AN EVALUATION OF SELECTED PILOT FISH HATCHERY OPERATIONS IN GHANA

BY

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A THESIS

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DEPARTMENT OF AGRICULTURAL ECONOMY AND FARM MANAGEMENT
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UNIVERSITY OF GHANA
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AUGUST, 1999

DEDICATION

Dedicated to

My daughters: El-Freda, Suzanne and Benigna

DECLARATION

I, Francis Kizito Yaw Amevenku, the author of this thesis, "An evaluation of selected pilot fish hatchery operations in Ghana", do hereby declare that with the exception of references to past and current literature duly cited, the entire research leading to this thesis was carried out by me at the Department of Agricultural Economy and Farm Management, University of Ghana, Legon. It is further declared that the research has never been presented either in part or in whole for any degree in this University or elsewhere.

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This thesis has been submitted for examination with our approval as supervisors.

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ABSTRACT

The failure of past attempts to develop aquaculture in Ghana has been of concern to many people. Relevant constraints identified included fmgerling shortages, low economic returns from the industry, inadequate tested extension messages among others. In recent years. The Water Research Institute and the Directorate of Fisheries have made some efforts to solve the immediate problems of inadequate seed supply and stunted growth of tilapia in ponds due to excessive reproduction. Pilot hatcheries were improvised from available facilities in Accra, Kumasi and Akosombo to produce the right age and quantity of fry/fmgerlings for fanners.

The objectives of this study are (1) To ascertain the viability of these pilot activities. *(2)* To propose viable option(s) built upon the above initiatives and (3) To contribute information on the economics of tilapia culture. Econometric models were estimated to assess technical and economic efficiencies of some beneficiary fanners. The Akosombo tilapia activities, showed signs of being financially/economically viable.

With regards to the Accra catfish activity sensitivity analysis revealed that, an increment of 10 per cent upon the current survival rate of 37 per cent could lead it to viability. However, at the same assumed improved survival rate, the Kumasi hatchery proved nonviable. Regression results showed that the experience of farmers, stocking density, quantity of manure and pond fertility levels significantly influenced tilapia output. Also, current rates of stocking and liming are below optimum levels.

Increased use of these inputs, as suggested by the input allocative efficiency criteria may not be realistic, given the subsistence nature of these farms. Assured availability of these inputs and cash are therefore, prerequisites to exploit further production and income from tilapia culture by farmers. Measures to encourage private fmgerling producers, strengthening of the requisite technical manpower in the country, regular training programs for farmers and the establishment of on-farm and on-station research programs to refine upon current practices are recommended.

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CHAPTER 1

INTRODUCTION

1.1. Background

The fisheries sub-sector, broadly categorized into marine and inland capture sources, contributes over 90 percent of local fish supply. Directly or indirectly, it provides livelihood for more than 2.2 million people and accounts for about 5 per cent of agriculture gross domestic production of the country (Institute of Statistical, Social and Economic Research, ISSER, 1997). Fish as a commodity is a major source of animal protein contributing about 60-70% of animal protein intake in the diet of many Ghanaians. Thus, the industry made up of fishing, processing, distribution and sales is a vital socioeconomic activity for many families and communities. Therefore, any situation which adversely affects fishing activity and eventually the availability of fish would be expected to have an effect on the entire population.

During the last three decades however, a number of events have influenced the sector such that the per capita fish consumption in the country which was estimated at 35kg/year at the time of independence had declined to about 20kg/year by the late 1980's and there is evidence of further decline (Ayinla & Denyoh, 1994). These developments are sufficiently important to warrant substantial changes in policy directions in the fisheries sub-sector. Notable among these are:

a. The realization that fish resources in both marine and inland waters are close to full exploitation, while population has been growing at approximately 3 per cent per annum (Balarin,1988; Loayza *et al,* 1993);

b. Serious overfishing of many commercial species as a result of free and open access or the absence of defined property rights and poor resource management (Loayza, 1992);

c. The continuing pollution of the general aquatic environment of the country (Biney, 1982);

d. The virtual collapse of the North West African Fisheries (from Morocco to Ghana) that used to serve the domestic market (SPORE *bulletin* No.63, 1996).

Fish imports over the period 1990-1996 have declined (Table 1.1) due probably to foreign exchange constraints. It appears from the Table that an increase in fish imports may not be a feasible alternative to address the shortfall in fish requirements. Given the present limitations on increasing production by capture fisheries as against a growing demand for animal protein, there is an increased awareness in the importance of aquaculture as an option for increasing fish supply.

Fish-farming an aspect of aquaculture has been practiced in most African countries including Ghana for at least four decades with virtually every system represented: rural pond production, integrated farming with poultry or animal husbandry, rice cum fish farming among others, with tilapia being the most cultivated species.

Table 1.1: Fish catch, imports and estimated consumption

Year	Local catch('1 000 metric tonnes)		Total	Imports	Available for consumption
	Marine	Inland			
1990	316	58	377	23	367
1991	290	57	347	27	344
1992	371	57	428	34	439
1993	319	52	371	30	383
1994	287	54	341	19	327
1995	336	55	391	2	na
1996	324	56	380	1	na

Source : Ministry of Food and Agriculture, Fisheries Directorate, 1998, Accra,

na = not availabe

Table 1.2 shows a compilation of national tilapia production figures of selected African countries during the period indicated. In general, a consistent rising trend in tilapia production could be observed for Benin, Cameron, Cote d'Ivoire and Niger and a decreasing trend in production for Burkina Faso, Central African Republic, Liberia and Togo. Whiles the rest including Ghana, experienced a decline followed by stagnation in production. In general it is obvious that tilapia production is assuming importance as an aquatic product for human consumption in these countries. Thus, seemingly easily understood and disarmingly simple, the idea of farming fish has almost been over-sold. Yet, the absence of clear policies has denied these countries even a nucleus of efficient small-scale producers while local economies and markets have been unable to sustain a mass of large-scale operators.

The concerns that led to a campaign in the early 1980's to popularize the practice in Ghana are still valid today as they were two decades ago. However, the implicit assumption that with increased interest and possible participation by farmers, the gap between fish needs and production would be bridged seems naive. The potency of any effort towards a sustainable growth and development of the industry would rest on the availability of reliable facilities and incentives.

Table 1.2: Production of tilapia from aquaculture (1985-1988)

Country	Species cultured
Benin	various tilapia
Burkina Faso	O.niloticus
Cameroon	various tilapia
Central African Rep.	O.niloticus
Cote d' Ivoire	O.niloticus
Gabon	various tilapia
Ghana	O.niloticus
Guinea	various tilapia
Liberia	O.niloticus
Niger	O.niloticus
Nigeria	various tilapia
Togo	O.niloticus

Source: FAO, 1990. Modified and updated by Pullin, 1991.

Production (' 000 metric tonnes)

1985	1986	1987	1988
11	15	14	17
43	40	36	7
91	87	96	116
283	190	85	77
559	503	648	740
2	3	3	2
321	225	270	297
2	1	1	0
8	6	3	2
7	8	14	16
4573	3274	3602	3962
30	9	9	5

In recent years, various plans have been formulated to improve operations towards increased production in the sub-sector. In the area of research for instance, several studies mainly biotechnical have been undertaken in the country. In a review of aquaculture research, Loayza (1992) indicated that the most important technological breakthrough during the few past decades had been the use of hormones to control breeding in many fish species. Worldwide this achievement has allowed spectacular increases in the supply of fish seed. Fish fry and fmgerlings are as essential to fish farmers as maize seed is to arable farmers. The availability of fish seed is therefore, a basic requirement in sustaining fish culture.

The culture of the African catfish *(Clarias gariepinus)* has been advocated since the early 1970's (De Kempe & Micha, 1974; Huisman, 1986; Haylor, 1992). However, due to difficulties encountered in producing catfish fmgerlings in tropical lacustrine environments, farmers interested in growing the fish resorted to the collection of small catfish from the wild at the end of the rainy season to stock their ponds. But these sources cannot be regarded as reliable since they remain erratic and vary from year to year. Consequently, the technically sound methods described by Viveen *et al,* (1985) are indispensable if catfish farming is to be programmed and commercialised in the tropics. Nevertheless, they are not necessarily feasible under local socioeconomic conditions (Middendorp, 1993). The dearth of economic information on fish hatchery operations therefore, remains a constraint to the effective establishment of fish hatcheries by private or corporate investors.

In the absence of hatcheries in the country to respond to the demand for fish seed even by the limited number of people engaged in various forms of the venture, productivity will definitely be low. Thus, the establishment of pilot fish hatcheries at Akosombo, Accra and Kumasi to produce fish seed for fish farmers is expected to program the production of the chosen species. The Accra, Akosombo and Kumasi hatcheries started their operations in 1993, 1996 and 1997 respectively. Other information on their performance, patronage and constraints are presented in Table 1.3.

Table 1.3: Statistics on the operations and constraints of the pilot hatcheries

	Accra	Kumasi	Akosombo
Year operations started	1993	1997	1996
Target (number of fingerlings per years)	180,000	100,000	100,000
Current level (number of fingerlings made available)	40,000	4,000	100,000
Average number of farmers requesting for fingerlings per year	21	40	50
Average number of fingerlings requested by each farmers	3,000	2,000	1,800
Shortfall in fmgerling production	20,000	76,000	nil
Constraints	Predation	Predation	Storms killing brooders.
	Cannibalism	Cannibalism	Chlorination
	Theft		

Sources: Fisheries Department, Ministry of Food and Agriculture (MOFA),

Water Research Institute (WRI), 1998.

The techniques being used in these hatcheries are aimed at producing monosex tilapia and catfish seed for farmers in an attempt to make the culture of these good food fishes, on commercial scales possible. This study is focused on the activities of the hatchery operators and in the case of the tilapia hatchery (Akosombo) a review of the activities of beneficiary farmers was undertaken.

1.2. Problem statement

Current fish requirements in Ghana, as estimated by the Fisheries Department is 600,000 metric tonnes per year, against an annual average domestic production of about 370,000 metric tonnes per year. Thus, leaving an unsatisfied demand of over 200,000 metric tonnes per year (Ayinla and Denyoh, 1994). These coupled with the fact that other sources of animal protein (mutton, pork, poultry, small ruminants beef etc.) are relatively more expensive make it imperative that measures be taken to increase fish supply so as to bridge the widening gap between supply and demand.

As our population grows whilst fish catches continue to dwindle alongside foreign exchange constraints, questions that should agitate the minds of policy makers in Ghana should include the following:

1. What has been the viability of government pilot fish hatcheries ?
2. What options need to be exploited to increase and sustain fish seed production ?
3. What socioeconomic factors have influenced the fish culture activities of the beneficiaries of the hatchery output ?

1.3. Objectives of the study

The general objective of the study is to review the operations of the hatcheries and the practices of some beneficiary farmers. The specific objectives include the following;

a. To ascertain the viability of the hatchery operations.

b. To offer investment options for hatchery establishment in the country.

c. To identify practices influencing the use of the hatchery product.

1.4. Relevance of the study

Attempts, in the past, to promote aquaculture research have stressed studies of biotechnical nature whose findings, although important for stakeholders are devoid of socioeconomic considerations. However, if the venture is to achieve widespread development, socioeconomic perspectives are needed to:

1. Complement biotechnical studies and thereby enhance incentives for the development of the practice;

2. Generate relevant data and information for researchers, extentionists, NGO's, and private entrepreneurs.

1.5. Organization of the study

The study is organized into six chapters. Chapter two briefly reviews some pertinent literature on the scope, nature and the economics of fish-farming enterprises, constraints to the development of fish-farming as well as the socioeconomic impacts of fish farming in Africa as a whole. Chapter three outlines the methodology adopted to accomplish the objectives of the study. Empirical results of the study are presented in chapters four and discussed in chapter five. Conclusions and policy recommendations are presented in chapter six.

1.6. Scope, study area and limitations of the study

The study concentrates on one aspect of fish farming (fmgerling production) which offers prospects for commercialisation. The fishes under focus are the relatively more familiar tilapia *Oreochromis niloticus* and catfish *Clarias gariepinus.* Other species like *Heterotis niloticus, Heterobranchus species* and Grey mullets *Liza species,* that also offer potentials for commercialisation have been excluded.

To accomplish the third objective of the study, two districts: Akwapim-North (Figure 1.1) and Kadjebi (Figure 1.2) were adopted. Within these locations beneficiaries of the Akosombo activity were comparatively well represented. There were however, 6 farmers (who although not located within these two districts) were included in the study because their locations were quite close to the Akwapim-North district coupled with the fact that they were regular beneficigries of the hatchery's output who kept useful records.

The major limitation of the study was the lack of pertinent production data to permit a thorough economic evaluation. Hence, the data and assumptions used were based mainly on interview results. Furthermore, catfish farmers who depended on the Accra and Kumasi hatcheries could not be included in the survey given their diverse distribution across the regions and the resources as well as time available for the study.

Figure 1*1 : Map of study area A (located within a portion of the Akwapim - North District!

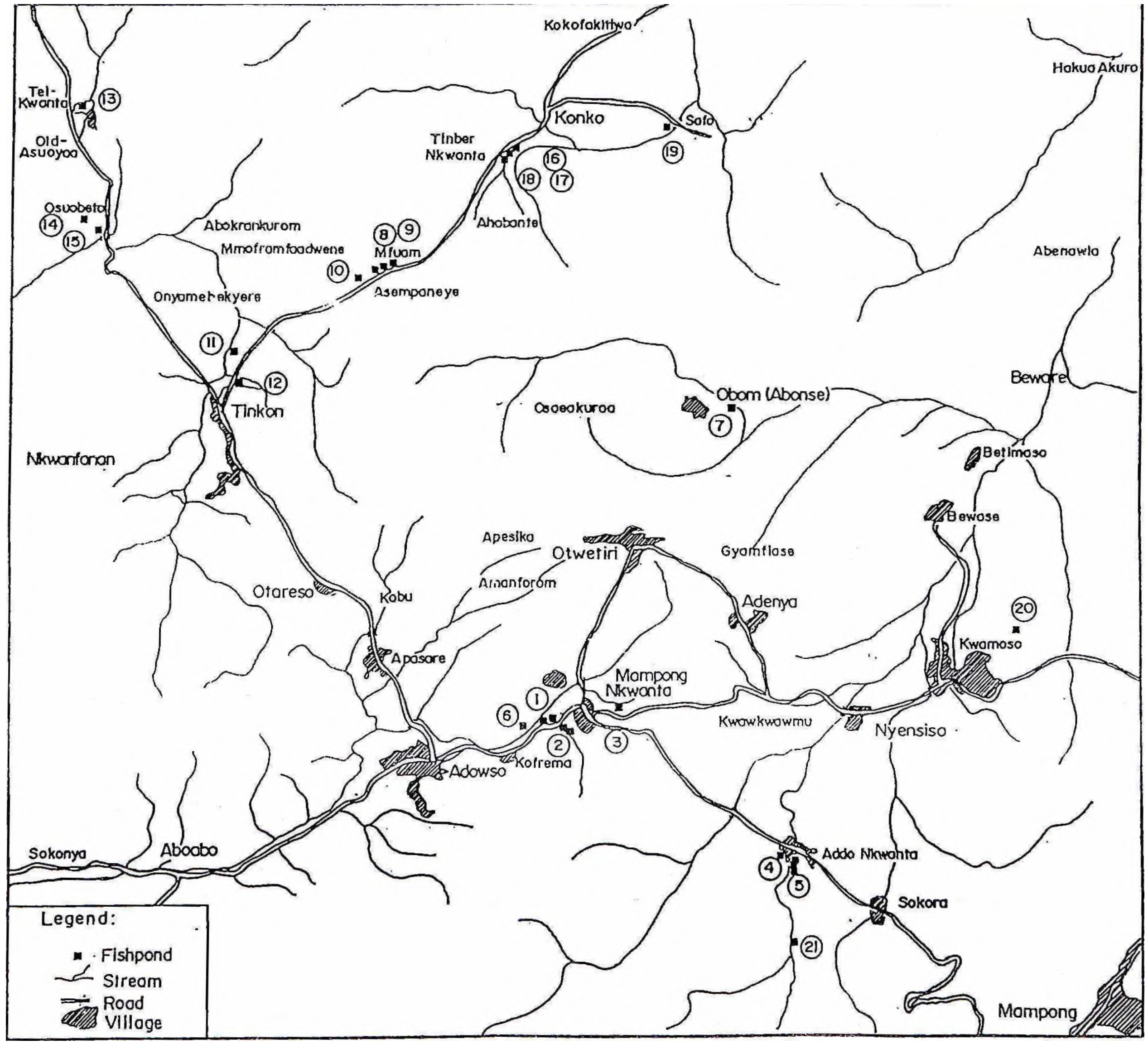
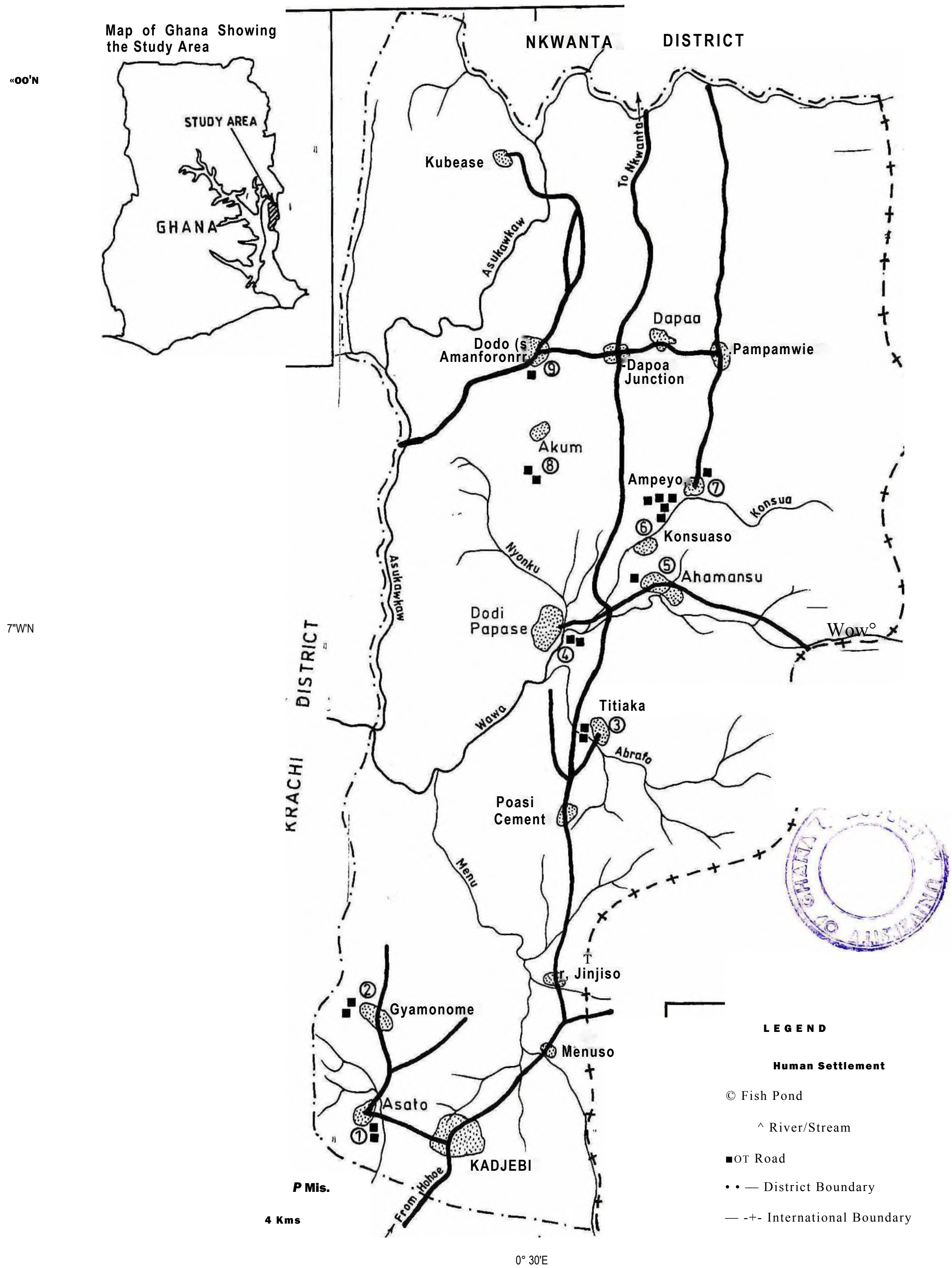


Figure 1-2: Map of Study Area B (Located Within the Kadjebi District).



