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A CASE STUDY OF CARP SEED PRODUCTION FARM IN BANGLADESH: FEASIBILITY ANALYSIS

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Abstract

This report represents an analytical tool developed for the purposes of evaluating the feasibility of a carp seed production farm in Bangladesh. The analyses were based on the assumptions of secondary data, which were collected from both printed and web publications. The financial feasibility of the farm was studied using the Profitability Assessment Model, which utilized some indicators of investment returns such as Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, Financial Ratios, Modified Internal Rate of Return (MIRR), etc. The risk of the investment was assessed through Impact Analysis, Scenario Analysis and Monte Carlo Simulation. Similarly, technical feasibility was studied by analysing the possible outcomes of a selective breeding programme and the scope of improving existing practices. Finally, environmental feasibility was analysed on the basis of the environmental factors and related acts or rules. The findings of the analyses indicate that the proposed carp seed production farm is financially, technically and environmentally feasible. Total financing of the project is calculated as 15 MBDT of which equity is 30%. The results obtained from the study show positive NPV, i.e. 26 MBDT of capital and 25 MBDT of equity from a 10-year-operation, which are acceptable. The IRR of capital and the IRR of equity are found to be 37% and 60% respectively, which are also adequate because the Marginal Attractive Rate of Return is determined as 10%. The discounted payback period of the investment is measured at only 4 years. As a result, the project is recommended as financially feasible even if it is operated only for 5 years. Further, the results of risk assessment present that there is 98% probability of getting profit from the investment. However, the project is sensitive to sales price followed by sales quantity. Similar to other fish selective breeding programmes, the project is also considered feasible both technically and environmentally. It is concluded that the planned investment is highly feasible to operate in Bangladesh.

Key Words: *Feasibility analysis, freshwater carps, quality of seeds*

List of Abbreviations

BB	Bangladesh Bank
BDT	Bangladeshi Taka
DoF	Department of Fisheries
DSCR	Debt Service Coverage Ratio
EBITDA	Earnings Before Interests, Taxes, Depreciation and Amortization
EBT	Earnings Before Taxes
FAO	Food and Agriculture Organization
FSYB	Fisheries Statistical Year Book
GoB	Government of Bangladesh
GDP	Gross Domestic Production
HCG	Human Chorionic Gonadotropin
ICIMFA	Information Centre of the Icelandic Ministry of Fisheries and Agriculture
IMC	Indian Major Carp
IRR	Internal Rate of Return
LLCR	Loan Life Coverage Ratio
MARR	Marginal Attractive Rate of Return
MBDT	Million Bangladeshi Taka
MIRR	Modified Internal Rate of Return
NBR	National Board of Revenue
NPV	Net Present Value
PG	Pituitary Gland
ROE	Return on Equity
ROI	Return on Investment
TPM	Three Point Method

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1 INTRODUCTION

Today, fisheries, including aquaculture, is a well-established technology and economic activity in the world. It provides a dynamic source of food, employment, recreation and economic benefits both for present and future generations all over the world (FAO, 1995). The fisheries of Bangladesh play an important role in alleviating animal protein shortage, providing jobs for millions of people and earning foreign currencies. Total fish production in 2008-09 was about 2.7 million mt contributing 3.74% to the GDP and over 22% to the agricultural GDP. Bangladesh earned more than 32 billion BDT by exporting about 73 thousand mt of fish and fish products and contributed 3% to the country's total export earnings in 2008-09. The average growth rate of Bangladesh fisheries is 5.4%. Per capita annual fish intake is about 17.5 kg supplementing about 60% of the animal protein of the daily national diet. About 10% of the total population is directly or indirectly employed in the fisheries sector (DoF, 2010).

Bangladesh is endowed with diversified fisheries resources. These are divided into three groups, i.e., inland capture, marine capture and aquaculture. Inland fisheries cover an area of about 4.6 million hectares of which aquaculture comprises more than 0.5 million hectares (DoF, 2010). Production from both aquaculture and capture fisheries of Bangladesh is gradually increasing (FAO, 2010; Figure 1). However, inland capture fisheries have been under heavy pressure as a result of worsening environmental conditions; siltation in river beds; water pollution from agricultural, industrial and municipal wastes; construction of embankments for flood protection;irresponsible and destructive fishing practices; and loss of natural breeding grounds through habitat degradation.

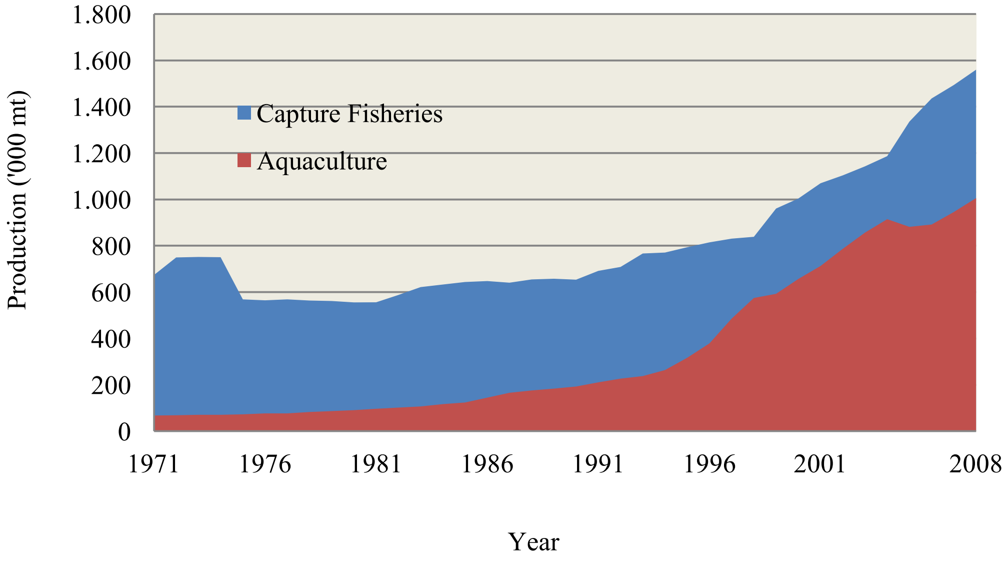

Figure 1: Production from aquaculture and capture fisheries in Bangladesh from 1971 to 2008 (FAO, 2010).

Therefore, Bangladesh has focused its attention on aquaculture, which has a high potential for development (Hussain and Mazid, 2005). The country aquaculture contributes more than 39% (Figure 2) to total fish production in 2008-09 (FSYB, 2010).

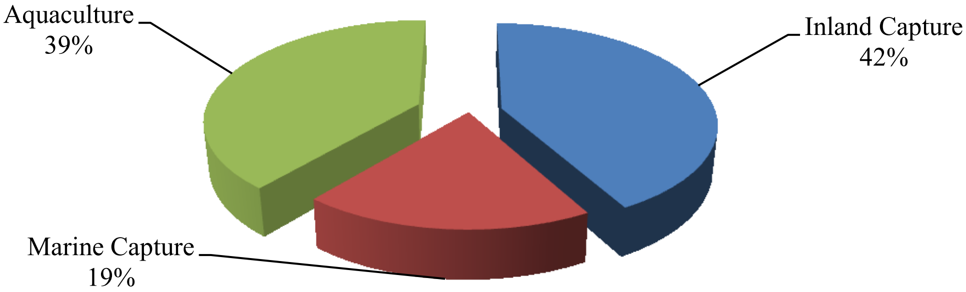

Figure 2: Sector-wise fisheries production in Bangladesh in 2008-09 (FSYB, 2010).

Carp aquaculture is rising sharply in Asia. Carp production from Asia contributed 95% to the world total carp production in 2001. In this region, there are more than 20 main inherent carp species, contributing to about 80% of the total freshwater fish production. The most carp production in Asia is contributed by China, India, Bangladesh and Indonesia. Carps are basically the most important species to aquaculture in Bangladesh. In 2001, carp production was estimated as 89% of the total freshwater fish production in the country (Dey *et al.*, 2005). The proportion of freshwater carps in total fish production is about 35% (Figure 3) in 2008-09 followed by small indigenous species, hilsha, marine fish, shrimp and prawn, and cat fish (FSYB, 2010).

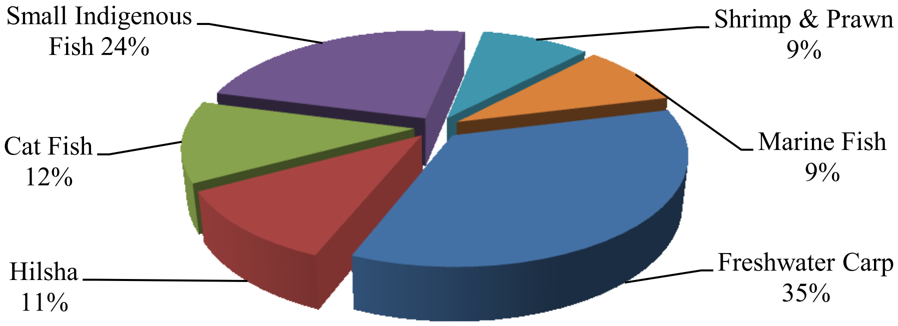

Figure 3: Contribution of different fish groups in national production in 2008-09 (FSYB, 2010).

Aquaculture of Bangladesh is enriched with a significant number of indigenous and exotic carp fishes. There are at least 13 endemic and 8 introduced species of carps, which are of interest to aquaculture in Bangladesh (Hussain and Mazid, 2005). The species of fish included in this study, either individually or as a group, are normally known as carps. The species referred to as carps are generally seven in number and are grouped on the basis of the geographical locations as the Chinese Carps, which include the grass carp, *Ctenopharyn godonidella*; the silver carp, *Hypophthalmichthys molitrix* and the bighead carp, *Aristichthys nobilis* and the Indian Major Carps, which comprise of catla, *Catla catla*; rohu, *Labeo rohita*; and mrigal, *Cirrhinus mrigala*. The seventh species is the common carp, *Cyprinus carpio* (Jhingran and Pullin, 1985).

The tradition of natural origin seeds of these fishes is becoming a thing of the past in Bangladesh. During the sixties and early seventies the state aquaculture was absolutely dependent on natural carp spawns collected from different rivers. In the course of time, the production of fish spawns in the rivers has been reduced due to habitat destruction and environmental change and, alternatively, induced spawning has started to fill the shortage of seeds (Sarder, 2007). In 2009, natural source contributed only 0.5% to total spawn production, whereas the private sector hatcheries 98.5% and public farms added only 1%. The country produced 9.6 billion carp fingerlings in 2008-09 from 466 mt carp spawns accumulated from 931 hatcheries and natural sources (FSYB, 2010). However, the hatchery-produced stocks, including carps, have presented lower growth and poor breeding performance, morphological deformities, susceptibility to diseases and high mortalities, which result in poor quality of seeds (Hussain and Mozid, 2005).

The quality of fish seeds in Bangladesh has declined over the years. The quality reduction is mostly observed in private hatcheries. There are many reasons for the low quality, for instance, inbreeding, inter-specific hybridization, negative selection, improper broodstock management, which lead to poor performance in aquaculture production (Sarder, 2007). Furthermore, hybridization and cross breeding are threatening the genetic diversity of indigenous wild stocks of Indian Major Carps (IMC), which may result in irreparable damage to their gene pool (Khan, 2008). However, quality artificial seed production is necessary to fill the shortage of natural seeds and to satisfy the growing demand for quality fish fingerlings in aquaculture. Therefore, new investment is needed to escalate the supply of good quality fish seed, which can improve the performance of cultivated species (Davy and Chouinard, 1981). Moreover, carps are the main species for the aquaculture system in Bangladesh, and the production of these species completely depends on timely and adequate supply of quality seeds (Sarder, 2007). Presently, both public and private hatcheries and nurseries are producing fish seeds, but there has been a growing concern over the availability of good quality seeds for sustainable fish production (Sattar and Das, 2002). For that reason, the production of quality carp spawns and fingerlings are essential for desired production of fish in Bangladesh (GoB, 2010).

Carp seed production is a profitable business in Bangladesh. As a result, many investors are coming forward to invest in aquaculture. Before making an investment in a carp seed production farm, it is necessary to determine whether the planned investment idea is feasible or not. Through this study the solution to the following research question will be found out.

Is it financially, technically and environmentally feasible to establish a carp seed production farm for the improvement of carp seed quality in Bangladesh?

Carrying out a feasibility analysis is, therefore, the most important step in the decision-making process for any investment. The goal of this study is to conduct a feasibility analysis and to develop a decision for whether to support establishment of a carp seed production farm for the improvement of carp seed quality in Bangladesh. The objectives of the study comprise the development of a profitability model through analysis of the financial feasibility and analyses of the technical and environmental feasibility of carp seed production farm in Bangladesh.

The methodology developed during this study will be a useful tool to analyse the feasibility of aquaculture farms. It will be an important pathway for profitability assessment of initial investment in carp seed farms, which will provide information about profit and risk of the investment. This model will be a valuable management tool for farm owners, investors, financial institutions and banks. Moreover, the profitability model can be used in planning as well as during the operations of the farm. The tool developed here can also be applied in evaluation of any other investment and operations. Furthermore, this study will assist fish farmers to know what they require before starting fish farming. Governmental agencies can also use the information to formulate policies and programmes for the development of fisheries in the country. Thus, the fisheries of Bangladesh would advance in a sustainable way.

This report is written to provide the basic ideas and the business plan that are needed to start a carp seed farm in order to improve the quality of seeds. The information in Chapter 2 is presented to give some background evidence that helps to explain the feasibility analysis. The materials and methods are discussed in Chapter 3, which include the necessary formula and tools used during the study. Chapter 4, which presents the results of feasibility analysis, illustrates the profitability of carp seed production. Chapter 5, which gives a detailed discussion of feasibility analysis, includes the financial feasibility of the investment, technology to be followed and environmental factors to be considered during establishment of a carp seed production farm in Bangladesh. Chapter 4 and chapter 5 are the heart and soul of the report. Chapter 6, which outlines the recommendations based on the study, discusses the possibility of research and government initiatives to be taken for further development of fish seed quality in Bangladesh. Chapter 7 characterises the conclusion of the feasibility analysis. Following chapter 7, a list of cited references is provided. Some important appendices are also added at the end of the report for understanding the profitability calculation in greater detail. Abbreviations are defined in the text when they are first used. Moreover, there is a list of abbreviations in the beginning of the report for reference.

2 LITERATURE AND REVIEW

A feasibility study is a tool which investigates the viability of a prospective project. Investors with a business idea should conduct a feasibility study to determine the suitability of their idea before proceeding with the establishment of a business. Conducting a feasibility study is a good business practice. If it is properly conducted, it may be the best investment one ever makes (Hofstrand and Holz-Clause, 2009). The purpose of the feasibility study is to reveal the practicality of the project. A feasibility study assists decision makers in considering alternative development opportunities. It also permits planners to outline their ideas on paper before implementing them. This can expose errors in project design before their implementation affects the project negatively. Applying the lessons gained from a feasibility study can significantly lower the project costs (Matson, 2000). Moreover, feasibility study is an analytical tool used during project planning, which includes financial feasibility, technical feasibility and environmental aspects.

2.1 Review of profitability of carp seed production

Today, fish seed production is a widespread commercial activity in Bangladesh. The recent development of aquaculture is increasingly taking advantage of the continual production of fish seed. The profitability of existing carp seed farms in Bangladesh is reviewed here.

Firstly, the excellence of carp seeds greatly depends on quality and source of brood fishes. To meet the rising demand of brood fishes, public hatcheries of Bangladesh are producing river and hatchery origin quality brood fishes. The price per kilogram of natural origin brood fish in public farms is 120 BDT (Hamid, 2010).

The price of ingredients used in farm management varies with season and quality. Table 1 shows the price of aquaculture ingredients in Bangladesh. The value of hatchery products such as spawns and fingerlings is also variable depending on several factors, viz. species, supply, demand, season, transportation and quality of spawns. It is reported that the price of spawns of Indian Major carp and Chinese carp varies both in private and public farms from 1,000 to 3,000 BDT per kg (Sarder, 2007). On the other hand, the average price of quality carp spawns produced in public farms is 4,000 BDT per kg with a price reduction by 1,000 BDT per kg from July of the year (Ullah, 2010). Similarly, the price of 2 to 3 inch-sized carp fingerlings varies from 200 to 1,000 BDT per 1,000 individuals (Sarder, 2007). The average price of 2-15 cm-sized quality carp fingerlings from public farms is 500 BDT per 1000 individuals (Ullah, 2010).

