	Aluminium phosphide 57%	Bangladesh Agricultural Industry	China	1kg	860	1400
8	Saota	Aluminium phosphide 57%	Intefa	India	1kg	850	1100
9	Gas To	Aluminium phosphide 57%	FasolAgro	China	1kg	680	950
10	King Fos	Aluminium phosphide 57%	Modern Agro	India	1kg	750	1520

Table no 21: List of prohibited chemical used by aqua farmers in the study area

No	Product brand name	Composition	Marketed by	Manufactured by	Pack size	TP (Tk)	MRP (Tk)
1	EDTA	Sodium thio sulphate	Chemical seller		1 liter	N/A	55-60 tk/kg
2	Formaline	38% formaldihyde	Chemical seller				(80-90)tk/l
3	Sumithion	Fanitrothion used as insecticides	Pesticide seller		100 ,500,1000 ml		100/100ml
4	Methylene Blue	$C_{10}H_{18}CIN_3S_XH_2O$	Chemical seller				70-75/100ml
5	Melathion	Active melathion usig as parasitical problems	Chemical seller	70-75/100ml			120 tk/100 ml

4.5 Benefits of chemicals on aquaculture in the study area

The study observed that 85% aqua farmers received high production by using chemicals while only 15% farmers did not get good results. For example growth promoter, enzyme and dietary probiotics were very helpful for aquaculture production. Fish farmers thought that if chemicals are used regularly then the process environment is good and if the pond environment was good then the health of the

fish is good. If the health of the fish was good, its grow fast. Most farmers regularly used disinfectants and probiotics in ponds. 85% of the farmers said that we can produce more by using regular chemicals because if the pond environment was good, feed wastage and disease are less. Almost all farmers regularly used various chemicals and probiotics to improve the health of their fish and the pond environment.

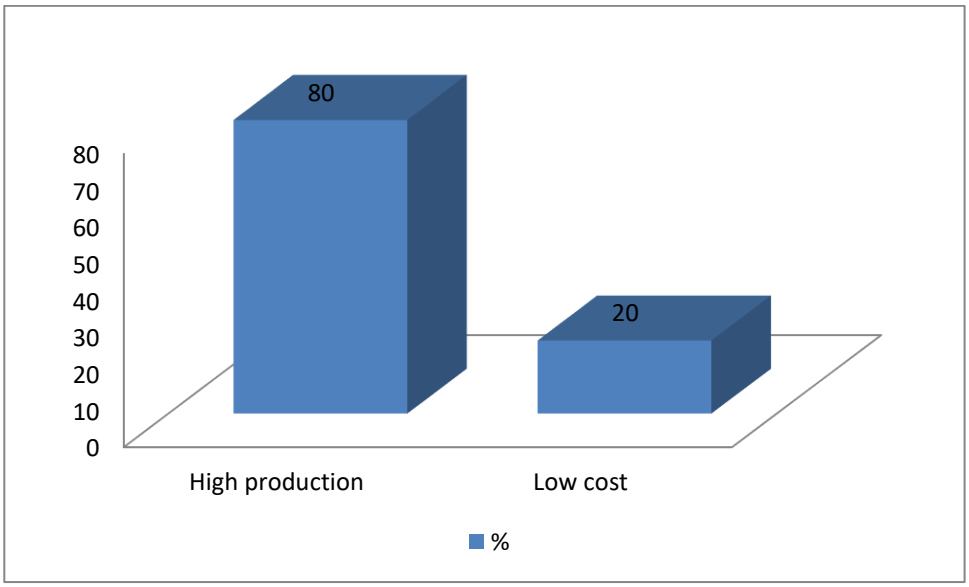

Fig 22: Benefits of using chemicals

4.5.1 Production trends after using chemicals in the study area

It was found that 90% aqua farmers got good results after using chemicals. They indicated that they have good solutions from various chemicals such as, causality management, mass mortality check; toxic gases control and short period of culture etc whose are very essential for good aquaculture production. On the other hand, only10 % farmers answered that they do not get good results after using chemicals from various problems facing.

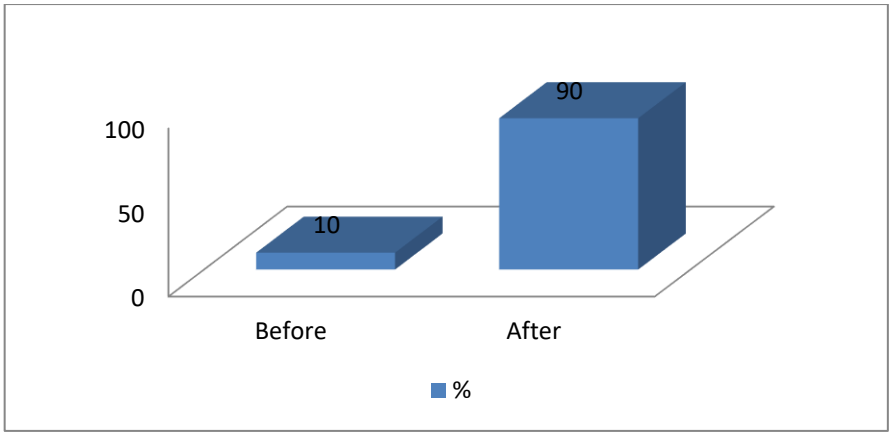

Fig 23: Production trends before and after using chemicals

Table no 22: ANOVA table to observe the statistical difference among different variables

Criteria	F-value	p-value
Do you use any banned chemicals?	12.32	0.01
High production	32.21	0.001
Low costs	23.25	0.06
Economic benefits	11.21	0.05
Environmental benefits	14.25	0.05
Economic problem	15.21	0.04
Environmental problem	18.32	0.002
Production before	13.21	0.01
Production after	19.32	0.01
Total production	16.25	0.05

Statistical result of among different parameters was related to fish production. Table 22 showed that fish production after chemicals use, economic benefits,

environmental benefits and total production varies significantly among the fish farmers.

Table no 23: Visual inspection of water color observation

Color	Odor	Comments
Green	Good	Good for pond
Brown	Bad	Bad for pond
Clear	Nothing	No food for fish

Table no 24: Statistical analysis of Visual inspection of pond and fish

Inspection	Criteria	Results	F-value	p-value
Visual inspection of the pond	Water color observation	Green	15.2	0.02
		Brown	21.21	0.03
	Odor in water	Good	23.25	0.001
		Bad	21.21	0.001
	Odor in soil	Good	25.21	0.01
		Bad	12.32	0.04
	Color of pond soil	Ash	21.36	0.03
		Black	36.21	0.01
Visual inspection of fish	Problem	Spot on body	12.32	0.001
		Suffocation	27.32	0.002

Statistical analysis of visual inspection of pond and fish (Table 23) showed that water color observation, odor in water, odor in soil, color of pond soil and problem varies significantly among the fish pond.

4.5.2 Causality management system used by fish farmers

In the study area, 20% of the fish farmers were affected by various diseases and 25% are affected by floods every year. These areas were usually flooded as a result of heavy rains and they are affected by the flow of water in India. Ponds were more prone to fish plagues, especially due to high temperatures and high temperature fluctuations. Outbreaks of bacterial infections usually increase in May-June. During data collection period it was observed showed that fish death rates were higher in many ponds. These were identified by physical features as aeromonas sp and Streptococcus infections. A major problem in this region was the water crisis, which does not cause excessive flow during the rainy season. On the other hand, in winter, there was usually a water crisis from January to April. During the monsoon season floods were usually caused by excess water flow.