CHAPTER 2

LITERATURE REVIEW

In this chapter, a review of some of the existing literature on the economics and social aspects of aquaculture is presented under the various sub-topics indicated.

2.1 Nature and scope of aquaculture enterprises

Fish farming, an aspect of aquaculture, is the application of biological principles to the business of producing fish. It is centuries old in Asia and other parts of the world but is a relatively new introduction in Ghana and Africa in general. The nature of aquaculture operations vary between countries, between types of culture and even between species cultivated (Bell & Canterbery, 1976) reflecting upon the nation's cultural preferences, environmental constraints and general economic conditions.

Pillay (1987) categorized the organization of fish fanning into two; small-scale rural fish farming and large-scale, often vertically integrated aquaculture. Although many small-scale fish farmers around the world undertake fish farming as a source of low cost protein, increasing evidence tend to demonstrate fish to be an important cash crop, even for limited-resource farmers (Engle, 1997).

In Ghana, the venture is being encouraged principally to (Council for Scientific & Industrial Research, CSIR, 1997):

(a) produce fish to supplement what is obtained from natural sources locally;

(b) increase the availability of fish, which is the main source of animal protein, in Ghana,

(c) provide new job opportunities to various people; (*Si I* ® j.i "|V_, ■/

(d) increase income generating activities of farmers; put some materials“iTsually considered as farm "wastes" into productive uses.

Consistent low yields is a major problem of many small-scale fish farmers in developing countries (Hishamunda *et al,* 1997). This problem plagues Ghanaian fish farmers as well and is embedded in production factors that act, directly or indirectly, in combination with management practices to influence yields. However, the rapid evolution of agricultural practices (Koffi *et al,* 1996) show the capacity of farmers to implement new systems of production. Actions seeking to mobilize this capacity of implementation must necessarily involve systematic research efforts on the efficient use of production factors. In this regard, economic considerations are essential in the selection of appropriate aquacultural options taking cognisance of their economic returns, efficiency, farmers' access to operating inputs, among others.

2.2. The economics of aquaculture

This is an area of increasing interest to fish farmers, researchers, extensionists, policy makers, non-governmental organization as well as governments all over the developing world. Although readily available information on this aspect is still limited, there have been a number of studies (Mitchell & Usry, 1967; Greenfield, 1970; Shang, 1972; Eng, 1973; Pillay, 1973; IPFC, 1975) that clearly show that, well-planned and properly-operated, aquaculture compares favourably with similar food production industries in respect of internal rates of return. For the newly established aquaculture industry in many countries, important economic concerns include the investment potential of new businesses, the need to understand trade and competition for markets and the identification of costs and benefits of fish farming to rural economies. In contrast to farming on land, however, aquaculture has a very poor grounding in economic knowledge. Neiland (1994) attributed this phenomenon to the relative youthfulness of the industry and the fact that development up to now has been technology-led. He identified pertinent issues in aquaculture economics as:

1. The need to clarify economic objectives in aquaculture to include among others, the efficient utilization of resources or the maximization of economic returns. An example of such an analysis of socioeconomic and social objectives in aquaculture in shrimp mariculture and policies for promoting the industry on a socially sound, technical and economically feasible basis, is provided by Bailey (1988).

2. The need to distinguish between financial and economic values in aquaculture and their derivation and analyses as provided by Gittinger (1982).

3. The need to utilise powerful tools outlined in economic analyses to assess the outcomes of allocating resources among different and often competing uses as described by

Edwards (1987) and the use of cost-benefit analysis (Neiland *et al,* 1992) to facilitate the choice between an aquaculture development and a competing project. At the project level, there is also the need for economic analysis to provide an appraisal framework for the evaluation of alternatives to enable a choice to be made between different cultivation techniques on the basis of the greatest financial/economic return.

The need to involve economists early in projects, preferably at the planning stage. Shang (1989) proposed the use of economic analysis at the experimental level in aquaculture if technologies to be transferred are to gain acceptance by farmers and entities interested in aquaculture.

The need for an integrated and multi-disciplinary approach to aquaculture project formulation especially those likely to impact on the commercial scene. This approach, (Insull & Nash, 1990) is being successfully employed in many countries across the globe.

The need to provide economic databases in aquaculture. Useful data for carrying out financial or economic feasibility studies cost-benefit analysis (CBA) for aquaculture ventures is not readily available. A change of approach is, therefore, needed (Shang, 1989).

The need to understand market behaviour, price formation and competition. Biotechnical research has focused on species observed to command high price. It is assumed, for instance, that at a commercial level of production, their high prices would ensure farm profitability.

Unfortunately, because the general understanding of price formation is limited for many aquatic products, such assumptions must be made with much care. There is, therefore, the need to investigate and forecast price changes under changing conditions of supply, demand, competition and market structures. Gibbs *et al* (1993) investigated price formation in the mussel sector and provided useful data for the planning and development of mussel projects.

The need to investigate the impact of changes in the wider economic environment. Shang (1990) emphasized the potential of aquaculture development in an economy as being determined by factors that are both internal and external to the economy. Thus, in an aquaculture project financial appraisal exercise, it will be appropriate to evaluate the impact of a range of factors on farm returns: for example, inflation, interest rate changes, changes in fiscal policy, license and permit fee, subsidies and grants, labour charges and changes in consumer activities.

Likewise for an economic evaluation, it is important to understand the relative economics of aquaculture versus other activities. Bom *et al* (1994) analysed macroeconomic factors influencing aquaculture production and the consequences of their results on policy and planning of future aquaculture development.

9. The need to incorporate economic issues into environmental impact studies. Soley *et al* (1995) have shown that economics can provide a unifying framework for the analysis of pollution problems, leading to well-defined objectives for corrective policy and the development of regulatory mechanism that are currently novel to the aquaculture sector.

Ru-feng Nu (1994) in considering the potential for enhancing fishery resources in Lake Tai, analyzed not only the traditional economics but also environmental (biological and non-biological) factors and socioeconomic factors in the light of systems economics. Shang (1990); Koffi *et al* (1996) observed that in the development of aquaculture, much attention has focused on biotechnical aspects. Economic research is often neglected. However, the importance of economic research has been gradually recognized. It is essential to evaluate the viability of investments in aquaculture, determine the efficiency of resource allocation, improve upon existing management practices, evaluate new culture technology, assess market potential and identify areas in which research in aquaculture can provide a basis not only for decision-making for fish farmers, but also for identifying research priorities and for formulating public aquaculture policies

2.3. Economic analysis of scientific results

Present aquaculture technology has been developed largely by trial and error rather than by scientific research (Shang, 1990). The productivity of existing resources can be increased through systematic research with a consequent increase in profitability. It is this dynamic element of constant improvement that provided the key to the development of agriculture, and it could also hold true for aquaculture.

Aquaculture is a multidisciplinary science that includes biology, engineering, nutrition, feed technology, genetics, economics among others. A wide spectrum of interrelated research is, therefore, required to develop an efficient system of operation and to improve upon existing management practices. Biotechnical research aims at improving production possibilities while economic research seeks to improve the profitability of operations. Thus, the avenue to explore seems to be the optimization of economic and biotechnical research already undertaken (Lazard, 1996). Most research in aquaculture aim at the establishment of viable operations; hence, economic research should play an important role in their development. Bardach *et al* (1972) cited examples to illustrate the dependence of aquaculture practice upon a large number of complex and interacting factors, often more sociological than technical, that are peculiar to a region of study and not unique to the individual enterprise. Thus, a blueprint of a profitable operation in one location is no guarantee for a successful application in another physical environment or in a different cultural or political setting. Environmental and socioeconomic conditions vary in different regions hence, a profitable technology in one region is no guarantee that it will be successful in another. Dittoh *et al* (1997) emphasize the importance of studies within local conditions to ascertain the economic viability of agricultural ventures. Shang (1990) advocates the use of economic analyses of developed technologies based largely on "artificial" data from experimental or pilot operations.

Much of the biotechnical research undertaken in the field of aquaculture aims to increase the productivity per unit area of water. The productivity per unit area from the biotechnical point of view, depends, mainly on the stocking rate, survival rate, and the average weight of the individual fish at the time of harvest (Ahmed *et al,* 1996). Stocking with the right number of fry or fingerlings and improving upon survival and growth rates are the primary means of maximising production of a given pond area (Van der Lingen, 1959). The fish pond can only support a certain quantity of fish because of the limited space and the amount of natural food available (Yashouv, 1959). This "carrying capacity" is affected mainly by soil conditions and the water quality of the pond. The carrying capacity can however, be increased partially through fertilization and/or supplemental feeding (Tang, 1970; Hepher, 1978). Consequently, an increase in production of a pond many times more than the natural condition could be realized (Shang, 1976).

Kawamoto (1957); Chiba (1965); Bardach *et al* (1972) mentioned polyculture, stock manipulation, aeration and running water systems as other measures of increasing the carrying capacity of a pond which ultimately result in increased fish production. Polyculture (stocking a number of species in the same pond) and stock manipulation (methods used to manage the fish in the pond such as monosex stocking), multistage stocking, double cropping and others, depend mainly on the compatibility and cost of fry or fmgerlings and the prices of fish. Increases in survival and growth rates are important factors in increasing production as mentioned earlier. However, the prevention of diseases and parasites, elimination of predator and competitors are also vital in ensuring increased yields. All these involve extra inputs and costs which must be analysed.

The measures mentioned above to increase the productivity of aquaculture practices have been developed in several countries on experimental or pilot scale. In some cases, additional inputs and costs e.g. labour and materials required for profit maximization and/or marginal analysis have been subjected to economic studies (Shang, 1989; Agbayani *et. al,* 1990; Cacho *et al,* 1990; Myers & Biosvert, 1990; Agbayani *et. al,* 1991). In one of such analyses, Shang (1989) determined that to a certain degree, different types of fertilizer, feed and pesticides are substitutable in aquaculture. The least-cost combination of inputs to produce a given level of output was found to occur when the marginal rate of substitution equals the inverse ratio of marginal input prices. The study also found that in the case of polyculture the profit maximizing combination of two or more species with given resources is achieved when the marginal rate of substitution equals the inverse ratio of their prices.

Consumer preference of tilapia in Ghana (Allotey & Abbey, 1996) offer opportunities for a rapid growth of commercial tilapia farming in some parts of the country just as it did in the Cameroon (Nji, 1991). To realise this however, the practice must be given a new impetus and made more attractive: improvements upon current practices in the industry are necessary. An increase in the demand for quality seed (fry and fmgerlings) for stocking ponds and other waterbodies is therefore, inevitable. Thus, the lack of suitable methods to mass produce fish seed remains a major constraint to the realization of the true potential as both a subsistence and commercial species in the country (Owusu-Frimpong, 1989). Studies elsewhere (PCARR, 1976; Radan, 1979; Guerrero 1980; 1981a) have outlined the major constraints as (1) supply shortage (2) high mortality of fmgerlings related to handling and transportation and (3) poor quality broodstock.

Considering that seed costs can range from 35-70% of total variable costs for tilapia production (Guerrero, 1981b), the ability of hatcheries to produce low cost, high quality fmgerlings would be an important element for the future success of farmers in the industry. In many countries with tilapia industries the trend is towards the establishment of large-scale centralized hatcheries which in addition to providing potential advantages of economies of scale, appear to be designed primarily to allow for the maintenance of high quality broodstock (Mires, 1982; Yater & Smith, 1985). The development of hypophysation technology had made possible the establishment of fish hatcheries and fish seed distribution centres where depending on the requirements of fish culturists, one or several fish species could be propagated (Woynarovich & Horvarth, 1980). In spite of the advantages of multispecies hatcheries over monospecies ones, there are many hatcheries devoted solely to the propagation of only one fish species. Tilapia hatcheries for example are devoted to the production of monosex seeds.

It has been mentioned in the introduction to the study that the culture of the African catfish *(Clarias gariepinus*) has been advocated since the early 1970's (De Kimpe & Micha, 1974; Huisman, 1986; Haylor, 1992). However, due to difficulties encountered in producing catfish fingerlings in tropical countries, interested farmers resorted to small catfish from the wild at the end of the rainy season to stock their ponds. These supplies remain erratic and vary from year to year. Consequently, the technically sound methods described by Viveen *et al* (1985) are indispensable if catfish farming is to be programmed and commercialised in the tropics. However, they are not necessarily feasible under local socioeconomic conditions (Middendorp, 1993). The dearth of economic information on fish hatchery operations therefore, remains a constraint to the effective establishment of fish hatcheries by private or corporate investors.

In La Cote d'Ivoire and Nigeria, corporate estates, as well as individuals with small-scale commercial farms generally operate semi-intensive systems for table fish production but prefer intensive management for seed production. In some cases, as in Nigeria, corporate bodies tend to specialize in seed or food production. It is worth noting that like Ghana, earlier attempts in these countries, especially by the public sector, generally did not maintain momentum, or even remain viable. Judging by the quality, interest and enthusiasm of present day operators, however, (the absence of research results on the economic evaluation of large-scale farms notwithstanding) their ventures at least seem viable. There are signs that, confidence in aquaculture as a sound long-term investment may be spreading (Satia, 1993). To accomplish a sound and an effective plan for national development, viable and appropriate investment projects capable of contributing to the national economy are essential. In this regard, social cost-benefit analysis have been advocated by a number of economists (Little and Mirrlees, 1969; Dasgupta, Marglin and Sen 1972; Shang, 1972; Harberger 1973; Squire van der Tak, 1975) for the appraisal of investment projects financed from public revenues. The methodologies dictated that since a project's benefit and costs occur at different points in time, they should be combined in some summary measure such as the project's net present value (NPV) or internal rate of return (IRR) :

measures that also interrelate a projects' technical, economic, financial, commercial, social and institutional aspects.

2.4. Socioeconomics of aquaculture

The promotion of aquaculture is retarded in Ghana by the lack of appreciation of social and economic aspects at all levels from the central government down to the farm household (Owusu-Frimpong, 1989). In particular, aquaculture needs to be recognized as an integral component of rural development programs if it is to address the major needs of poor small-scale fanners and consumers. Being an emerging industry, fish farming had attracted new entrants with little association with fisheries or farming (Pillay, 1992). There had been significant success, as well as dismal failures in the venture, causing major disappointment for those who expected to make fast profits, but sustaining those who recognized the inevitability of a learning phase. Many of the early attempts at fish culture were oriented to developing sport fisheries, and this continues to be so in some areas, however, the motive of commercial production is becoming more dominant.

Traditionally, in some countries: India, Malawi, Cameroon fish pond is a mark of social prestige (Nji, 1991). The "put and take fishing" or stocking waterbodies with young or adult fish for permitting recreational fishing on payment of an amount of money can be considered a modem commercialized version of this social practice (Pillay, 1992).

In many developing countries, the earlier attempts to develop small-scale fish farming were aimed at improving the nutritional status of rural populations. This objective was later enforced with the generation of rural employment to the eradication of poverty. Quantitative data on the accomplishment of these aims are not readily available, even though an appreciable number of mral people have found employment as owner-operators or wage earners on aquaculture farms. In many other countries including Ghana, it is not only peasants who have gone into aquaculture, but also people from more affluent sections of society. Molnar *et al* (1985) observed that spectacular development in the industry have been due to the resources and socio-political clout the latter have been able to exercise. They therefore, suggested that the participation or sponsorship by respected elites may serve to provide technical leadership, ensure good management and monitor the distribution of benefits in communal farming enterprises.

Pillay (1992) cited examples to illustrate the point that religious beliefs and practices have in many ways affected the development of aquaculture. His examples revealed that beliefs and practices either encourage or restrict the species that can be reared in certain areas for domestic consumption. Experiences in many developing countries seem to suggest that a reasonable cash income from the sale of produce is a major incentive for farmers, even though a part of the crop may be used for domestic consumption and thus contribute to the nutrition of family members. Available economic data, though limited, show that many farmers and farming groups have been able to achieve such incomes and improve their overall standard of living in a number of developing countries from appropriately planned and operated rural aquaculture projects. Aquaculture therefore, has a definitive role in managing social changes under certain special circumstances, and is likely to receive more prominence in the future with on-going socio-political transformation in some areas.

On the African continent although the concept of aquaculture is relatively a novelty, a number of studies (Pollnac, 1978; Grover *et al,* 1980; Nyman, 1980; Schmidt, 1982; Jhocson and Smith, 1985; Lazard *et al* 1988; Ali, 1989; Wijkstrom and Hans, 1989; Meltzhoff, 1990; Koffi, 1991; Nji, 1991; Satia, 1991; Van der Mheen, 1991) have expressed the need for aquaculture objectives to address conflicts associated with technology transfer, adoption vis-a-vis promoting rural development and environmental quality.

2.5. Indigenous knowledge and fish culture

Ngwarsiri (1995) used the term indigenous knowledge to distinguish between knowledge systems developed by a community and the international knowledge systems generated through universities, government research centres and private industries. He explained that in practical terms indigenous knowledge refers to "local knowledge", "location and culture specific knowledge" unique to a particular society or ethnic group to solve a particular problem taking into account all the local relevant factors. In the case of agriculture, indigenous knowledge is developed by farmers. The technology and knowledge is specific to the farm's environmental conditions and the farmers' need and it helps them to produce enough to feed their families and in many cases to provide surpluses for local markets. He however, cautioned that whilst the value of indigenous knowledge must not be underestimated it should not necessarily be considered more important than Western or international knowledge. Even when technologies will have to be imported cognisance must be taken of indigenous knowledge (Nketia, 1997). To ignore any of the two knowledge systems will be to exclude some knowledge that can be beneficial for the future of a community. However, neither indigenous knowledge nor international knowledge systems seem to be able to provide sustainable solutions to meet future demands. Both have their weaknesses, but by using the two in a complementary rather than competitive way, the best results can be achieved.

In order to do this effectively, there has to be a comprehensive information on the indigenous knowledge available to allow the relative strengths and weaknesses to be compared and contrasted with those of their global counterpart. Countries that include indigenous knowledge in their development planning derived many advantages, examples can be cited of Japan, China, Thailand and other Asian Pacific states. In addition to being an important first step to development, indigenous knowledge also empowers rural people to use their own knowledge to seek solutions to their problems. Used this way, indigenous knowledge will gradually convert rural people from receivers of development to participants in their own development (Johannes, 1981a). It is important to realize that being participants in development does not imply accepting without modification Western technologies. To achieve the best end results, a community can apply local knowledge and expertise to the problems and develop their own solution. This is also expected to increase their contribution and commitment to a project. Siar *et al* (1994) outlined reasons why researchers, development workers and policy makers must understand the indigenous knowledge shared by a particular community. They emphasized the need to research indigenous knowledge and retrieve it from communities as a means for unraveling the potential of indigenous knowledge. Pertinent to culture fisheries is their conviction that management would benefit from time-tested practices of fisher folks.

Johannes (1981b) stated that political, economic, culture and social dimensions of a fishery severely restrict the effectiveness of management programs based solely on the biology of the stocks. Thus, one must study fisherfolks as well as fish. Understanding their customary practices of resource allocation, for example, will help define the context to which biological information from farmers' experience, skills and know-how will be useful in comprehending the complexities involved before intervention measures and recommendations are designed.