Table 1: The price of aquaculture ingredients in Bangladesh in 2010.

Ingredients	Price (BDT)	References
Wheat bran	24 per kg	(Ullah,2010)
Mustard oil cake	28 per kg	
Wheat flour	25 per kg	
Cow-dung	1.5 per kg	
Urea	15 per kg	
Triple super phosphate	25 per kg	
Lime	16 per kg	
Plastic bag/Jute sac	10 per piece	
Wheat bran	15 per kg	(Islam, 2010)
Mustard oil cake	20 per kg	
Rice bran	10 per kg	
Pituitary Gland	2,500 per g	
Human Chorionic Gonadotropin	200 per vial	

Furthermore, other farm management costs, i.e. labour cost, also vary with season and locality. On average, the cost of aquaculture labour in Bangladesh is 150 BDT per day (Ullah, 2010). One favourable thing for aquaculture is that the income of fisheries is exempted from tax, but listed companies are entitled to pay 5% tax as corporations (NBR, 2010). However, monetary inflation can adversely affect the profitability of any company. It was recorded by Bangladesh Bank that Bangladesh's inflation (general) rate was 7.31% during a 12-month average in 2009-10 (Akhtaruzzaman, 2010). Finally, the bank loan interest rate for agriculture was 13% in Bangladesh in 2010 (BB, 2010).

However, profitability assessment is essential for the feasibility study of a new investment. According to Park (2002), the profitability of any project is measured by some indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), Return on Investment (ROI), Return on Equity (ROE), Financial Ratios, etc. As it is described, if the NPV is positive for a single project, the project should be accepted. This means that the project has greater equivalent value of inflows than outflows, and therefore makes a profit. The decision rule for NPV (Park, 2002) is: if NPV>0, the investment is accepted; if NPV=0, the investment remains indifferent; and if NPV< 0, the investment is rejected.

Presently, profitability assessment is a pervasive tool used by many researchers. For instance, the profitability of Trawl Fleet Investment in Liberia was analysed by Togba (2008). From the study it was found that the proposed investment achieved 15% Internal Rate of Return (IRR) of net cash flow and a positive Net Present Value (NPV). The payback period was found to be 8 years. The ROI and the ROE were calculated as 51% and 56% respectively at the end of a 10-year operation. Both net current ratio and liquidity ratio were 5.5. The internal value of shares was calculated as 4.3 times and debt service coverage ratio was 3.0, whereas the acceptable minimum was decided to be 1.5. It was concluded the investment in trawl fishery was acceptable based on NPV and IRR (Togba, 2008).

Further, the profitability of African Catfish farming in Kenya was studied by Okechi (2005) to determine financial feasibility of the enterprise. The study found a payback period of 4 years and a positive Net Present Value (NPV). The Internal Rate of Return (IRR) was computed as 34% and 60% for total cash flow and net cash flow respectively. As it was described, the IRR for the farm was above the Marginal Attractive Rate of Return (MARR). As a result the investment was found profitable to operate. The report also stated that debt service coverage ratio was above 1.5 showing the cash flow well above the repayment and interest of loans. Moreover, net current ratio was also above 1.0. Thus, the current assets were more than the current liabilities. Therefore, the investment was recommended.

Finally, projects are rarely financed independently. A combination of sources is usually needed. For instance, the equity for new investment is provided by the different commercial banks as well as by the Central Bank of Bangladesh. The central bank of Bangladesh, the Bangladesh Bank, is authorized by the Government to manage the Equity and Entrepreneurship Fund. According to Bangladesh Bank, the project should have to be viable technically and financially to obtain equity fund. As is reported, the project must offer minimum 15% Internal Rate of Return (IRR), 15% Return on Equity (ROE), 1.5 Debt Service Coverage Ratio and 1.5 Liquid Current Ratio (BB, 2003).

2.2 Review of carp breeding technology

A carp breeding programme comprises three major activities: brood stock management, hatchery operation and nursery management. The data and information related to the study collected from different sources are described at this point.

2.2.1 Benefits of selective breeding programmes

Selective breeding programmes are common both for plants and animals throughout the world. Selective breeding in fishes is also gaining in popularity in many countries. It is an effective method of increasing yields, which has long-term benefits (Tave, 1995). The selective breeding of Atlantic salmon in Norway, the Channel catfish in the USA and the Nile tilapia in the Philippines, for instance, are improving qualities like survival rate, growth rate, resistance to disease, meat quality etc. through selection (Reddy, 1999).

In India, for example, selective breeding work was performed at the Central Institute of Freshwater Aquaculture, Bhubaneswar. The study was performed in collaboration with the Institute of Aquaculture Research, Norway. Rohu (*Labeo rohita*) was chosen as the model species among Indian Major Carps (IMC). It was reported that after four generations of selection, an average of 17% higher growth per generation was observed in improved rohu (Mahapatra *et al.*, 2011).

An Atlantic salmon selective breeding programme was undertaken by Elliott *et al.,* (2007) in Tasmania. The programme was conducted with the objectives to increase growth traits of fish, to improve feed conversion efficiency and to reduce the length of production cycle. It was predicted that the growth rate would be improved by 10% per generation. The report also stated that the period of Atlantic salmon 'grow-out' was reduced from 4 to 3 years through selective breeding in Norway (Elliott *et al.*, 2007).

Likewise, selective breeding programmes have been initiated by several private companies and public institutions in Iceland (ICIMFA, 2011). For example, selective breeding programmes for Atlantic salmon by Stofnfiskur, for Arctic charr by the Holar University College and for Atlantic cod by the company Icecod are in operation with the objectives of achieving faster growth, later sexual maturity, higher survival rate, better flesh quantity and more resistance to disease.

2.2.2 Brood stock management

Management of brood stock is the prime way to improve the quality of carp seeds. Brood stock is the heart of the fish seed production farm. The success of induced breeding depends on the availability of sufficient number of brood fish and their proper management (Sarder, 2007). It was observed that most of the hatcheries or farms in Bangladesh used under weighted and sized fishes for breeding. However, for the improvement of seed quality, 2-3 year old mature males and females of natural origin are recommended as brood fish. Brood stock of the same age may also be collected from culture ponds. For exotic species the culture pond is the only source of brood stock (Sarder *et al.*, 2002).

Pedigree recording is an essential task in spawning for the improvement of carp seed quality. It is reported that no brood stocks having pedigree are found in existing fish farms in Bangladesh except two government carp hatcheries, where brood fishes are nurtured in species-specific ponds. In these hatcheries, they recruit their brood stock every year through collecting spawn from natural sources. Alternatively, in most private hatcheries, the existing and newly recruited brood fishes are stocked in the same pond due to shortage of ponds without any pedigree record. Therefore, the fishes collected as brood stock should be pedigreed prior to starting a fish hatchery (Khan, 2008).

Before stocking brood fish, ponds should be well prepared. The usual practice of brood fish pond preparation is the removal of predators and weed fishes through drying the pond. Sometimes toxins such as rotenone are used to kill the unwanted fishes. Afterwards, aquatic weeds are removed manually. Then, lime is applied at the rate of 1-2 kg per decimal (Sarder, 2007). The stocking density is vital for proper development of brood fishes. It is often observed that fishes with high density are reared in a small pond resulting in poor quality of broods. The size of brood ponds should range from 0.25 to 0.5 hectares. For good quality brood, the stocking density should be maintained at 1.5 to 2.0 mt per hectare with an equal ratio of male and female (Islam, 2009).

The post-stocking management of brood fish ponds can also affect the quality of seeds. For example, fertilization in ponds is an important post-stocking management measure to ensure natural food production. The brood fish pond should be fertilized with cow-dung, urea and triple super phosphate (TSP) at the rate of 500 kg, 12.5 kg and 6.25 kg per hectare per week, respectively, for producing natural food (Islam, 2009).

The success of induced breeding is greatly dependent on the brood stock's reaching the right stage of gonadal development (Davy and Chouinard, 1981). It is reported that the broods of most farms in Bangladesh are not provided with a sufficiently balanced diet. As a result, the spawns produced from these broods are poor in quality (Khan, 2008). Aside from the availability of natural food, most farm owners offer the brood fish supplementary feed with 25-30% protein level. The feed is applied at 2-3% body weight of brood fish stocked. In addition, cut pieces of soft grass are supplied to the pond for grass carp and silver barb (Sarder, 2007).

The ingredients of supplementary feed used for feed formulation in Bangladesh contain different amount of nutrients. Doses and nutritive values of ingredients used for fish feed formulation are shown in Table 2.

Table 2: Doses and nutritive values of ingredients used in supplementary feeds forbrood fishes (Sarder, 2007, Islam, 2009 and Khandaker, 2007).

Ingredients	Amount Used in Feed (%)	Protein (%)	Carbohydrate (%)	Lipid (%)
Mustard Oil Cake	30	9.1	10.3	4.0
Fish Meal (Grade-A)	15	8.5	0.6	1.7
Rice Bran	30	3.6	13.3	3.1
Wheat Bran	15	2.2	10.0	0.7
Wheat Flour	5	0.9	3.8	0.2
Molasses	4	0.2	3.3	0.0
Vitamin Premix	1	-	-	-
Total	100	24.5	41.3	9.7

2.2.3 Hatchery operation

Hatchery management practices generally followed during induced breeding of carps in Bangladesh are reviewed below.

The facility for the carp hatchery is one of the important factors for seed quality improvement. Most of the fish seed farms or hatcheries are not running smoothly due to lack of adequate farm facilities. Fish seed farms lack laboratory facilities. A carp hatchery complex should have sufficient facilities for spawning, for hatching of eggs, and for rearing the fish hatchlings up to post-larval stage and laboratory facilities as well (Khan, 2008).

Another significant factor that can affect the quality of seeds is selection and calculation of hormone doses. Therefore, prior to induced breeding, the required dosages of hormones should be calculated in relation to body weight of brood fishes to be induced (Sarder, 2007). Indian Major carps are bred with Pituitary Gland (PG) extract and Chinese carps with a combination of PG and Human Chorionic Gonadotropin (Jhingran and Pullin, 1985). On average, carp females require two injections of 10 mg of PG per kg body weight, and carp males are injected with 2 mg of PG per kg body weight (May *et al.*, 1984). The pituitary glands of Indian Major carps, Chinese carps and common carp are commonly used for induced breeding (Sukumaran, 1985). It is reported that hormone content is the highest in the pituitary of sexually mature fishes (Woynarovich and Horvath, 1980).

The amount of spawn produced from mature fish is important for the calculation of carp hatchery production. It is reported that the amount of eggs collected during induced breeding varies from 30% to 35% per kg body weight of female fish. It is estimated that 1 kg of carp eggs contains 0.7 to 1.1 million eggs from which at least 0.5 kg spawn can be produced. It is also estimated that 1 kg of carp spawn contains 250 to 400 thousand spawns (Islam, 2009).

Government planning is also important for the advancement of aquaculture. The provision of fish hatchery registration is one of the significant initiatives undertaken by the Government of Bangladesh for improving seed quality. Recently Bangladesh passed Fish Hatchery Act 2010 (GoB, 2010). It states that no hatcheries can operate without registration. Further, hatcheries cannot apply hybridization technique, except government-authorized Fish Research and Extension Centre or Organizations. Moreover, every hatchery must take initiative during induced or artificial breeding to stop inbreeding in fish.

2.2.4 *Nursery management*

Nursery management is an integral part of a fish seed production farm. The significant aspects of nursery management are reviewed here.

The management of nursery ponds is an important part of fish seed production to improve the survival rate, growth rate and health of fish fry (Jhingran and Pullin, 1985). There are two types of ponds in Bangladesh: seasonal and perennial ponds. In general, preparation of seasonal ponds is started through pond drying. Perennial ponds are prepared through dewatering or applying poisons such as Rotenone, Phostoxin, etc. After drying or poisoning, lime is applied at 1-2 kg per decimal and cow-dung at 5-7 kg per decimal. In addition, inorganic fertilizers viz., urea and triple super phosphate (TSP) are also used. Insecticides, for example, Dipterex or Sumothion are used for removing insects 24 hours before spawn release.

The stocking of nursery ponds varies with nursing stages. In single-stage nursing, the stocking density is maintained at 1.0 to 2.0 million spawns per hectare and 2-3 inch-sized fingerlings are obtained within 4 to 6 weeks. In two-stage nursing, hatchlings are stocked with a density of 6.0 million per hectare. Then the fries are reared for about 6 to 8 weeks for growing up to 2 to 3 inch-sized fingerlings (Sarder, 2007).

The proper feeding of fish fry is vital for quality. During nursing, spawns should be provided with boiled-egg yolks for 2-3 days and then overnight wet mustard oil cake mixed with fishmeal should be supplied for the next 7 days. After that a common supplementary feed consisting of 25-30% protein are allocated at 5% body weight (Khan, 2008). Regular fertilization with TSP and urea is performed at 25 and 50 kg/ha/month, respectively (Sarder, 2007). The survival rate of spawn is found to be 32% during fingerling production by fry traders (Rahman *et al.*, 1987).

2.3 Review of environmental factors

It is of great concern to prevent pollution of the environment. Aquaculture can be harmful to the environment if it is not properly planned and managed. To that end national and overseas organizations have formulated various acts and rules. According to the Rule for the Conservation of the Environment of 1997, establishment of farms or companies in ecologically critical areas such as mangroves, game reserves, marshes, and forest areas is restricted (GoB, 1997). Similarly, the provisions of the Bangladesh Environment Act of 1995 are directed to protect the environment from any pollutants (GoB, 1995).

According to the Bangladesh Environment Act of 1995, ‘pollution’ means the contamination or alteration of the physical, chemical or biological properties of air, water or soil; and ‘waste’ means any solid, liquid, gaseous, radioactive substance, the discharge, disposal and dumping of which may result in harmful change to the environment (GoB, 1995). According to Khan (2008) hatcheries should have necessary treatment facilities which could facilitate the treatment of wastewater produced during the production period. Effluents should be discharged from hatcheries in a manner so that it could not pollute the environment. Hatcheries should have an internal composting facility in order to process the solid waste.

Moreover, the Food and Agriculture Organization (FAO, 2008) developed Aquaculture Certification Guidelines to avoid possible hazards to the environment from aquaculture farms. According to the guidelines, aquaculture should ensure the health and welfare of farmed fishes. Management should be aimed to reduce stress, optimize health, reduce disease risks and maintain a healthy environment during all phases of the culture system (FAO, 2008). The guidelines also mention that fish farming should be conducted in a socially responsible manner, which will abide by the state rules and regulations beneficial to the employees, farmers, local people, investors and the state. Therefore, it is important to investigate the environmental parameters available at the site before farm construction to make it successful (Jhingran and Pullin, 1985).

3 MATERIALS AND METHODS

3.1 Collection and review of data

Secondary data and information on carp seed production in Bangladesh were collected and reviewed from different sources, i.e., printed documents, online documents and publications, etc. Other information was also collected by the author based on his personal experience with carp seed production in Bangladesh.

3.2 Estimation of cost and main assumptions

The cost of operations was estimated using the Three Point Method (TPM), which includes the following formulations:

The expected value of each cost item was calculated as:

$$\mathrm{t} = \frac{a + 4 * m + b}{6}$$

The standard deviation of each cost item was found by:

$$\mathrm{s} = \frac{\mathrm{b} - \mathrm{a}}{6}$$

The variance of each cost item was then found as:

$$\mathrm{v} = s^2$$

Where, t=expected value, a=optimistic value, m=most likely value, p=pessimistic value, s=standard deviation and v=variance.

Then the standard deviation of the total cost was calculated as the square root of the total variance. Finally, the total cost was estimated using the following formula,

$$\text{Estimated Cost} = \text{Expected total cost} + Z * \text{Standard Deviation}$$

Where, Z was determined as 1.65 at the confidence level (95%) using the standardized normal distribution.

3.3 Financial feasibility study

The financial feasibility of the carp seed farm was studied through the development of a Profitability Assessment Model. The main components performed for the profitability model (Jensson, 2006) are shown in Figure 4. Each component was implemented in a separate Excel sheet in the same workbook. In this case study, it was assumed one year of construction and investment and 10 years of operational lifetime.