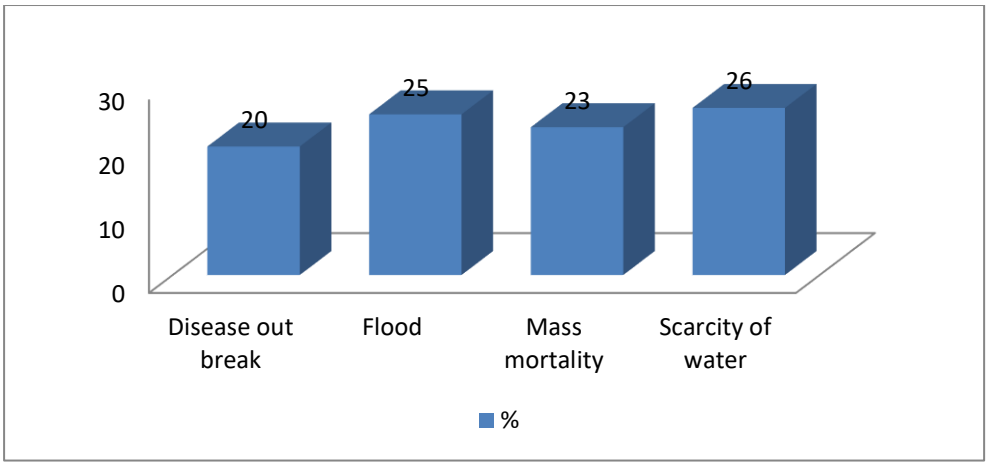

Fig: 24 Causality of management of farm in the study area

Causality of management of farm in the study area was shown in figure 24. These included disease outbreak, flood, mass mortality and scarcity of water. ANOVA table to observe the statistical difference among different variables (Table 18) showed that disease outbreak, flood, mass mortality and scarcity of water vary significantly among the fish farmers.

Table no 25: ANOVA table to observe the statistical difference among different variables.

Criteria	F-value	p-value
Disease out break	12.32	0.02
Flood	25.36	0.05
Mass mortality	14.28	0.01
Scarcity of water	32.21	0.001

From ANOVA (table 25) showed that disease outbreak, mass mortality and scarcity of water in varies significant among the farmers but food affected farmers were quite difference among others farmers (P=0.05).

4.5.3 Major physic-chemical parameters found in the fish pond

Physico-chemical parameters of the ponds selected for the study was shown in figure 25. Average water temperature was found 24^0C, water pH was found 7, transparency was found 5 m, soil pH was found 5 and NH_4 was found 1.6. Standard pH is (7.5-8.5) and NH_4 is 0. But in the study area, we found low pH value and high range of ammonium. All parameters collected from March 2018 to April 2019. Pearson

correlation table for different environmental variables is shown in table 25. Findings showed that parameters are strongly related with each other.

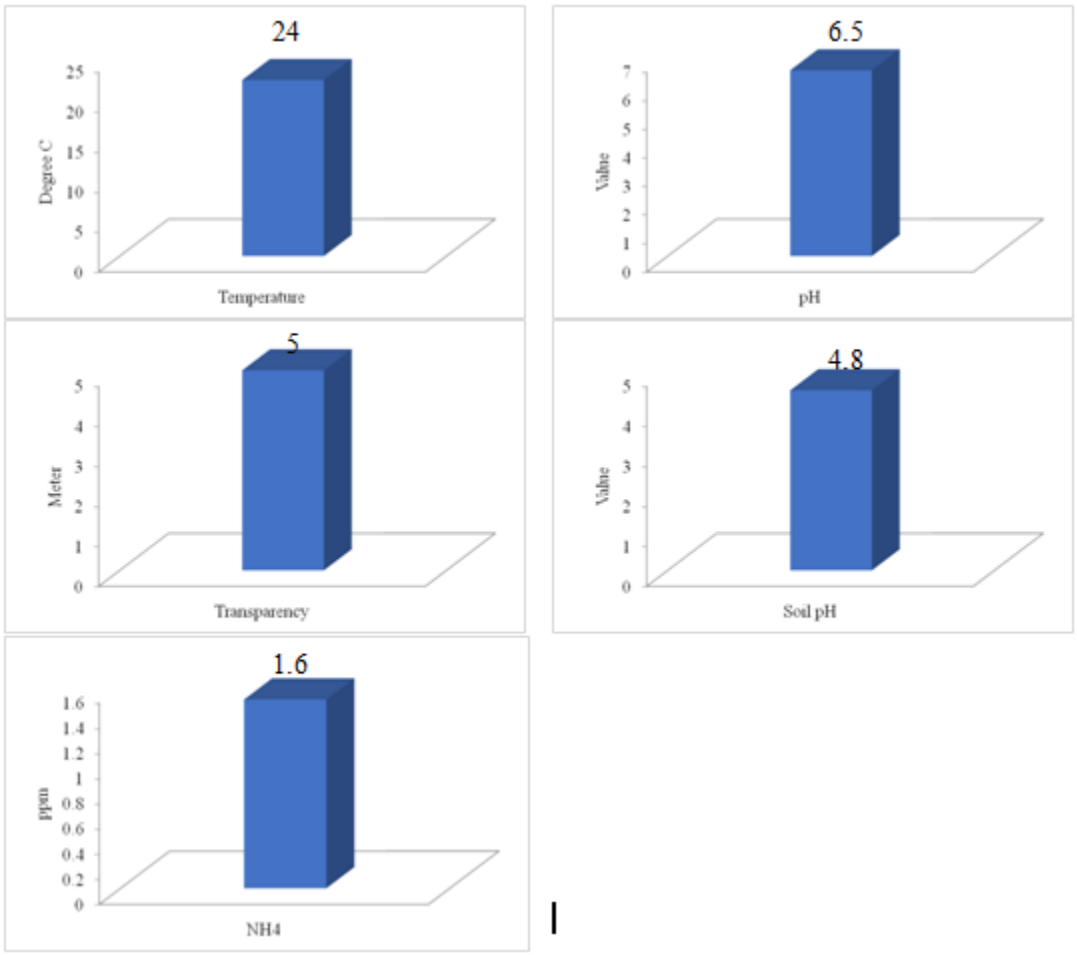

Figure 25: Physico-chemical parameters of the ponds selected for the study

Table no 26. Pearson correlation table for different environmental variables

	Temperature	Transparency	pH	Soil pH	NH_4
Temperature	1				
Transparency	0.21*	1			
pH	0.51**	-0.32*	1		
Soil pH	0.45**	-0.24ns	0.68***	1	

NH4	0.7^{***}	-0.35^{ns}	0.54^{***}	-0.45^{**}	1

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, ns = not significant

4.6 Average Cost-benefit analysis

The cost benefit analysis was usually based on a mixed farming method of one lakh tilapia. This was because the fish farming system in the region is a combination of tilapia and carp. The period of cultivation was usually six months and the income and expenditure of a fish farmer was calculated as six months. Generally those who cultivate tilapia fish and mixed farming with it are familiar with the technology and they were aware and especially the farming methods are semi intensive. One lakh tilapia for fish farming and usually took four acres pond area and average was based on cost benefits analysis is showed in table 27.

Table no 27. Average Cost-benefit analysis of the pond in the study

Cost items	Description	BDT
Pond lease	This cost related to the price that needed to pay the pond owner by the farmer. The farmer takes the pond lease for several years by paying a fixed amount of money at beginning.	120000
Fingerlings	This const related to the price of fish fry those are bought from wild or hatchery sources.	150000
Feed	This cost is related to the price of feed used in the farm for fish.	1500000
Chemicals	Cost related to buy different types of chemical for fish and	15000

	fish farm by the farmer.	
Pond preparation	Cost related to prepare the pond before the stocking fish.	20000
Pond maintenance	Cost related to the maintenance the pond.	40000
Total cost		1845000
Sell	Selling price of fish(total)	2500000
Profit/Loss	Positive value indicate profit	655000
Benefit-Cost ratio	High ratio indicate higher profit	0.35501355

Cost-benefit analysis of the pond was shown in table 26. Total cost was estimated BDT 1845000 while sell was 2500000. The net profit was found BDT 655000 and benefit cost ratio was found 0.36.

4.7 The purposes of usage of widely used drugs and chemicals

Lime

Lime is an important chemical that used in Bangladesh for water and soil treatment in aquaculture .It was used properly to hold pond bottom and stabilize water ph. Lime was mentioned that it ensures that the water plankton is healthy and helps to retain plankton bloom. The farmers understand well the different types of lime and how to use them for the right purpose and at the proper dose. Not knowing the proper use of the lime can have a negative impact on the aquatic environment .So lime is very essential chemical for good aquaculture practice. During the data collection it

was found that the ph of all the ponds is good, the water color of all the ponds is good and the health of the fish is good and there is less disease of fish and their production is good.