CHAPTER 3

METHODOLOGY

In the present chapter an outline of the approaches used to achieve the objectives is presented. It draws on elements of Microeconomic theory of production, fisheries resource economics and spatial economic analysis.

3.1. Viability indicators

3.1.1. Tvnes and sources of data

To accomplish the objectives of the study, both primary and secondary cross-sectional data were used. In addressing the first and second objectives data was obtained using questionnaires (Appendix 1) and personal interviews of the pilot hatchery operators located in Accra, Kumasi and Akosombo. Data from the experimental results of the tilapia and catfish fingerling production operations of the Freshwater Fisheries and Aquaculture Research Programme/National Agricultural Research Project (NARP) were used to compute the various measures of investment worth employed.

Details of information sought are given in the questionnaires included (Appendix 2). Broadly, the data covered:

(1) Capital, equipment and operational costs

(2) Time allocation for the hatchery operations

(3) Technical data on the spawners, survival rate, number of spawning cycles per year as well as pricing of fmgerlings.

Inquires about actual prices in recent transactions and consultations with fish farmers, small merchants, importers, extension and research officials as well as published statistics formed data for other aspects of the analysis.

Data for the third objective was obtained from farmers who had benefited from the tilapia hatchery operations at Akosombo. A total of thirty-one (31) farmers responded to the questionnaires (Appendix 18) and interviews and their ponds were also inspected to obtain the requisite data. The farmers (Appendix 19) were drawn from six districts. For the purpose of this study, respondents within the portion of the Akwapim-North district (Figure 1.1) as well as those from Koforidua, Abor, Manya and Yilo Krobo districts were designated as being in area A while those within the Kadjebi district (Figure 1.2) constituted respondents in area B.

3.1.2. Types of analysis

To address the first objective and part of the second, historical data from the hatcheries were subjected to the analyses that follow: A 10 per cent annual price increase was adopted on market prices of equipment, materials, supplies and other inputs. The rate was based on the year-on-year non-food mean inflation sub-index of 10.3 per cent at the end of 1998 (Institute of Statistics, Social and Economic Research: ISSER, 1999; Centre for Policy Analysis: CEPA ,1999). A projection over a 10-year period (to cover the short to medium terms) was made for each hatchery. Discounted cashflows were then generated for each hatchery using a discount rate of 36 per cent (ISSER, 1999). From the resultant cashflows discounted measures of project worth were obtained

The algebraic forms used and interpretations follows:

t = n

a Jit

t=l (l+i) [1]

Benefit / Cost ratio

(B / C) t =n

t=l (l+i) [1] 3.1

Where

B_t = Value of fmgerlings sold to farmers in each year.

C_t = Cost of equipment and recurrent expenses incurred in each year and t = 1,2, ,n

n = number of years and

'i' = Discount rate.

The decision criterion of this measurement is that an investment with a B/C ratio > 1 is viable.

For each hatchery Net present value (NPV) was computed as:

t = n

S B_t - C_t / (l+i) ^{t}

t = l 3.2

The decision criterion being that if:

NPV >0 : investment would be profitable

NPV <0 : investment would not be profitable

NPV =0 : investment would be a break even situation.

Elsewhere in the study, internal rate of return (IRR), was calculated such that:

t = n

£ B_t - C t / (1 +i)' = 0... 3.3

t= 1

The decision criterion being that if the discount rate i is greater than the opportunity cost of capital, investment is considered viable. In addition Profitability index, a measurement of total cedis returned as compared to the total cedis invested was calculated for each hatchery operation adopting

Profitability index = Present Value of inflows^)

Present Value of outflows(jzS).. 3.4

after Viscione (1977).

The decision criterion being the higher the ratio, the better the investment. The financial and economic desirability of the operations were also evaluated using the payback period, defined as the time from the beginning of a project until the net (undiscounted) value of the incremental production stream totals the amount of the undiscounted investment of capital (Gittinger, 1982). The decision criterion being that the shorter the period, the better the investment.

3.2. Investment options

To facilitate the reader's appreciation of the cost and benefit elements involved in fish hatchery activities an introduction to the fundamental operations of a fish hatchery precedes the presentation of analysis used to address the second objective.

General aspects of fish hatchery operation:

The establishment of a fish hatchery requires the existence of certain basic factors. Some of these are listed below:

1. The choice of a suitable site
2. Adequate supply of water
3. Adequate supply of broodstock
4. Adequate experience of hatchery workers
5. Technological expertise
6. Effectiveness and efficiency of the hatchery design and
7. Constant and reliable supply of electricity.

Different authors propose different classifications of hatcheries but in general, they base their classifications on functional requirements as well as economic efficiency. The main determinants however, are target species, production target and level of financial inputs. The production of any chosen fish is determined based on market demand in addition to financial input before the hatchery is set up. In the study, although there was no econometric estimation of the market for fish fingerlings, it was assumed based on the outcome of interviews with the various hatcheries operating on pilot scales that there is a good market for the product.

In addition to the above requirements, a well-planned fish hatchery would be expected to have the following as major components:

1. Broodstock pond
2. Hatching facility
3. Nursery facility
4. Fingerling rearing cum production ponds.

3.2.1 Description of hatchery processes

(a) Tilapia seed:

Genetic sex in fish is determined at fertilization but sexual differentiation generally does not occur until after hatching. At this point modifications in development, in response to the genetic constitution of the embryo programme the primordial germ cells to become either ovary or testis (Shehadeh, 1973). Subsequently, with further growth of the gonads and the production of sex-specific steroid hormones, the fish undergo full maturation and realise their genetic sex (Shehadeh, 1973; Hilge 1975 and Rothbard & Pruginin, 1975). Fortunately for aquaculture, the sex-determining mechanisms in fish are extremely "labile[1] or malleable processes offering considerable potential for artificial manipulation (Sherperd and Bromage, 1992). The decision taken by the management of a hatchery regarding the sex of fish to produce would be determined by the economically desirable sexual maturation characteristics of the two sexes duringtheir growth cycle on the farm. Generally, tilapia farmers would wish toexclude female tilapiafrom their ponds. This is because females comparatively, grow five times slower than males (Rakocy and Mcginty, 1988). In addition, male monosex culture offers the advantage of higher stocking rates and shorter culture periods. These together lead to greater yield per unit area.

Figure 3.1 shows a flow chart of the masculinisation process. The process starts with the selection of suitable male and female breeders and placing them in breeder tanks at ratios of 1 male : 2 females. After about 2-3 months 'just-feeding' fry are seen swimming freely in the tanks. These are immediately collected with scoop nets and transferred into clean rearing tanks free from algal growth. Feeding with hormone incorporated diet begins immediately. The hormone employed is 17 a-methyltestosterone which is a derivative of the naturally occurring hormone testosterone. Dosages of the hormone for common commercial tilapias range from 30-60mg/kg food fed and for a treatment duration of 25-60 days from first day of feeding (Sherperd and Bromage, 1992).

Trials conducted in Ghana, on *Oreochromis niloticus, Sarotherodon galilaeus* and *Tilapia zillii* indicated that best results were obtained using *O. niloticus* (Owusu-Frimpong *et al* 1991). Hence, for commercial purposes sexually undifferentiated first feeding fry of the species must be available in large numbers if they are to be predictably, successfully and economically treated. Guerrero *et al* (1984); Popma and Green (1990) outlined suitable methods for the harvesting and treatment of first-feeding fry from tanks and ponds on commercial basis.

(b) Induced spawning of catfish:

The African catfish present the problem of being unable to reproduce easily in captivity. Hence, there is an acute shortage of its seed for farming. Consequently, ponds are grossly understocked with the species. Therefore, the techniques for artificially inducing reproduction of spawners and the growing of fry under hatchery conditions, schematically shown in Figure 3.2 was received with optimism, in countries with set objectives to develop the industry (Viveen *et al,* 1986).

Figure 3.1: Masculinisation of tilapia fry

Selection of breeders

£

Collection of sexually undifferentiated first feeding

fry from broodstock holding facility

£

Transfer to concrete tanks

Masculinisation of fry with diet incorporated with

17 a- methyltestosterone

■& **30-60 days**

Monosex tilapia fmgerling

Figure 3.2 shows the steps involved in the hypophysation process that leads to the production of catfish fmgerlings. Suitable males and females are collected from broodstock ponds. Females with soft bellies are often matured for the purpose. These are stocked without food for about 36 hours in a container. Pituitary extracts are then obtained from other females or males freshly killed. The female spawners are then injected with the extracts and placed back in the container. Viable eggs are then obtained from females that have responded to the treatment after 12 hours. During this latency period, milt from male spawners are obtained by sacrificing the fish and removing the testes. After the latency period, the females are stripped during which eggs run freely from their bellies. Artificial fertilization of the eggs is then carried out and the fertilized eggs incubated. Larvae that emerge after 20-57 hours are reared on live brine shrimp, Artemia for about 2 weeks and weaned (Viveen *et al,* 1986). Owusu-Frimpong *et al,* (1991) observed the completion of the above process in Ghana, within 12-14 days. Subsequent rearing of fmgerlings to grow-out stages required 4-5 weeks.

Figure 3.2: Induced spawning of catfish

Selection of breeders

£

Injection of female breeders with fish pituitary extract

£

stripping

£

Fertilization

V

Incubation and hatching

£

Larval rearing on Artemia

■a

Weaning from live food

$

Catfish fingerling.

To address the objectives on investment options, two scenarios are proposed as follows:

Option one: a solely private approach

The hatchery activities being proposed in this section was postulated with the private sector in view. Thus, it was considered as a purely private entity with little or virtually no direct government involvement. The physical infrastructure of the proposed hatchery was assumed to be suitably sited (in accordance with the requirements outlined above) on a leased land where ponds and a working shed are constructed. Whilst offices, stores and others are housed in a rented premise. The operation of the hatchery was assumed based on a 2-shift, 12-hour per day, 7-day per week and a 32-week per year working regime. The remaining time would be used for maintenance, rearing broodstock, holidays, cleaning and repairs of equipment.

3.2.1. Types of analysis

Based on the experimental data presented in Table 3.1 the average survival rates of 36.7 per cent (up to nursery) for catfish and 60 per cent for tilapia (Table 3.1) and an annual estimated fingerling production capacity ranging from 906,500 to 2,719,500 for catfish (Table 3.2) and 624,000 to 1,248,000 for tilapia (Table 3.3) could be expected.

Table 3.1: Technical data from experimental results of the pilot hatcheries

	Catfish			Tilapia
	Accra	Kumasi*	Akosombo**	Akosombo
1. Number of spawners	82	15	32	160
Male : Female ratio	2:01	2:01	1:01	1:04
2. Estimated number of eggs per spawning fish	114,000	46,000	156,000	1,500
3. Frequency of spawning per fish per year	2	3	2	8
4. Survival rate (from fertilization to nursery)	0.5	0.05	0.55	0.7
5. Period of availability of fmgerlings	April-January	April-October	April-November	J anuary-December

Source: Water Research Institute(WRI) and Fisheries Department(FD), 1998.

* Only one year data was available.

** Owusu-Frimpong *et al,* 1991(IAB/IDRC)

Table 3.2: Projected catfish fingerling production for the proposed solely private hatchery development option

Years	1	2	3	4	5	6	7	8	9	10
'lumber of spawners	50	100	150	200	200	200	200	200	200	200
Estimated number of eggs/fish/season	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000
fertilization rate	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Number of fertilized eggs	1,225,000	2,450,000	3,675,000	3,675,000	3,675,000	3,675,000	3,675,000	3,675,000	3,675,000	3,675,000
Survival rate (from fertilized egg to nursery stage)	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Frequency of spawning/fish/year	2	2	2	2	2	2	2	2	2	2
Number of fingerlings/year	906,500	1,813,000	2,719,500	2,719,500	2,719,500	2,719,500	2,719,500	2,719,500	2,719,500	2,719,500

Source: Water Research Institute (Akosombo and Accra). Department of Fisheries (Accra and Kumasi),1998.

Table 3.3. Projected tilapia fingerling *(Oreochromis niloticus)* production for the proposed solely private hatchery development option

Years	1	2	3	4	5	6	7		8	9	10
Number of spawners	200		300	400	400	400	400	400	400	400	400
Estimated number of fry/fish/spawning	1,300		1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Survival rate (from fertilized egg to nursery stage)	0.6		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Frequency of spawning/fish/year	4	4	4	4	4	4	4	4	4		4
Number of fmgerlings/year	624,000		936,000	1,248,000	1,248,000	1,248,000	1,248,000	1,248,000	1,248,000	1,248,000	1,248,000

Source: Water Research Institute (Akosombo and Accra). Department of Fisheries (Accra and Kumasi), 1998.

Enumeration of costs

To provide the prospective investor with an idea of the magnitude of the financial cost involved, the experimental data above were updated and used to estimate total capital investment, operational, depreciation and production costs. Annual depreciation on a salvage value of zero, was computed by the straight line method (Viscione, 1977; Peters and Timmerhaus, 1980) based on the estimated economic lives of the various items, equipment and structures. In determining the cost of fmgerlings to the operations of the proposed hatchery, the estimated annual operating cost plus a 20 percent mark-up running from year 1 to year 10 was used.

Estimation of revenue

It was assumed that there exited an unsatisfied demand for both tilapia and catfish fmgerlings. Annual income from the operation was estimated according to the production expected from both species. The selling price of both tilapia and catfish were conservatively fixed at one hundred and fifty cedis (0150) per fingerling and an annual price increase of 10 percent was assumed in the projected cashflow. Cost-revenue analysis was used to determine the return on investment (ROI) as the ratio of net benefit to the total value of investment (Agbayani *et al,* 1991).

Profit strategies

In examining the financial consequences of pricing, cost changes and profitability (Selvavinayagam, 1991) break-even analysis was undertaken using the relation:

Break-even quantity of fingerling = TFC/C.. 3.4

Break-even sales value of the above = [TFC X TS]/ TC.. 3.5

Thus, giving the break-even price as equation 3.5/equation 3.4

Where TFC is the total fixed cost,

C the contribution per fingerling,

TS the total sales of fmgerlings and

TC the total cost of production.

Sensitivity analysis using increasing mortality rates ranging from 10 to 25 per cent for both the catfish and tilapia fmgerlings was performed to assess profitability at those levels.

Option two: State - private (farmer) cooperation in the establishment of backyard fish hatcheries: The direct transfer of low-cost technologies for improved seed production and control of reproduction, to selected private small-scale farmers is another option available for the improvement upon the current level of the practice in Ghana. In this option the opportunity is opened for techniques developed by government institutions to be commercialized by the private sector. The spectrum of activities envisaged under this proposal range from practical training of the selected farmers in seed production, packaging and transportation to marketing.

Type of fish: Attributes of tilapia *O.niloticus* show promise to easily lend the species to the development of backyard hatchery because it's reproduction and nursing are simple and do not require sophisticated techniques. The use of catfish on the other hand would involve a more complex phase of reproduction and larval culture that can hardly be considered by the farmers, at least for the moment, except in the context of a nursery or hatchery (such as in option 1). Stocking material of catfish may therefore, be obtained from any available well established hatchery or caught from the wild subject to all the risks involved: seasonality, heterogeneity of sizes, species mixing, need for storing and transportation after capture (Lazard and Legendre, 1996). Public sector involvement would mainly be the traditional role of fisheries establishments in providing technical support to the sector. In addition, they would be responsible for the organizational aspects of the project.

Project components:

The major phases of the project comprises:

1. Refresher course on mass production of all-male tilapia fmgerlings for project personnel drawn from the regions.

2. Selection of qualified farmers with sites, pond designs and facilities amenable to seed production from within the districts of the country.

3. Training of selected fanners on the techniques.

4. Provision of technical assistance and support to successful trainees to facilitate the production of seed and the marketing of the product to other fish farmers within the district,

5. Institutional proposals for the formulation and promulgation of a nationwide fish seed policy, regulations, control and enforcement measures not only to enhance the objectives of the project but also to maintain the genetic integrity of the fish species being used. A seed regulation authority within the public sector would be required to

test and certify the batches of seed to be distributed to farmers.

3.2.2. Cost-Benefit analysis

To assess the economic merits of undertaking this option, relevant costs were identified and listed as:

1. Investment and recurrent costs
2. Equipment
3. Vehicle and motorcycles
4. Rehabilitation of existing ponds and facilitiesof public fisheries establishments.
5. Credit/input for redesigning and rehabilitation of ponds and other facilities of selected farmers.
6. Organizational overheads

On the benefit side, expected receipts included:

1. Increased availability of fish seed.
2 Improvement upon quality of product.
3. Increased fish output from culture sources.
4. Creation of specialized employment avenues.
5. Reduced incidence of contamination of fish seed,
6. Food security enhancement in rural farming household.

3.2.3. Economic rate of return TERR')

As the project is expected to meet a growing demand for fish but the expected yield is small relative to the total fish production of the nation and based on the assumption that prices reflect value or can be adjusted to reflect value, the market price of tilapia fingerling was used directly as estimates of their economic value (Gittinger, 1982). The Economic rates of return (ERR) were thus computed based on those values using formula 3.3 above.

From these sources figures that adequately reflected the magnitude of costs (1-5) were derived. In the projections that follow, an annual price increase of 10 per cent was adopted. The rate was based on the year-on-year non-food mean inflation sub-index of 10.3 per cent at the end of 1998 (Institute of Statistics, Social and Economic Research: ISSER, 1999; Centre for Policy Analysis:

CEPA ,1999). Based on an annual mean tilapia fingerling production of 30,000 representing two cycles and an annual fingerling price increase of 10 per cent, the magnitude of benefit (1) was derived. However, benefits (2-6) were difficult to value and consequently, not included in the analysis. A discount rate of 36 per cent was used in the calculation of the various indicators based on the prevailing lending rate for agricultural purposes (ISSER, 1999).

To assess the sensitivity of the proposal the following changes were made to the parameters:

1. The effect of a 50 per cent drop in interest rate (that is to 18 per cent).
2. Each of the 110 farmers attain the capability to produce at least 45,000 tilapia fmgerlings per year.
3. All successful farmer-trainees actually undertook the production of seed upon completion of the training programme.

3.3. A survey of the activities of beneficiaries of the pilot tilapia hatchery

In separate collaborative programs with two non-governmental organizations viz, the Ghana Rural Reconstruction Movement (GhRRM) and the African Centre for Human Development (Sankofa), the Water Research Institute (WRI) of the Council for Scientific and Industrial Research (CSIR) disseminated the practice of all-male tilapia culture in ponds to groups of farmers mainly in the Akwapim-North and Kadjebi districts. The farmers were given lessons on the rudiments of fish farming pond preparation, stocking, fertilization, feeding and harvesting. They were also thought the essential requirements for the cultivation of all-male tilapia. Following the training received these farmers have become dependent on the tilapia hatchery for their supply of tilapia stocking material. There were however, a few respondents who did not benefit from the training sessions but regularly obtained their fmgerlings from the hatchery.

3.3.1. Types of analyses adopted

In addressing the third objective therefore, data on thirty-one (31) of these farmers was collated and analyzed using descriptive, financial as well as econometric analytical tools. The Statistical package for the social sciences (SPSS/PC+ program) was also employed in the analysis.

Cost and return analysis of selected respondents:

While reliable data was easily collected on production practices and assets ownership, it was difficult to obtain reliability in data on initial pond development, variable costs and on returns.

For instance, supplemental feeding was done at irregular intervals and some respondents could not estimate quantities used. Expenses for other inputs were also incurred at irregular intervals during a given cultivation period. Consequently, a conscious effort was made during the study, to thoroughly review and assess all data provided on costs and earnings and to eliminate those responses deemed unreliable. This screening process produced a reduced number of nineteen (19) respondents, whose data formed the basis for the analysis in this subsection. On the computation of the total cost incurred by each farmer (fixed and variable) data used included information on labour, fingerling, feed, manure/fertilizer cost plus their cost of transportation, depreciation of pond and piping/fittings, fencing, fishing net hiring and land rent.