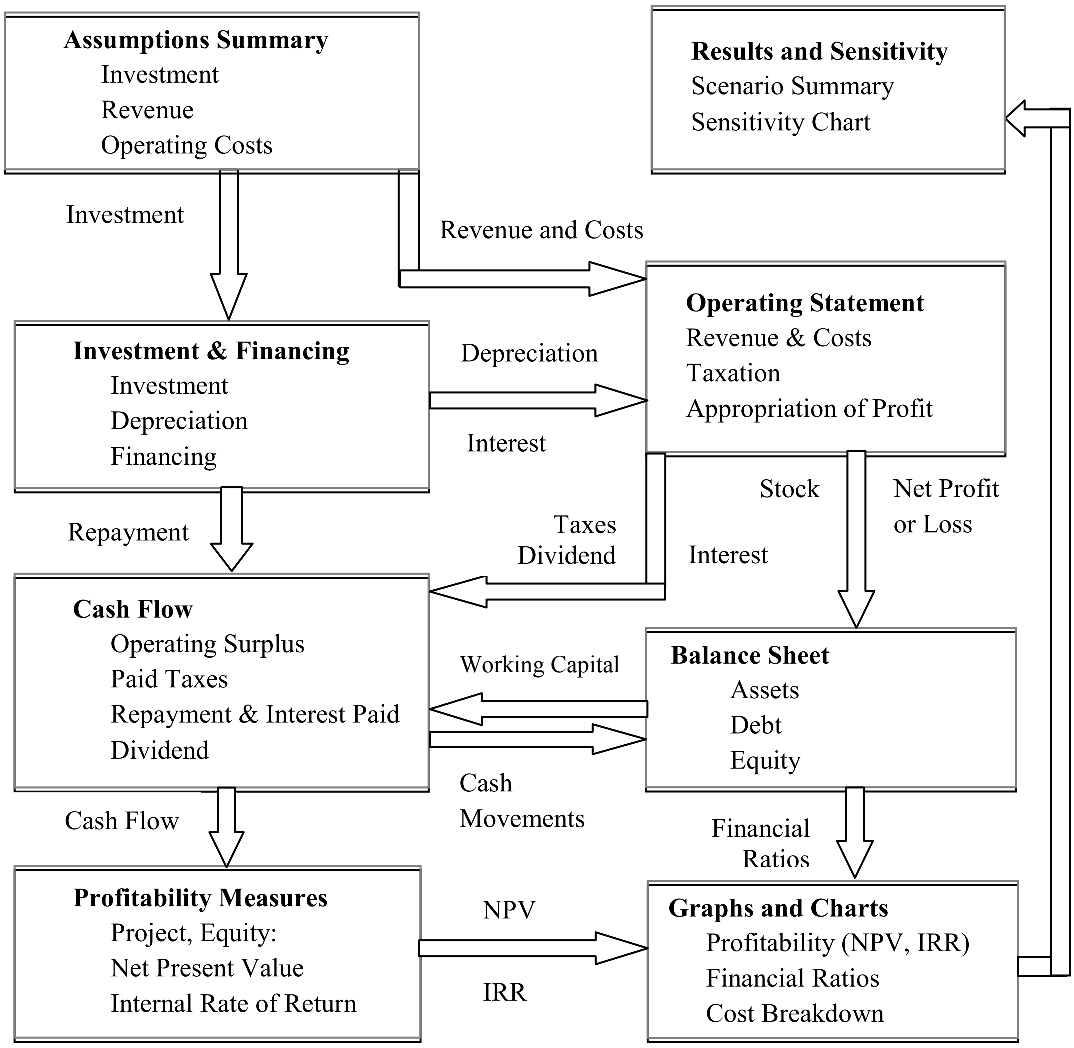

Figure 4: The main components of the Profitability Assessment Model (Jensson, 2006).

Then, profitability of the carp seed production farm was analysed by using the results of investment. The following measures were used as indicators for analysing Financial Feasibility in the model.

3.3.1 Net Present Value (NPV)

The Net Present Value with a 10% discount factor was calculated for the cash flow series: i) total capital invested and cash flow after taxes and ii) equity and net cash flow. NPV was calculated for all years through the lifetime. The formula for calculating NPV is:

$$NPV(i) = \frac{A_0}{(1+i)^0} + \frac{A_1}{(1+i)^1} + \dots + \frac{A_N}{(1+i)^N} = \sum_{n=0}^{N} \frac{A_n}{(1+i)^n}$$

Where,

A_n = Net cash flow at the end of period n, i = Marginal Attractive Rate of Return and N = Planning horizon of the project.

3.3.2 Internal Rate of Return (IRR)

The Internal Rate of Return was estimated for the cash flow series: i) total capital and cash flow after taxes and ii) equity and net cash flow. The IRR was calculated using the Excel built-in formula for all years through the lifetime. As it is stated by Park (2002), the decision rule for a simple project is: if $IRR > MARR$, the project is accepted; if $IRR = MARR$, it remains indifferent; and if $IRR < MARR$, the project is rejected.

3.3.3 Modified Internal Rate of Return (MIRR)

Modified Internal Rate of Return is a measure which provides a different and more accurate measure of financial feasibility. The decision rule for MIRR is: if $MIRR > Cost\ of\ Capital$, the project is accepted; if $MIRR = Cost\ of\ Capital$, it remains indifferent; and if $MIRR < Cost\ of\ Capital$, the project is rejected.

3.3.4 Financial ratios

Financial ratios were calculated to assess the risk of the investment. The following financial ratios were analysed in this study.

Liquid Current Ratio is a liquidity ratio which shows the relationship between liquid assets and current liabilities. The formula for the liquid current ratio is:

$$Liquid\ Current\ Ratio = \frac{Current\ assets - Inventory}{Current\ liabilities}$$

Return on Investment (ROI) is a profitability ratio which measures the performance of the capital involved. The formula for the return on investment is:

$$ROI = \frac{Earnings\ before\ interests\ and\ taxes}{Debts\ and\ capital}$$

Return on Equity (ROE) is a profitability ratio which represents the rate of return to shareholders' equity. The higher ratio presents the more efficient use of the investors' equity.The formula for the return on equity ratio is:

$$ROE = \frac{Profit\ after\ taxes}{Total\ capital}$$

Internal value of shares is a market trend ratio which describes the relationship between equity and capital. The formula for the internal value of shares is:

$$Internal\ value\ of\ shares = \frac{Total\ capital}{Total\ equity}$$

Debt Service Coverage Ratio (DSCR) is a cash flow ratio showing the cash available for paying the interest and repayments of loans which is used by financiers to assure that the borrowers will have sufficient funds to pay the debts. The formula for Debt Service Coverage Ratio is:

$$DSCR = \frac{Cash\ flow\ after\ tax}{Interest\ and\ Repayment}$$

Loan Life Coverage Ratio (LLCR) is one of the most commonly used debt ratios which considers the whole lifetime of the loan, not just year-to-year bases like the DSCR. The formula for the Loan Life Coverage Ratio is:

$$LLCR = \frac{NPV\ of\ future\ cash\ flow}{Principal\ of\ loan}$$

3.4 Risk analysis

Risk analysis was performed in different ways for exploring and better understanding the effects of uncertainties. These are as follows:

3.4.1 Impact Analysis

Impact Analysis was performed using one uncertain item at a time, for example, sales price, sales quantity, cost of equipment and cost of building. To facilitate this, so-called impact factors, which were used on Assumptions Summary sheet (Appendix 2) of Profitability Model, were inserted as the default value 100%. These were multiplied with the uncertain items. Then the Data Table in Excel What-if Analysis was applied in order to analyse the results such as Internal Rate of Return on Equity for a range of impact factors, for instance, from 50% to 150%. The same process was followed for each of the uncertain items.

3.4.2 Scenario Analysis

Scenario Analysis deals with simultaneous changes in more than one uncertain item. The Scenario Manager of Excel What-if Analysis was used for this purpose. The changing cells were selected and their values for each scenario, for example, the costs of buildings, equipment, sales price and sales quantity were examined in both the best case and the worst case. The scenarios were named, for example, Optimistic Scenario and Pessimistic Scenario, respectively. In this study, the IRR of Equity was selected as a Result cell.

3.4.3 Monte Carlo Simulation

Monte Carlo Simulation is the most advanced method of the sensitivity analysis. The Excel software @Risk was used for this purpose. This simulation tool allowed specifying a probability distribution for each of the uncertain items. The built-in random number generators tool was then used to make as many observations of these items as found necessary. As it is described by Albright and Winston (2009), the random numbers and the number of simulations were set to 1000 and 1 respectively, and then the simulation was run as usual. The result was a histogram of a selected output item, in this case the IRR of Equity. It was decided that IRR=10% was critical, i.e. values under this threshold were considered insufficient. Further, the sensitivity of all cost items was estimated by using correlation coefficients (Spearman Rank) through @Risk software and the result was a Tornado Chart.

3.5 Analysis of technical feasibility

Initially, the carp breeding technology was reviewed using information on existing practices collected from literatures. Then, the process flows of recommended practices necessary to improve the quality of seeds were incorporated as shown in Figure 5, Figure 6 and Figure 7. Finally, the technical feasibility was studied considering the possible outcomes of the selective breeding programme and possibility to overcome the weaknesses of the existing technologies followed, such as brood stock management, hatchery operation and nursery management.

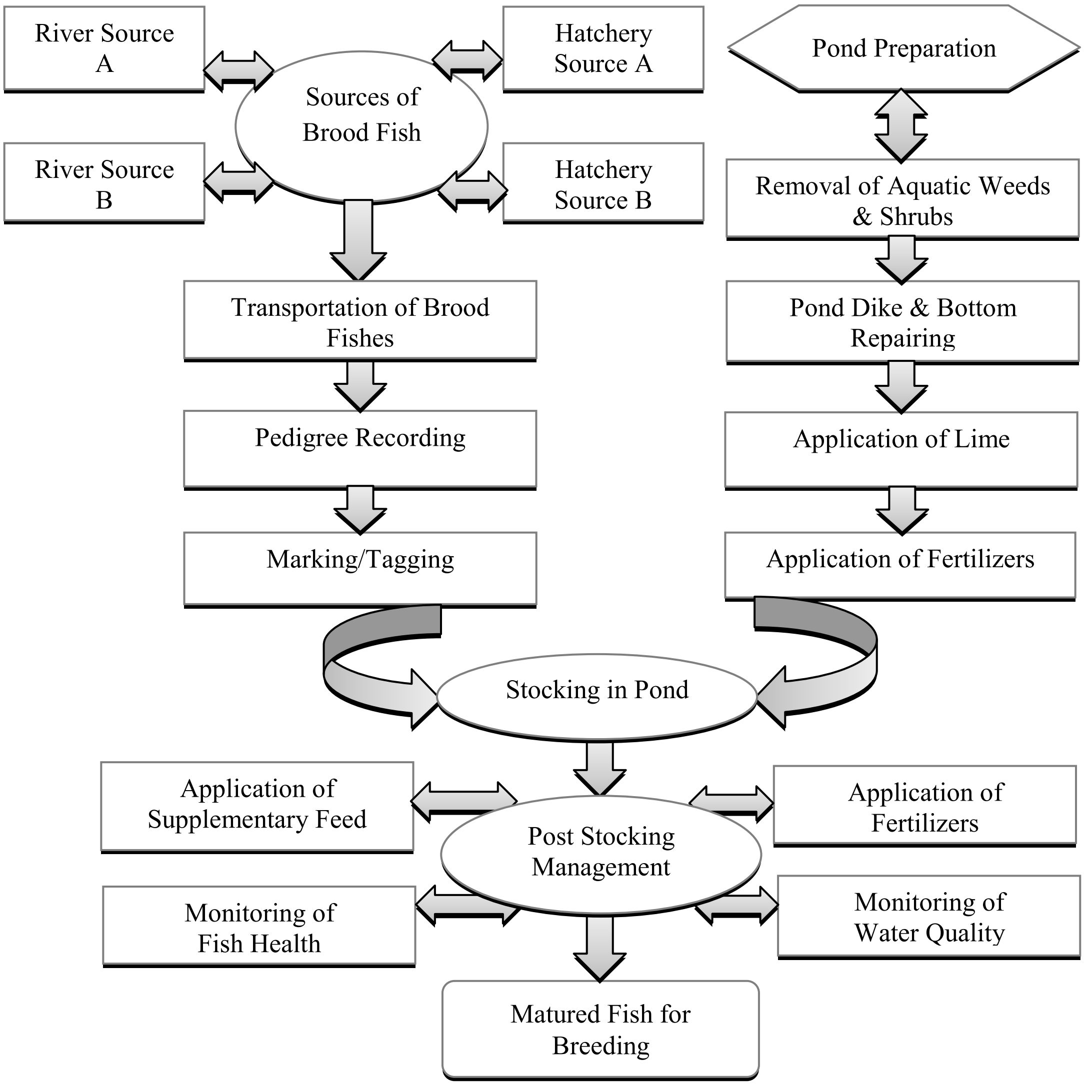

Figure 5: Process flow chart of brood stock management.

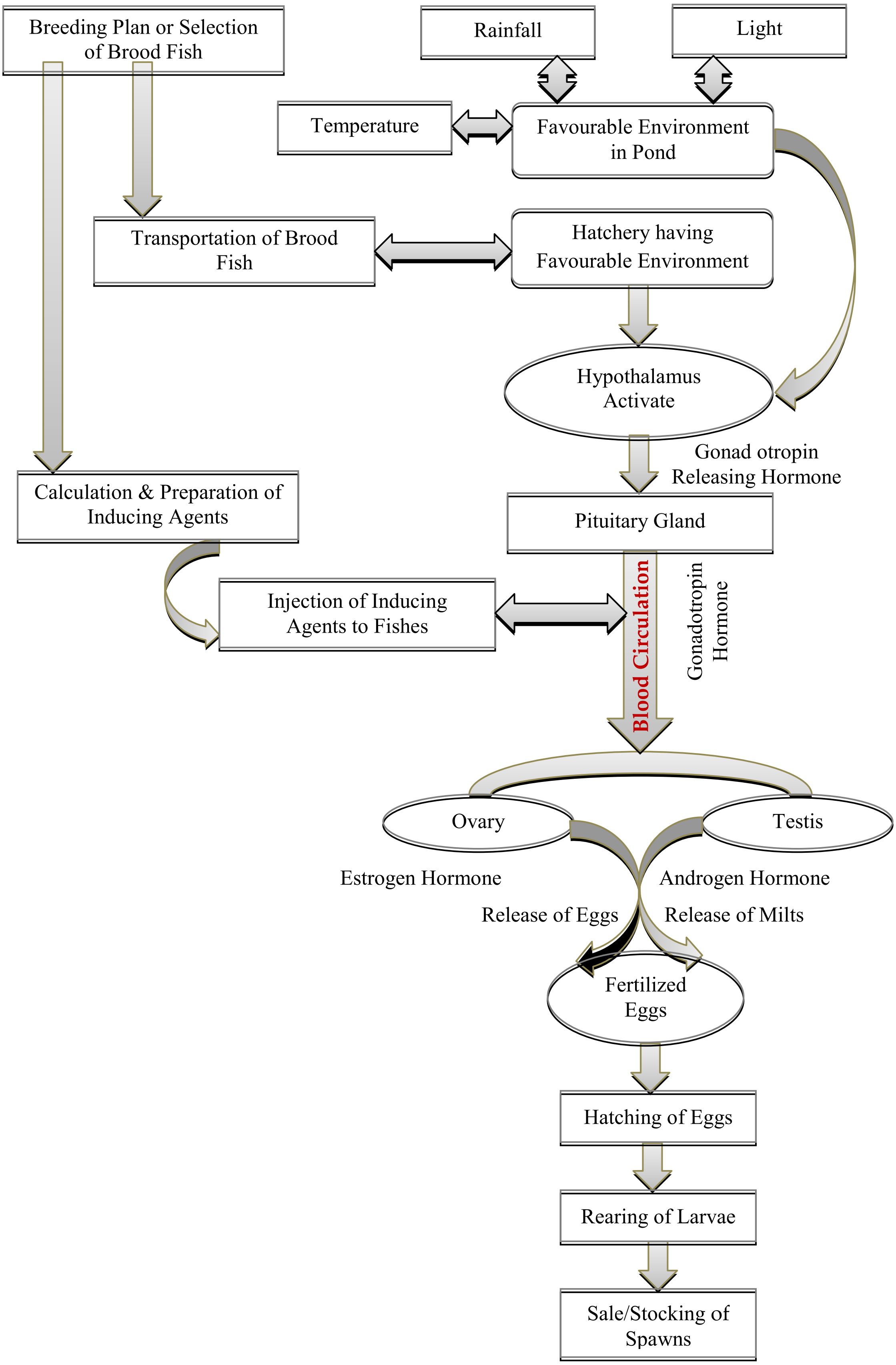

Figure 6: Process flow chart of hatchery operation (modified from Ahmed, 2005).