Fertilizers

The use of fertilizers was a basic part of pond preparation and important for the aquatic environment. Adequate amount of plankton helps in making fertilizers ponds. These included phytoplankton and zooplankton. Phytoplankton in general was very beneficial for aquaculture production. Plankton was an important food for herbivorous fish that must be in sufficient quality in advance before stocking fish. Different type of fertilizers such as urea and NPK mixture were used for phytoplankton production. If the right phytoplankton bloom was not produced, more fertilizers were added which may cause water pollution. Excess plankton produced ammonia gas in the water and can cause oxygen depletion and even weaken the fish. When there was excess ammonia gas in the pond and oxygen is depleted, it was a negative effect on fish production. The use of extra feed could increase the plankton and ammonia in the pond and usually use a gas remover to protect the area.

Zeolite

Zeolite was an important ingredient for fish farming who use it regularly. Zeolite was commonly used to remove carbon dioxide, hydrogen sulphide and ammonia as it had strong cataon capacity to absorb molecules. Zeolite was an important mineral which provides adequate supply of minerals in the water body. Adequate supply of minerals helped in increasing fish production and enhances immunity of fish. However the use of extra zeolites causeed financial loss to the farmers and increases the production cost many times over.

Pesticides

Different types of chemicals such as Sumithion, Diazinon, Malathion, Phostoxin, and Rotenone were widely used to destroy different types of predators/ unwanted fish during pond preparation and harvesting of fish for fingerling stocking. This type of chemicals not generally applicable to fish farming, it was banned in good aquaculture practice. The use of these chemicals usually broken the food chain in the pond and has a huge negative impact on the food chain. These pesticides or insecticides were commonly used in agriculture and at some point they are washed out and released into the water. As a results, eutrophication and water quality details were turned as and its affects the biotope and thus their fishery, and in turn human health.

Chlorine

Chlorine was regularly used as an important disinfect in fish and shrimp hatcheries all over the world including Bangladesh. Chlorine was used to remove harmful organisms that enter the pond with water. Usually in the form of powdered calcium hypochlorite with 65% active content found in area. Other form was sodium chloride. Sodium chloride was commonly used in first aid. Excess chlorine can cause death in fish.

Potassium

Potassium permanganate $KMNO_4$ was one of the first important chemicals commonly used in aquaculture as a chemotherapeutant. Potassium was commonly used as disinfectant and in the removal of internal and external parasites. Potassium was also commonly used for bacterial diseases. Excessive used of potassium affects the fish growth and makes the fish relatively hard which has a negative effect on production.

Copper

Copper compound was an important disinfectant it has been used for a long time as it was commonly used in cases of external protozoan infestation. Copper sulphate was mainly used in pond extra plankton control. Elevated copper concentrations could be harmed in water for fish and other aquatic life. Copper could be destroyed the primary productivity in the pond.

BKC

BKC had been using aqua culture as a broad-spectrum disinfectant. It usually worked well in the case of bacterial diseases and helps in quick recovery of fish. Farmers usually used BKC more because it helps to get instant results. BKC assists in additional plankton control of the pond. Regular bkc were usually used in hatcheries to control extra plankton. Excessive use of BKCs can lead to ammonia gas in the pond which can later cause severe economic damage to the farm due to reduce the plankton concentration.

Antibiotics

At present the use of antibiotics in aquaculture was become a common practice. Adequate amounts of antibiotics were usually used to ward off the attack, especially in fresh water aquaculture. It was very difficult to recovery without antibiotics. Bacterial infections were usually caused by different types of bacteria such as aeromonas bacteria, streptococcus, and various species of vibrio. Antibiotics were usually used orally or orally with mixing feed and often sprayed into the water when the fish was more infected. However, according to the Bangladesh government and WHO, the use of antibiotics in fish was completely banned. Despite the ban on the use of antibiotics in fish, farmers regularly used it to protect their fish. Although antibiotics had many harmful aspects, they cause a great deal of pollution to the

environment, even due to harmful for human health. Many high-potency antibiotics are currently being used in aquaculture to control fish diseases. These antibiotics included erythromycin, azithromycin, ciprofloxacin, sulfardiazine, methionine and many more. While all of these high potency antibiotics were quick recovering from diseases but long- term damage to fish is far-reaching. Farmers were using these antibiotics without realizing it. Representatives of different companies were directly helping them to use these antibiotics. There were usually no guidelines for using these antibiotics in aquaculture.

Feed additives

Feed additives that were currently very well known as an important component of aquaculture. Feed additives were commonly used for the rapid growth of fish and for short-term production. Artificial feeds were usually not just protein, fat and carbohydrates but various others ingredients including vitamins and minerals. These feeds additives were usually used to increase the disease capacity of fish and it helps in digestion of fish. Vitamin C and various enzymes were commonly used regularly and various minerals are used to make natural food which reduces the cost of production and was used regularly for all these reasons.

Gas remover

Gas remover was a well-known name that is regularly practiced to remove excess ammonia gas, hydrogen sulfide gas, which was extremely harmful to cultivation. Gas removers with various probiotics were commonly available in the market and yucca usually use as a gas remover. Excessive harmful gases in the pond usually caused the fish to float and eat lees food and even oxygen depletion at last fishes of deaths which cause a lot of financial loss to a farmer. The main caused of ammonia gas in ponds is the loss of fish manure, excess feeding and excess plankton. Usually

farmers used regular gas remover in the pond for their own safety though now with the help of technology they regularly determine the amount of dissolved oxygen, ph and ammonia and take action accordingly. According to fish farmers, medicines that were not always effective and even good quality medicines were very difficult to find in the market. In many cases the use of these substandard drugs at the best level usually caused financial loss of different pharmaceutical and feed companies.

4.8 Major problems associated with aqua products in the study area.

Numerous problems were reported from farmers who were not aware of the proper use rules of the products. Some conscious farmers know about different products but are mostly depends on others. Many fish farmers were also unaware of the side effects and residual effects of chemicals and drugs. Farmers typically did not continue the recommended dose. Occasionally farmers applied an upper dose of drugs and chemicals than the recommended dose. This upper dose becomes too much for other organisms that cannot tolerate which can result in severe biodiversity loss of aquatic organisms such as

1. Drugs and chemicals may generate problem for non-target species.
2. Fish farmers have deficiency of required knowledge about the drugs and chemicals.
3. Aqua farmers have deficiency of required knowledge about adverse effect and withdrawal time of chemicals and drugs.
4. Drugs and chemicals may continue in aquatic environment for long time.
5. Drugs can generate drug resistant strains of bacteria.
6. Shortage of information on the body of chemical and drugs about possible health issue.

7. Burden on farmers from drug and chemical sellers.

8. Shortage of the safety issues and awareness about in using insecticides and predatory killer chemicals.

8. Underprivileged diagnostic facilities of lack of knowledge for diagnosis of fish disease.

10. Shortage of technical manpower to prescribe aqua drugs and chemicals.

It may be resolved that aquaculture plays an important role in the economy of Bangladesh as well as in the fulfillment of the animal protein demand, employment opportunity, alleviation of poverty and foreign currency earning. With the extension of aquaculture and intensification of the culture systems in Bangladesh, lots of pharmaceuticals companies supplied different types of drugs and chemicals with various brand names to fulfill the farmers demand for the most valuable purposes of the fish health management and disease treatment. Disease of fish was excessive threat to gain optimum production and becomes a limiting factor to economic success of aquaculture in Bangladesh. Additionally in depth study in aqua drugs and chemicals to controlled potential diseases throughout the country is warrantee

Chapter-five

Discussion

Use of chemicals and drugs in aquaculture has become a fundamental input for the commercial fish farming globally. They are not only crucial for health management and controlling disease outbreaks but also essential for improving the soil and water quality, enhancing natural food productivity of the water body, enhancing feed efficacy and so on. On the one hand, the application of aqua drugs and chemicals consequences timely development of aquaculture productivity in Bangladesh, on the other hand, due to the lack of knowledge about the chemicals and drugs in terms of their appropriate doses, price, methods of application and other necessary precautions, these chemicals create ecological and fish health problems as well as the risk to the human health concerns in deed. The aquaculture management in Bangladesh is also controlled by a number of drugs and chemicals. The current research was identified to know the present status of chemicals and drugs in fish health management in aquaculture production in north-east region. The present study identified variety of aqua chemicals and drugs marketed by various companies for applying in different activities of aquaculture. Fish health management and disease treatment were the major issues where farmers were applied to use a lot of such types of products. Other uses products included growth promotion, stress reducer, predatory killer, and sanitizer, improve water quality, oxygen supplier, parasite controller, and as probiotics. Commonly identified traditional chemicals in health management included lime, salt, potassium permanganate, sumithion, ivermectin, sincivermectin, deltrametrin, bleaching powder, and methylene blue etc. Previous

studies also found the similar reports about the application of chemicals applied in aquaculture of Bangladesh (Brown and Brooks, 2002; DoF, 2002; Faruk etal., 2004).