Cash receipts of the farmers were mainly used as gross returns since data on non-cash returns were not readily available. Net return to management and land was obtained by subtracting the total cost from the gross cash return. For farmers with positive net returns, the rate of return on operating cost was determined as the ratio of profit (positive return) to the total operating cost (Appendix 21).

3.3.2. Factors affecting pond tilapia cultivation: an econometric analysis

For an examination of the technical and economic factors that influenced the use of inputs and the output of fish by farmer respondents, the following generalized production function was adopted.

$$Y = f(X, X,,)$$

where Y = the output

Xj = the ith input.

The following specification of the production functions on per farm basis were considered (Hendry, 1991; Johnson *et al,* 1987; Johnston, 1984; Koutsoyiannis, 1996; Neal & Shone, 1976; James & Throsby, 1973 and Christ, 1966).

1. First degree polynomial or linear production function;

$$Y = ao + S BiXj + E \quad \ldots \quad 3.6$$

2. Double logarithmic (Cobb-Douglas) or power function;

$$Y = ao\ n\ Xj\ ft; + E \quad \ldots \quad 3.7$$

3. Linear-logarithmic (semi-log)

$$Y = ao + fli \ In \ Xj + E \qquad 3.8$$

4. Logarithmic-linear (exponential, also Cobb-Douglas)

$$y = e^{aO+(liXi} + g \qquad 39$$

5. Reciprocal (hyperbola);

$$Y = a_0 + bj/Xj + E \qquad 3.10$$

It was hypothesized that variations in output could be explained by nine explanatory variables as follows:

Y = yield of fish (kgm'2 per season);

Xi = culture experience of pond operators (years);

X_2 = stocking density (number m'2);

X_3 = acclimatization time before stocking (hours);

X_4 = miscellaneous (variable cost *£);*

X_5 = lime (kg);

X_6 = organic manure (kg);

X_7 = supplemental feed fed (kg).

To reflect the influence of locations of ponds and water quality on tilapia yields dummy variables (Di and D_2) were used such that Di = 1 for ponds in study area A and Di = 0 if otherwise. Similarly, D_2 = 1 if pond water was turbid or clear and D_2 = 0 if pond water was green.

3.3.2.1 Bases for choice of variables

In the per farm specification adopted, the significance of a variable in explaining variation in output would indicate that an increase in that variable would have a desirable impact on output. A description of the individual variables follows:

(i) Culture experience of operator (Xj)

Experience has been chosen as a proxy variable for management. It is expected that years of experience of the operator based primarily on knowledge of methods of culture would have a positive effect on output as it is generally believed that on the average experienced fanners are more efficient than those with little or no experience. Experience here is measured by the number of years a particular farmer has been active in the fish farming business.

(ii) Stocking density (X_2)

An important practice in fish farming is the stocking of the right amount of fry or fmgerlings to maximize production. As productivity per unit water area depends among others, on the stocking density, it could be expected that to an extent, increasing the density would reflect positively on the output.

(iii) Acclimatization time prior to stocking (X_3)

Fish fingerlings are sensitive to changes in their environment (Marilyn, 1976). Variations in temperature, pH, salinity and other water conditions result in shock and could lead to stress or mortalities. It was therefore, expected that acclimatization period especially after prolong transportation from the hatchery could have a positive influence crucial in explaining output variation.

(iv) Miscellaneous operating cost (X_4)

These are mainly variable cost covering a wide variety of items such as repair and maintenance, food for labourers, depreciation, interest rates and other fees.

(v) Application of lime (X_5)

Lime serves the dual purpose of enhancing the fertility of the pond and at the same time offering protection to the stocked fish against pests and disease infestation. It was expected that the right application of lime would contribute positively to output.

Organic manure (Xg)

The application of fertilizers was expected to positively affect yield to a large extent. In many situations organic fertilizers have been used in place of inorganic fertilizers in fish production. If the scope of pond expansion is limited, the application of large quantities could be an option for increasing output.

(vii) Supplemental feed (X_7)

To substantially increase output of cultured fish supplemental feeding is essential even if the pond's natural food production has been enhanced through fertilization. Supplemental feed comes in various forms: vegetable matter, rice bran, wheat bran, brewery waste among others. As a good management practice, feed input increases with stocking density. Thus, at a given density it could be expected that fish output increases with supplemental feed input.

In the various specifications ao and lij represent production coefficients to be estimated whilst E denotes the error term. The magnitude of ao, the technical coefficient of production, facilitates the comparison of the effects of alternative policy decisions. Similarly, in the linear formulation (1) the lij coefficients represent constant marginal productivity of individual factors or inputs.

In the Cobb-Douglas formulations the sum of the coefficients were considered as returns to scale. With constant return to scale being Elij = 1 meaning doubling all inputs would result in doubling the output. A value of E lij > 1 implying doubling all inputs would result in more than doubling the output, and the reverse being true for 2lij < 1.

Five models were fitted these were; a linear model, double logarithm, semi-logarithm, logarithmic-linear and reciprocal models. The choice of the most appropriate model was determined by a number of factors. Amongst them, the model selected had sound statistical qualities with the empirically estimated parameters satisfying all statistical requirements. To correct for bias introduced as a result of iterating models but using the same data set, a mathematical formulation to determine the true level of significance was adopted as:

$$a^* = 1 - (1 - a)^{c/k}$$

Lovell (1983)..3.11

Where a* = true level;

a = nominal level of significance;

c = total number of potential variables that would feature in the model;

k = number of variables finally selected.

In this study c = 9 at 5 per cent nominal level of significance and assuming k = 4 then with reference from Lovell's tabulated figures, the true significance level (a*) could be determined as

1.2 per cent. Not only were the parameters expected to be significant at this level using the student t-statistic but also their corresponding F-statistic were expected to be significant. In the present circumstance, a* is approximately 1 per cent. Hence, the standard 5 and 1 per cent were adopted. These requirements having been met, the model with the highest coefficient of multiple determination R^2 and/or adjusted R^2 was chosen.

3.3.2.2 Statement of hypotheses

The hypotheses to be validated follows with the null and alternate hypotheses denoted as Ho and H_A respectively.

1. Ho: Pond operators posses the same level of experience versus H_A: Pond operators do not posses the same level of experience.

2. Ho: Differences in stocking densities of ponds were not significant versus H_A: Significant differences existed in the stocking densities of ponds.

3. Ho: The acclimatization period observed by pond operators prior to stocking with fmgerlings was the same versus H_A: Acclimatization period prior to fmgerling stocking was not the same.

4. Ho: Miscellaneous cost incurred by the farmers were the same versus H_A: Miscellaneous cost incurred by the respondents were significantly different.

5. Ho: The quantity of lime applied by the farmers was the same versus H_A: The quantity of lime applied by the farmers was significantly different.

6. Ho: Equal quantities of manure were applied by the fanners versus H_A: The quantities of manure applied by the various respondents were significantly different.

7. Ho: Quantities of supplemental feed fed by the farmers were equal versus H_A: Quantities of supplemental feed fed by farmers were significantly different.

8. Ho: There was no significant difference between the yields of ponds in the study areas labelled A and B versus H_A: There was a significant difference in yields of ponds located in study area A relative to area B.

9. Ho: There was no difference between the water quality of ponds in the entire studyarea versus H_A: The difference in water quality observed in the ponds were significant.

The standard student t-test used to test the null hypothesis was:

Ho: **bj* = O**

versus alternate hypothesis:

H_A : bi* > 0

bj* <0

given by

t* = ^b - bi *

Sb~1 .... 3.17

and N-K degrees of freedom.

Where:

^b denotes least squares estimates of bi for a given equation.

Sbj denotes estimated standard error of bj for a given equation,

bj* denotes hypothesized value of bj.

N denotes sample size of the data for fitting the given equation and

K denotes total number of estimated parameters in the given equation (here K = 9).

The estimated t-ratio is compared with the critical tabulated value of to. 12,n-k which defines the critical region in a single tailed test. The decision criteria were as follows:

If t* > to. 12,n-k then we reject the Ho otherwise we do not reject Ho.

3.3.3. Allocative efficiency of production inputs

The economic efficiency of production inputs was determined for the chosen production function by comparing the marginal product with the input-output price ratio. At the point of optimum input combination, which maximizes net return, given a capital constraint, the ratio of the input-output prices to marginal product must be the same for each of the inputs used. If capital is not a constraint, the value of the marginal product would be equated to the input price written algebraically as:

$MPi = Pi/P_0$ 3.18

or VMPj = Pi since MPi x P_o = Pi

where

MPi = marginal product of input i

Pi = price of input (e.g. fingerling)

P_0 = price of output (fish).

With data on prices of inputs and output as well as marginal product (obtained by taking the first partial derivative of the estimated production function, with respect to the input i) comparisons would be made such that if

$$VMPi > P| \qquad \text{3.19}$$

then the use of that input should be increased. Similarly, if

$$VMPj < Pi \qquad \text{3.20}$$

then the use of that input i should be decreased. And if

$$VMPj = Pi \qquad \text{3.21}$$

then producers are economically efficient (Chambers, 1988; Kee-Chang *et al,* 1992). As it was not likely that VMPj would be absolutely equal to Pi even if producers were economically efficient, Students' t-test was performed to determine whether Pi was significantly different from VMPj. Prevailing market prices were used in valuing the on-farm resources used as production inputs.

CHAPTER 4

RESULTS

The major findings of the study are presented in this chapter. The chapter is structured into three sections. The first section covers the three pilot hatcheries, the second presents the results of assessments of the important assumptions underlying the two proposed hatchery activities and the final section presents the results of the survey of the activities of beneficiaries of the pilot tilapia hatchery activities.

4.1 Viability indicators of the pilot hatchery activities

The results of the viability measurements are presented in Table 4.1 derived from a consolidated 10-year cashflow prepared for the three pilot fish hatcheries shown in Appendix 3. Figures 4.1 and 4.2 show the profile of the net present value of the respective hatcheries.

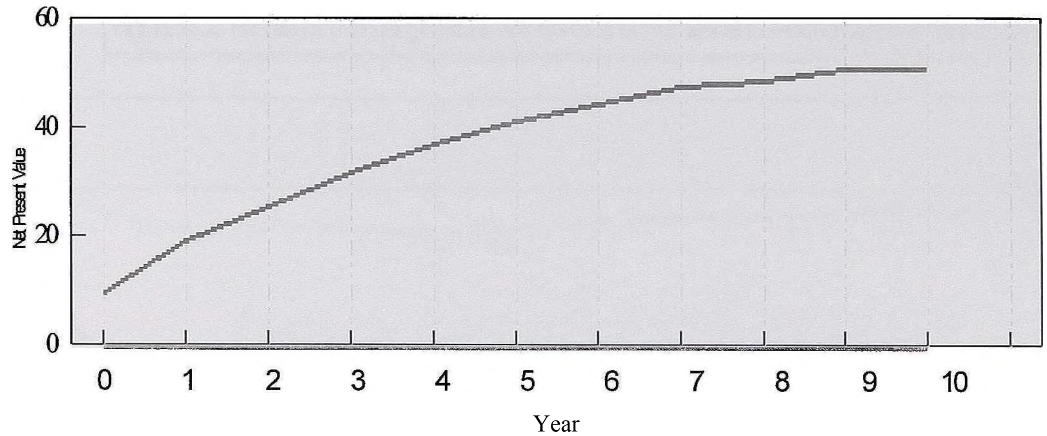
Sensitivity analyses revealed that if catfish survival improved by 10-25 per cent, the NPV of the Accra hatchery could improve from (£459,967 to 04,032,179 with B/C ratios improving from 0.87 to 1.27 respectively (Appendix 3d & 3e). However, even at these levels of improved survival, the Kumasi hatchery gives figures that were indicative of low prospects of being viable. The profile of the NPV given the improved rates is shown in Figure 4.3.

Table 4.1 Viability of pilot hatcheries at Kumasi, Akosombo and Accra

	Akosombo	Kumasi	Accra
Net Present Value (NPV)(₀)	38,004,964	-27,061,136	-1,924,883
Benefit/Cost (B/C)ratio	1.59	0.04	0.87
Internal Rate of return (IRR) (%)	43.30	-93.56	21.66
Profitability index (PI)	8.74	-1.77	0.69
Payback period (years)	1	No payback	No payback

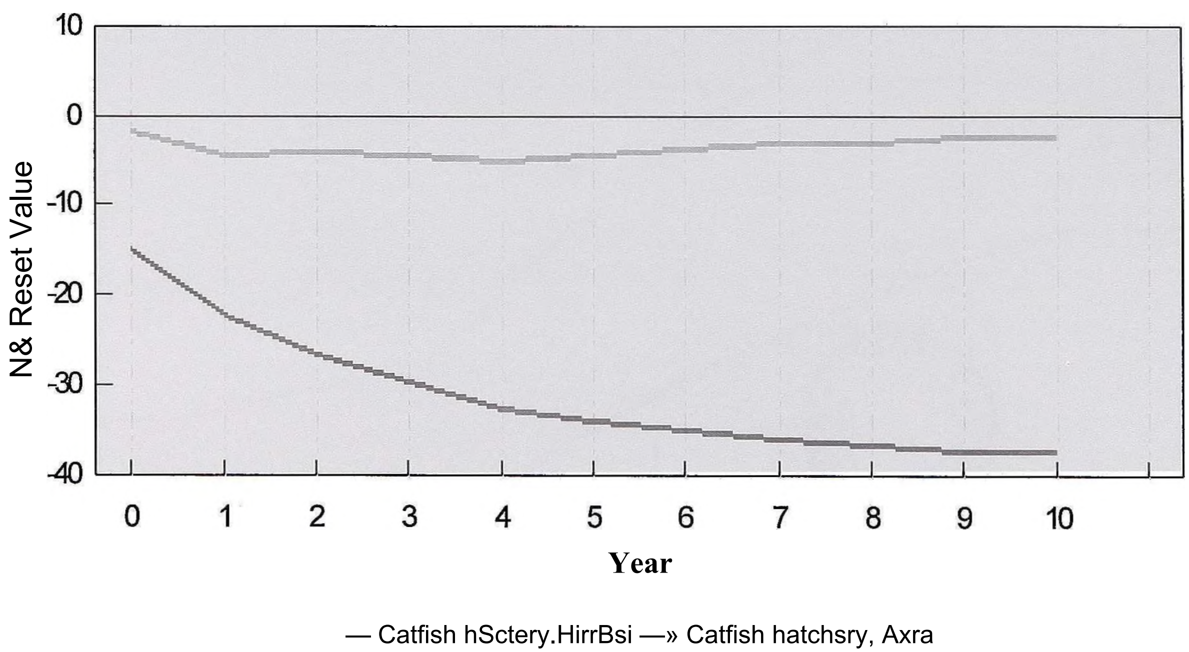
Source: Author's computation.

Figre4.1 The profile of the net present vahe of the Akoaorrbo tilapia hatchety

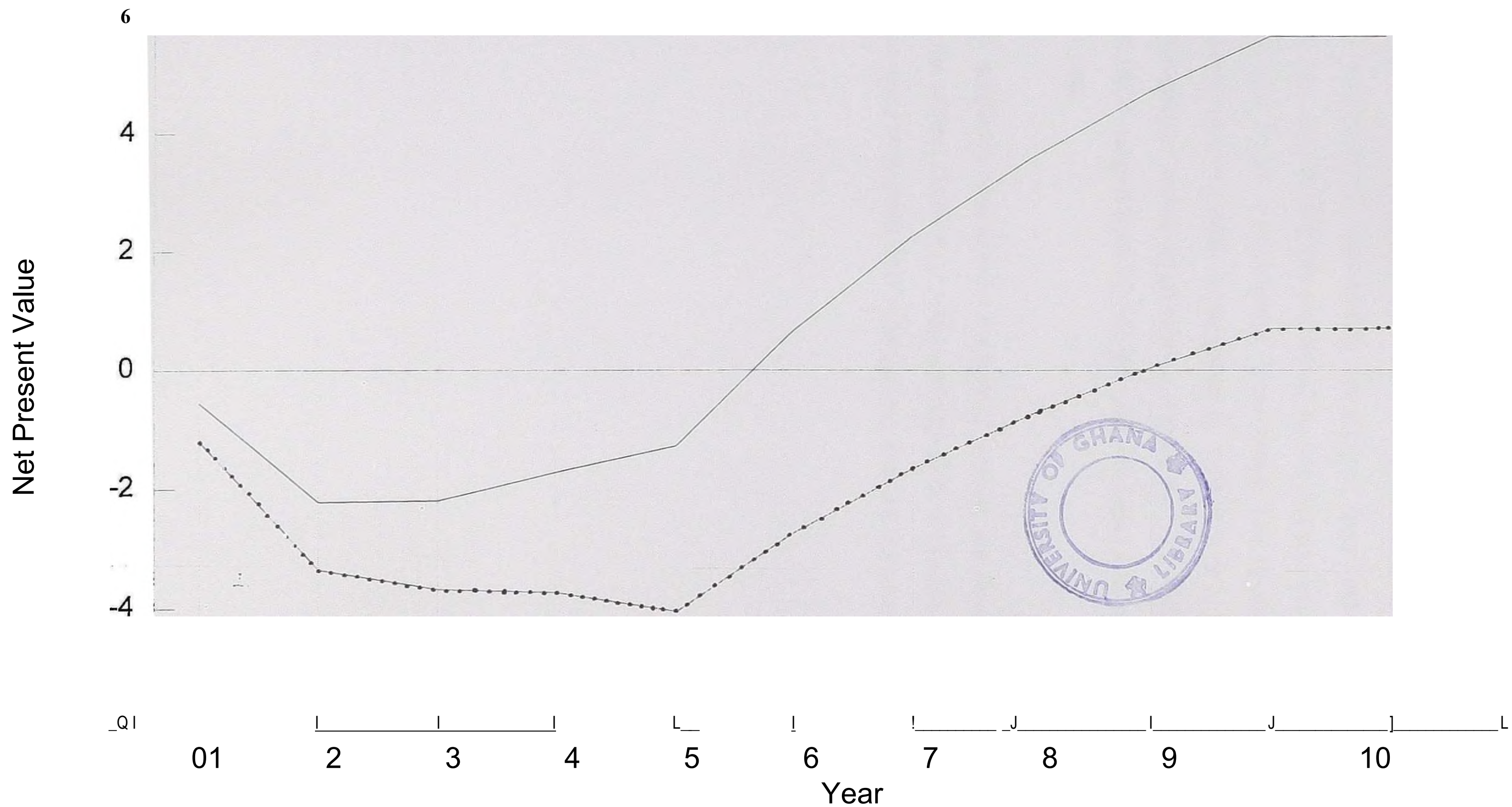


_ Tlapiahatchoy,Akosonbo

RgLre4.2 Rcfilecf therEtpresert^LEScf tteKLn^andAxracstfishh^chaies



' Figure 4.3 Profile of the net present value of the Accra hatchery at 65 and 80 per cent survival rates^



Sensitivity analysis of the Accra hatch, at 65% _ Sensitivity analysis of the Accra hatch.at 80%

4.2 Investment options proposed for hatchery development

The solely private option;

The investment schedule prepared for the private option shown in Table 4.2. The estimated total investment was 0345,800,000.00. The initial investment capital needed for the venture to take off was estimated at 0188,000,000.00 representing the sum of fixed and working capitals. The annual depreciation was 015,300,000.00, computed by the straight-line method based on the estimated economic lives of the various items of equipment and structures. The cost-revenue analysis for the private hatchery option is presented in Table 4.3. It is based upon production efficiencies and experimental results expressed in Tables 3.1, 3.2 and 3.3 respectively. The return on investment (ROI) ranged from 20-340 per cent averaging 200 per cent with discounted pay back period of 1 year.

The major financial indicators obtained for the private venture are shown in Table 4.4. With positive NPV over the project duration, a relatively high IRR, compared to the current interest rate of 36.00 per cent and a favourable B/C ratio (greater than 1), the venture gives an indication of being viable.