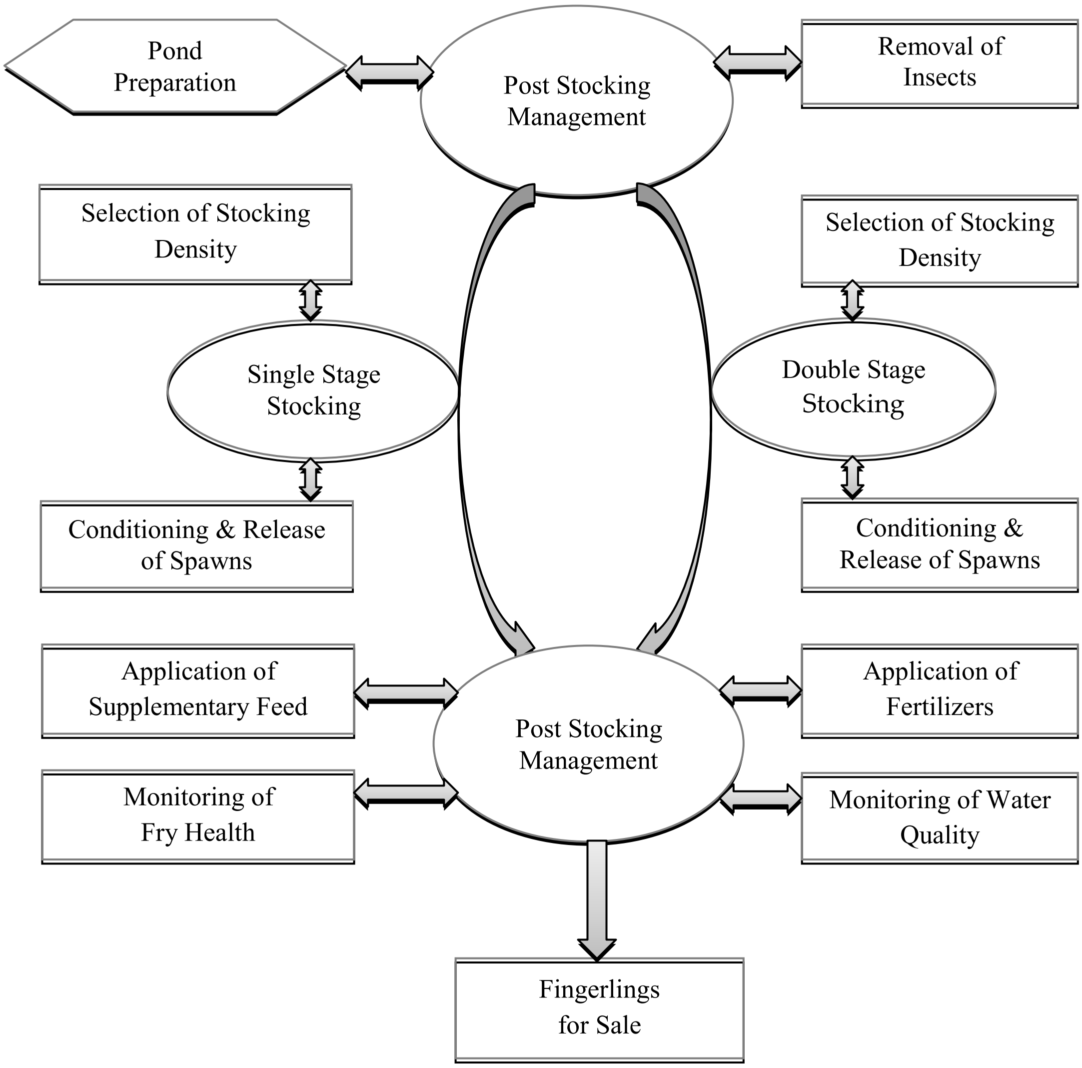

Figure 7: Process flow chart of nursery management

3.6 Analysis of environmental feasibility

The environmental considerations for establishing of the carp seed production farm were analysed using the information based on Draft FAO guidelines for aquaculture certification (FAO, 2008), DoF Proposed Guidelines on Genetic Improvement of Carp Seeds and Brood Stock Management (Khan, 2008) and Fish Hatchery Act 2010 (GoB, 2010). The possible impact of a carp seed production farm on surrounding environment was analyzed. On the other hand, environmental factors affecting the success of quality carp seed production were also considered during the study.

4 RESULTS

4.1 Cost estimation and main assumptions

Initially, the costs and assumptions for investment in a carp seed production farm are estimated on the basis of planned project dimension. It is assumed that the planned farm will be established in 10 hectares of land having 15 brood fish ponds of 0.5 hectare area each and 5 nursery ponds of 0.2 hectare area each. Besides, the farm will comprise of a hatchery complex and adequate infrastructural facilities. The costs involved with the establishment are divided into three groups such as investment costs, variable costs and fixed costs. Further, investment costs comprise of cost of buildings, equipment and others. Similarly, variable costs and fixed costs are also divided into different cost items. Then the most likely costs in the optimistic and pessimistic case for each item are assumed on the basis of reviewed (Chapter 2) quantity and unit price of items required for the establishment and operation of the farm. Finally, the costs of each item are estimated using the Three Point Method (Appendix 1). The estimation of building costs using Three Point Method is shown below:

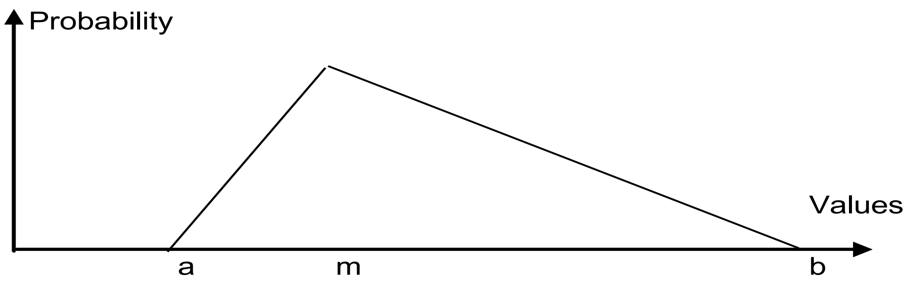

Figure 8: A beta probability distribution (or triangular) of cost estimation.

Here, the optimistic value of building is a=8.3 MBDT; the pessimistic value is b=11.5 MBDT; the most likely value is m=10 MBDT and at 95% confidence level, Z=1.65. Thus, the total expected value (t) of buildings is calculated as about 10 MBDT using the following formula:

$$t = \frac{8.3+4*10+11.5}{6} = 10 \text{ MBDT}$$

The variance of the buildings is estimated as 0.10, thus the standard deviation is the square root of variance, i.e. 0.31. Finally, the total building cost is calculated by adding the standard deviation multiplied by 1.65 with the expected value. It gives a higher value than the expected value, which is 10.5 MBDT. Similarly, other costs are estimated following the same method.

The results of the cost estimation are shown in Table 3. Other operational costs presumed are also shown in Table 4.

Table 3: Assumptions of investment and operational costs.

Item of Cost	Amount
Investment	
Buildings	10.5 MBDT
Equipment	2.0 MBDT
Other	0.5 MBDT
Variable Costs (MBDT/mt)	**0.50**
Labour	0.08
Suplementary Feed	0.35
Fertilizers	0.03
Inducing Agents	0.03
Chemicals	0.005
Other	0.005
Fixed Costs (MBDT/year)	**0.50**
Maintenance	0.25
Insurance	0.05
Management	0.1
Sales	0.05
Other	0.05
Financing	
Equity	30%
Loans	70%
Loan Repayments	6 Years
Interest	13%
Loan Management Fees	2%
Depreciation	
Depreciation Buildings	4%
Depreciation Equipment	15%
Depreciation Other	20%
Working Capital (MBDT)	**2.0**
Inventory (MBDT)-Brood Stock	**2.0**
Income Tax	**Nil**
Dividend	**20%**

Table 4: Other operational assumptions.

Components	Amount
Total Farm Area	10 hectares
A. Spawn Production	
Pond Used	15 Nos. (0.5 hectare each)
Total Brood fish used	15 mt
Stocking Density of Brood Fish	2 mt/hectare
Price of Brood fish (2-3 years old)	120 BDT/kg
Application of Supplementary Feed	2% body weight
Price of Supplementary Feed	25 BDT/kg
Spawn (2-3 days old) Production	> 50% body weight of female brood fish
Spawn (2-3 days old) Production	125 kg/week
Period of Production	10 months/year
B. Fingerling (3-5 cm) Production	
Pond Used	5 Nos.(0.2 hectare each)
Stocking with Spawn	5 kg/hectare
Fingerling (3-5 cm) Production	2.5mt/hectare/cycle
Length of Cycle	2 months
No. of Cycle	2 per year

4.2 Market plan

The market plan is anticipated on the basis of production capacity of the suggested farm and the existing price of carp seeds reviewed in Chapter 2. Finally, the sales and prices are presumed for the five production years and are shown in Table 5.

Table 5: Market plan of sales and revenues from 2011 to 2015.

Item	Year of Operation				
	2011	2012	2013	2014	2015
Sales of Spawn (mt)	4	5	5	6	6
Price (MBDT/mt)	2.0	2.5	2.7	2.0	2.0
Sales of Fingerling (mt)	5	5	5	5	5
Price (MBDT/mt)	0.2	0.2	0.2	0.2	0.2
Average Revenue (MBDT/mt)	**1.00**	**1.35**	**1.45**	**1.25**	**1.25**

4.3 Financial analysis

Financial analysis is an integral part of the feasibility study. The financial analysis of the proposed venture is performed using the Profitability Model which is a simulation model of an initial investment and subsequent operations. The main components of the model developed during the study are shown in Figure 4. Each element of the model is executed in a separate Excel sheet in the same workbook. The results of each component are shown in below.

4.3.1 Assumptions summary

The assumptions summary accumulates all necessary information and assumptions of the project estimated, which are needed for the financial feasibility. It is stated that all subsequent components are based on it and contain only formulas but no direct input cells at all. All input cells of the assumptions summary (Appendix 2) are coloured with blue. Assumptions generally comprise of sales and revenues (Table 5) and all associated expenses, such as investment costs, financing, working capital, taxes, depreciation rates, dividend payments (Table 3), variable and fixed costs (Table 3), the Marginal Attractive Rate Return (MARR) and equity of the project. The working capital, which is the capital needed to pay short-term debts and continue operations, which is 2 MBDT determined by looking at the cash account of the cash flow (Appendix 6) that cannot be negative. The MARR of the project, which is 10%, is determined on the basis of the inflation rate of Bangladesh. The summary also contains the planning horizon of the project. In this study, it is planned as 10 years. An additional assumption sheet has been used in the study case for details of Investment and Operational Costs (Appendix 1).

4.3.2 Investment and financing

The investment and financing component calculates the financial need of the venture, which includes the investment, depreciations and financing of the project (Appendix 3). First, there is the assumed breakdown of the investment cost into buildings, equipment and other investment. The investment, which is copied from the assumptions summary and estimated as 13 MBDT in the year of establishment, 2010, which will reduce up to about 6.5 MBDT in 2020 due to depreciations. Depreciation is calculated mainly with the purpose of getting an accurate estimate of income tax. The equity is determined as 30% of the total project financing, which is 15 MBDT, whereas loans comprise 70%. The loan is payable by 6 years with a year grace period. The interest of the loans is firmed as 13% on the basis of bank loan interest rate in Bangladesh with a loan management fee of 2%.

4.3.3 Operating statement

The operating statement (Appendix 4) represents the performance of the project in each period, i.e. it reveals the profit or loss generated by the project. The purpose of the component is to calculate the revenue and costs annually, which are then used to calculate the EBITDA (Earnings Before Interests, Taxes, Depreciation and Amortization), which is 2 MBDT in the first year of operation. EBT (Earnings Before Taxes) is then calculated as about 2 MBDT by subtracting interest expenses, depreciation and amortization from the EBITDA. In this case study, profit before tax is equivalent to profit after tax as aquaculture of Bangladesh is exempted from tax except corporation (NBR, 2010). In the case study, the total dividend, which is called appropriation of profit, is 20% of the profit after tax. Finally, the net profit is calculated as 1.5 MBDT after appropriation, which is added to the profit and loss balance on the balance sheet.

4.3.4 Balance sheet

The balance sheet (Appendix 5) gives a more complete picture to be able to follow the forecasted development, which includes total assets and debts and capital. In this case study, total assets is calculated as 15 MBDT in the year of establishment, 2010, and 57 MBDT in 2020. The debts and capital is also calculated as same as the total assets which verifies no logical errors. Thus, the balance sheet is used as a verification tool between total assets and total debt and capital. Moreover, financial ratios are also calculated on the basis of the data on the balance sheet, which are presented graphically in Figure 12, Figure 13 and Figure 14.

4.3.5 Cash flow

The cash flow (Appendix 6) represents the actual cash flows of the project, i.e. the incoming and outgoing flow of cash and cash equivalents to and from the farm respectively. The cash flow calculation originates with the operating surplus copied from the operating statement. Debtor and creditor changes are calculated on the basis of debtors and creditors on the balance sheet, giving cash flow before taxes. It is stated that debtor and creditor changes cannot be calculated until the balance sheet is ready. Cash flow after tax and before tax is equal as there is no income tax in the planned project. Then, free or net cash flow is calculated by subtracting interest and repayment. Finally, cash movements are found by adding working capital with net cash flow after paying the dividend. In the study case, the cash movement will be negative only in the first year of operation, i.e. 2011 but positive in the other years including the establishment year. The cash movement is the highest, which will be more than 6 MBDT, in the year of 2020. The cash movements are then added to the cash account on the balance sheet.

4.3.6 Source and allocation of funds

An alternative method of cash flow analysis is the "Source and Allocation of Funds" (Appendix 7). This approach comprises three sections: source of funds, allocation of funds and changes in net current assets. The first section represents the generation of cash from different sources such as operations, drawdown of loan and equity. The second section, allocation of funds, calculates the total allocation. Similarly, the final section, analysis of changes, includes current assets and liabilities. According to the analysis, the total funds for allocation is calculated as approximately 15 MBDT and the total allocation is 13 MBDT in the year of investment. Thus, changes in net current assets are estimated by subtracting the total allocation from the funds for allocation, which is about 2 MBDT in 2010. Likewise, changes in net current assets are computed by subtracting liabilities from changes in current assets, which is also approximately 2 MBDT in the year of investment. Thus, changes in net current assets are found to be similar in both methods of calculation for all the years of the project lifetime, which represents the accuracy of cash balance.

4.3.7 Profitability measures

The component profitability measures (Appendix 8) estimates the profitability of the investment. The most important measures used in this model are the Net Present Value (NPV) with a 10% discounting factor and the Internal Rate of Return (IRR). These measures are calculated for the following cash flow series:

i) Total Cash Flow and Capital
ii) Net Cash Flow and Equity

In general, both the total cash flow and capital and net cash flow and equity will increase up to 8 MBDT during the operation period (Figure 9). The total cash flow and capital will be negative only in the year of project construction, after that it will gradually increase up to 9 MBDT in 2013. After that there is a slight drop in the next year and then it remains constant at 8 MBDT for the rest of the operation period. On the other hand, net cash flow and equity will be negative in the year of farm establishment and the first year of production. After that it will moderately increase up to 8 MBDT in the year 2018 and will reach a plateau for rest of the project period.

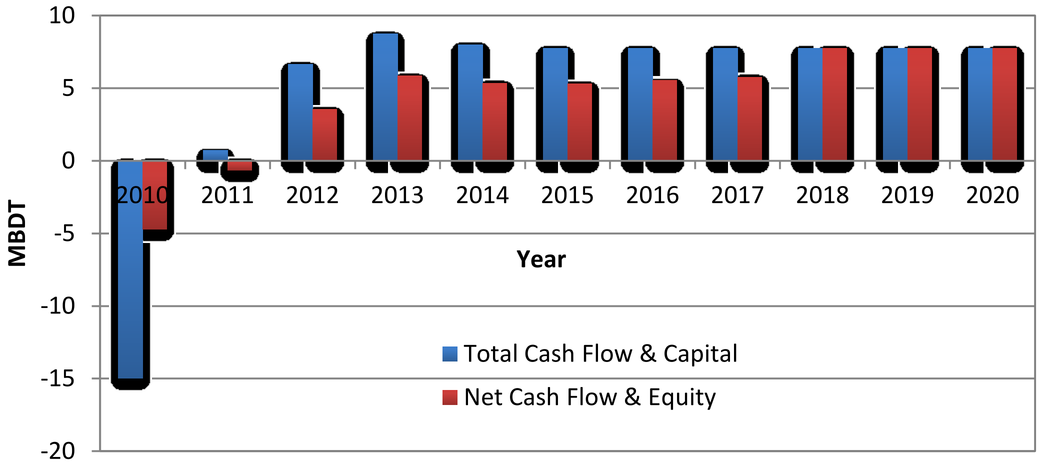

Figure 9: Cash flow series of a carp seed production farm from 2010 to 2020.