The current research showed that there were many different types of new products with various brand names in the market. These products are usually available at local animal feed and chemicals traders from where farmers usually collected these. All these activities are usually associated with better health management of fish. However, fish disease treatment was one of the most important major issues where all types of drugs were used to control fish disease. It indicated that disease problem of fish is one of the major concerns in aquaculture of the country. In the current investigation the major diseases and conditions reported by farmers and authors were EUS, dropsy, black spot, tail and fin rot, anal protrusion, fungal disease, nutritional disease, scale intrusion, and red and white spot. A number of authors also reported similar conditions in aquaculture of Bangladesh (Mazid, 2005; DoF, 2002; Faruk et al., 2004).

5.1 Beneficial effects of chemicals as growth promoters

Nearly 11 branded growth promoters with different trade names were used by the fish farmers in north-east Bangladesh. The mentioned growth promoters, except Charger gel, were only used by the private farms. Charger gel was used by both public and private farms. According to the respondents, growth promoter support to improve growth rate, improve FCR (Food Conversion Ratio) and thus add to the yield. Ahmed et al (2014) reported that aqua boost, aqua nourishes, and square aqua mix and charger gel were used as growth supporters in Khulna region. Shamsuddin (2012) that aqua boost, bio-grow and charger gel were used as growth supporters in

Mymensingh region. Hossain (2012) described about 5 chemicals, which were used as growth supporter in different fish farms in Bogra district. Chowdhury (2015) reported that chemicals like rapid grow, megavit aqua, aqua boost; aqua savor, super fish etc. were used as growth supporter in north-east region.

5.2 Chemicals used as insecticides and ectoparasiticides

Chemicals like Deletix Egret and Argulex are generally used for controlling back swimmer (Hash poka) and treat Argulosis in fish farm. From the present study it was found that deletix were remarkably used as insecticides and ectoparasiticides followed by Paratics and Engreb. Faruk et al. (2008) stated that melathion, dipterex, melachite green, methylene blue were useful for eradication of external parasites as well as fungal diseases. Tonguthai (2000) reported that acriflavin, dipterex, malachite green was widely used in fish pond to treat for crustacean and protozoan parasites in Thailand. Trichlorfon, malathion, dichlorvos were used for fish pond management in Stockholm, Sweden mentioned by GESAMP (1997).

5.3 Probiotics used as drugs and beneficial effects on fish production

Probiotics are " Eco friendly bacteria" that are analogous to organisms that happen naturally in the digestive area. Probiotics are biologically safe pathogens that are active, disease germicidal, natural and soil-dwelling bacteria. Positive strains or types of probiotics have been connected to all sorts of health benefits, from helping with irritable bowel syndrome and boosting the immune system. Commercially these are recognized as: Ecotoxnil, pondcare, props,Aqua gold, Bio-Zyme, C-150, Eco marine, Ecomax, Golden Bac, pond health, pH Fixer, Procon-PS, Super Biotic, Super PS, Zymetine. The common probiotics used inculture supervision are live bacterial

culture (non-pathogenic organisms) and fermentation products well-off in extracellular. Benefits of using probiotics in aquaculture production comprise improved in nitrogen and phosphorus concentrations, better algal growth, breakdown of organic matter reduction; greater availability of dissolved oxygen, control of and hydrogen sulfide, ammonia, nitrite, lower incidence of disease and greater survival and fish production. (Boyd and Gross, 1998; Queiroz and Boyd, 1998).The probiotics contains mainly different concentration of beneficial bacteria which include Bacillius sp., Saccharomyces sp., Aspergillus sp., Lactobacillus sp., Rodobacter sp., Rodococcus sp., Streptococcus faecalis, etc. No food and environment safety hazards are thinking to be presented by addition of probiotics aquaculture ponds. The gastro-intestinal (GI) area of fish has been renowned as an important harbors of a multiple microbial community, mainly two discrete groups, such as autochthonous (indigenous) and allochthonous (exogenous)(Nayak,2010).

Autochthonous microorganisms have important effects in the development of GI area of fish, with improvement and maturation of the intestine and immune system and resistance to infectious pathogenic micro biota (Birkbeck et al,2005). These microorganisms are also capable to block the colonization of some other bacteria using some mechanisms such as antagonism for space and food, secreting antimicrobial compounds as well as being receptors at mucosal surfaces (Nayak, 2010).

5.4 Chemicals used as stress reducers

Virtually 10 branded stress reducers with various brand names were used by the fish farmers. From the existing scrutiny it was found that ossic was exceedingly used of the total uses followed by Osmosaline. The available stress removers were Aqua-C,

Osmosaline and antistress. These stress reducers, except Aqua-C, were only used by the private farms. Aqua-C was used by both public and private farms. Hossain (2018) mentioned several aqua-drugs such as cevit aqua, ossi-c, osmo-saline, aqua-c etc to be used as stress reducer in Sylhet District. Vitamin C, Vitamin B12 and Vitamin E were used for fish health management in Stockholm, Sweden mentioned by GESAMP (1992).

5.5 Impacts on fish health and disease management

Numerous types of disease were commonly detected of inland aquaculture of north-east region. Black spot, EUS, Dropsy, Antenna flagellum, Edward cellulosis, Pop eye, white spots and fin rot diseases were originated from Pangas, Tilapia, Sing and Koi from Ahmed et al. (2014) of the research results. EUS, dropsy and Edward siellosis were found in the north-east region in Pangas, Koi and Tilapia. From the current research farmers have applied vitamin c, ossic, zeolite, potash, gastab, timsen, renamycin, renamox and polgard plus for the treatment of EUS in pangus and tilapia in north-east region.According to Rahman (2013) in the case of EUS, farmers in Jamalpur applied oxysentin 20%, aquamycin &acimox powder and attained 90% recovery with tilapia, rui, catla and pangus. Farmers of Trishal upazilla were used renamycin, polgard plus, ossi-c and aquamycine which had an average salvage of 80-85% in EUS affected tilapia & koi. However the farmers in Bhaluka upazilla used renamycin and ossi-c to treat EUS infected tilapia which had an average salvage of 70-80% recovery. According to Ahmed et al statements (2014) to treat EUS affected tilapia farmers of Fulpur upazilla used renamycin, polgard plus and ossi-c with a consequence of 80-95% recovery. Rahman (2011) treated EU infected tilapia with renamycin, polgard plus and ossi-c and achieved 95% recovery. In the current

research, farmers of Sylhet sador used erythromycin, timsen, ossi-c and polgard plus for the treatment of Edward siellosis and gill rot in tilapia and koi with an outcome of recovery respectively.

5.6 Impacts on Environment and Public health

Aquaculture in Bangladesh is currently legend on the path of commercialization and intensification. The present exploration of commercial aqua-drugs was conducted to know the current status and their effects on the fish health management. A variety of drugs and chemicals have considered as part of successful aquaculture production. At present about 30 animal health companies were involved in marketing more than168 products at field level. Moreover, these prescribed drugs firms found to own terribly engaging info leaflet to sell their merchandise to the farmer. In this current study, farmers were used commercial aqua-drugs and chemicals about 168 different categories for different aquaculture activities such as disease treatment, pond preparation, disinfectants, and growth promotion and improve disease resistance, water quality management in this present study. All of these activities were related to management of improved health of aquatic animals. Farmers in the selected areas mainly used Erythromycin, Amoxifish, Renamycin, Timsen ,Aquamysine, Deletix , Aqua clean, pond safe,Seaweed, Ossi-C ,Oxy gold, Charger gel, Renaquine, Polgard plus, bactisol, Aqua kleen, Rotenone , Aqua, boost, Timsen, Sumithione, Doxi oxy, Aqua boost and Virex as trade name for disease treatment Faruk et al (2008). Diverse types of fish diseases like EUS, tail rot, fin rot, red spot, white spot and dropsy in different fish species mainly in Shing, Koi, Tilapia and Pangus were observed in the study area. The similar conditions in aquaculture of Bangladesh also reported a number of authors (DoF, 2002 and Faruk et al., 2004). Maximum of the farmers of

the selected areas used drugs and chemicals to regulator these types of disease. The disease problem was one of the major concerns in aquaculture of the studied areas.