Table 4.2: Investment schedule for the solely private hatchery development option (in million of cedis)

	Quantity	Unit Cost (¢)	Total cost (¢)	Economic Life (yr)	Annual Depreciation (¢)
A. Capital outlay					
1. Land area (square metre)	2 x 10,000	8.0	16.00		
2. Civil Works and facilities:					
* Surveys, area delimination, staking, perimeter fencing	-	15.00	15.00	10	2.00
* Construction of shed over working space	-	-	20.00	10	0.50
- broodstock holding facility (Concrete)	10	0.50	5.00	10	0.10
- broodstock ponds (earthen)	10	1.00	1.00	10	0.50
- Concrete (outdoor) larval tanks	10	0.50	5.00	10	0.80
- nursery ponds (earthen)	10	8.00	8.00	10	0.20
- grow-out ponds (earthen)	10	2.00	2.00	10	0.30
3. Tanks					
- Larval tanks (PVC)	10	3.00	3.00	10	0.30
- Hatchery/incubation tanks (PVC)	20	0.10	2.00	10	0.20
4. Water Supply System (Appendix 10)	-	■	4.60	5	0.92
5. Aeration System (Appendix 10)	-	■	3.80	5	0.76
6. Power and Fire Extinguishing System (Appendix 10)	-	■	2.50	5	0.50
7. Refrigerator	1	0.60	0.60	5	0.12
8. Microscope	1	1.40	1.40	10	0.14
9. Water analysis kit (Hach)	1	0.69	0.69	5	0.14
10. Feed grinding mill with assessories	1	2.50	2.50	10	0.25
B. Environmental Impact Assessment (EIA) process (in accordance with Environmental Protection Agency laid down procedure)	-	8.00	8.00	-	-
C. Equipment and tools for routine hatchery processes (Appendices 4-9)	-	5.80	5.80	2	2.90
D. Recurrent expenditure (Appendix 11)	-		185.40	-	-
E. Pick-up Vehicle	1		50.00	10	5.00
F. Insurance @1 Percent Cost			3.50		15.00
TOTAL INVESTMENT			345.79		30.63

Source: Author's compilation from survey results and estimates.

Table 4,3: Projected Expenditure - Income statement for the solely private effort at hatchery development in the country.

(in millions of cedis)

	Year 1	2	3	4	5	6	7	8	9	10
A. Expenditure										
i. Operating Cost (annual total)	142.00	156.00	171.00	188.00	207.2	228	251	276.00	303.00	334.00
ii. Overhead Cost*	3.00	3.10	3.40	4.00	4.10	5.00	5.00	6.00	6.10	6.70
iii. Depreciation	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Total Expenditure	160.00	174.00	190.00	207.00	226.00	248.00	271.00	297.00	324.00	355.70
B. Income										
Revenue**										
i Tilapia Sales	93.60	154.00	226.00	249.00	270.00	302.00	362.00	398.00	438.00	482.00
ii. Catfish Sales	136.00	299.00	494.00	543.00	597.00	657.00	788.00	867.00	954.00	1,050.00
Total Revenue	230.00	454.00	720.00	792.00	867.00	959.00	1,150.00	1,265.00	1,392.00	1,531.00
Net Income	70.00	279.00	530.00	585.00	641.00	711.00	879.00	969.00	1,067.00	1,175.00
Return on Investment (%)	20.20	80.90	153.40	169.20	185.30	205.60	254.30	280.2	308.7	340.1
Average Return on Investment (%)	199.80									

Source: Author's computation from estimates.

* Overheads include cost of stationery, marketing expenses, postage among others

** Selling price (in cedis) in year 1: 150 per fingerling for both catfish and tilapia. Both selling price and operating cost increased by 10 per cent annually.

Table 4.4: Viability of proposed private hatchery

Indicator	Magnitude
Net present value (0)(NPV)	1,203,763,912
Internal rate of return (%)(IRR)	61.04
Benefit/Cost ratio (B/C)	1.84
Profitability index (PI)	9.47
Payback period (years)	1.2

Source: Author's computation from estimates.

The cost, to the proposed hatchery, of producing a fingerling estimated over a period of ten years fluctuated (Figure 4.4) showing high figures during the first, fifth and tenth years of operation. During the first year, the estimated cost is 0100,900 per thousand fmgerlings. It decreased during the second to fourth year, when estimated incremental revenue exceeded the estimated incremental costs. The peak of the profile occurs in the fifth year, dropped sharply in year sixth and increased gradually in successive years.

Sensitivity analysis (Table 4.5) reveals that at the proposed selling price of fmgerlings even if there is a simultaneous reduction in survival rates to 28 and 45 per cent for catfish and tilapia respectively, the NPV, Profitability Index and Payback periods show favourable figures in terms of viability.

Figure 4.4 Estimated cost of fingerling production for the proposed private hatchery

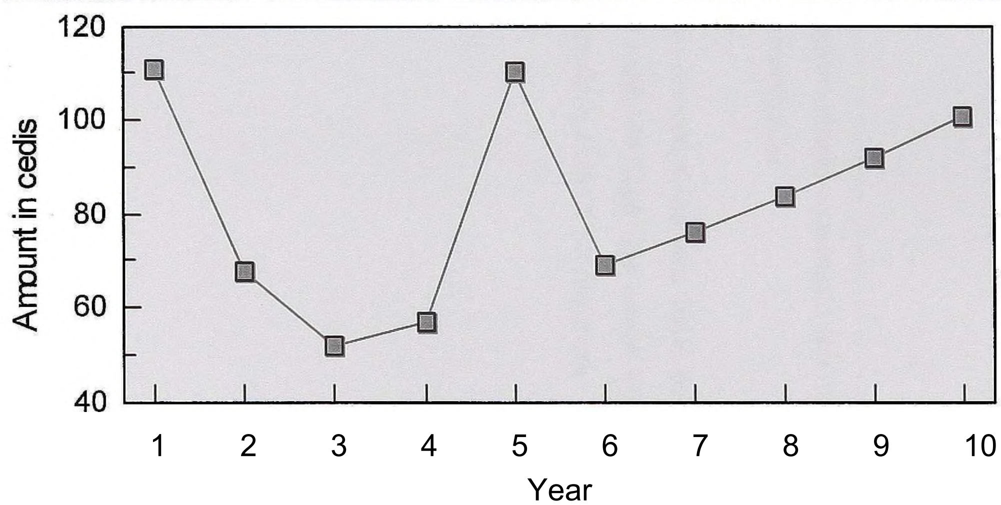


Table 4.5: Viability of proposed private hatchery at reduced survival rates

Indicator	Magnitude
Net present value (0)(NPV)	570,862,296
Profitability index (PI)	5.02
Payback period (years)	2

Source: Author's computation based on assumed survival rates of 28 and 45 percent for catfish and tilapia fingerlings respectively.

The results of the break-even analysis showed that to achieve a break-even level, the proposed hatchery would require 1,058,198 fingerlings valued at 0158,782,251.90 per year. The derived break-even price was therefore, 0150.05 per fingerling.

The state-private (farmer) cooperation option:

The investment schedule prepared for the second option is shown in Table 4.6. The estimated total value of the investment is 0981,300,000. The cost-retum stream is shown in Table 4.7. The quantifiable benefits are based on the expected value of fmgerlings produced by the trained farmers. The major indicators are shown in Table 4.8 Figure 4.5. shows the trend in NPV over the proposed period. It shows a profile that drops sharply, recovers gradually in successive years but could not reach the NPV = 0 level during the period.

Comparing the magnitudes of the indicators in Table 4.8 with the decision criteria outlined in Formulae 3.1, 3.2, 3.3 and 3.4 as well as that of the payback period, it is obvious that in terms of these measures the proposal could not pass: a fact further strengthened by the results of the sensitivity analysis (Table 4.9) under the assumption of a 50 per cent reduction in interest rate. Thus the option shows a low prospect of being viable. However, at an assumed average fingerling production capacity of 45,000 (an increase of 50 per cent) the indicators show level of viability (Table 4.10).

Table 4,6 : Investment schedule for the state-private (farmer) effort towards the development of backyard hatcheries (in millions of cedis)

Description	Quantity	Unit Cost (0)	Total Cost (0)
A. Training schedule (Appendix 14)	-	-	343.40
B. Equipment and tools for training and feed preparation (Appendix 15)	-	-	0.90
C. Recurrent expenditure (Appendix 16)	-	-	478.00
D. Pick-up vehicle	1	60.00	60.00
E. Motorcycles and accessories	10	100.00	100.00
Total			981.31

Source: Author's computation from estimates.

Table 4.7: Projected Cost - return statement for the joint state-private (farmer) effort towards the development of backyard fish hatcheries (in millions of cedis).

	Year									
	1	2	3	4	5	6	7	8	9	10
A. Expenditure										
Operating Cost (annual total)	478.00	526.00	578.00	636.00	700.00	770.00	847.00	932	1,025.00	1,127.00
B. Income										
Revenue*	495.00	546.00	599.00	659.00	726.00	799.00	878.00	966.00	1,059.00	1,165.00
(Fingerling sales)										
Net Income	17.00	19.00	21.00	23.00	26.00	29.00	31.00	35.00	35.00	38.00

* Gross value of tilapia fmgerling produced per year.

Source: Author's computation

Table 4.8: Viability of the state-private (farmer) option

Indicator	Magnitude
Net present value (0)(NPV)	-746,206,807
Economic rate of return (%)(ERR)	-19.80
Benefit/Cost ratio (B/C)	0.04
Profitability index (PI)	0.08
Payback period (years)	No payback

Source: Author's computation from estimates.

Figure 4.5 Profile of the Net Present Value of the joint state-private(farmer) effort to backyard hatchery development in Ghana.

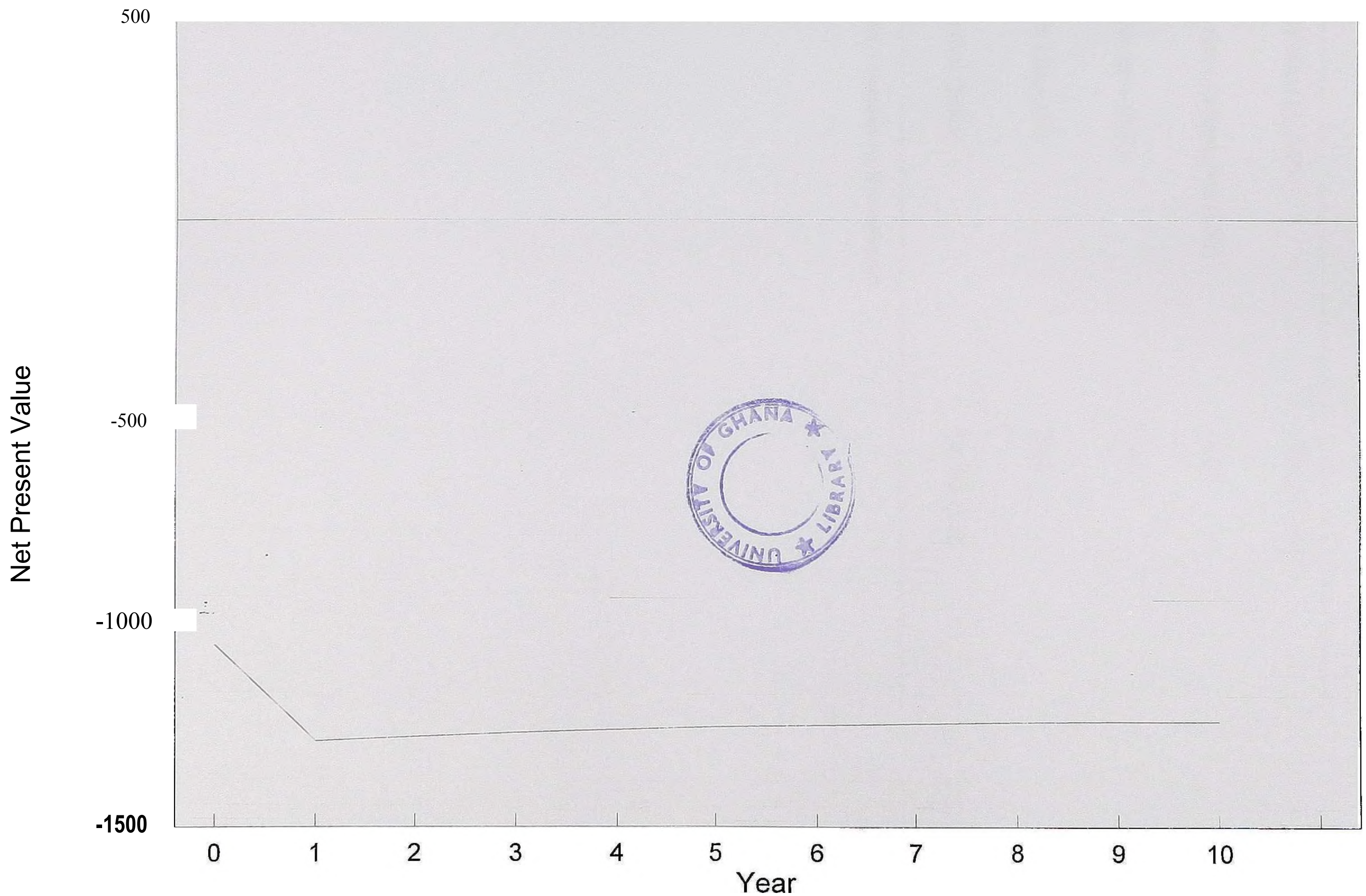


Table 4.9: Viability of state-private farmer at 18 per cent discount rate

Indicator	Magnitude
Net present value (0)(NPV)	-766,205,914
Economic rate of return (%)(ERR)	-5.07
Benefit/Cost ratio (B/C)	0.05
Profitability index (PI)	0.13
Payback period (years)	No Payback

Source: Author's computation from estimates.

Table 4.10: Viability of state-private farmer option at an assumed fmgerling production level

Indicator	Magnitude
Net present value (jzS)(NPV)	242,741,804
Economic rate of return (%)(ERR)	5.15
Benefit/Cost ratio (B/C)	0.98
Profitability index (PI)	1.30
Payback period (years)	No Payback

Source: Author's computation based on an assumed tilapia fmgerling production capacity of 45, 000 per farmer per year.

4.3 Survey results of the activities of beneficiary farmers

Data obtained from the survey indicates that most of the respondents (93.5 per cent, n = 29) started fish farming activities after the training sessions organized by the Ghana Rural Reconstruction Movement (GHRRM) and the Sankofa programme both in conjunction with the Water Research Institute. The remaining two had earlier practiced some form of fish farming: stocking fmgerlings with little or no management. In addition, none of the respondents had any indigenous knowledge nor traditional methods of producing fish in ponds. Thus, the majority of respondents were not only new to aquaculture but also ignorant about traditional fish culture techniques, an indication of the need for more training and motivation.

The size of water bodies used for tilapia farming ranged from 48 to 1800 m^2. Forty-eight (48%) per cent of ponds surveyed retained water throughout the year (Table 4.11). Most (77.4 per cent) of the ponds were drainable under gravity and had well conditioned dykes. Vital installations for the culture of all-male tilapia (inlet and outlet valves fitted with screens) were available in half of the total number of ponds surveyed. In general, the survey showed that ponds were well sited and constructed.

Table 4.11: Characteristics of ponds used by the farmers for tilapia culture

Information categories	Magnitude I
1. Pond size range (m^2)	48-1800
2. Water retention capacity	
Perennial Water Supply (Percentage)	48
Seasonal Water Supply (Percentage)	52
3. Drainage Status	
Pond drainage under gravity (Percentage)	77.2 i
Pond undrainable under gravity (percentage)	22.6
4. Condition of dyke	
Broken dykes (Percentage)	13
Flood prone (Percentage)	16
Grassed (Percentage)	61
5. Other vital installations	
Inlet and outlet valves with screens (percentage)	48 !
Inlet only present and fitted with screens (Percentage)	13
Outlet valve present and fitted with screen (percentage)	32
Pond with neither inlet nor outlet valve (percentage)	6.5

Source: **Author's** compilation from responses of farmers and inspections of **fish** ponds

A variety of inputs were used by the farmers as feeds and fertilizers. Lime was used for pond preparation whilst cattle and poultry manure as well as inorganic fertilizers were used for pond fertilization. Kitchen waste, wheatbran, rice bran, cocoyam leaves, cassava chips and leaves, oil cake, riped pawpaw fruits and leaves, local brewery waste, termite, concentrates, maize bran, *leaucena leococephala* leaves, and groundnut bran were used as supplementary feeds.

In terms of proportions, 52 per cent of respondents fertilized their ponds with poultry manure and 45 per cent with cattle manure (Figure 4.6) and 19 per cent with inorganic fertilizer (N.P.K. as well as ammonia). Rice bran was used by all farmers (Figure 4.7). Few (9.6%) used oil cake whilst wheat bran, kitchen waste, cocoyam leaves and cassava products were used by 38.7, 12.9, 48.4 and 3.2 per cent of respondents respectively. Pawpaw fruits and leaves, brewery waste, termites, concentrates, maize bran, leaucena leaves and groundnut bran were used as feed by 25.8, 19.4, 9.7, 9.7, 6.5, 6.5 and 3.2 per cent respectively.

Although farmers were aware of the importance of lime for pond preparation only 38.7 percent used lime in their ponds. The use of lime, inorganic fertilizer, cocoyam leaves and brewery waste was common within the Kadjebi group than it was in the other area. In general, pond inputs could not be accurately quantified by respondents but observations made of pond water colour as a proxy for fertility and fish samples suggested that less than the quantities of recommended inputs were applied.

Figure 4.6 Percentage of fanners using different fertilizing agents in the culture of all-male tilapia |

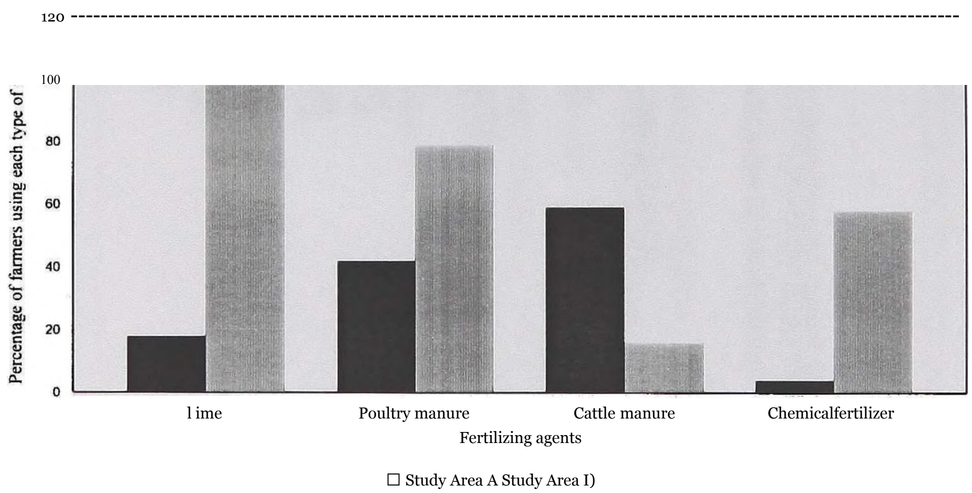
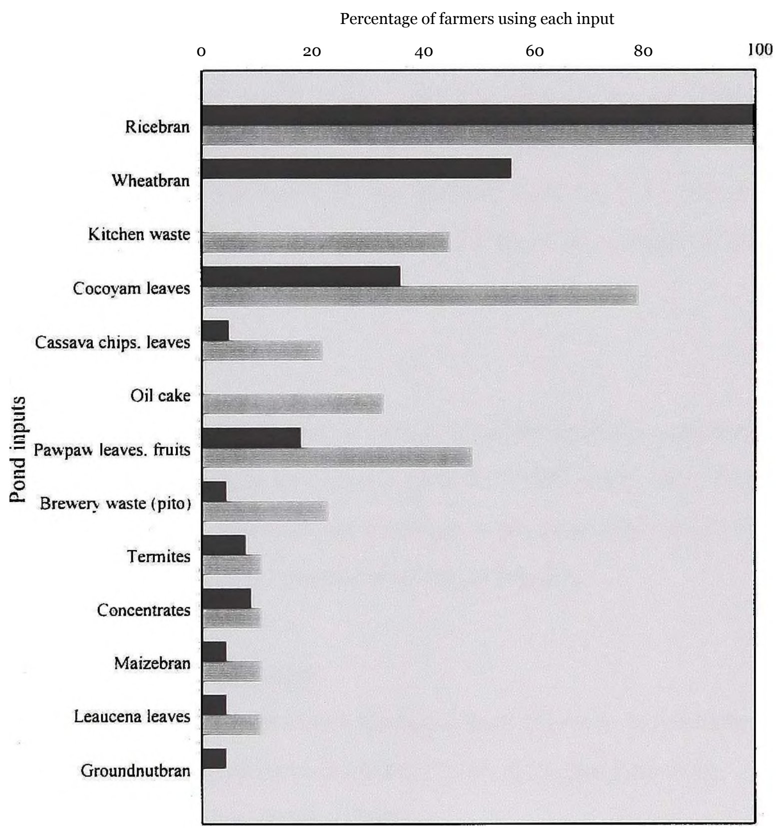


Figure 4.7 Percentage of farmers using different inputs for the culture of all-male tilapia



I Study Area A I Study Area B

4.3.1 Farmers' perception of the hatchery (tilapia) seed

4.3.1.1. Benefits derived bv farmers

Most respondents (61%) expressed satisfaction with the use of the seed. Fifty-two per cent were of the opinion that it had been very effective in providing stocking material at the time they were required (Table 4.12). Whilst 70 per cent claimed it was effective in reducing the cost as well as risks they could have encountered in the search of seed from the wild.