Net Present Value (NPV)

The NPV of total cash flow and net cash flow are measured with a 10% discounting factor for all the years of the project lifetime and the results are shown in Figure 10.

The NPV of total cash flow as well as NPV of net cash flow will rise steadily throughout the project lifetime (Figure 10). The NPV of total cash flow will be negative for the initial 4 years up to 2013 but it will gradually increase during the operation period passing parallel just over the NPV of net cash flow after 2016. The NPV of total cash flow will be at its maximum, which will be 26 MBDT, in 2020. On the other hand, NPV of net cash flow will be much higher than NPV of total cash flow in 2010, being negative up to 2012, but it will maintain a moderate growth to reach the highest value of 25 MBDT in 2020. As can be seen, the discounted payback period will be below 4 years on the basis of accumulated NPV of total cash flow.

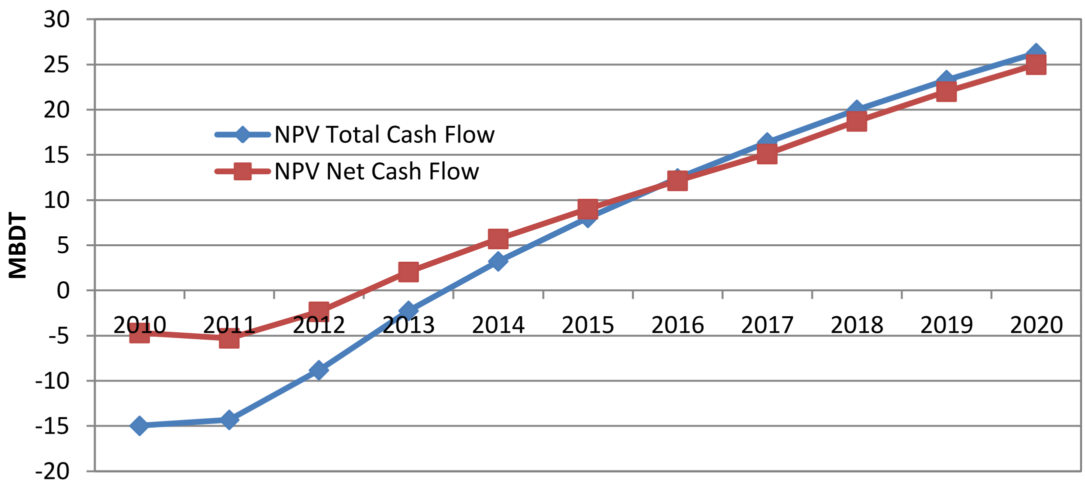

Figure 10: Accumulated Net Present Value from 2010 to 2020.

4.3.7.1 Internal Rate of Return (IRR)

The IRR of total cash flow and IRR of net cash flow are computed for the whole project period using Excel's built in IRR formula and the results are presented in Figure 11.

Both IRR of total cash flow and NPV of net cash flow will climb exponentially over the project period (Figure 11). No IRR of total cash flow will be found during the early 3 years up to 2012, but after that it will follow an increasing trend for the rest of the planned period to reach the maximum IRR of 37% in 2020. Likewise, IRR of net cash flow will be well over the IRR of total cash flow from the fourth year through the rest of the operation period. It will grow exponentially from 2012 having the highest value of 60% in 2020.

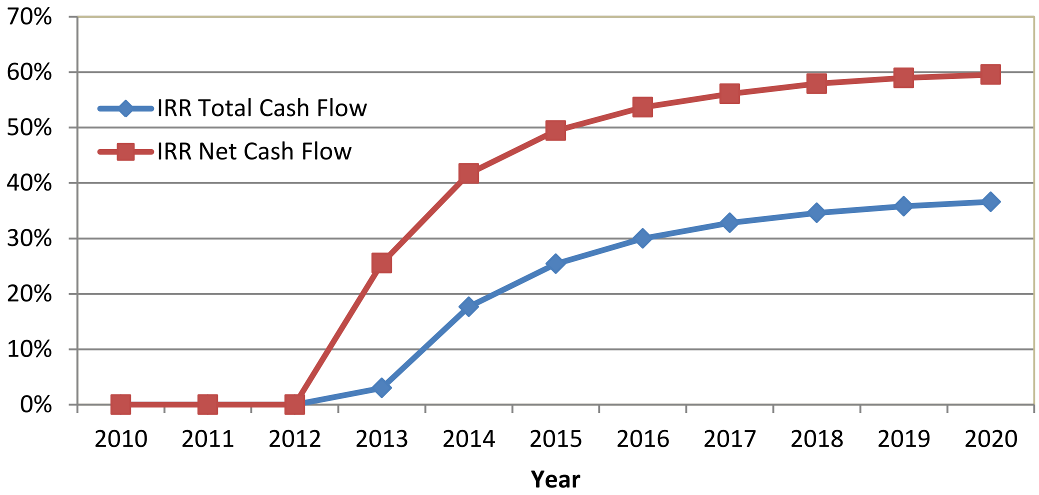

Figure 11: IRR of total cash flow and IRR of net cash flow from 2010 to 2020.

4.3.7.2 Financial ratios

Financial ratios are determined to assess the profitability and the risk of investment. The results of some important financial ratios are presented in Figure 12, Figure 13 and Figure 14.

In particular, the Liquid Current Ratio (LCR) gradually escalates throughout the operation life (Figure 12). LCR will be just over 1 in 2011, the first year of operation. Then it will slightly grow in the next 5 years to reach more than 6 in 2016. After that, it will rise gradually to reach the peak in 2020, which will be 21. In the instance of the study case, the acceptable minimum is decided as 1.5.

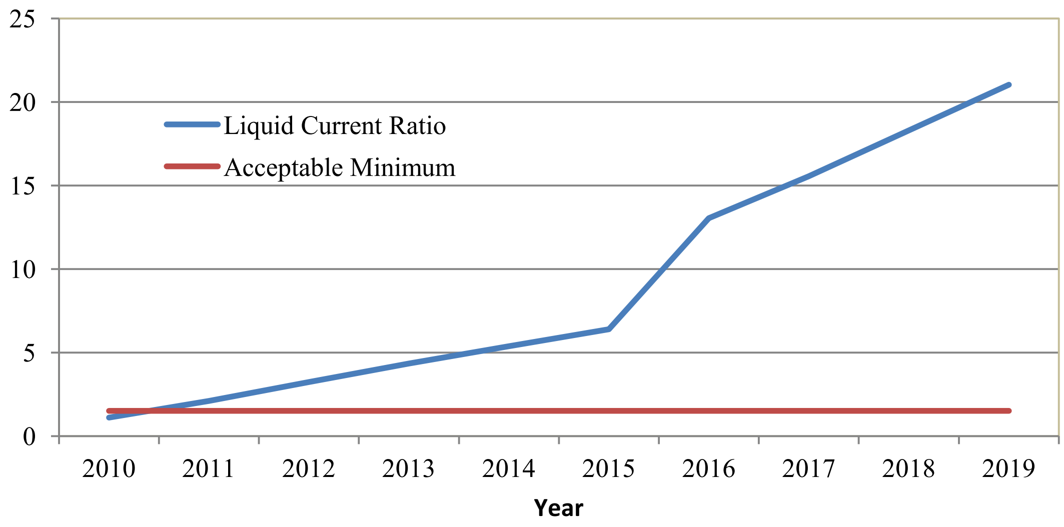

Figure 12: Cash flow ratios of the project from 2010-2020.

In general, the Debt Service Coverage Ratio (DSCR) will grow steadily but the Loan Life Cover Ratio will rise slightly during the operation period (Figure 13). DSCR will be only 0.5 in the first year of operation. Then it will gradually increase in the next 5 years to reach approximately 19 in 2016. After that, it will rise dramatically in the next year and will reach the maximum value of about 36. However, the Loan Life Cover Ratio will grow slowly from about 3 in 2011 to over 4 in 2016. In the case of the study, the acceptable minimum is also determined as 1.5.

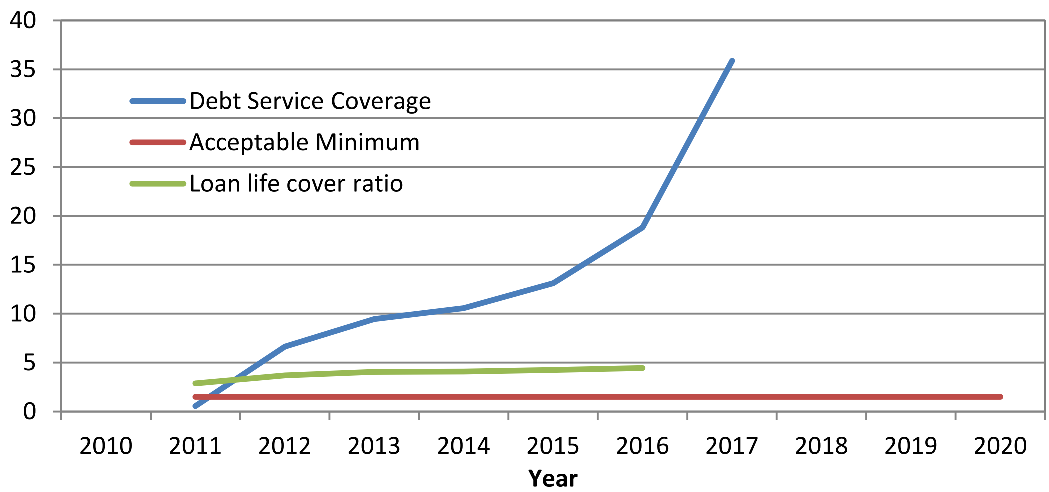

Figure 13: Cash flow ratios of the project from 2010 to 2020.

Generally, both the return on investment and the return on equity drop slightly during the operation period (Figure 14). Return on investment will be 22% in the first year of operation. Then it will moderately increase in the next year to reach approximately 41% in 2012. After that, it will fall slightly throughout the project life and will reach the minimum value of 14% in 2020. However, return on equity will be 42% in 2011. Then it will sharply increase in the next year to reach 101%. Later on, it will decrease steadily throughout the operation time and will reach the minimum value of 15% in the final year of the planning horizon.

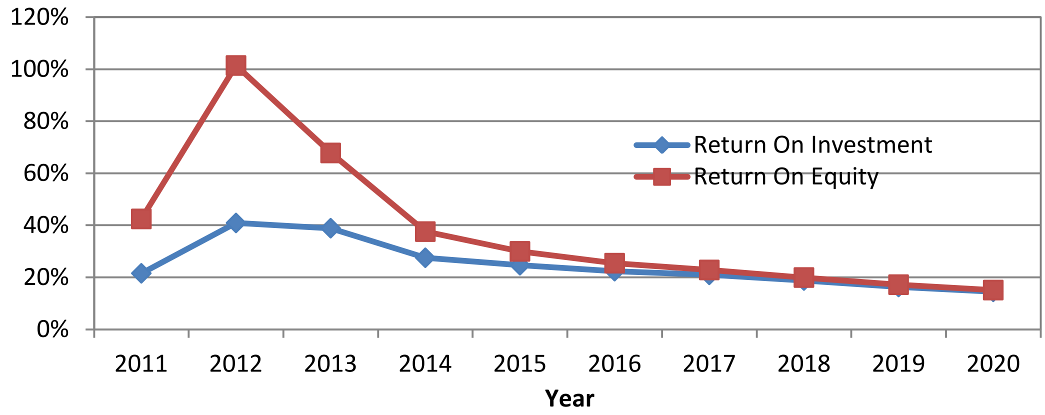

Figure 14: Return on investment and return on equity from 2011 to 2020.

4.3.8 Results and sensitivity

The last component, first presented in the assumptions summary (Appendix 2) of the profitability model, is the results and sensitivity. The component is incorporated so that it can be handed over to possible investors, financiers and others to offer an overview of the project. It presents all important indicators of profitability such as Net Present Value, Internal Rate of Return, External Rate or Modified Internal Rate of Return for both capital and equity and the Internal Value of Shares after 10 years, which is over 12 times. The colour code used for the results is yellow. The results also include the breakdown of costs, which is shown in Figure 15.

Normally, variable cost comprises the highest proportion of the farm costs. Variable costs occupied the highest value, which is 63%, followed by loan repayment, dividend, loan interest and fixed cost.

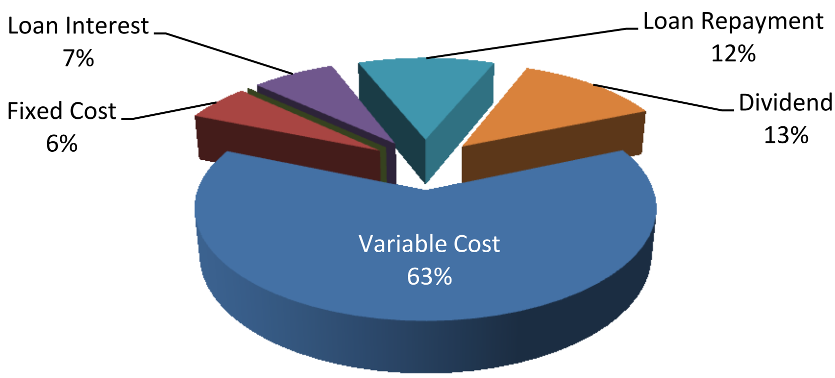

Figure 15: Breakdown of costs of a carp seed production farm in Bangladesh.

4.4 Risk analysis

Risk analysis was performed using three methods: impact analysis, scenario analysis and Monte Carlo simulation. The results of the sensitivity analysis are shown as follows:

4.4.1 Impact analysis

Impact analysis was accomplished using one uncertain item at a time, for example sales price, sales quantity, cost of equipment or cost of building. The results of the impact analysis for each of the uncertain items are shown in Figure 16.

Generally, the increase of sale price and production tends to increase the IRR of equity, but the opposite is true for the equipment and building costs (Figure 16). The calculated value of IRR of equity is 60%. In response to an increase of sales price up to 50% the IRR of equity grows up to 134%, and in response to a decrease of 40% it falls to 0%. As can be seen, the IRR of equity decreases up to 14% with the decrease of sales price by 30%. Similarly, in the case of production the IRR of equity rises to 101% in response to an increase by 50% and it drops up to 14% with a decrease of 50%. On the other hand, due to the increase of building costs up to 50% the IRR of equity goes down to 41%, and with a decrease of 50% it goes up to 93%. Likewise, in case of equipment, the IRR of equity drops up to 55% due to an increase by 50% and it rises up to 64% with a decrease of costs by 50%.

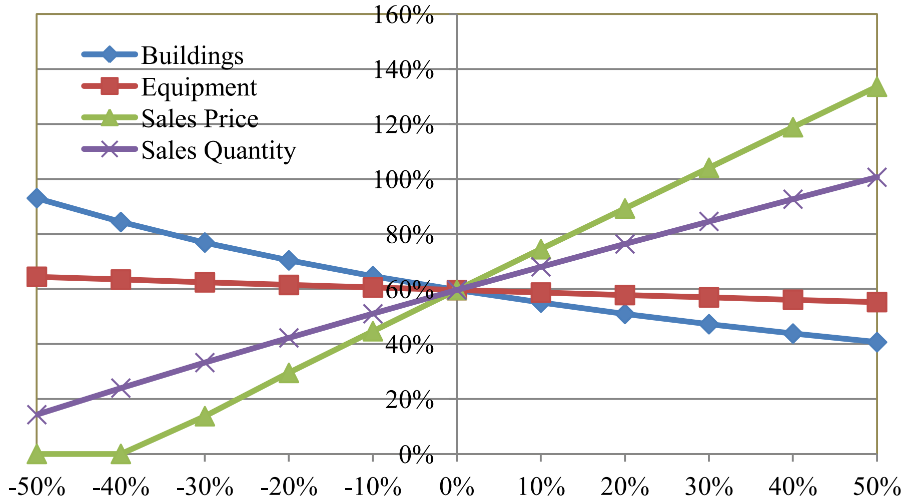

Figure 16: Impact analysis of IRR of equity.