Commercial aqua drugs have some positive impact on fish health management and disease treatment at farmer's level during the present study revealed that. It was observed that farmers of the selected areas grew good results in disease treatments by applying single or combinations of various aqua-drugs and chemicals. In some cases after use of drugs they got about 95% recoveries within a short period of time. To use more commercial aqua-drugs in controlling disease were influenced farmers. From time to time they applied drugs higher than recommended doses to obtain quick improvement. So, they did not get better results than commercial drugs and chemicals during study period. Farmer exhibited less interest to outdated drugs for disease control.

It was detected that about 14 antibiotics with dissimilar trade names were used by the farmer in the present study. Antibiotics should be applied only for the management of bacterial diseases. It was found in the present study that antibiotics were applied indiscriminately without knowing the accurate reasons of disease. Some farmers did not follow the prescribed dosages for treatment. It is extensively recognized that the excessive use of antibiotics contributes the development of anti strains of bacteria (Inglis, 1996).

In the field level, it was observed that some aqua products were seen only available as trade names. Either farmers or traders did not have clear idea about the active ingredients of certain aqua products and method of presentation even though they were using medicines without hesitation. If the causative agents of infectious diseases were identified via a sensitivity or diagnostic test, it will be very easy to

successful administration of antibiotics with actual dose. It was also realized that same harvests of different corporations had variable dosages. As a result, the farmer became puzzled which product would be effective in controlling disease. However, it is important to follow the suggested dosages and approaches of application of specific antibiotics to get the best results for disease control in aquaculture .The use of marketable aqua drugs and chemicals in fish farming for various purposes is broadly now recognized. The activities aquaculture in Bangladesh is also prejudiced by a number of chemicals. It is significant that policy makers, researchers, and scientists work together to address the issues of use of new commercial aqua-drugs and chemicals in order to reduce their adverse impacts occurred during culture period. In aquaculture, disease treatment can be a fair value when used properly but when not applied properly can cause great damage to the aquatic ecosystem. Thus, it applies drug against appropriate disease and best methods of application for aquatic health management throughout the period. Aqua products inputs companies should carry out additional research and development towards reducing the harmful impact of aqua-medicine in aquaculture. Determinations should be made towards result non-chemotherapeutic solutions to health management and disease control. Also, there is a need for better thoughtful of fish farm health management and disease prevention practices that could reduce the need for drug treatments.The nutrient concentrations that can inspire to lead the pollution the surface waters. The integrated erosion of stagnant water bodies' serves to provide a water exchange supply with a site based treatment and exchange of water including herbivorous fish with minimum impact of surface water. The nutrient budgets specify that, although only 15-20% of input nitrogen and 8-12% of phosphorus have been recovered as fish, most of the nutrients add in the sediments (Edwards, 1993). Sewage nutrient depletion (<10% of both N

and P) and seepage are nominal (Boyd, 1985). Although poultry manure contains faecal bacteria and viruses that fast attenuation of pathogens arises in most stable, waste-fed ponds (Edwards, 1986, 1993). Undoubtedly, Salmonella and anti bacterial control may be effective in creating human disease and debris that is important for fish culture water maintenance below the marginal level that can cause infection (Buras,1993). Blooming of toxic blue green algae in the water focused by eutrophication has also been developed as an issue (Maclean, 1993). The toxic strain of microcystis aggregators is recognized in mammals' drinking water in winter climates and research has indicated that the Nile tilapia avoids eating toxic strains (Beveridge, 1993). However, in practical conditions, this type of fish grows rapidly in ponds that affected by blooming of toxic algae (Edwards, 1993). Although there is possibility of poisoning of fish and mammals from poultry manure fertilized water exists, their controlled use in fish ponds decreases the livelihood of pollution to other water bodies.

5.7 Adverse impacts of aqua drugs and chemicals

5.7.1 Impact on the farmers' investment

The scenario of the grave economic losses due to diseases epidemics has been explicated by Randall Brummett (2017) the Senior aquaculture specialist World Bank, "according to the FAO, disease outbreaks cost the global aquaculture industry some US$ 6 billion per year and represent the major firm-level risk". In Bangladesh, the economic impacts of diseases on aquaculture production are alarmingly thriving in the fin fish culture as well as shrimp and prawn farming simultaneously. A relevant report (Faruk, 2004) showed that average loss US$ 344 per one hectare of fish farming due to diseases occurrence in Bangladesh.

Likewise, the farmers investment cost is raising unexpectedly due to the indiscriminate application of aqua drugs. The present scenario show that almost 5 - 10% cost of the total investment for fish and shrimp farming is being elevated for the use of aqua drugs and medicine in to their farms (DOF, 2018). The most impact is noticed when the medicines do not work effectively against the diseases of the farmers. Ahmed, G.U. (2015) showed the following observations in his study in a particular area of Bangladesh. He founded farmers were using a lot portion of aqua drugs, whereas a few percentages of them were not getting benefits at all.

Table no 28. Impacts of aqua drugs and chemicals on fish health and diseases control in Sherpur district of Bangladesh. [Ref: Ahmed, G.U. 2015]

Study areas	Species	Diseases	Drugs/chemicals with dose	Failure (%)
Sherpur Sadar and NalitabariUpazila	Thai Koi	EUS	GR Plus 20ml/dec, Active Blue 15ml/dec, ID Plus10ml/dec, Aqua C-Vit 3g/kg feed, H.vit Plus 5ml/kg feed, Para Con 1ml/dec	10-20
		Edwardsiellosis	OTC power 3g/kg feed, GR Plus 20ml/dec, Active Blue15ml/dec, Aqua C-Vit 3g/kg feed, H.vit Plus5ml/kg	20-25

			feed	
		Tail and Fin rot	OTC power 3g/kg feed, GR Plus 20ml/dec, Active Blue Aqua C-Vit 3g/kg feed, ID Plus10ml/dec, Lime 0.5-1 kg/dec, salt 0.5-1 kg/dec	20-25
	Pangus	EUS	GR Plus 20ml/dec, Active Blue 15ml/dec, ID Plus10ml/dec, Aqua C-Vit 3g/kg feed, H.vit Plus 5ml/kg feed, Para Con 1ml/dec	10-15
		Dropsy	OTC power 3g/kg feed, GR Plus 20ml/dec, ID Plus10ml/dec, Aqua C-Vit 3g/kg feed, H.vit Plus 5ml/kg feed	15-20
		Edwardsiellosis	OTC power 3g/kg feed, GR Plus 20ml/dec, Active Blue Aqua C-Vit 3g/kg feed, ID Plus10ml/dec, Para Con 1ml/dec, lime 0.5-1 kg/dec, salt 0.5-1 kg/dec.	15-20
	Shing	EUS	GR Plus 20ml/dec, Active	10-15

			Blue 15ml/dec, ID Plus10ml/dec, Aqua C-Vit 3g/kg feed, H.vit Plus 5ml/kg feed, Para Con 1ml/dec Lime 0.5-1 kg/dec, salt 0.5-1 kg/dec	
		White spot	GR Plus 20ml/dec, ID Plus15ml/dec, Para Con 1ml/dec, Active Blue 15ml/dec, Aqua C-Vit 3g/kg feed, H.Vit plus 5ml/kg feed, lime 0.5-1kg/dec, salt 0.5-1kg/dec,	25-30
		Dropsy	OTC power 3g/kg feed, GR Plus 20ml/dec, Active Blue 15ml/dec, Aqua C-Vit 3g/kg feed, H.vit Plus 5ml/kg feed	20-30

Another study (Anwar, M.A., 2018) showed that the more loss due to the ineffectiveness of the aqua drugs as follows:

Table no 29. Impact of aqua drugs and chemicals on fish health and diseases control [Ref: Anwar, M.A. 2018]

Disease name	Affected Species	Treatment	Season	Failure (%)
Bacterial infection	Pangus, Shing, Koi, Magur, Pabda	Aquamycine: 1-2 g/Kg feed Oxysentin 20%: 100-200 g/100 Kg Captor: 50-70 g/100 Kg feed	Winter season	50
Argulosis	Rui, Catla, Mrigal, Grass carp, Silver carp, Mirror carp	Argulex: 12-13 ml/dec.Sumithion (Fenitrothion): 200 ml/33 dec	All over the year	40
Fungal disease	Rui, Catla, Mrigal, Tilapia, Bata	Renamycin: 50 mg/Kg body weight for 5-7 day Ossi-C: 4-5 g/Kg feed for 5-7 day	August-September	5

Sometimes, there are grave losses incurred due to the inappropriate or over doses of medicine application in their ponds. Recently, a report has drawn attention through the mass media “15,000,000 BDT worth fish damaged due to the inappropriate use of aqua medicine at Bagmara, Rajshahi” (The Daily Janakantha, 18.02.2020).