More than 50 per cent of the respondents were of the view that it enhanced the production of marketable fish at harvest. In terms of output, 35.5 per cent indicated that compared to the use of wild fingerlings, they observed higher yields with the hatchery weed. However, a relatively greater percentage (45%) had no basis for comparison. Considering quality, 42 per cent observed improvements in output by comparison with non-hatchery seed. Only 13 percent of respondents were of the view that their profit as well as income increased as a result of using the hatchery seed.

4.3.1.2. Attitude of Farmers

The majority (64.5%) of respondents were in favour of expanding their operation while 32.3 per cent expressed the desire to continue on the present scale (Table 4.13). Only 3.2 per cent wanted to discontinue. As to whether farmers would continue to purchase fingerlings from the hatchery 93.6 per cent irrespective of location, responded in the affirmative.

4.3.1.3. Problems encountered by farmers

Asked without prompting, what factors have hindered their efforts to culture the tilapia seed they purchased from the hatchery respondents identified (Table 4.14) the following:

i. Non availability of credit to buy inputs (100%)

ii. Occurrence of reproduction (48.8%)

iii. Marketing (28.8%) 4$^

iv. Too short a period of water availability or retention (22.6%) ^ \ \ d

v. Flooding (12.9%) v xif

vi. Poaching (6.4%) and

vii. Invasion by thrash fish (3.2%).

4.3.2. Cost and return analysis of selected respondents

An abstraction from the enterprise budgets prepared for the selected farmers (Appendix 20) indicates that four (4) out of the total of nineteen(19) obtained positive net return to management and land (Appendix 21) with their corresponding rates of return on operating cost varying from 0.18 to 0.98 per cent.

Table 4.12: Perception of farmers regarding the use of all-male tilapia fmgerlings

	Very effective (%)	Effective (%)	Somewhat effective (%)	Not effective (%
(a) Availability of seed:				
(i) Provided stocking material at the right time	52(16)	9(3)	5(2)	3.2(1)
(ii) Reduced cost/risk involved in obtaining seed or other farms	26.6(8)	38.4(12)	9(3)	0
(iii) Facilitated the production of table-sized fish (marketable) at harvest	28.8(9)	22.4(7)	32(10)	9(3)

(b) Output of fish:	Increased (%'	Same (%'	Decreased (%	Not applicable (%)
(i) Quantity	35.5(11)	9.6(3)	3.2(1)	45 (14)
(ii) Quality	43 (13)	13(4)	0	15(5)
(iii) Profit	13(4)	0	3.2(1)	61.3 (19)
(iv) Income	13(4)	3.2(1)	0	64.5 (20)

Number of respondents are in parentheses,

Source: Author's compilation from responses.

Table 4.13: Attitude of farmers regarding the future of all-male tilapia

	Kadjebi District		Akwapim-North and other districts		Pooled data	
Attitude:	Frequency	Percent	Frequency	Percent	Frequency	Percent
Expand	7	77.7	13	59	2	64.5
Continue on the same scale	3	22.3	8	36.4	11	32.3
Discontinue	0	0	1	4.6	1	3.2

Source: Author's compilation from responses to questionnaires.

Table 4.14: Problems encountered by beneficiary farmers

Nature of problem:	Frequency	Percent
Non-availability of credit	31	100
Fish reproduction	15	48.4
Marketing	9	28.8
Short water retention in pond	7	22.6
Flooding	4	12.9
Poaching	2	6.4
Invasion by unwanted fish	1	3.2

Source: Author's compilation.

4.3.3. Factors affecting tilapia output: an econometric analysis

The ordinary least square (OLS) estimates of parameters employing the five models are presented in Table 4.15 From the table, the superior R^2, in addition to the overall "fit" of the double logarithmic model judged by the F-value suggests that it is the plausible explanatory model in terms of the ability to explain changes in the output of tilapia. The specified model (with t-values in parenthesis) follows:

$$\text{Ln } Y = -4.59 - 0.64 \text{ Ln } X, + 1.99 \text{ Ln } X_2 + 0.67 \text{ Ln } X_3 + 0.3 \text{ ILn } X_4 - 0.20 \text{ Ln } X_5 + 1.14 \text{ Ln } X_6 - 0.19 \text{ Ln } X_7 - 3.77 D, + 0.76D,$$
$$(-2.80)\ (-3.60)\quad (3.80)\quad (0,2)\quad (1.69)\quad (-0.95)\quad (4.62)\quad (-0.71)\quad (-7.92)\quad (2.57)$$

In the chosen model, 9 variables explained 91 per cent of the variation in all-male tilapia output. However, only five were statistically significant at both 5 and 1 per cent levels of confidence. These are the experience of the farmer, stocking density, quantity of organic manure applied, location as well as water quality.

The absolute values of the estimated production co-efficients were relatively low, indicating that the response of tilapia output to the application of supplemental input was low. The sum of all partial output (Sbj) elasticities was 0.75 indicating diminishing returns to scale.

4.3.4. <u>Allocative efficiency of production inputs</u>

Fingerling and lime as pond inputs were the only variables for which prices were readily available. Using the double logarithmic model, price efficiencies determined for these inputs revealed that for both inputs, the value of marginal product (VMP) were significantly ($P<0.05$) greater than the input price (Table 4.16). This suggests that profit from all-male tilapia culture as is being practiced could be increased by increasing the stocking density as well as the quantity of lime applied.

Table 4.15: Comparison of estimated production functions

Variable	Linear		Double Loaarithm		Semi - Loaarithm		Loaarithm - linear		Reciprocal	
	Regression Coefficient	T-value	Regression Coefficient	T-value	Regression Coefficient	T-value	Regression Coefficient	T-value	Regression Coefficient	T-value
Intercept	11.8127	0.169	-4.5935**	-2.804	-1411.4667	-2.942	3.3809	7.902	489.9142	1.501
Experience of farmer	-7.5193	-1.312	-0.6369**	-3.596	-56.655	-1.092	-0.021	-0.6	40.9351	0.219
Stocking density	1.8673	0.156	1.9939**	3.795	226.1985	1.47	0.112	1.532	-1121.323	-0.934
Acclimatization period	6.6579	0.066	1.6651	0.26	-74.4775	-0.994	0.4838	0.779	34.3851	0.995
Miscellaneous	2.8261	0.543	0.3084	1.692	50.7383	0.95	3.247	1.019	-435909.7	-0.313
Lime	-2.5539	-0.442	-0.2044	-0.948	-49.6669	-0.787	-0.0407	-1.151	422.9132	1.041
Organic manure	0.6369**	4.648	1.1362**	4.617	138.4360**	1.921	4.6294	5.522	-13901.47	-1.473
Rice bran	0.4096**	2.215	-0.1893	-0.714	28.7321	0.37	8.2971	0.733	-11665.38	-1.03
D! (location)	-137.9096**	-2.458	-3.7683**	-7.915	270.7643**	-1.941	-2.7205**	-7.923	-173.0507	-0.951
D_2 (water quality)	0.4096	0.161	0.7648**	2.566	49.8981	0.572	3.8925	0.014	-42.9377	0.305
Durbin-Watson Test	1.3606		2.6414		2.3454		1.653		2.8345	
R^2	0.85		0.97		0.88		0.81		0.66	
Adjusted R^2	0.78		0.91		0.79		0.8		0.05	
F- statistic	13.15***		17.82***		3.27***		16.96***		1.08	

"Significant at both 5 and 1 per cent

‘"Significant at V, =30 and V_2 = 9 degree of freedom.

Table 4.16: Marginal physical product, input price and price efficiencies of respondents

	Fingerlings	Lime
MPPXi	199	0.20
VMPXi	399(n=31)	60,280.60*(n=15)
PXi	302(n=31)	1,000*(n=15)
VMPXj/PXi	1.32	60.28
Input use	Increase	Increase

* Absolute values only were considered.

Mean price of 02409.70 per seven pieces and an exchange rate of 02450.00 = US $ 1.00 (September, 1998).

Source: Author's computation.

CHAPTER 5

DISCUSSION

The key findings of the study presented are discussed in the present chapter. The first part discusses the results obtained for the viability levels of the 3 pilot hatcheries. The second section centres on the assumptions and estimates underlying the investment options proposed and the final section presents a discussion of the survey results and some relevant policy issues for consideration.

5.1 Viability of pilot hatcheries

Ghana is principally a fish consuming nation with an estimated per caput consumption of 20kg compared with the world average of 13.5kg as at 1993 (Ayinla & Denyoh, 1994). The country's main local sources of fish are marine catches and to a lesser extent inland fisheries from the Volta lake, reservoirs and rivers. Pond production forms an insignificant portion of national fish sources at an estimated total of 500 tons per year (FAO, 1995). Catches from the marine and inland capture fisheries have stagnated in recent years (Fisheries Directorate, 1997). In relation to population growth , there is an indication of a decrease in fish availability for the future.

Fish production from aquaculture is regarded as a means to counter this shortfall. With an estimated 2000 farmers known to practice fish farming over an estimated area of 350 hectares and an average production of 1.0 - 1.5 tons/ha/year, Ghana has the potential to increase aquaculture production and fish availability through cultural and improved management practices (Fisheries Directorate, 1997). However, to realize this potential a myriad of constraints have to be addressed. Prominent among them is the unavailability of quality fmgerlings.

In recent years the efforts of both research and extension personnel to tackle the problem culminating in the establishment of the hatcheries is laudable. These activities have clearly demonstrated the in-country capability to adopt or assimilate the techniques involved in the production of fish fry/fingerlings artificially. The positive NPV of the Akosombo hatchery activity (Table 4.1) relative to the negative NPV of the Accra and Kumasi catfish hatchery activities suggests that in terms of viability it was only the Akosombo hatchery that attained a level worth considering as acceptable. This appears to be collaborated by the other indicators in Table 4.1: B/C ratios, IRR, PI as well as the Payback period. The same table revealed figures that cast doubts on the viability of the other two hatcheries.

Physically, the disparity in results between the hatcheries could not be readily attributed to differences in environmental factors as most conditions of climate, soil, water and other natural environmental conditions in Ghana are generally favourable for the development of hatcheries. But technically and institutionally relative differences exist between the agencies operating the hatcheries. A balance must, therefore, be fostered among the prevailing physical and technical conditions. On the one hand, the favourable environmental conditions must be capitalized upon; on the other hand, the institutional and technical constraints confronting operators of the hatcheries must be overcome so that available technology can be more widely harnessed. The seemingly poor economic indicators for the catfish hatcheries could thus, be attributed mainly to:

1. The use of imported brine shrimp *Artemia* to feed the larval stages of the catfish
2. The lack of the appropriate equipment/facilities
3. Inadequate experience on the part of the hatchery operators in the hatchery management practices.

Against the background that fish farming is still a novel concept in Ghana (with extremely weak specialized institutional set-ups) one could not expect that financial, economic and social considerations were integrated in the designing and implementation stages of these activities. Thus, while demonstrating the ability to adapt the techniques, the incorporation of additional distinct resources required for managing and putting the techniques to productive uses were not given the due considerations. These resources include among others institutional structures and linkages, expertise and experience. The accumulation of the technical capability to undertake the hatchery activities seemed not to have been treated as activities on their own rights but rather as by-products of some other activities. This is evidently supported by the absence of comprehensive financial records and forecasts, investment plans and technology assessment arrangements.

The development of fish farming like indeed all other ventures require an appreciable investment in basic supporting services (Pillay, 1987). In this regard, while it is essential that centres be established to produce adequate and quality seed for timely delivery to farmers, the resources used in the process become specialized and complex (World Bank/FAO, 1991). Therefore, economic, commercial and financial considerations are required to directly optimize investments in the sub-sector to the most efficient levels.

The low returns and/or high risks associated with these hatchery activities emphasise the need for a major effort by the public sector to intervene and create incentives for investment in fish seed production if aquaculture is to meet economic development objectives and increase the production of this relatively cheap animal protein. However, it is important to note that Public sector involvement although considerable could only be justified by the socioeconomic benefits derived by the entire community rather than the financial profits accruing to investment. Thus, the incessant requests from farmers all over the country for fmgerlings to stock waterbodies offer prospects for the strengthening of the hatcheries and to establish a long-term strategy to seed supply for aquaculture.

On the other hand, recent changes in the political and economic environment of the country (that had reduced the role of the central government in favour of decentralization and privatization) offer the opportunity for the identification of alternative channels and a reconsideration of the role of the state in fmgerling supply. The privatization of fish seed production has in many countries including Madagascar, Iran, Burundi, Rwanda and Jamaica led to major breakthroughs that have resulted in the expansion of fish farming ventures in those countries (FAO, 1998; PCARR, 1976; Hanley, 1991; Broussard & Reyes, 1985; Little *et al,* 1995; Pedini, 1996). Given the necessary encouragement and support, the private sector in Ghana could also take advantage of these relatively low-cost technologies for seed production and control of reproduction developed by government institutions to commercialize the practice. Thus, expanding the role and range of possible counterparts for aquaculture development programs.

Quite often the lacks of credit facilities have been mentioned as a factor contributing to the current low level of investment in aquaculture. The results expressed in Table 4.14 seem to support this assertion. To enhance private sector participation in fmgerling production, credit must be made available not only to small-scale fish farmers but also to the hatchery operators, along with a determined effort by the credit granting agencies to supervise the operations of beneficiaries effectively.

It would also be desirable that subsidy of some form: low interest payments, outright grants or the supply of basic site requirements (road, electricity and water supply) be made.

The results of the sensitivity analysis performed on the pilot catfish activities suggest that they are not beyond the realms of being viable. Indeed, well-planned, properly operated and financially attractive hatcheries have been reported as yielding higher return on investment than the cultivation of fish for the table (Broussard *et al,* 1983; Broussard & Reyes, 1985; Durez *et al,* 1980; Yater & Smith, 1985). It is however, important to indicate that these success cases were realized by hatcheries and nursery facilities operating to full capacity throughout the year, employing technical and management expertise crucial in taking precautionary measures and steps to minimize losses. The implications for the management of the pilot hatcheries are therefore, to rethink past strategies regarding seed production and a redefinition of their roles.

5.2. Options for the development of fish hatcheries in Ghana

The necessary investment requirements for hatchery situations were based on the assumptions of favourable conditions of price and demand for the output as well as the availability of expertise. The existing core of farmers (estimated to be about 2000) was also assumed to be an excellent base of consumers of the hatchery products.

The solely private option:

An assessment of the first option, a solely private venture with virtually no state involvement revealed a total capital requirement of about three hundred and fifty million cedis (0350,000,000.00). In dollar terms this amounts to US $143,000.00. The figure is undoubtedly substantial and accentuated the notion that fish farming activities are capital intensive (Keenum & Waldrop, 1988). Estimates of annual operating costs, assuming moderate mortalities and no marketing constraints ranged from about one hundred and forty million cedis (0140,000,000.00 being the equivalence of US$63,000.00) to three hundred and thirty million cedis (0330,000,000.00 equivalent to US$150,000.00). Based on these assumptions the unconstrained cost of producing a fingerling (either tilapia or catfish) ranged from a low of about fifty-two cedis (052.00) to a high of one hundred and ten cedis (0110.00) being less than the equivalents of US$0.02 and 0.05 respectively. Due to the absence of pertinent data comparisons could not be made. However, for the hatchery to continue to be viable, remain healthy and expand, all segments within it must generate enough revenue to cover these costs. A financial monitoring plan would therefore, be necessary towards that direction. The means of the major financial indicators NPV, ROI, IRR and Payback period as well as the B/C ratio reveal figures that were obviously, acceptable in terms of viability.

Given the factor costs used and assumptions made, the proposed private hatchery showed favourable financial returns and therefore, recommendable for adoption. However, viability in the short term does not imply long term sustainability (Dasgupta *et al,* 1972; Little and Mirrles, 1974; Elkan, 1976). Therefore, to sustain this level of viability, critical areas of concern should include financing of operations, improvement of facilities, the upgrading of technology, diversification and a collective marketing effort through cooperatives.

On the need to upgrade technology, the objective should be towards the attainment of a high level of efficiency. Fingerling production every where is not far from scientific experimental approaches (Yater and Smith, 1985). It obviously, would continue to be so for some time to come. For instance, the outcome of experiments currently on-going to achieve sex reversal by immersion of tilapia fry in androgen for just three hours on two days (Contreras-Sanchez *et al,* 1997) offers opportunities not only to eliminate the establishment of feeding hierarchies (resulting from the availability of supplemental feed and primary productivity in ponds) identified as a major source of inefficiency associated with the oral method, but also to reduce operational costs. As a diversification strategy, the hatchery managers could consider producing, on a limited scale, excess fmgerlings to food size fish. The critical assumptions underlying this proposal however, need assessment. With regard to marketing efforts, there would be the need for the hatchery managers to strengthen linkage with their clients (farmers) and formulate realistic arrangements that would programme activities on both sides; such that pond harvesting and restocking are done on regular basis.

Hatcheiy personnel would in addition have to recognize the fact that farmers occasionally encounter obstacles that pose difficulties to the marketing of food-size fish. Small-sizes of harvested fish could have significant impacts on the costs of production and therefore, become an obstacle. Little *et al* (1974) indicated that when such obstacles are ameliorated and a reduction in the gap between fingerling availability and stocking periods is attained, the socioeconomic viability of the hatchery output could be easily proven thus facilitating farmers' confidence in the hatchery activities and the acceptance of the output.

This emphasizes the need for the integration of financial, economic and social facets of the venture.