4.4.2 Scenario analysis

Scenario analysis was done using the scenario manager of Excel's what-if analysis. Changing the cells and their values for each scenario, for example, the costs of buildings and equipment are calculated in the best case 80% of the base estimate but 120% in the worst case. Similarly, the values of sales quantity and sales price are calculated in the optimistic case 120% of the base estimate but 80% in the worst case. The results of the scenario analysis are shown in Table 5.

A decreasing trend of both NPV of equity and IRR of equity is usually observed in the worst case, but an upward trend in the best case (Table 5). The NPV of equity is found as 3 MBDT in the worst case, but 53 MBDT in the optimistic case, whereas the current value is 25 MBDT. Likewise, the IRR of equity is observed as 17% in the worst case, but 111% in the optimistic case, while the estimated value is 60%.

Table 5: Scenario analysis of NPV of equity and IRR of equity.

Scenario Summary		Current Values:	Worst Case	Best Case
Changing Cells:				
	Buildings	100%	120%	80%
	Equipment	100%	120%	80%
	Sales Quantity	100%	80%	120%
	Sales Price	100%	80%	120%
Result Cells:				
	NPV Equity	25	3	53
	IRR Equity	60%	17%	111%

4.4.3 Monte Carlo simulation

Monte Carlo simulation (Albright and Winston, 2009) was implemented by using the @Risk add-in to Excel software. In this case 1000 random distributions were used to analyse the risk of the project. The result was a histogram (Figure 17) of the IRR of equity. Further, sensitivity of all cost items was estimated by using correlation coefficients (Spearman Rank) through @Risk software and the result was a tornado graph (Figure 18).

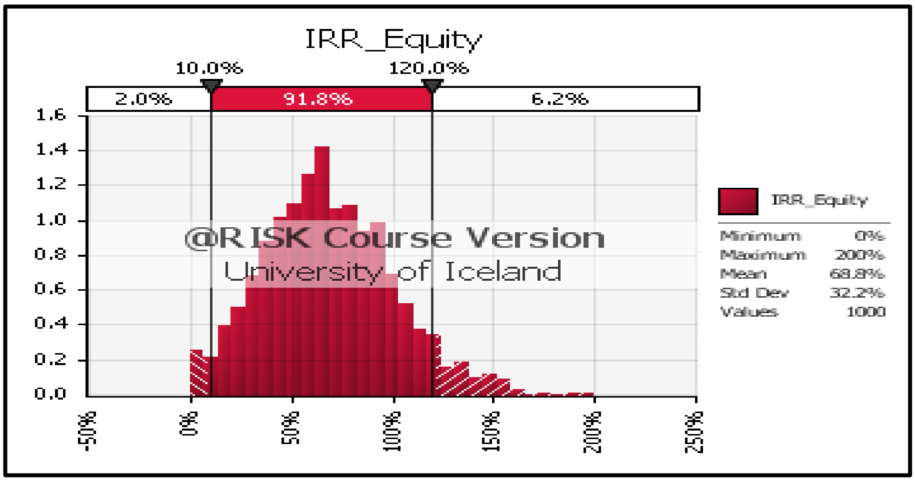

Figure 17: A histogram of IRR of equity.

Particularly, 98% of cases show the IRR of equity above the critical value, i.e. 10%. Alternatively, only 2% of cases demonstrate the IRR of equity to be less than the critical IRR (Figure 17). The coefficient of IRR of equity is highly positive in the case of sales price followed by production and fixed cost, but much lower in the case of variable cost followed by buildings, equipment and other costs (Figure 18). The results of the correlation coefficients indicate that the project is more sensitive to sales price followed by production.

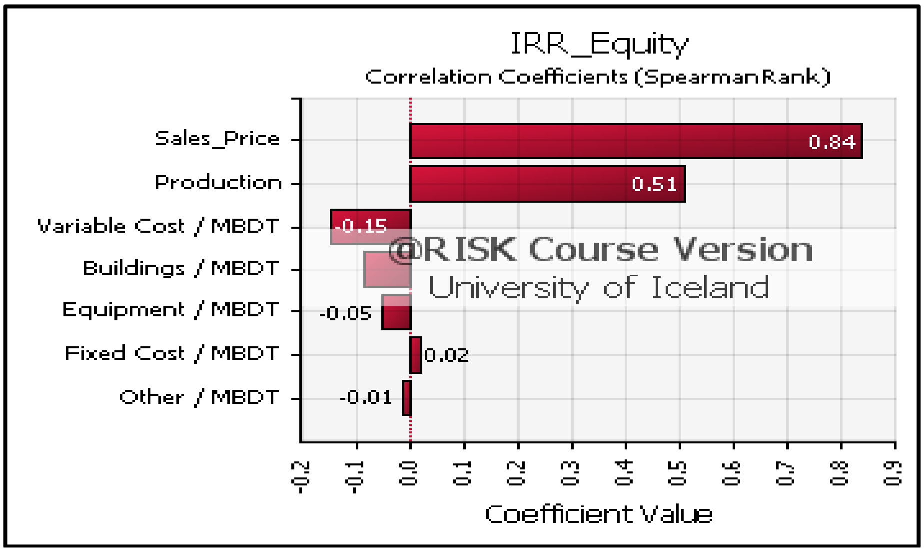

Figure 18: Correlation coefficients of IRR of equity.

5 DISCUSSION

5.1 Analysis of financial feasibility

As is commonly understood, financial feasibility analysis is an analytical tool used to evaluate the economic viability of an investment, which is often a predominant factor in feasibility analysis. It has been observed that financial feasibility evaluates the financial condition and operating performance of the investment and forecasts its future condition and performance (Fabozzi and Peterson, 2003). It has been realized from the results that the case study of a carp seed production farm in Bangladesh is financially feasible. This will be shown by analysing the results of the profitability analysis such as Net Present Value, Internal Rate of Return and financial ratios and the results of the risk analysis.

5.1.1 Profitability assessment

First will be considered **Net Present Value (NPV)**, which is the difference between the present value of all cash inflows and cash outflows associated with an investment. As it is observed in the case study, both the NPV of total cash flow and NPV of net cash flow will be positive (Figure 10). According to Park (2002), the decision rule for NPV is: NPV>0, meaning the investment is acceptable. It is further stated that a positive NPV means that the project has greater equivalent value of inflows than outflows and therefore it makes a profit. Besides, similar studies were performed by Togba (2008) for trawl fleet investment in Liberia, where a positive NPV was found and the project was recommended as acceptable. Further, Okechi (2005) studied the profitability of African Catfish farming in Kenya, where the project was reported acceptable on the basis of positive NPV. These examples clearly show that the proposed investment is acceptable on the basis of NPV.

Secondly, **Internal rate of return (IRR)** measures the level of annual return over the life of an investment. In the case study, IRR of total cash flow and IRR of net cash flow are 37% and 60% respectively (Figure 11). A somewhat lower IRR of total cash flow, which was 34%, was reported by Okechi (2005), but a similar IRR of net cash flow, which was 60%, was observed during the profitability analysis of African Catfish farming in Kenya. However, the investment policy usually defines a MARR, which is 10% in this case study. In that case the IRR and the MARR can be used to decide the project's feasibility. According to Park (2002), the decision rule for a simple project is: if IRR is greater than MARR, the project is acceptable. The central bank of Bangladesh, Bangladesh Bank, has set a criterion that the project has to offer a minimum IRR of 15% to borrow from the bank, but this study case offers a much higher IRR, which is acceptable for bank equity. Consequently, on the basis of the results of IRR the proposed investment in a carp seed production farm in Bangladesh is profitable to operate.

Thirdly, **financial ratios** are often use for analysing financial feasibility. The profitability ratios show the combined effects of liquidity, asset management and debt on operating results. Therefore, financial ratios that measure profitability play a great role in the decision making process (Park, 2002). However, the projected financial statements are used to calculate the relevant ratios in order to gain a better understanding of the performance of the project. Among the ratios the Liquid Current Ratio, Loan Life Cover Ratio, Debt Service Coverage Ratio, etc. are significantly considered in financial feasibility studies. As it is seen in this case study, the Liquid Current Ratio (Figure 12) will be approximately 21 in the end of planning horizon. As the Liquid Current Ratio is significantly greater than the Acceptable Minimum, which has been decided as 1.5, the investment is financially viable. Similarly, the Debt Service Coverage Ratio will be about 36 in the sixth year of operation. Moreover, the Loan Life Cover Ratio will be over 4 in the sixth year of operation. Both the Debt Service Coverage Ratio and the Loan Life Cover Ratio (Figure 13) in this case study are greater than the acceptable minimum which is defined as 1.5, which proves the acceptability of the project. Moreover, return on investment and return on equity in the last year of operation will be 14% and 15% respectively which is also acceptable. The return on equity also fulfils the requirement of Bangladesh Bank for lending equity by the investors, which is 15% (BB, 2003). When looking at these ratios, there is no doubt that the planned investment is profitable to operate.

Further, the **payback period** is another method which is sometimes used in financial feasibility analysis. The method determines when the project will break even, i.e. how long time it takes to pay investment outlays (Park, 2002). In this case study, the payback period is only 4 years which is lower than the payback period (8 years) calculated by Togba (2008) for the feasibility study of trawl fleet investment in Liberia. A similar payback period of 4 years was estimated by Okechi (2005) during the profitability analysis of African Catfish farming in Kenya. Thus, the quick payback period implies low risk in the investment. However, the method does not measure profitability that is made after paying back the initial investment. The method also ignores all revenues and cost after the payback period and the time value of money. This example makes it clear that the project is feasible in terms of payback period.

Lastly, the NPV and IRR methods can rank projects differently and assume reinvestment is always possible at the discounting rate or IRR, respectively. However, the **Modified Internal Rate of Return (MIRR)** is a measure that avoids these problems and provides a different and more accurate measure of financial feasibility (Kierulff, 2008). The MIRR method is almost identical to the internal rate of return method, but it does not assume that all cash flows are reinvested at the calculated IRR, but it assumes that all cash flows will be reinvested at another rate, i.e. an external rate of return (Remer and Nieto, 1995). In this study, MIRR or external rate of return is calculated as 22% of the capital and 31% of the equity, which are also higher than the critical IRR, 10%. It is clear when looking at the MIRR that the farm is profitable to operate. From this it can be concluded that the project is quite feasible to undertake an investment based on the Modified Internal Rate of Return.

5.1.2 Risk analysis

Risk or sensitivity analysis was performed during this study using impact analysis, scenario analysis and Monte Carlo simulation.

Impact analysis was executed using one uncertain item at the time, for example, sales price, sales quantity, cost of equipment and cost of building (Figure 16). The calculated value of IRR of equity was found to be 60%, and it was decided that IRR of equity 10% is critical, i.e. values under this threshold are not sufficient. In response to an increase of sales price up to 50% the IRR of equity grows up to 134%, and with a decrease of 30% it falls to 14%, which is also acceptable. Similarly, the IRR of equity rises to 101% in response to a 50% increase and with a 50% decrease of production it drops up to 14%, which is also acceptable. According to this analysis, a decrease in sales price of more than 30% can result in an unacceptable IRR. From this discussion it is clear that the profitability of a carp seed production farm is sensitive to the sales price followed by the production.

Scenario analysis was performed using the Excel scenario manager with changing cells selected and their values for each scenario. The results of the optimistic and pessimistic cases are shown in Table 5. The NPV of equity and the IRR of equity was found to be 53 MBDT and 111% respectively in optimistic case, which is acceptable. In the worst case, the NPV of equity and the IRR of equity was found to be 3 MBDT and 17% respectively, which is also acceptable. When looking at this example there is no doubt that the planned project is financially viable to operate having almost no risk.

Monte Carlo simulation is well suited for project risk assessments, especially for risky projects. When the risk is high and the cost of failure is very expensive, it is extremely important to have as much information as possible before making a decision to enter into a project. The results of the simulation give decision makers a deeper understanding of the possible outcomes of the project, as the distribution of IRR helps to draw conclusions about the financial feasibility of the project (Albright and Winston, 2009). According to the Monte Carlo simulation (Figure 17), 98% distribution is above the critical IRR of Equity, which means that there is 98%

possibility of getting profit from the planned project. There is, however, only 2% probability of losing investment. Moreover, this simulation also shows that the investment is more sensitive to sales price followed by production (Figure 18).

After analysing the results of the profitability assessment and risk analyses it is found that the planned farm is profitable to operate but somewhat sensitive to sales price. As has been proven a carp seed production farm would be highly profitable to operate in Bangladesh.

5.2 Analysis of technical feasibility

Fisheries is a well-developed technology providing food and jobs for the ever-growing population of the world (FAO, 1995). This has been seen in fish breeding technology assisting rising aquaculture through supplying quality and high yielding seeds. It is found that carp breeding technology is a widely accepted science, which makes it technically feasible. This will be proven by analysing the possible outcome of the selective breeding programme, the scope of improvement of existing practices in different components of carp breeding technology such as brood stock management, hatchery operation and nursery management for the excellence of carp seed quality in Bangladesh.

First will be considered selective breeding programmes, which is a significant method for increasing yields and which has long-term benefits (Tave, 1995). Selective breeding programmes, for instance, have been undertaken by different countries to improve many economic traits (Reddy, 1999). In India, selective breeding work has been tested on Rohu, *Labeo rohita*, which offered an average of 17% higher growth per generation after four generations of selection (Mahapatra *et al.*, 2011). Similarly, an Atlantic salmon selective breeding programme was commenced in Tasmania for better growth traits, feed conversion efficiency and reducing the length of the production cycle. The growth rate was assumed as 10% per generation. Further, it was stated that the selective breeding programme in Norway reduced the period of Atlantic salmon 'grow-out' from 4 to 3 years (Elliott *et al.*, 2007). Moreover, a similar breeding programme is going on in Iceland for Atlantic salmon, Arctic char and Atlantic cod to achieve faster growth, later sexual maturity, higher resistance to diseases, higher survival rate, better flesh quantity, etc. These examples make it clear that selective breeding programmes can improve the quality of subsequent generations of fish, which makes the project feasible.

Second will be considered management of brood stock, which is considered to be the key success factor of induced breeding (Sarder, 2007). It is common that hatcheries use immature and under weighted fishes. Therefore, for brood, 2-3 years old fishes are recommended from natural source as well as from culture ponds (Sarder *et al.*, 2002), which can be collected from three river sources viz. the Halda, the Jamuna and the Padma of Bangladesh as well as from the public brood fish farm (Khan, 2008). On the other hand, pedigree recording is another essential task for success in improvement of carp seed quality, which is rarely observed in existing fish seed farms in Bangladesh. Therefore, brood stocks can be reared in species-specific ponds after marking and pedigree recording (Khan, 2008). To make the farm feasible, the appropriate density should be allowed with an equal ratio of male and female fishes during stocking and breeding, which will help to improve the quality of carp seeds (Islam, 2009). Moreover, the broods of most farms are not provided with a sufficient balanced diet which results in poor quality of seeds (Khan, 2008). So, the brood fish should be fed with supplementary feed with a 25-30% protein level (Sarder, 2007) at the rate of 2-3% body weight of brood fish stocked (May *et al*., 1984). Accordingly, brood fish can be developed in a proper way through correcting the existing practices. From this, it can be stated that brood stock technology will be quite feasible in Bangladesh.

Thirdly, the techniques followed in hatchery can affect the quality of spawns. For example, the facility of the carp hatchery is important for quality improvement. Most of the farms/hatcheries in Bangladesh are not running smoothly due to lack of adequate farm facilities including laboratory facilities. Therefore, a carp hatchery complex should be comprised of facilities for fish spawning, hatching of eggs, rearing of fish seeds and laboratory testing. Other examples of mismanagement of carp seed farms are improper selection of broods, non-selective hybridization, mating between close relatives, etc. (Khan, 2008). Consequently, the government sets criteria for fish seed farms that no hatcheries can apply the technique of hybridization except with government permission and initiative has to be taken during breeding to avoid inbreeding in fish through proper selection (GoB, 2010). The inducing agent is another factor which can affect seed quality. Prior to induced breeding, the required dosages of PG and HCG should be calculated in relation to body weight of brood fishes to be induced (Sarder, 2007). It is apparent that the planned hatchery management will be able to improve the quality of carp seeds by following better hatchery management techniques, and will be feasible in Bangladesh.