[Ref: Photo Credit: The Daily Star]

5.7.2 Impact on the human health by using aqua drugs

Use of antibiotics in fish farm is totally banned by the Department of Fisheries (DoF). Unfortunately, the unawarded farmers are still using antibiotics which are collected from the different sources of poultry medicines, such as tetracycline, oxytetracycline, salfomithoxin, sulfadimethoxine, sulfadiazine, sulfadiazine, amoxicillin, oxilinic acid, difloxin, chlortetracycline, and sulfanilamide and chelinos in Bangladesh. About 9 trades named antibiotics were found to be used by farmers of this region. Shamsuzzaman and Biswas (2012) showed that those antibiotics were seen to use indiscriminately in present study without knowing the exact reasons of disease. According to farmers' statement, they applied those antibiotics to the supplementary feed to prevent diseases prior to facing any disease problem. It could be said that those compounds were widely abused in aquaculture in this district without any hesitation. It is well known that excessive use of antibacterial

compounds in aquaculture causes toxicity to the host, the develop resistance of aquatic bacteria and sometimes remain aquatic food residues (Selim and Cavit 2011)**.**

Table no 30. Antibiotics used for fish disease treatment [Ref: Hossain S.M.S., 2018]

Active ingredients	Recommended Dose	Applied dose (Average ± Stdv.)	User (%)	Price (Taka/Kg)
Oxytetracyclin	50 g kg-1 feed	50 g kg-1	16	700-800
Doxycycline, colistinesulphate+vitaminpremix+mineral	25 g kg-1 feed	27.5±3.54 g kg-1	15	1020
Oxytetracycline HCL 25%	2 g kg-1 feed	2 g kg-1	10	700
Erytrhomycine+ Sulphadiazine+ Trimethoprim	5 g kg-1 feed	5 g kg-1 feed	10	3500

The effects and ultimate fates of those products and their residues in cultured organisms, within the aquaculture system itself is still quite unknown (Weston 2000), therefore this practice should be come under scrutiny through department of fisheries and other related organization providing appropriate informational and technical support to the farmers to overcome these problems and should enforce the rules and regulation properly to ensure proper use of these chemicals to get better product through good aquaculture practice

5.7.3 Impact on the fish health

Aqua drugs, chemicals and pesticides have a bad impact on fish physiology and reproduction system, consequently on the total fish production. Introduction of female fish to lipophilic organic compounds such as oregano chlorines, organ metals and to heavy metals may result in their stimulation and storage in the lipid-rich tissues (e.g. liver). These accumulated substances can be transferred to genes developed with the help of lipid deposits during detoxification and may have a adverse effect on the next generation through biosynthesis in the ovarian cysts (Black et al., 1988, Cameron et al., 1992, Von Westernhagen et al., 1988). In case of male fish, the effect of contaminants on their sperm quality is mostly observed in the case of reduced sperm motility. For example, it has been observed in contact with heavy metals (e.g. Cd, Zn) (Kime et al., 1996), or organ chlorine pesticides (Singh et al., 2008).

Another important adverse impact of insecticide and pesticides in aquatic ecosystem are: planktons death and breakdown of food chain, direct killing of fish, physiological change of fish and other aquatic animals, change in feeding and breeding grounds and increase epidemic of fish disease (Mazid &Haldar 2005).

5.7.4 Impact on the ecology and environment

a) Water quality degradation

Water quality is being changed and deteriorated gradually in the fish farming project as well as the nearby natural water bodies. Farmers are randomly using different kinds of lime stones, inorganic fertilizers, chlorine compounds, carbonated compounds, insecticides, pesticides, disinfectants, parasiticides, different kinds of antibiotics into their farms. Active ingredients and some residues of most of the

chemicals remain in the water bodies and in the aquatic animals. Water quality parameters of the water bodies have a great fluctuation due to the improper use of aqua drugs into the waters. For example, the pH level of the fish farming projects remains always basic (more than 8.0 to 8.5), alkalinity and total hardness are also higher ranged than the normal water. Studies of pesticide residues in selected reservoirs of Bangladesh have showed the residual level of malathion was 0.0241 to 0.463 ppm, carbofuran was 0.0302 to 0.0629 ppm and cypermethrin was 0.0141 to 0.09 ppm (Amin Uddin et.al., 2012). Resudes of diazinon and chlorpyriphosin Meherpur region of Bangladesh ranged from 0.033 to 0.079 ppm and 0.010 to 0.471 ppm, respectively. Among the carbamate pesticides, carbofuran was detected from two samples ranged from 0.0143 to 0.0387 ppm. The detection limit (LOD) in pond water was 0.01 ppm (Amin Uddin et.al. 2013).

b) Adverse effect on microbial community

Treatment of soil and pond water with pesticides and other chemicals can reduce the populations of beneficial soil microorganisms. Excessive amounts uses of chemical fertilizers and pesticides have adverse effects on the soil organisms due to excessive use of human antibiotics. Indiscriminate use of chemicals can work from a few years but after a while. There are not enough beneficial organisms to retain nutrients. Glycophosfate reduces the growth and ability of free-living nitrogen fixing bacteria in the soil (Santos and Flores, 1995). 2, 4- D reduces nitrogen fixation by the bacteria that live on the roots of bean plants (Fabra, et al., 1997). Nitrogen-fixing reduces the growth and activity of blue green algae (Singh and Singh, 1989) and converts of ammonia into nitrates (Martens and Bremner, 1993).

C) Loss of aquatic biodiversity

Fish especially one type of small native species (SIS). Fish and other aquatic life can be damaged by water contaminated with pesticides. The surface of the pesticides can spread to rivers and streams and can be deadly from aquatic life. Sometimes all fish are killed in a certain period. Applying herbicides to the body of a certain stream of water can cause the dead plant to decay and take up oxygen in the water, suffocating the fish and death of fish. Herbicides are very toxic to fish and other aquatic animals according to the concentration used to kill the plants, according to copper sulfide which is used in water to kill plants. Used for throwing sub lethal doses of some pesticide exposures can result in physiological and behavioral changes that reduce fish populations, for example weaken the immune system, abandonment of nests and broods, and reduced predator avoidance. Insecticides can gather in bodies of water to levels that kill off zooplankton the main source of food for baby fish. Insecticides and Pesticides can also kill insects that feed on some fish, causing the fish to travel farther in search and put them at greater risk from predators. The faster a given pesticide released in the environment breakdown, the lower the risk of aquatic life. Pesticides are generally more toxic to aquatic animals than herbicides and fungicides. (Wikipedia).

Chapter six

6.1 Conclusion

The study revealed the present status of the application of commercial aqua drugs and chemicals in aquaculture and their impact on fish production in north-east region of Bangladesh. A large numbers of drugs and chemicals were observed available in the local market to apply in aquaculture for various purposes. Fish health management and disease recovery were the major issues where fish farmers observed to apply a lot of such products. From the initial of pond preparation, Pond management and disease treatment diverse drugs and chemicals were used by the farmers. There are various Agro-vet companies were searched to provide dissimilar types of drugs and chemicals with different trade name to assemble the farmers need. Different types of fish diseases like EUS, tail rot, fin rot, red spot, white spot and dropsy in diverse fish species mainly in carps, pabda, shing, tilapia and pangas were observed in the study area. To overcome various sort of situation farmers used dissimilar kinds of drugs and chemicals. After using of drug they got high-quality to better result. But some cases they did not get any good results. During the field inspection some problems were identified in using aqua-drugs which engage poor understanding of farmers about the application of drugs, insufficient withdrawal period and some adverse effect on fish and human health. It was also established that all the drugs of a company may not suitable for treatment of disease in a culture system. Feed, fry and medicine cost were very high but fish selling price was very low and fry quality was not satisfactory. The above discussion indicated that the farmers of this region benefitted by using chemicals. Aqua farmers should proper

knowledge about the use of drugs and chemicals. They also should uphold proper withdrawal period for use of drugs and chemicals.