The joint state-farmer option:

An assessment of the important assumptions underlying the second option, which proposes a joint state-farmer approach to the development of backyard hatcheries across the country, revealed a capital investment of about 0900,000,000.00 (equivalent to US$370,000.00). Mean annual operating cost was about 0762,000,000 (the equivalence of US$312,000.00) whilst mean annual net income stood at about 028,000,000 (US$12,000.00). The economic analysis using discounted cashflow at a discount rate of 36 per cent showed the mean NPV was negative for the project and likewise the ERR was negative (Table 4.9). However, the NPV (Figure 4.5) showed a gentle upward trend starting in year 2 of the proposed period. A 50 per cent reduction in discount rate to 18 per cent could not render the venture viable (Table 4.10) but if the assumed fmgerling production of 30,000 per farmer per year increases by 50 per cent to 45,000 per farmer per year, the NPV increases from about 0-750,000,000 (US$-3061) to about 0240,000,000 (US$98,000.00) and the ERR from about -20.00 per cent (Table 4.9) to about 5.00 per cent (Table 4.11). Despite these improvements there was no indication of the cash inflows being capable of paying back the cash outflows in the immediate future.

The seemingly poor economic indicators could be attributed to the relatively high recurrent expenditure as well as the investment to be incurred in the training schedule (Table 4.6). When the government invests in a project, which benefits a particular sector of society, in this case, tilapia fmgerling producers, the unrecovered cost is subsidized by other sectors of the economy. The government however, could recover the cost of the project by improving the economic efficiency through sustained research and development efforts. An alternative action of the government in this case of fmgerling production is to concentrate on catfish fmgerling production by maintaining the pilot-scale hatcheries for research, training and extension purposes. The fish fry produced can then be sold to the private hatchery operators for nursing to fmgerling size using local cost-effective feedstuff. Non-quantifiable benefits to be derived from the joint state-farmer approach include:

1. The strengthening of the horizons and perspectives of farmers that could lead not only to improvement upon quantity but also quality of stocking materials.

2. The provision of wider and more varied career path that could create specialized employment avenues to fish farmers and fishery professionals to substantially increase fish output from culture sources. "x

3. The strengthening of linkages between stakeholders in aquaculture nationwide.

4. The strengthening of institutional set-up and programs to reduce the incidence of contamination of fish seed and there by enhance sound fisheries management regime and environmental quality.

5. The availability of fmgerlings, the basic input in aquaculture, could result in an increase rate of adoption of the practice especially among rural farming households. That being the case, rural food security objectives could be appreciably enhanced.

Under the two options being proposed the main chances of undesirable events that could hamper the anticipated benefits are of biological, financial and institutional nature. The survival of fish and the timing of reproduction have been moderately assumed. Nevertheless, the life of fish could be adversely or favourably influenced by unforeseen factors such as the quality of water (Boyd, 1984). The financial risks include unpredictable price increases especially of cost factors, exchange rate fluctuations and a shortage of counterpart funds where foreign loans are involved. Institutional risks relate to the capacity of stakeholders in aquaculture; it is weak relative to the task at hand and although the second option seeks to tackle aspects of it, changes in management and administrative processes and culture may not occur at the pace assumed. Therefore, irrespective of the option(s) chosen the appropriate steps have to be taken to ameliorate, to the barest minimum, the adverse effects of these factors. Furthermore, it must be emphasized that this section of the study represents an attempt to provide a techno-economic guide to the economics of establishing fingerling production units. It is of utmost importance that the investor undertakes a full-scale technical and economic feasibility study into the proposed venture, taking into account the use of factor costs relevant to existing situations, types of machinery to be used and the choice of pricing among others.

5.3 A review of the activities of beneficiary farmers

The survey showed that most of the respondents began fish farming after the training organised by the Water Research Institute and the two Non-governmental organizations: the African Centre For Human Development (Sankofa) and the Ghana Rural Reconstruction Movement (GHRRM). Against the backdrop of an absence of fish culture tradition, the selection, siting and construction of ponds could be considered generally as being satisfactorily done. However, it was apparent in same instances, that mechanical equipment was required for the construction of typical ponds appropriate for the particular topographic settings. The cost of such mechanical equipment was clearly beyond the means of the respondents. As an incentive to retain these farmers and therefore, establish a competent core of fish farmers, government and donor investments in aquaculture could be channeled into the provision of a central pool of the requisite equipment and the training of extensionists. There is also a need to consolidate gains so far attained through further training sessions. Furthermore, to promote rural small-scale aquaculture the focus of future training should not only be on a few selected farmers but the local community as a whole through demonstrations in small ponds established for such purposes in local elementary and Secondary Schools (Kent, 1986).

Under our fragile socioeconomic and environmental conditions, external inputs farming have increased risks associated with agricultural activities rather than reducing them (Lightfoot and Noble, 1992). Consequently, training of the type being advocated should be tailored as to enable trainees glean useful information devoid of the reliance on expensive external and often non-renewable inputs. At the same time, it is important that an oversimplified training programme does not compromise the fundamental principles of fish farming. An alternative approach would be to develop a protocol for enabling trainees to experiment in designing resource management systems that are appropriate to their local environment.

On the use of the hatchery fingerlings, most of the farmers expressed their satisfaction. In addition to the provision of stocking material at the time required, respondents were of the view that risks and costs otherwise associated with obtaining fingerlings from the wild or other ponds were reduced. Most of the farmers also expressed satisfaction with the size range of fish harvested. With these favourable responses and judging from the number in favour of expanding upon their operations in the immediate future, it could be deduced that the use of the seed was beneficial to the farmers. Thus, there was an indication of a high suitability for adoption (of he hatchery output) by small-scale fish farmers. Despite these advantages, a major constraint identified was the fact that reproduction occurred in the otherwise "all-male" stock.

Almost half (48.8 per cent) of the total number of respondents expressed this concern. What was not amply clear however, was whether the reproduction observed could be attributed to the hatchery operations or to the lack of proper screening of water on the part of the farmers. However, the fact that most respondents (61 per cent) had at least an inlet valve casts some-level of doubt on the quality of the seed. Although one could deduce from the responses that marketing was not an impediment, the fact that reproduction of some degree occurred should be of concern to the hatchery workers since the masculinization process could have resulted in success rates that were less than the acceptable 98-100 per cent (Buddie 1954; Owusu-Frimpong and Nijhar, 1981).

On the other hand, faulty screen installation and/or poor cultural practices (especially as evidenced by the absence or inadequate application of pond inputs (Figures 4.6 and 4.7) could have contributed to the small sizes of fish observed in the ponds. Coupled with these possibilities, an extended period of cultivation beyond 7-8 months could have aggravated the situation where the sexes have been inadvertently mixed. These could be reasons for the small sizes of fish harvested, but to confirm them would require tested and proven on-station research findings and recommendations. Another constraint expressed by all respondents although not directly connected with the use of seed from the hatchery, was the lack of credit facilities. To boost their activities, subsidies of some form would be desirable.

In terms of profitability, only four (4) of the nineteen (19) farmers studied registered positive returns. The positive rates of return on operating costs varied from 0.18 to 0.98 per cent. These were low by any standard, however, for farmers financial costs and benefits are not the only relevant parameters for the choice of methods or techniques as profit maximization is usually not the ultimate goal (Ruerd and Heerink, 1995). Other less tangible economic benefits that should be valued include the reduction of risk (through diversification), less dependence on markets to guarantee household food security, reduced credit demand and several cultural gains that contribute to household utility. A composite index of household utility that would account for these additional factors might be the most appropriate to effectively evaluate the acceptance or otherwise of the seed input by the farmers.

5.3.1. Factors affecting tilapia output: an econometric approach

The double logarithmic function estimated for the "all-male" tilapia culture in ponds could explain 91 per cent of the variation in output. Of the 9 explanatory variables hypothesized to explain the variation in fish output, five were statistically significant at both the 0.05 and 0.01 per cent. The model revealed that experience of farmers, stocking density, quantity of manure applied, location and water quality significantly influenced tilapia output. The absolute values of the estimated production coefficient were generally low indicating a low response of tilapia output to the inputs employed.

A discussion of the significant and insignificant explanatory variables as they highlight the potential strengths and weaknesses of the farmers follows:

Experience of farmer(Xi):

An inverse relationship was shown between the experience of respondents and variation in fish output. Although the observation was surprising, experience used within this context, was a proxy variable for management ability based primarily upon technical know-how and not on traditional methods or years of cultivation. To an extent therefore, the need for more information on the technique as well as increased use of supplementary inputs was highlighted.

Fingerling (X_2):

Stocking density was significant in explaining tilapia output. This was expected as fmgerlings are the basic inputs in the production of fish. The estimated production coefficient for tilapia fingerling was 1.99. This implied that for every 1.0 per cent increase in fmgerling stocking an approximately 2.0 per cent increase in tilapia could be expected assuming all other factors are held constant.

Organic manure (X<$):

The absolute figure of the production coefficient (1.14) for the input was quite small although significant and seemed to imply that the application of manure was not widely practiced or where it was used the quantities were not enough to influence fish yield in an appreciable manner. The application of appreciable quantities of manure is therefore, recommended.

Location (Dj):

The dummy variable representing location was significant, implying that differences in tilapia production existed between farmers within the two demarcations: study areas A and B. Although each of the geographical areas had peculiar advantages and limitations, the scope was available for tilapia farmers in these locations to increase materially their po ıd yields by using larger quantities of inputs.

Water quality (D_2):

Favourable environmental conditions (usually manifested in pond water colour: green) as expected was significant in explaining the variation in yield. The low level of the parameter could probably be attributed to the limited extent of the factor. Field information dissemination to upgrade farmers' knowledge on the need for an increase rate of pond fertilization to create favourable pond conditions is therefore, essential.

Insignificant variables:

An insignificant variable is one for which the coefficient is not significantly different from zero. Increases in those factors would therefore, have no significant impact on output.

Acclimatization period (X_3):

The young tilapia are certainly affected by factors within their immediate surroundings. Thus, shocks that could result from differences in the water quality or transporting medium could lead to unnecessary stress. One would therefore, expect that the number of hours of acclimatization during which they recover from shocks or stress would help to explain output variation. The insignificance of the coefficient implied that the number of hours may not have measured the required process adequately. It could also be speculated that the process of acclimatization may not have been properly undertaken by the farmers.

Miscellaneous costs(X_4):

The insignificance of miscellaneous costs on the basis of the estimated production coefficients could have originated from the fact that respondents could not accurately recall the expenses incurred. For example, most respondents did not consider the cost of food provided to hired labourers as cost nor did they consider minor repairs undertaken on ponds as worth recording or even valuing. It could also be argued that miscellaneous costs was narrowly defined, and did not include other important additional expenditure. Miscellaneous costs, in fact, would have a significant effect on output if accurately measured.

Lime (X_5):

The application of lime to enhance soil fertility and to protect tilapia stocked from diseases had no significant effect on the yield. While disease infection could not possibly be a threat at the current level of production, the degree of water fertility was not scientifically determined. Hence, one could not conclusively deduce that the incorrect or low levels of lime application had partly contributed to it's insignificance.

Rice bran (X_7):

As the major supplemental feed input employed by all respondents, the use of rice bran was expected to significantly influence yield. The insignificance of the coefficient therefore, brought into disrepute the nutritional value of rice bran as an appropriate feed for pond fish culture.

The sum of all partial outputs (Sb,=0.75) indicated diminishing returns to scale. Thus, while one input was being increased, the simultaneous increase expected for all other factors failed to occur (that is a movement along the same production function). The implication is that if the farmers switched to the use of larger quantities of all supplemental material inputs, output would likewise be increased as all factors would then move up to a new production frontier.

Using the double logarithmic model, the estimates of price efficiencies revealed that fmgerlings and lime were used inefficiently. The values of their marginal physical products (VMP) were greater than their respective prices. The implication therefore, is that increasing either the stocking density or the application rate of lime could still increase profits from all-male tilapia culture. There is thus, the scope for further increasing the production of tilapia in ponds. There is also an indication that given the current prices of inputs and output, increasing the stocking density, the rate of lime application and indeed the rate of quality feed input would increase the economic efficiency of tilapia production operations. However, given the subsistence nature of tilapia farming in the country, increased use of commercial inputs may not only be unsustainable but also unaffordable to rural farmers. Input support and credit facilities may enable fish farmers to exploit further the production and income from tilapia aquaculture.

5.4. Policy implications

From the available information, the main issues for aquaculture policy in Ghana include the following:

1. Fish production locally from natural waters has stagnated at about 350.000 metric tonnes (fluctuating between 320.000 and 420.000 metric tones) per year.

2. Population is increasing at a rate of 3.0 per annum. The population of Ghana is now at 18.4 million (ISSER. 1999). As a result, per fish consumption which stood at 35 kg/year

at the time of independence (in the mid-1950s) declined to about 20kg/year by the late 1990s and is further declining.

3. Fish represents 60 - 70 per cent of total animal protein intake in the diet of many Ghanaians.

4. In Ghana 68 per cent of the population are in the rural areas; 51 per cent are females and 56 per cent are children under 18 years of age (ISSER, 1999). The majority of the population is therefore vulnerable to poverty and malnutrition.

5. Fish farming at the smallholder level has begun expanding as a result of interest generated by government agencies, non-governmental organizations (NGOs) and individuals since the 1980s. The number of smallholder fish farmers is now over 2000 and indications are that it will continue to increase.

6. Aquaculture expansion in the smallholder sector has not resulted in any significant increase in fish supply. For instance, total production that stood at 500 tons in 1995 has not changed by 1998 (Directorate of Fisheries. 1998). Smallholder aquaculture seems unlikely to significantly supplement declining capture fisheries. Aquaculture policy should therefore promote fish farming as a source of income, high value protein and also as a source of employment for the rural poor.

7. Results obtained so far indicate that fish fanning could be economically viable at the smallholder level and could be profitable at semi-intensive to commercial levels if prices of inputs were reduced and productivity increased.

8. There is need to know what motivates farmers to take up fish farming: the role of gender is especially important in this regard.

Clearly, aquaculture cannot be left to evolve over time under essentially laissez-faire conditions.
For the purposes of this study, the following issues are presented for consideration in future policy:

1. As aquaculture develops, more farmers dig ponds and probably estate type (commercial) fish farming gets developed the demand for inputs of various kinds will increase. The issue of quality fish seed for stocking will become very important. This need to be specially considered in future policy.

2. As it is government policy to alleviate poverty and expand employment opportunities for the rural population, the only way aquaculture can contribute significantly towards this objective is through substantial increases in fish production from culture sources. Government policy strategies should therefore emphasize the promotion of aquaculture production at all levels (smallholder, semi-intensive and commercial). This will ensure economic growth, reduce poverty and enhance nutritional quality standards for human development.

3. Aquaculture development in Ghana can take place when adequately trained and motivated people are available. Since it is also government policy to improve upon manpower resource development, aquaculture development policies must include aspects of staff development in terms of training and promotional opportunities.

4. The need for government fisheries agencies to involve themselves in international cooperation cannot be over-emphasized. The agencies are already cooperating with some international organizations all of which shall be of importance in the development of aquaculture in the country. For this purpose therefore aquaculture policies for the future should highlight this as an important issue.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

The development of aquaculture in Ghana rests on a well-planned and coordinated action to solve the major constraints to the orderly and rapid progress of the industry. Although the technical aspects of aquaculture have been and continue to be discussed by experts, planning of the industry in the country has not received more than a cursory attention.

The present study has provided an evaluation of a basic and important requirement of the industry: hatcheries to produce fmgerlings for farmers. It has been shown that, in all except one, the activities of the pilot hatcheries were not viable. Two approaches were therefore, proposed for redirecting hatchery development in the country. The merits and demerits of each approach were assessed and discussed. To expect a nation with a long aquaculture tradition to develop viable hatcheries is a definite possibility. However, to expect another nation with no such tradition to attain a similar level is perhaps, a little optimistic. To ensure that the less experienced country attained at least the minimum level of viability, the following are recommended:

1. **A** refocusing of research and training programs at all levels to cater for the option(s) advocated.

2. The development of stocks better suited for local conditions and management to maintain genetic integrity in the light of potential fish transfers.

3. Efforts to ensure all year round supply of quality fish seed.

4. Inclusion of aquaculture objectives in national and international agricultural seed development funding programs or projects.

5. The strengthening of technical manpower, provision of equipment and other logistics to facilitate hatchery production and delivery of fmgerlings to farmers.

Above all, the relevant state institutions should take advantage of studies of this nature in prescribing feasible policy recommendations based on substantial empirical evidence rather than on political aspirations.

As a group, the beneficiaries of the pilot tilapia hatchery output appear to have built on one of their strengths: knowledge of aquaculture acquired from the training of the Water Research Institute (WRI) and the Non-Governmental Organizations. In general, they have adopted fish culture in earthen ponds based mainly on monoculture of all-male tilapia *(Oreochromis niloticus)* at moderate densities and irregularly fed with poor quality but locally available food material. Commercial feed plus other essential inputs were used on trial basis.

Thus, although the hatchery-produced fingerlings have gained acceptance by the farmers, the availability of feeds and appropriate feeding strategies appeared to be key problems. To maintain and extend the progress attained so far, some constraints need to be addressed on an on-going basis. In this regard, a project dealing with nutrition and feeding to offer alternative non-conventional methods for feeding cultured fishes at lower cost needs to be pursued for the purpose of aquaculture development.

Other measures recommended are:

1. Regular training courses for fish farmers to broaden not only their understanding of the concepts involved but also to facilitate records keeping.

2. On-farm and on-station research programs to refine upon current practices.

3. The broadening of credit facilities to cater for fish farmers.

4. The strengthening of extension services to provide tested and proven technical information on production systems and their management.

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APPENDICES

APPENDIX 1: Technical Data from hatchery managers

I will be grateful if you could indicate the following:

Broodstock

The number of matured individuals used as broodstock male..female

Number of fmgerlings per spawning period of fish.......................................

Number of spawning cycle(s) per year.......................................

Stocking density in the hatchery..

Survival rate in the hatchery...

Pricing

How often are fmgerlings available in the hatchery per year?

What is the prevailing /current price of fingerling?..............................

How is the price of fingerling determined?

Bidding...

Dictated by seller..

Dictated by buyer..

Other...

Indicate the total number of customers and their approximate requests for fmgerlings.

....(number of farmers).

....(number of fmgerlings).

TIME ALLOCATION FOR HATCHERY OPERATION

(a) Percentage of time spent on hatchery activities by

Senior Officer... (Percentage).............................. (number)

Junior Officer .... (Percentage).............................. (number)

Assistant .... (Percentage).............................. (number)

(b) Basic Salary (per annum)

(i) Senior Officer.. (Percentage).............................. (number)

Junior Officer .... (Percentage).............................. (number)

Assistant .... (Percentage).............................. (number)

OR:

Salary paid (from project funds) to

Senior Officer:....................................

Junior Officer:...................................

Assistant:..

Coordinator/Manager:.........................

Administrative Assistant:.....................

Clerk:...

Driver:...