Finally, nursery management of carp spawns can also influence the quality of seeds. For example, the preparation and maintenance of nursery and rearing ponds is important to improve the survival rate, growth rate and health of fish fry (Jhingran and Pullin, 1985), which are not properly followed in most of hatcheries in Bangladesh (Khan, 2008). Only recommended poisons and insecticides with appropriate doses should be applied to avoid any adverse effect on seed quality. Natural food productivity using fertilizers also can improve the health and quality of seeds. The appropriate stocking density with non-competitive species can influence quality (Sarder, 2007). Further, the proper feeding of fish fry is vital for superiority. Fish seed should be provided with sufficient quantity of supplementary feed with all nutrients (Khan, 2008). It is obvious when looking at the management techniques that there is ample scope of upgrading seed quality by improving the existing management practices.

Following the analyses of benefits of selective breeding and the scope of development of management practices, the quality of carp seeds can be improved by avoiding inbreeding, negative selection and following appropriate management practices. It has now been shown that establishment of a carp seed production farm is technically feasible in Bangladesh.

5.3 Analysis of environmental feasibility

It is of concern today that the environment is continually affected by human activities, including industrialization, use of fossil fuels, deforestation, overexploitation of nature, etc. This can be seen in fisheries in growing aquaculture industries and overexploitation of natural aquatic resources. However, aquaculture, particularly a carp seed production farm, has little impact on the surrounding environment and is environmentally feasible. This will be shown by analysing the environmental factors affecting the farm's production and the farm management factors that affect the environment. A carp seed production farm can have almost no impact on the adjacent environment if it is properly managed.

Firstly, the success of a carp seed farm largely depends on the neighbouring environment where it is located. For instance, the quality of soil has direct influence on water holding capacity, turbidity and pH of water (Islam, 2009). Therefore, before hatchery construction launching, it is necessary to search for the subsoil water table during the dry season of the year and perform laboratory examination of the parameters of the water available at the site (Jhingran and Pullin, 1985). Even though Bangladesh is not very affected by draught, dry areas with low water retention capacity must not be selected as farm area. Further, the presence of predators and pathogens can also affect the fish seed production (Khan, 2008). Mostly forest, river/canal and swamp areas with high vegetation are the habitats of fish predators and pathogens, and should not be selected as a farm area. Moreover, all types of pollution such as water, air and sound pollution can adversely affect the production, the quality of brood, hygiene condition of hatchery, survivability and quality of seeds. Therefore, areas, particularly industrial areas, with pollution from industrial effluents, city sewage, waste dumping, etc. should be avoided as a farm area. By selecting an appropriate site for a carp seed farm, possible environmental impact can be avoided.

Secondly, certain farm management practices can cause probable harm to the environment, but appropriate farm management can prevent putting pressure on the environment. Generally, hatchery effluents consist of nutrient loads, sediment sludge and some chemicals. Good hatchery management practice will be able to improve effluent quality and reduce its volume and subsequently environmental impact. In general, most of the carp seed farms of Bangladesh prefer to breed Indian major carps and introduced carps as these fishes have no adverse impact to the environment (Khan, 2008). Moreover, each carp seed farm should have a combination of management, technical and supporting staff to operate the facilities. Proper design of a carp seed production farm is important for effective production and minimization environmental hazards. Besides, the design will be considered as a criterion for farm registration in Bangladesh (GoB, 2010). It is better to establish a design in consultation with an Aquaculture Specialist or Aquaculture Engineer. Potential injury of the environment can be evaded following proper farm management practices.

After analysing the areas of environmental factors affecting farm production and farm management practices affecting the environment, which are preventable through proper planning and good management practices, the carp seed production farm is found as relatively not harmful to environment. From this discussion it can be concluded that establishment of a carp seed production farm in Bangladesh is environmentally feasible. It is important that farm management always care for the environment.

6 RECOMMENDATIONS

The success and feasibility of a fish seed production farm in Bangladesh completely depend on continual production of quality seeds. Based on the outcomes of the study the following aspects are recommended:

i) It is obvious that the findings of the study should be proven through field implementation in reality.
ii) Similar studies on other components of fisheries companies/farms like shrimp farming, fish processing plants, fish feed industry, etc. should be conducted prior to investment avoiding possible loss or risk.
iii) Total Quality Management should be ensured in all stages of fish seed production for sustainability of the farm.
iv) Carp seed farm management is based on technical knowledge. Therefore, staff and employees related with seed production should be provided with training on new aquaculture technologies.
v) All fish seed farms should follow the rules of the Fish Hatchery Act 2010 enacted by the government of Bangladesh to improve the quality of seeds.
vi) It is expected that concerned parties will take necessary monetary steps in favour of quality carp seed production investment in Bangladesh.
vii) Linkage should be established among aquaculture producers, related organizations, industries and governments for sustainable development of aquaculture in Bangladesh.

7 CONCLUSION

Bangladesh fisheries are growing steadily offering employment, nutrition and economic development. Its aquatic resources are diverse. Initially, fisheries of the state were based on capture fisheries, which is now under threat due to natural and human interferences. However, aquaculture of Bangladesh is rising dramatically to meet the demand of the fast growing population of Bangladesh. In the beginning, aquaculture fully relied on naturallly sourced fish seeds, but is presently almost completely dependent on artificially sourced seeds. Due to unplanned breeding practices in hatcheries the quality of fish seeds, particularly carp seeds, falls rapidly resulting in poor performance in the culture system. Therefore, the demand of quality carp seeds is predominant. To overcome this problem, it is essential to establish quality breeding practices in new investment or existing farms. Consequently, this study attempted to answer the question, 'Is it financially, technically and environmentally feasible to establish a carp seed production farm to improve carp seed quality in Bangladesh?'

The study is based on secondary information which was collected from different printed and electronic sources. The collected information was reviewed to find the best breeding practices and the probable costs to implement the technology. Then the costs of investment and farm operation were assumed using the Three Point Method. These costs were then fitted in a Profitability Assessment Model, which consists of several components such as the assumption summary, investment and financing, operating statement, balance sheet, cash flow, profitability measures, graphs and charts, results and sensitivity. All the components of the model have been executed in separate Excel sheets but in the same workbook. The results for profitability show positive NPV based on 10% MARR, IRR of capital 37%, IRR of equity 60%, MIRR of capital 22%, MIRR of equity 31%, internal value of shares after 10 years above 12 times, financial ratios much higher than the acceptable minimum 1.5, which show that the proposed farm is financially feasible to operate. Moreover, there is 98% probability of profit with moderate sensitivity to sales price followed by sales quantity. Similarly, feasibility of the farm is analysed in terms of technology and environment. The analysis, based on existing selective breeding programmes, shows that there is significant possibility for the improvement of seed quality regarding growth rate, survival rate and fish traits. Alternatively, there is ample scope for improving existing management practices, which contributes to seed quality and mitigates environmental damage. Following the results of the analyses it can be concluded that the project is highly feasible to operate. As has been shown, the planned carp seed production farm is financially, technically and environmentally feasible in Bangladesh.

Even though the study is based on secondary data, the report will provide necessary information for new investors and for existing farm owners about the fundamental practices and the profitability of carp seed production farms. Consequently, culture of carps will increase due to the availability of quality carp seeds. It is predicted that new investments in carp seed production will also come forward to meet the rising demand of quality seeds. As a result, the production of aquaculture will be stimulated through continual supply of quality seeds. It is expected that the concerned departments of Bangladesh will extend necessary assistance and monitoring to increase fisheries production by improving the quality of fish seeds.

LIST OF REFERENCES

Ahmed, M. N. U. 2005. Fish Genetic Improvement and Brood Stock Management. Training Module. *Department of Fisheries*, Bangladesh. 112p.

Albright, C. S. and Winston, W. L. 2009. *Management Science Modeling*. Revised Third Edition. South-western Cengage Learning, Canada. 992p.

Akhtaruzzaman, M. (ed.). 2010. Monthly Economic Trends. *Statistic Department, Bangladesh Bank.* November, 2010. v. xxxv(11). [08.12.2010] <http://www.bangladesh-bank.org/pub/monthly/econtrds/econtrds.html>

Bangladesh Bank (BB) 2003. Equity and Entrepreneurship Fund Unit. *Bangladesh Bank*, Dhaka, Bangladesh. [01.12.2010] http://www.bangladesh-bank.org/aboutus/dept/eef/ eligibility.html

Bangladesh Bank (BB), 2010. Bank-wise Interest Rate Structure. Banking Regulation and Policy Department, Bangladesh Bank. [27.12.2010] <http://www.bangladesh-bank.org/pub/monthly/econtrds/econtrdsxv.pdf>

Davy, F. B. and Chouinard, A. 1981. Induced fish breeding in Southeast Asia: Report of a workshop held in Singapore, 25-28 November 1980. Ottawa, Canada, *Internationa Development Research Centre*, 1981.48 p.

Dey, M. M., Paraguas, F. J., Bhatta, R., Alam, F., Weimin, M., Piumsombun, S., Koeshandrajana, S. Dung, L. T. C. & Sang, N. V. 2005. Carp Production in Asia: Past Trends and Present Status. pp 6-15. In Penman, D. J., Gupta, M. V. And Dey, M. M.(eds.). Carp Genetic Resources for Aquaculture in Asia. *World Fish Center Technical Report* 65, 152p.

DoF, 2010. National Fish Week 2010 Compendium. *Department of Fisheries,* Ministry of Fisheries and Livestock, Bangladesh.120 p.

Elliott, N., Bennett, B. and King, H. 2007. An Atlantic Salmon Selective Breeding Program for Tasmania. [10.01.2010] http://www.csiro.au/files/files/p7hh.pdf

FAO, 2010. FishStat Plus - Universal software for fishery statistical time series. [04.01.2011] < http://www.fao.org/fishery/statistics/software/fishstat/en#1>

FAO, 2008. Technical Guidelines on Aquaculture Certification. *Food and Agricultural Organization*, Sub-committee on Aquaculture, Fourth session, Puerto Varas, Chile, 6 - 10 October 2008.

FAO, 1995. Code of Conduct for Responsible Fisheries. *Food and Agricultural Organization*, Rome, Italy. 1995. 41 p.

FSYB, 2010. Fisheries Statistical Yearbook of Bangladesh. *Fisheries Resource Survey System,* Department of Fisheries, Bangladesh. 26(1), 41p.

Fabozzi, F.J. and Peterson, P.P., (2003). *Financial management & analysis.* 2nd ed. New Jersey: John Wiley & Sons.

GoB, 2010. Fish Hatchery Act, 2010. *Bangladesh Gazette (additional number)*, Government of the People's Republic of Bangladesh (GoB). March, 2010.

GoB, 1997. Rule for the Conservation of the Environment 1997. *Bangladesh Gazette*, Supplementary Issue of 28 August, 1997. pp. 293-303

GoB, 1995. Bangladesh Environment Conservation Act, 1995 (Act No. 1 of 1995). *Government of the People's Republic of Bangladesh* (GoB).

Hamid, A. N. M. M. A. 2010. Production Plan 2010. Fish Seed Multiplication Farm, Netrakona, *Department of Fisheries*, Bangladesh. 15p.

Hofstrand, D. and Holz-Clause, M., (2009). What is a feasibility study? Iowa State University. [21 December 2010] <http://www.extension.iastate.edu/agdm/wholefarm/pdf/c5-65.pdf>.

Hussain, M. G. and Mazid, M. A. 2005. Carp Genetic Resources of Bangladesh. pp. 16-25. In Penman, D. J., Gupta, M. V. And Dey, M. M. (eds.). Carp Genetic Resources for Aquaculture in Asia. *World Fish Center Technical Report* 65, 152p.

ICIMFA, 2011. Selective Breeding - The Key to Sustainability in Aquaculture. *Icelandic Fisheries - The Information Centre of the Icelandic Ministry of Fisheries and Agriculture.* [16.01.2011] <http://www.fisheries.is/aquaculture/slective-breeding/>

Islam, M. R. 2009. Carp Breeding and Hatchery Management. Training Module. *Department of Fisheries*, Bangladesh. 152p.

Jensson, P. 2006. Profitability Assessment Model. In: Workshop on Fisheries and Aquaculture in Southern Africa: Development and Management. Windoek, Namibia. ICEIDA and UNU-FTP, August 21-24 2006.

Jhingran, V. G. and Pullin, R. S. V. 1985. A Hatchery Manual for the Common, Chinese and Indian Major Carps. *Asian Development Bank-International Center for Living Aquatic Resources Management*. Manila, Philippines. 191p.

Khan, M. M. R. 2008. Genetic Improvement of Carp Seeds and Brood Stock *Management. Strengthening Institutional Capacity of DoF Project*, Department of Fisheries, Bangladesh. 100p.

Khandaker, H. R.(Ed.). 2007. Prawn Culture Management. Freshwater Prawn Culture Extension Project, Department of Fisheries, Bangladesh. 80p.

Kierulff, H., (2008). MIRR: A Better Measure. *Business Horizons.* 51,pp. 321-329.

Mahapatra, K. D., Jana, R. K., Saha, J. N., Gjerde, G. and Sarangi, N. 2011. Lessons from the breeding program of rohu. *Development of Aquatic Animal genetic Improvement and Dissemination Programs: Current Status and Action Plans.* pp. 34-40.

Matson, J. 2000. Cooperative Feasibility Study Guide. United States Department of Agriculture. *Rural Business – Cooperative Service. Report* 58.24p. [21.12.2010] <http://www.rurdev.usda.gov/rbs/pub/sr58.pdf>.

May, R.C., Pullin, R. S. V. and Jhingran, V. G., (eds). 1984. Summary Report of the Asian Regional Workshop on Carp Hatchery and Nursery Technology. *ICLARM Conference Proceedings* 11, 38p. Asian Development Bank, Manila, Philippines and International Center for Living Aquatic Resources Management, Manila, Philippines.

NBR, 2010. Income Tax-At a Glance. Budget 2010-1011 Fiscal Year. *National Board of Revenue*, Bangladesh. [08.12.2010] <http://www.nbr-bd.org/incometax.html>

Okechi, J. K. 2005. Profitability Assessment: A Case Study of African Catfish (*Clarias gariepinus*) Farming in the Lake Victoria Basin, Kenya. The United Nations University-Fisheries Training Programme, Reykjavik, Iceland. 65p.

Park, C. S. 2002. *Contemporary Engineering Economics*. 3rd ed. Prentice-Hall. Inc., New Jersey, USA.

Reddy, P. V. G. K. 1999. Genetic resources of Indian major carps. *FAO Fisheries Technical Paper*. No. 387. Rome, FAO. 76p.

Rahman, S. S., Perschbacher, P., and Hussain M. G. 1987. A baseline survey of spawn buyers at the Freshwater Aquaculture Research Station hatchery, Mymensingh (Bangladesh). *Bangladesh Journal of Fisheries.*v. 10(1), pp.29-35.

Remer, D. S. and Nieto, A. P., (1995). A compendium and comparison of 25 project evaluation techniques. Part 1: Net present value and rate of return methods. *International J. of Prod.Econ*. 42, pp. 79-96.

Sarder, R. 2007. Freshwater fish seed resources in Bangladesh, p. 105-128. In: Bondad-Reantaso, M. G. (ed.). Assessment of freshwater fish seed resources for sustainable aquaculture. *FAO Fisheries Technical Paper.* No. 501. Food and Agriculture Organization, Rome, Italy. 628p.

Sarder, A. S., Azam, M. R. and Hossain, M. A. 2002. Private hatchery owners' perspectives on hatchery management in Bangladesh. pp. 77-81. In: Penman, D.J., Hussain, M.G., McAndrew, B.J. and Mazid, M.A. (eds.). Proceedings of a workshop on Genetic Management and Improvement Strategies for Exotic Carps in Asia, 12-14 February 2002, Dhaka, Bangladesh. *Bangladesh Fisheries Research Institute*, Mymensingh, Bangladesh.

Sattar, M. A. and Das, T. K. 2002. Broodstock management of Chinese carps and dissemination strategy at NFEP, Parbatipur. pp. 43-50. In: Penman, D.J., Hussain, M.G., McAndrew, B.J. and Mazid, M.A. (eds.). Proceedings of a workshop on Genetic Management and Improvement Strategies for Exotic Carps in Asia, 12-14 February 2002, Dhaka, *Bangladesh. Bangladesh Fisheries Research Institute*, Mymensingh, Bangladesh.

Sukumaran, K. K. 1985. Seed Production and Hatchery Management. In. Lecture notes on composite fish culture and its extension in India, *Corporate Document Repository, FAO*, India, Asia. [31.12.2010] <http://www.fao.org/docrep/field/003/AC229E/AC229E03.htm>

Tave, D. 1995. Selective breeding programmes for medium-sized fish farms. *FAO Fisheries Technical Paper*.No. 352. Rome, FAO. 122 p.