6.2 Recommendation

Government should make awareness among the farmers and traders regarding the toxic and beneficial effect of using chemicals and drugs in aquatic environment by training, workshop, publications etc. Government should be arranged more training program in various purposes and step to manage products price, stop to import and need to necessary measure for exporting fish in abroad. Farmers need to provide accurate advice to maintain sustainable fish production. The government needs proper guidelines to stop the unnecessary drugs and chemicals. Government, research organization and private organizations should work together for the proper use of these drugs and chemicals to increase sustainable fish production properly. Research is a regular process that is important to maintain continuity. Public-private and research institutions need to pay more attention to proper research. The present investigate has been only conducted in north-east region and thus other parts of the country need to be investigated to have a clear and appropriate picture of the use and impact of commercial aqua-drugs and chemicals in aquaculture production of Bangladesh.

Chapter-seven

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Apendix-01

Questionnaire

Questionnaire (part-1)

Impacts of commercial drugs and chemicals on aquaculture in north-east Bangladesh

1.Name:

Age:

Mobile No:

Farm Name:

Cultured species:

Culture type:

Questionnaire Number	
Interviewer Name	
Supervisor Signature	
Zilla	
Upozilla	
Union/Ward	
Village	

2. Preparation for culture:

3. How many ponds do you have? ……

4.Total aria of ponds do you have? ……Acre/Bigha

Do you have your own pond or lease?

Own	Lease
1	2

What type of procedure do you follow to prepare the pond?

4.1, Drying ?

Yes	No

1	2

4.2 Liming?

Yes	No
1	2

4.3 If yes what types lime?

CalciamCarbonet	Quick Lime	Calciam Oxide	Dolomite
1	2	3	4

4.4 Do you eradicate of predatory fish or insects?

Yes	No
1	2

4.5 If yes, what types of chemical used?

Rotenon	Tea cake	Aluminum Phosphate	Pesticide
1	2	3	4

4.6 Do you use fertilizer?

Yes	No
1	2

5. What is the source of your fries?

Hatchery	Wild
1	2

5.1 Name of Hatchery, if hatchery? (May one more)

BRAC	Fishtech	Mega	Quality	Niribili	Akota	Moriom	Testy	CP	Others(Specify)
1	2	3	4	5	6	7	8	9	

5.2 Source of wild name, if wild? (May one more)

Haor	Baor	Bill	River	Pond	Canal	Others(Specify)
1	2	3	4	5	6	

6. How you stock your fingerlings?

Scientific method	Traditional method
1	2

7. What is the stocking density in your pond?

Species	Size	Fry source	Stocking density	price

8. How do you manage your pond?

8.1 Use of fertilizer

Yes	No
1	2

8.2 Regular monitoring

Yes	No
1	2

8.3 Regular water quality check

Yes	No
1	2

8.4 Regular feeding

Yes	No
1	2

9. Culture Period, feeding scheme of the cultured species

Feed type	Ingredients	Species	Feeding frequency	Price per kg	Feeding rate
1 Pre-					

nursery					
2 Nursery					
3 Pre- stater					
4 Stater					
5 Grower					
6 Finisher					

10. How much your Feed Conversion Ratio (FCR) value: ……

11. Do you have any water exchange facilities in the farm?

Yes	No
1	2

11.1 If yes, what type of facilities?

Pumping	Natural Source
1	2

11.2 If no, how you control water?

Chemical	Biological
1	2

12. Do you have any aeration facilities in the farm?

Yes	No
1	2

12.1 If yes, what type of facilities?

Pumping	Aeration	Artificial Oxygen
1	2	3

12.2 If no, how you give aeration?

Moving Water	No method applied
1	2

13. Do you use any drugs/chemicals in the pond?

Yes	No
1	2

13.1 If no, how do you control disease or water quality in your pond?

Moving Water	No method applied
1	2

13.2 If yes, please give the answer of following questions:

13.2.1 Chemicals used for pond and water quality management:

Trade name	Ingredients	Dose	Source	Price/ L or kg	Cause of use

13.2.2 Chemicals used as disinfectant:

Trade name	Ingredients	Dose	Source	price	Species	Cause of use

13.2.3 Chemical used for oxygen supply:

Trade	Ingredients	Dose	Source	price	Species	Cause of use

name						

13.2.4 Chemicals used for disease treatment:

Trade name	Ingredients	Dose	Source	price	Species	Cause of use

13.2.5 Antibiotics used for disease treatment:

Trade name	Ingredients	Dose	Source	price	Species	Cause of use

13.2.6 Chemicals used as growth promoter:

Trade name	Ingredients	Dose	Source	price	Species

13.2.7 Probiotics used in culture:

Trade name	compositions	Purpose	Dose	Source	price	Species

14. When do you use these drugs/chemicals?

Name	Time of use (month)

15. Do you use any banned chemicals in the pond?

Yes	No
1	2

If yes, then

Name	Reason of use

16. What type of benefits do you get if you use chemicals in the pond?

Economical benefits	Environmental benefits

17. What type of problems do you face if you use chemicals in the pond?

Economic problems	Environmental problems

1.	1.
2.	2.
3.	3.

18. What was the production rate after chemical use in the pond?

Scheme	Code
Increase	1
Decrease	2
Neither increase nor decrease	3
None of these	4

19. Total production of fish: ……M Ton.

20. Visual inspection of the pond

21.1 Water color observation

Color	Month	Season
Brown		
Green		

Clear		

Odor in water

Type	Month	Season
Good		
Bad		
No		

21.2 Odor in soil

Type	Month	Season
Good		
Bad		
No		

21.3 Color of pond soil

Color	Month	Season
Black		
Ash		
Brown		
Others		

21.4 Visual inspection of fish

Problem	Month	Season

Spot on body		
Suffocations		
Mortality		
Others		

22. How do you manage the causality of your farm?

Types of causality	Month	Season	Steps taken to manage
1, Disease out break			
2, Flood			
3, Mass mortality			
4, Scarcity of water			

23. Water quality parameters of the pond

Parameters	Time (YY+MM+DD+HH)	Value
1, Temperature (℃)		
2, Transparency		
3, pH		
4, Soil pH		
5, Water color		
6, NH_4		

24. Cost benefit analysis of the pond

Cost items	cost
Pond lease	
Fingerlings	
Feed	
Chemicals	
Pond preparation	
Pond maintenance	
Others	
Selling price of fish (total)	

25. Do you take any advice from fisheries professionals?

Yes	No
1	2

26.1 If yes, Govt./private organization

Govt.	Private	Both
1	2	3

Any comments on valuable respondent:

1……

……..

2……

……..

3……

……

(Questionnaire part-2) some questions were coded for information collection

7. What is the stocking density in your pond?

Species	code	Size (in inch)	code	Stocking density (per decimal)	code	Price (per pices, in TK.)	code
Tilapia	1	0.1-0.5	1	30-50	1	0.40-0.60	1
Pangush	2	0.5-1.0	2	50-100	2	0.60-0.80	2
Koi	3	1.0-1.5	3	100-150	3	0.80-1.0	3
Rui	4	1.5-2.0	4	150-200	4	1.0-1.2	4
Mrigel	5	2.0-3.0	5	200-250	5	1.2-1.4	5
Katla	6	3.0-4.0	6	250-300	6	1.4-2.0	6
Silver	7	4.0-5.0	7	300-350	7	2.0-3.0	7
Bighet	8	5.0-6.0	8	350-400	8	3.0-4.0	8
Miror Carp	9					4.0-5.0	9
Sorputi	10					5.0-6.0	10
Grass Carp	11						

9. Feed type used by farmers

Feed type	Ingredients				Species	Feeding rate			
	Value	Code	Valu	Code		value	code	value	code

			e						
1 Pre-nursery	Yes	1	No	2	See Q. 7	30-40	1	Otherwise	2
2 Nursery	Yes	1	No	2		20-30	1	Otherwise	2
3 Pre-stater	Yes	1	No	2		15-20	1	Otherwise	2
4 Stater	Yes	1	No	2		10-15	1	Otherwise	2
5 Grower	Yes	1	No	2		5-10	1	Otherwise	2
6 Finisher	Yes	1	No	2		2-5	1	Otherwise	2

13.2.1 Chemicals use

Trade Name		Ingredients	Cause of use	
Name	Code		Cause	Code
Lime	1	See Q. 9	Water quality improvement	1
Solt	2		Disease treatment	2
Fertilizer	3		Preventive measures	3
Zeolite	4		Feed additives	4
Probiotics	5		Growth promotor	5

13.2.2 BkC products

Trade Name		Species	Cause of use	
Name	Code		Cause	Code
Polgard plus	1	See Q. 7	Treatment	1

Timsem	2		Preventive	2
Pondsafe	3			
Aquaclean	4			
Bactisol	5			
Virex	6			
Aquaside plus	7			
Vimekon	8			

13.2.3 oxygen supplier

Trade Name		Species	Cause of use	
Name	Code		Cause	Code
Oxygold	1	See Q. 7	Cloudy sky	1
Bio-ox	2		Heavy rain	2
Oxyplus	3		Excess feeding	3
Oxymax	4		Excess NH_3 & H_2S	4
Oxymore	5		Excess CO_2	5
Oxysos	6		Excess BOD	6
Oxy-a	7			

13.2.4 Vitamin –c and gas reducer

Trade Name		Species	Cause of use	
Name	Code		Cause	Code

Ossic-c	1	See Q. 7	Bacterial infection	1
Anti stress	2		Excess NH_3	2
Rena-c	3		Paracitical infection	3
Deletix	4		Slow feed intake	4
Gasonex plus	5			
Gas kil	6			
Gas check	7			
Bio-50	8			
Gas killer	9			
Angrave	10			
Paratix	11			
Aurgolosis	12			
Vita-c	13			
Bio zime	14			

13.2.5 Name of antibiotics

Trade Name		Species	Cause of use	
Name	Code		Cause	Code
Novamix-104	1	See Q. 7	Bacterial disease	1
Novamix-	2		Fungal disease	2

102				
Micronid	3		Parasitical disease	3
Urocord	4		Viral disease	4
Ablage	5			
Renamicyn	6			
Renamox	7			
ESTvet-plus	8			
Oxytin	9			

13.2.6 Growth enhancer

Trade Name		Species
Name	Code	
Rapid grow	1	See Q. 7
Charger gel	2	
Multi grow	3	
Vitagel	4	
Spa	5	
Growth gel	6	

14.Probiotics

Trade Name		Purpose		Species
Name	Code	Value	Code	
Aqumagic	1	Yes	1	See Q.

plus				7
Props	2	No	2	
Pond plus	3			
Biotics	4			
Pond health	5			
Ecotoxnil	6			
Soilgrow	7			
Bactigrow	8			
Nitogrow	9			
Navana	10			
	11			

15. Use chemicals and purposes

Name	Code	Time of use	Code
Chemicals used for pond and water quality management	1	January	1
Chemicals used as disinfectant	2	February	2
Chemical used for oxygen supply	3	March	3
Chemicals used for disease treatment	4	April	4
Antibiotics used for disease treatment	5	May	5
Chemicals used as growth promoter	6	June	6
Probiotics used in culture	7	July	7
		August	8
		September	9

		October	10
		November	11
		December	12

16.Banned chemical using

Name	Code	Reason of use	Code
Antibiotics	1	Desease treatment	1
Pesticide	2	Eradicate the predatory fish	2
Gas tablet (Aluminium Phosphet)	3	For total harvesting	3

17. Benifits of using chemicals and drugs

Economical benefits	Code	Environmental benefits	Code
Profit	1	Remove bad odor in soil	1
Loss	2	Remove bad odor in water	2
Neither profit nor loss	3	Green water color	3
		No disease outbreak	4
		Germ free water	5
		Neither profit nor loss	6
		Loss	7

21.1, 21.2, 21.3, 21.4, 22, 23(column 2, 3)

Month	Code	Season	Code

January	1	Dry season	1
February	2	Rainy season	2
March	3	winter season	3
April	4		
May	5		
June	6		
July	7		
August	8		
September	9		
October	10		
November	11		
December	12		

23. Steps taken to manage

Disease out break	Code	Flood	Code	Mass mortality	Code	Scarcity of water	Code
Use of medicine	1	Netting	1	Use of medicine	1	water Pumping	1
Use of chemicals	2	Use outlay	2	Use of chemicals	2	Water collect from natural source	2
Exchange of water	3	None of these	3	Exchange of water	3	None of these	3
Separation of	4			Die fish	4		

infectious fish				dumping on the environment			
				Die fish dump into the soil	5		

24. Water quality measurements

Time	Code	Temperature (℃)	Code	Transparency	Code	pH	Code	Soil pH	Code	Water color	Code	NH_4	Code
8-10	1	10-15	1	10-15	1	6-6.5	1	4-4.5	1	Brown	1	0-.25	1
10-12	2	15-20	2	15-20	2	6.5-7	2	4.5-5	2	Green	2	.25-.5	2
12-2	3	20-25	3	20-25	3	7-7.5	3	5-5.5	3	Clear	3	.5-1	3
2-4	4	25-30	4	25-30	4	7.5-8	4	5.5-6	4			1-2	4
4-6	5	30-35	5	30-35	5	8-8.5	5	6-6.5	5			2-3	5
		35-40	6	35-40	6	8.5-9	6	6.5-7	6			3-4	6

Thank you for your valuable time.

Apendix-02

Fig 26. Water Parameter Check Activities

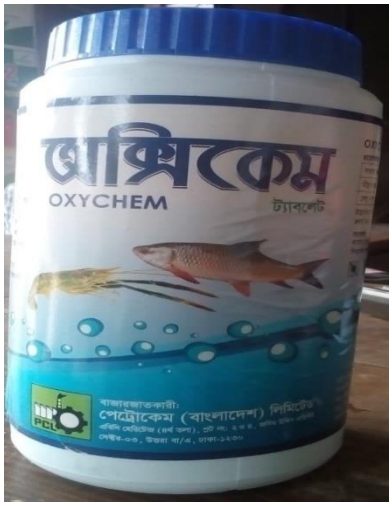
Fig 27. Some affected fish in the study area

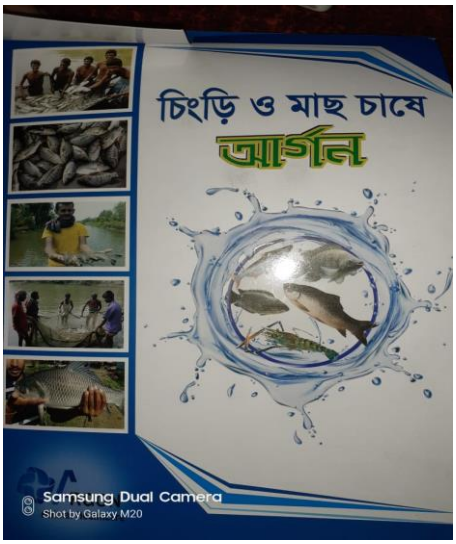
Fig 28. Fish health observation & information collection

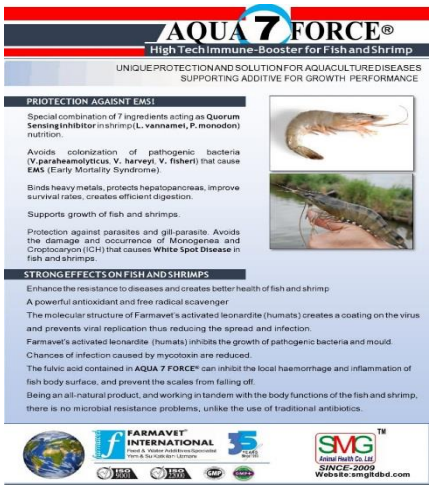
Fig 29. Focus group discussion & Seminar

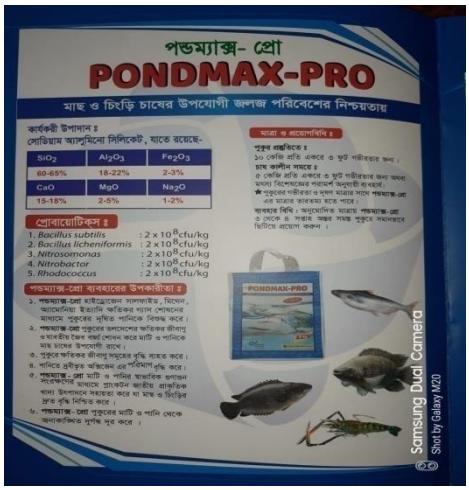
Apendix-3

Fig 30. Some New products are found in study









Thank you