Togba, G. B. 2008. Analysis of Profitability of Trawl Fleet Investment in Liberia.*The United Nations University-Fisheries Training Programme*, Reykjavik, Iceland.65 p.

Ullah, S. M. M. 2010. Production Plan 2010 (Revised). Fish Spawning and Training Centre, *Department of Fisheries*, Raipur, Laxmipur, Bangladesh. 20p.

Woynarovich, E and Horvath, L. 1980. The artificial propagation of warm-water finfishes-A manual for extension. *FAO Fish. Tech. Pap.*, (201). 183p.

APPENDICES

Appendix 1: Estimation of costs

Investment Cost (MBDT)	Optimistic	Most Likely	Pessimistic	Expected Value	Standard Deviation	Variance	Cost at 95% Confidence level
Buildings	**a**	**m**	**b**	**t**	**s**	**v**	
Pond Construction	3.50	4.00	4.50	4.00	0.17	0.03	-
Hatchery Complex	4.00	4.50	5.00	4.50	0.17	0.03	-
Fence	0.80	1.50	2.00	1.47	0.20	0.04	-
Total Buildings	**8.30**	**10.00**	**11.50**	**9.97**	**0.31**	**0.10**	**10.50**
Equipment							
Pumps	0.80	1.00	1.40	1.03	0.10	0.01	-
Pipes	0.25	0.30	0.35	0.30	0.02	0.00	-
Oxygen Cylinder	0.03	0.04	0.05	0.04	0.00	0.00	-
Nets	0.02	0.03	0.04	0.03	0.00	0.00	-
Vehicles	0.30	0.40	0.50	0.40	0.03	0.00	-
Others	0.01	0.02	0.03	0.02	0.00	0.00	-
Total Equipment	**1.41**	**1.79**	**2.37**	**1.82**	**0.11**	**0.01**	**2.00**
Other Costs							
Design	0.03	0.04	0.05	0.04	0.00	0.00	-
Consultation	0.25	0.35	0.45	0.35	0.03	0.00	-
Licence	0.04	0.05	0.07	0.05	0.01	0.00	-
Total Other Costs	**0.32**	**0.44**	**0.57**	**0.44**	**0.03**	**0.00**	**0.50**
Variable Costs (MBDT/ton)							
Labour	0.06	0.07	0.08	0.070	0.00	0.00	-
Feed	0.32	0.37	0.46	0.377	0.02	0.00	-
Fertilizers	0.02	0.03	0.04	0.030	0.00	0.00	-
Inducing Agents	0.03	0.03	0.04	0.030	0.00	0.00	-
Chemicals	0.01	0.02	0.02	0.015	0.00	0.00	-
Other	0.01	0.01	0.02	0.010	0.00	0.00	-
Total Variable Costs	**0.38**	**0.53**	**0.57**	**0.461**	**0.02**	**0.00**	**0.50**
Fixed Costs (MBDT/year)							
Maintenance	0.15	0.20	0.25	0.20	0.02	0.00	-
Registration/Insurance	0.04	0.05	0.07	0.05	0.01	0.00	-
Management	0.08	0.11	0.14	0.11	0.01	0.00	-
Sales	0.03	0.05	0.07	0.05	0.01	0.00	-
Other Fixed Costs	0.04	0.05	0.07	0.05	0.01	0.00	-
Total Fixed Costs	**0.34**	**0.46**	**0.60**	**0.46**	**0.02**	**0.00**	**0.50**

Appendix 2: Assumptions and results

		2010
Investment		MBDT
Buildings	100%	10.5
Equipment	100%	2.0
Other		0.5
Total Investment		**13.0**
Financing		
Working Capital		2.0
Total Financing		**15.0**
Equity		30%
Loan Repayments		6 years
Loan Interest		13%

Discounting Rate	10%	MARR	
Planning Horizon	10	years	
	Total Capital	Equity	
NPV of Cash Flow	26	25	MBDT
Internal Rate of Return	37%	60%	
External Rate of Return	22%	31%	
Internal Value of Shares after 10 years	12.1		
Minimum Cash Account	1		

Operations		**2011**	**2012**	**2013**	**2014**	**2015**	
Sales Quantity	100%	9	10	10	11	11	ton/yr.
Sales Price	100%	1.0	1.4	1.5	1.3	1.3	MBDT /ton

Variable Cost	100%	0.5	MBDT/ton
Fixed Cost	100%	0.5	MBDT/year
Inventory Build-up		**2.0**	MBDT

Debtors (Accounts Receivable)	25%	of turnover
Creditors (Accounts Payable)	15%	of variable cost
Dividend	20%	of profit
Depreciations Buildings	4%	
Equipment	15%	down to 10% rest value
Other	20%	
Loan Management Fees	2%	
Income Tax	0%	

Breakdown of cost	**MBDT**	**Per cent**
Variable Cost	55	63%
Fixed Cost	5	6%
Income Tax	0	0%
Loan Interest	6	7%
Repayment	10	12%
Dividend	11	13%
Total	**88**	**100%**

Colour Code:

Blue: Assumptions **Yellow: Results**

Appendix 3: Investment and financing

Investment and Financing		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Investment:													
Buildings		10.5	10.1	9.6	9.2	8.8	8.4	8.0	7.5	7.1	6.7	6.3	-
Equipment		2.0	1.7	1.4	1.1	0.8	0.5	0.2	0.2	0.2	0.2	0.2	-
Other		0.5	0.4	0.3	0.2	0.1	0	0	0	0	0	0	-
Booked Value		**13.0**	**12.2**	**11.3**	**10.5**	**9.7**	**8.9**	**8.2**	**7.7**	**7.3**	**6.9**	**6.5**	-
Depreciation													
Depreciation Buildings	4%	-	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	**4.2**
Depreciation Equipment	15%	-	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	**1.8**
Depreciation Other	20%	-	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	**0.5**
Total Depreciation		-	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.7**	**0.4**	**0.4**	**0.4**	**0.4**	**6.5**
Financing:		**15.0**	-	-	-	-	-	-	-	-	-	-	
Equity	30%	4.5	-	-	-	-	-	-	-	-	-	-	
Loans	70%	10.5	-	-	-	-	-	-	-	-	-	-	
Repayment	6	-	0	1.7	1.7	1.7	1.7	1.7	1.7	-	-	-	**10.5**
Principal		10.5	10.5	8.7	7.0	5.2	3.5	1.7	0.0	0.0	0.0	0.0	
Interest	13%	-	1.4	1.4	1.1	0.9	0.7	0.5	0.2	0.0	0.0	0.0	**6.1**
Loan Management Fees	2%	0.2											**16.6**

Appendix 4: Operating statement

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Operations Statement													
Sales			9	10	10	11	11	11	11	11	11	11	**106**
Price			1.0	1.4	1.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Revenue			**9.0**	**13.5**	**14.5**	**13.8**	**13.8**	**13.8**	**13.8**	**13.8**	**13.8**	**13.8**	**133**
Variable Cost	0.5		6.5	5.0	5.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	**55**
Net Profit Contribution			**2.5**	**8.5**	**9.5**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**78**
Fixed Cost	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	**5.0**
Diverse Taxes	0%		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EBITDA/ Operating Surplus			**2.0**	**8.0**	**9.0**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**73.2**
Inventory Movement			2.0										**2.0**
Depreciation			0.8	0.8	0.8	0.8	0.8	0.7	0.4	0.4	0.4	0.4	**6.5**
Operating Gain/Loss(EBIT)			**3.2**	**7.2**	**8.2**	**6.9**	**6.9**	**7.0**	**7.3**	**7.3**	**7.3**	**7.3**	**68.7**
Financial Costs (Interest & Loan management fee)		0.2	1.4	1.4	1.1	0.9	0.7	0.5	0.2	0.0	0.0	0.0	**6.3**
Profit before Tax/EBT		**-0.2**	**1.8**	**5.8**	**7.0**	**6.0**	**6.2**	**6.6**	**7.1**	**7.3**	**7.3**	**7.3**	**62.4**
Loss Transfer	0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Taxable Profit		0	1.6	5.8	7.0	6.0	6.2	6.6	7.1	7.3	7.3	7.3	
Income Tax	0%	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Profit after Tax		**-0.2**	**1.8**	**5.8**	**7.0**	**6.0**	**6.2**	**6.6**	**7.1**	**7.3**	**7.3**	**7.3**	**62.4**
Dividend	20 **%**	**0.0**	**0.4**	**1.2**	**1.4**	**1.2**	**1.2**	**1.3**	**1.4**	**1.5**	**1.5**	**1.5**	**12.5**
Net Profit/Loss		**-0.2**	**1.5**	**4.7**	**5.6**	**4.8**	**5.0**	**5.3**	**5.7**	**5.9**	**5.9**	**5.9**	**49.9**

Appendix 5: Balance sheet

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Balance Sheet												
Assets												
Cash Account	0	2	1	4	9	13	17	21	26	32	38	45
Debtors (Accounts Receivable)	25%	0	2	3	4	3	3	3	3	3	3	3
Stock/Inventory	0	0	2	2	2	2	2	2	2	2	2	2
Current Assets		**2**	**5**	**10**	**15**	**18**	**23**	**27**	**31**	**38**	**44**	**50**
Fixed Assets		13	12	11	11	10	9	8	8	7	7	6
Total Assets		**15**	**18**	**21**	**25**	**28**	**31**	**35**	**39**	**45**	**51**	**57**
Debts												
Dividend Payable		0	0	1	1	1	1	1	1	1	1	1
Taxes Payable		0	0	0	0	0	0	0	0	0	0	0
Creditors/Accounts Payable	15%	0	1.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Next Year Repayment		0	2	2	2	2	2	2	0	0	0	
Current Liabilities		**0**	**3**	**4**	**4**	**4**	**4**	**4**	**2**	**2**	**2**	**2**
Long Term Loans		**10**	**9**	**7**	**5**	**3**	**2**	**0**	**0**	**0**	**0**	
Total Debt		**10**	**12**	**11**	**9**	**7**	**6**	**4**	**2**	**2**	**2**	**2**
Equity	0	4	4	4	4	4	4	4	4	4	4	4
Profit & Loss Balance	0	0	1	6	12	16	21	27	32	38	44	50
Total Capital		**4**	**6**	**10**	**16**	**21**	**26**	**31**	**37**	**43**	**49**	**54**
Debts and Capital		**15**	**18**	**21**	**25**	**28**	**31**	**35**	**39**	**45**	**51**	**57**
Error check		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Appendix 6: Cash flow

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Cash Flow EBITDA/ Operating Surplus	0	2.0	8.0	9.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	**73**
Debtor Changes	0	2.3	1.1	0.3	-0.2	0	0	0	0	0	0	**3**
Creditor Changes	0	1.0	0	0	0	0	0	0	0	0	0	**1**
Cash Flow before Tax	**0**	**0.7**	**6.6**	**8.7**	**8.0**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**71**
												0
Paid Taxes		0	0	0	0	0	0	0	0	0	0	**0**
Cash Flow after Tax	0	0.7	6.6	8.7	8.0	7.7	7.7	7.7	7.7	7.7	7.7	**71**
												0
Financial Costs (Interest)	0.2	1.4	1.4	1.1	0.9	0.7	0.5	0.2	0.0	0.0	0.0	**6**
Repayment	0	0	1.7	1.7	1.7	1.7	1.7	1.7	0	0	0	**10**
Free (Net) Cash Flow	-0.2	-0.6	3.5	5.9	5.4	5.3	5.5	5.8	7.7	7.7	7.7	**54**
Paid Dividend		0	0.4	1.2	1.4	1.2	1.2	1.3	1.4	1.5	1.5	**11**
Financing – Expenditure (Working Capital)	2	0	0	0	0	0	0	0	0	0	0	**2**
Cash Movement	1.8	-0.6	3.2	4.7	3.9	4.1	4.3	4.5	6.3	6.3	6.3	**45**

Appendix 7: Source and allocation of funds

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Source of Funds												
Profit before Tax	-0.2	1.8	5.8	7.0	6.0	6.2	6.6	7.1	7.3	7.3	7.3	62.4
Depreciation		0.8	0.8	0.8	0.8	0.8	0.7	0.4	0.4	0.4	0.4	6.5
Funds from Operations	**-0.2**	**2.6**	**6.6**	**7.9**	**6.8**	**7.1**	**7.3**	**7.5**	**7.7**	**7.7**	**7.7**	**68.9**
Loan Drawdown	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.4
Equity Drawdown	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.3
Funds for allocation	**14.8**	**2.6**	**6.6**	**7.9**	**6.8**	**7.1**	**7.3**	**7.5**	**7.7**	**7.7**	**7.7**	**83.9**
Allocation of Funds												
Investment	13.0											13.0
Repayment	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	0.0	0.0	0.0	10.5
Paid Taxes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paid Dividend	0.0	0.0	0.4	1.2	1.4	1.2	1.2	1.3	1.4	1.5	1.5	11.1
Total allocation	**13.0**	**0.0**	**2.1**	**2.9**	**3.2**	**3.0**	**3.0**	**3.1**	**1.4**	**1.5**	**1.5**	**34.5**
Changes Net Current Assets	**1.8**	**2.6**	**4.5**	**5.0**	**3.7**	**4.1**	**4.3**	**4.5**	**6.3**	**6.3**	**6.3**	**49.4**
Analysis of Changes												
Current Assets												
Cash at start of year	0.0	1.8	1.2	4.3	9.0	13.0	17.1	21.4	25.8	32.2	38.5	
Cash at end of year	1.8	1.2	4.3	9.0	13.0	17.1	21.4	25.8	32.2	38.5	44.7	
Changes in Cash	1.8	-0.6	3.2	4.7	3.9	4.1	4.3	4.5	6.3	6.3	6.3	44.7
Debtor changes	0.0	2.3	1.1	0.3	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	3.4
Stock Movements	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Changes in Current Assets	**1.8**	**3.6**	**4.3**	**5.0**	**3.8**	**4.1**	**4.3**	**4.5**	**6.3**	**6.3**	**6.3**	**50.2**
Liabilities												
Creditor changes	0.0	1.0	-0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Changes Net Current Assets	**1.8**	**2.6**	**4.5**	**5.0**	**3.7**	**4.1**	**4.3**	**4.5**	**6.3**	**6.3**	**6.3**	**49.4**
Error Check	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

Appendix 8: Profitability measures

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Profitability Measurements													
NPV and IRR of Total Cash Flow													
Cash Flow after Taxes		0	1	7	9	8	8	8	8	8	8	8	**71**
Equity		-4											
Loan		-10											
Total Cash Flow & Capital		**-15**	**1**	**7**	**9**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	
NPV Total Cash Flow	10%	-15	-14	-9	-2	3	8	12	16	20	23	26	
IRR Total Cash Flow		0%	0%	0%	3%	18%	25%	30%	33%	35%	36%	37%	
MIRR/External Rate of Return of total CF							20%	22%	22%	22%	22%	22%	
NPV and IRR of Net Cash Flow													
Free (Net) Cash Flow		0	-1	4	6	5	5	6	6	8	8	8	**54**
Equity		-4											**-4**
Net Cash Flow & Equity		**-5**	**-1**	**4**	**6**	**5**	**5**	**6**	**6**	**8**	**8**	**8**	**49**
NPV Net Cash Flow	10%	-5	-5	-2	2	6	9	12	15	19	22	25	
IRR Net Cash Flow		0%	0%	0%	26%	42%	49%	54%	56%	58%	59%	60%	
External Rate of Return of free Cash Flow							34%	34%	33%	33%	32%	31%	
Financial Ratios													
Return On Investment			22%	41%	39%	28%	25%	22%	21%	19%	16%	14%	
Return On Equity			42%	101%	68%	38%	30%	25%	23%	20%	17%	15%	
Turnover Ratio			61%	77%	69%	55%	49%	44%	39%	35%	31%	27%	
Current Ratio			33%	49%	64%	74%	82%	89%	94%	95%	95%	96%	
Net Current Ratio			1.8	2.7	3.8	4.9	5.9	6.9	13.9	16.4	19.2	21.9	
Liquid Current Ratio			1.1	2.1	3.2	4.3	5.4	6.4	13.0	15.5	18.3	21.0	
Internal Value of Shares			1.3	2.3	3.6	4.6	5.8	6.9	8.2	9.5	10.8	12.1	
Debt Service Coverage			0.5	6.6	9.5	10.6	13.1	18.8	35.9				
Acceptable Minimum			**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	
NPV of Future Cash Flow during loan life			30	32	28	21	15	8					
Principal of Loan			10	9	7	5	3	2					
Loan Life Cover Ratio			2.9	3.7	4.0	4.1	4.2	4.4					

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