/VriTJMJIA Z

4.0 CAPITAL OUTLAY FOR HATCHERY OPERATIONS LOCATION:

Item	YEAR..............................			YEAR..............................			YEAR			YEAR			YEAR		
	Qly.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cos
			t		i	0		*	i			0		*	t
A. Infractructures:															
Land (m2)															
Caretaker's house															
Concrete tank (tons)															
Floating cage (m3)															
Perimeter fencing (m)															
Elevated water tanks															
Hatching tanks															
Shed for larval tank (m2)															
Tank cover															
Aeration system: - Blower...mode; kw....units, - Aeration piping (airlines, valves, airstones, hoses etc.)															
Water system:- Pump............hp, - Water lines, - Well															
Reservoir............................... tons															
Filteration system															
Power System; - Generating se...KVA, - Electrical lines															
Perimeter lightening															
Other (indicate)															
B. Equipment:															
Vehicle															
Balance............................Model															
Weighing Scale						$		J!v							
Thermometers						ts									
Dissecting Set							J	t'4							
Wire cutter or sharp knife								&							
Working Table															
Mortar															
Water Analysis kit															
Others (indicate)															
Grand Total of Capital Cost per Year															

5.0 OPERATING EXPENSES OF... HATCHERY OPERATIONS LOCATION:.

Item	YEAR....................			YEAR.................			YEAR.................			YEAR...............			YEAR...............		
	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost	Qty.	Unit Cost	Total Cost
		¢	¢		¢	¢		¢	¢		¢	¢		¢	¢
A. Materials and Supplies															
Fish Stock															
Feed															
Feed															
Fertilizer															
Artemia															
Hormones															
Chemicals															
Nettings															
Ruler															
Tray															
Towel															
Polybag															
Canules															
Syringes and Needles															
Glassware															
Brushes															
Twines, ropes, etc.															
Others (indicate)															
B. Labour															
Senior Officer															
Junior Officer															
Aide															
C. Project Coordination/Management															
- Coordinator/Manager															
- Administrative Asst.															
- Clerk															
- Driver															
D. Power															
Fuel															
Water															
Repairs and maintenance															
Miscellaneous															
Grand Total of Capital Cost per Year															

APPENDIX 3a

CASHFLOW FOR THE THREE HATCHERIES

Benefit/Cost computation comparing gross benefit with gross cost; Akosombo Tilapia hatchery operation (in cedis)

YEARS	CAPITAL ITEMS	OPERATION & MAINTENANCE	GROSS COST	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%	GROSS BENEFIT	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%
0	2,727,000.00	17,166,255.00	19,893,255.00	0.735	14,621,542.00	30,240,000.00	0.735	22,226,400.00
1	1,175,000.00	19,456,238.00	20,631,238.00	0.541	11,161,500.00	33,264,000.00	0.541	17,995,824.00
2	3,070,000.00	21,611,021.00	24,681,021.00	0.398	9,823,046.00	36,590,400.00	0.398	14,562,979.00
3	650,000.00	23,682,171.00	24,332,171.00	0.292	7,104,994.00	40,279,680.00	0.292	11,761,667.00
4	1,207,000.00	26,110,686.00	27,317,686.00	0.215	5,873,302.00	44,271,360.00	0.215	9,518,342.00
5	2,075,000.00	27,988,748.00	30,063,748.00	0.158	4,750,072.00	48,686,400.00	0.158	7,692,451.00
6	770,000.00	30,770,130.00	31,540,130.00	0.116	3,658,655.00	53,585,280.00	0.116	6,215,892.00
7	912,000.00	33,315,976.00	34,227,976.00	0.085	2,909,378.00	58,968,000.00	0.085	5,012,280.00
8	1,181,700.00	37,229,388.00	38,411,088.00	0.062	2,381,487.00	64,834,560.00	0.062	4,019,743.00
9	1,069,870.00	40,949,795.00	42,019,665.00	0.042	1,764,826.00	72,576,000.00	0.042	3,048,192.00
Total	14,837,570.00	278,280,408.00	293,117,978.00	2.644	64,048,802.00	483,295,680.00	2.644	102,053,770.00

Benefit/Cost ratio (B/C) 102,053,770/64,048,802=1.59

Net Present Value (NPV) 102,053,770-64,048,802=38,004,968.00

APPENDIX 3b

Benefit/Cost computation comparing gross benefit with gross cost; Kumasi Catfish hatchery operation (in cedis)

YEARS	CAPITAL ITEMS	OPERATION & MAINTENANCE	GROSS COST	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%	GROSS BENEFIT	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%
0	10,080,000.00	4,696,064.00	14,776,064.00	0.735	10,860,407.00	130,000.00	0.735	95,550.00
1	2,268,000.00	7,989,600.00	10,257,600.00	0.541	5,549,361.00	429,000.00	0.541	232,089.00
2	1,860,000.00	6,979,220.00	8,839,220.00	0.398	3,518,010.00	471,000.00	0.398	187,458.00
3	484,000.00	7,410,440.00	7,894,440.00	0.292	2,305,176.00	519,000.00	0.292	151,548.00
4	440,000.00	10,112,252.00	10,552,252.00	0.215	2,268,734.00	570,000.00	0.215	122,550.00
5	260,000.00	6,665,462.00	6,925,462.00	0.158	1,094,223.00	630,000.00	0.158	99,540.00
6	432,000.00	7,283,000.00	7,715,000.00	0.116	894,940.00	690,000.00	0.116	80,040.00
7	277,000.00	8,059,054.00	8,336,054.00	0.085	708,565.00	759,000.00	0.085	64,515.00
8	474,000.00	8,614,955.00	9,088,955.00	0.062	563,515.00	834,000.00	0.062	51,708.00
9	290,000.00	9,751,878.00	10,041,878.00	0.042	421,759.00	918,000.00	0.042	38,556.00
Total	16,865,000.00	77,561,925.00	94,426,925.00	2.644	28,184,690.00	5,950,000.00	2.644	1,123,554.00

Benefit/Cost ratio (B/C) 1,123,554/28,184,690=0.04

Net Present Value (NPV) 1,123,554-28,184,690= -27,061,136

APPENDIX 3c

Benefit/Cost computation comparing gross benefit with gross cost; Accra Catfish hatchery operation (in cedis)

YEARS	CAPITAL ITEMS	OPERATION & MAINTENANCE	GROSS COST	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%	GROSS BENEFIT	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%
0	1,708,377.00	2,331,184.00	4,039,561.00	0.735	2,969,077.00	2,400,000.00	0.735	1,764,000.00
1	2,500,000.00	3,258,614.00	5,758,614.00	0.541	3,115,410.00	2,400,000.00	0.541	1,298,400.00
2	220,000.00	3,230,362.00	3,450,362.00	0.398	1,373,244.00	2,400,000.00	0.398	955,200.00
3	1,935,960.00	3,851,202.00	5,787,162.00	0.292	1,689,851.00	4,800,000.00	0.292	1,401,600.00
4	8,075,700.00	4,367,000.00	12,352,000.00	0.215	2,675,181.00	9,600,000.00	0.215	2,064,000.00
5	478,500.00	5,873,500.00	6,352,000.00	0.158	1,003,616.00	10,560,000.00	0.158	1,668,480.00
6	573,500.00	6,317,200.00	6,890,700.00	0.116	799,321.00	11,616,000.00	0.116	1,347,456.00
7	333,200.00	6,836,299.00	7,169,499.00	0.085	609,407.00	12,768,000.00	0.085	1,085,280.00
8	431,050.00	7,164,811.00	7,595,861.00	0.062	470,943.00	14,064,000.00	0.062	871,968.00
9	255,000.00	7,468,077.00	7,723,077.00	0.042	324,369.00	15,456,000.00	0.042	649,152.00
Total	16,511,287.00	50,698,249.00	67,209,536.00	2.644	15,030,419.00	86,064,000.00	2.644	13,105,536.00

Benefit/Cost ratio (B/C)	13,105,536 /15,030,419=0.87
Net Present Value (NPV)	13,105,536-15,030,419= 1,924,883

APPENDIX 3d

Benefit/Cost computation comparing gross benefit with gross cost employing an improved survival rate (65%) for the Accra hatchery operation (in Cedis)

YEARS	CAPITAL ITEMS	OPERATION & MAINTENANCE	GROSS COST	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%	GROSS BENEFIT	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36°,
0	1,708,377.00	2,331,184.00	4,039,561.00	0.735	2,969,077.00	2,836,363.00	0.735	2,084,727.00
1	2,500,000.00	3,258,614.00	5,758,614.00	0.541	3,115,410.00	2,836,363.00	0.541	1,534,472.00
2	220,000.00	3,230,362.00	3,450,362.00	0.398	1,373,244.00	2,836,363.00	0.398	1,128,872.00
3	1,935,960.00	3,851,202.00	5,787,162.00	0.292	1,689,851.00	5,672,726.00	0.292	1,656,436.00
4	8,075,700.00	4,367,000.00	12,442,700.00	0.215	2,675,180.00	11,345,454.00	0.215	2,439,273.00
5	478,500.00	5,873,500.00	6,352,000.00	0.158	1,003,616.00	12,480,000.00	0.158	1,971,840.00
6	573,500.00	6,317,200.00	6,890,700.00	0.116	799,321.00	13,728,000.00	0.116	1,592,448.00
7	333,200.00	6,836,299.00	7,169,499.00	0.085	609,407.00	15,098,454.00	0.085	1,283,369.00
8	431,050.00	7,164,811.00	7,595,861.00	0.062	470,943.00	16,621,090.00	0.062	1,030,508.00
9	225,000.00	7,468,077.00	7,693,077.00	0.042	323,109.00	18,266,181.00	0.042	767,180.00
Total	16,481,287.00	50,698,249.00	67,179,536.00	2.644	15,029,158.00	101,721,084.00	2.644	15,489,125.00

Benefit/Cost ratio (B/C) 15,489,125/15,029,158=1.03

Net Present Value (NPV) 15,489,125 - 15,029,158=459,967.00

APPENDIX 3e

Benefit/Cost computation comparing Gross benefit with Gross cost, employing an improved survival rate (80%) for the Accra hatchery operation (in cedis)

YEARS	CAPITAL ITEMS	OPERATION & MAINTENANCE	GROSS COST	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36%	GROSS BENEFIT	DISCOUNT FACTOR AT 36%	PRESENT WORTH AT 36c
0	1,708,377.00	2,331,184.00	4,039,561.00	0.735	2,969,077.00	3,490,909.00	0.735	2,565,818.00
1	2,500,000.00	3,258,614.00	5,758,614.00	0.541	3,115,410.00	3,490,909.00	0.541	1,888,582.00
2	220,000.00	3,230,362.00	3,450,362.00	0.398	1,373,244.00	3,490,909.00	0.398	1,389,382.00
3	1,935,960.00	3,851,202.00	5,787,162.00	0.292	1,689,851.00	6,981,818.00	0.292	2,038,691.00
4	8,075,700.00	4,367,000.00	12,442,700.00	0.215	2,675,180.00	13,963,636.00	0.215	3,002,182.00
5	478,500.00	5,873,500.00	6,352,000.00	0.158	1,003,616.00	15,360,000.00	0.158	2,426,880.00
6	573,500.00	6,317,200.00	6,890,700.00	0.116	799,321.00	16,896,000.00	0.116	1,959,936.00
7	333,200.00	6,836,299.00	7,169,499.00	0.085	609,407.00	18,571,636.00	0.085	1,578,589.00
8	431,050.00	7,164,811.00	7,595,861.00	0.062	470,943.00	20,456,727.00	0.062	1,268,317.00
9	225,000.00	7,468,077.00	7,693,077.00	0.042	323,109.00	22,481,454.00	0.042	944,221.00
Total	16,481,287.00	50,698,249.00	67,179,536.00	2.644	15,029,158.00	125,183,998.00	2.644	19,062,598.00

Benefit/Cost ratio (B/C) 19,062,598/15,030,419=1.27

Net Present Value (NPV) 19,062,598 - 15,030,419= 4,032,179

T. IUUIO IUI VU^IUIUI^ .ransporting broodfish

Description	Quantity	Unit cost (₵)	Total cost (₵)
1. A battery of fishing net (Drag net)	1	1,000,000	1,000,000
2. Satchel (gray baft) for short distance transport of fish		1,000	4,000
3. Scoop net (various sizes)	5	2,000	10,000
4. Styrofoam-lined box and plastic (for long distance transportation of fish)	4	10,000	40,000
5. Oxygen supply facility	2	250,000	500,000
6. Weighing balance	1	568,100	568,100
7. Towels	24	4,500	57,600
Total			2,179,700

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Description	Quantity	Unit cost (₵)		Total cost(₵)	
1. Hypodermic syringes with needles	30	150		4,500	
2. Porcelain mortars and pestles	2	85,600		171,200	
3. Rubber bottle 100-200ml for saline	10	-		22,800	
4. Measuring cylinders	assorted	-		200,000	
5. Tagging gun	2	10,000		20,000	
6. Cotton anaesthetizing bag	10	500		Svfg^'000	
			$	\ O	
7. Beakers	assorted	-	v^V xg>)m		8O0
8. Plastic buckets	10	7,000		70,000	
9. Wooden foldable table with rubber mat attached	4	6,000		24,000	
10. Saw	1	35,600		35,600	
11. Balance (for chemicals, glands and others)	1	522,100		522,100	
12, Dissecting set	2	110,200		220,400	
Total				1,781,400	

APPENDIX 6: Cost of tools for stripping and fertilization

Description		Unit cost (0)	TotalcostQS)
1. Bowls (plastic) 2.5 1	20	3,000	60,000
2. Buckets (plastic) 10-201, graduated)	10	5.000	50,000
3. Pipettes (milt collection)	500		58,000
4. Spoons(plastic)/ feathers(for mixing sexual product)	10	200	2,000
5. Mugs, graduated plastic	24		9,775
6. Straining spoon	10	600	6,000
7. Knives	5	2.000	10,000
8. Funnels (assorted)	10	600	6,000
Total			202,425

APPENDIX 7: Cost of tools for fish egg incubation, larval rearing and fry nursing

Description	Quantity	Unit cost (0)	Total cost(0)
1. Scoop (Polyethylene)	10	1,000	10,000
2. Tubing of suitable diameter	15		18,800
3. Tubing connectors	10	-	27,000
4. Dip net (100,200 & 250mm mesh sizes)	4	15,000	60,000
5. Thermometers	10		51,865
6. Fine brushes(for cleaning incubators and larva rearing devices)	5	500	2,500
7. Strong brushes(for scrubbing and cleaning basins)	5	1,000	5,000
8. Meshnets(0.3,0.5,0.7mm)	3 x 1.0 mt.	10,000	30,000
9. Mosquito net	3	36,000	108,000
10. 0.5-2.01 Strainer (for estimating number of young fish)	5	3,000	15,000
Total			328,565

APPENDIX 8: Cost of tools for collecting, handling and storing pituitary glands

Description	Quantity	Unit cost(0)	Total cost(0)
1.Wooden support or frame (for holding fish head while cutting)	4	1,000	4,000
2.Tweezers or forceps	4	1,500	6,000
3.Phials with cork (to collect glands in acetone)	10	-	12,000
4. Cotton	4	2,000	8,000
5.Polycarbonate vacuum dessicator and accessories (for storing acetone dried pituitary glands)	1	348,000	348.000
Total			378.000

APPENDIX 9

A. Cost of tools for collecting and transporting young fish (j ust-feeding fry, advanced fry and fmgerlings)

Description	Quantity	Unit cost(^)	Total cost(jzS)
1. Plastic bag	1	50,000	50,000
2. Twine	2	1,000	2,000
3. Dip net(mesh sizes 200,250)	2	5,000	10,000
Total			62,000

B: Cost of equipment for sex-reversal of tilapia fry

Description	Quantity	Unit cost(0)	Total cost(0)
1. Spraying gun	1	65,000	65,000
2.Trays (for drying prepared feed)	10	5,000 *gf* \	50,000
Total			& 115,000

C: Cost of equipment for hatchery Arte<u>mi</u>a eggs

Description	Quantity	Unit cost(0)	Total cost(0)
1 .Plastic one ton conically-shaped tank	2	300,000	600,000
2.PVC components		100,000	100,000
3.Aeration system		50,000	50,000
Total			750,000

APPENDIX 10: Cost of elements of the main operating systems

Equipment Quantity	Unit cost(0)	Total cost(£
1.Water system:		
Reservoir 2	500,000	1,000,000
Well 2	800,000	1,600,000
Pump 1	1,340,000	1,340,000
Waterlines 15mt x 10	8,500	85,000
Connectors 100	500	50,000
Filteration device 1	500,000	500,000
2. Aeration system:		
Blower and accessories 1	3,700,000	3,700,000
Piping(airlines,valves, airstones,others)	100,000	100,000
3. Power system:		
Generator set 1	1,600,000	1,600,000
Electrical lines	200,000	200,000
Electrical gadgets	100,000	100,000
Perimeter lightening	500,000	500,000
4. Fire extinguishing system	100,000	100,000
Total		10,875,000

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	Number	Unit annual salary(0)	Total annual salary(0)
A. Human resource			
Manager	1	6,952,408	6,952,408
Production supervisor	1	4,949,962	4,949,962
Skilled labour	2	4,949,962	9,899,962
Semi-skilled labour	4	4,442,985	17,771,940
General duties (secretarial,book-keeping, purchase and supply)	1	2,986,534	2,986,534
Security	3	2,021,75	6,065,625
Driver	1	1,918,191	1,918,191
Messenger/cleaner	1	1,732,421	1,732,421
Social security contribution @ 20 per cent of total salary			
Perquisities @ 20 per cent total salary		-	10,051,026
B Advertisement		-	5,000,000
C.Operating expenses			
Fish stock			5,500,000
Feeds		-	10,000,000
Artemia	36	103,500	3,726,000
Chemicals (Table 12)			6,308,275
Bills -Water			600,000
-Electricity			2,000,000
Fuel,oil,grease		-	4,000,000
Repairs and maintenance		-	5,000,000
Vehicle operating cost (Table 12)		-	14,970,000
Rent (office & store)		.	4,000,000
Office equipment		-	6,000,000
Laboratory services		.	2,000,000

operating cost	-	35,120,833
Contigencies 5 **percent**	■	8,780,208
Total		185,404,373

1 .Fuel consumption per day	**^ gallons.**
2.Number of working days per breeding season	**140 days**
3.Total annual fuel consumption	**6 x 140 ga .**
rpi r Therefore, annual'fuel cost	**=6 x 140 x 3400 (diesel)**
4.0il and lubricants @ 25 per cent annual fuel cost	**- 714,000**
5.Maintenance and repairs @ 25 per cent of historical cost of vehicle	**- 10,000,000.00**
6.1nsurance @ 1 per cent historical cost of vehicle	**-500,000.00**

--- - „3d for use in the hatchery

Name	Quantity	Unit cost(0)	Total cost(0)
1. Common salt	1kg	500	500
2. Carbamide	500g	163,990	163,990
3. Tannin	500g	51,635	51,635
4. Formalin	Igal.	73,485	73,485
5, Malachite green	500g	232,645	232,645
6. Copper sulphate	6 x 500g	67,045	402,270
7. Copper oxychlorine	1kg	142,715	142,715
8. Potassium permanganate	1kg	66,930	66,930
9. Ethyl alcohol	4 x 2 1	52,210	208,840
10. Absolute alcohol	3 x 2.51	125,000	375,000
11. Acetone	4x 11	19,608	78,430
12. Quicklime	1kg x 500	1000	500,000
13. Organic phosphoric acid esters	Img x 2	248,055	496,110
14. Oxytetracycline	lOOg x 2	138,230	276,460
15. 17-methyltestoterone	lOOg	42,100/g	421,000
16. Quinaldine/Chinaldin	500mL	357,995	357,995
17. MS 22	2 x 250g	405,605	811,210
18. Alkaline pro tease enzyme	1 x 5mg	649,060	649,060
19. Fertilizers	20 bags	50,000	1,000,000
Total			6,308,275

APPENDIX 14:

Expected expenditure for the training schedule involved in the state-private effort at hatchery development

Item	Number of persons	Number of groups	Number of days	Rate per day (f0	Total
1. Refresher course for Technical Staff (Drawn from Public Fisheries Institutions)	20	1	7	60,000	8,400,000
b. Remuneration: Resource Persons	5	1	7	100,000	3,500,000
2. Selection of farmers from districts and survey of ponds and other facilities	3	110	2	60,000	39,600,000
3. Training of farmers	37	3	21	100,000	233,100,000
b. Renumeration: Resource Persons	5	3	21	100,000	31,500,000
4, Training materials, stationery etc.					10,000,000
5. Contigencies					16.305.000
					342.405.000

APPENDIX 15

A. Cost of tools for collecting and transporting young fish

(Just feeding fry, advanced fry and fmgerlings)

Description	Quantity	Unit Cost *(f)*	Total Cost *(f)*
1. Plastic bag	1	50,000	50,000
2. Twine	2	1,000	2,000
3. Dip net (mosquito mesh size)	2	20,000	20,000
Total			92,000

B. Cost of equipment for the treatment of tilapia fry

Description	Quantity	Unit Cost (£)	Total Cost *{£)*
1. Spraying gun	1	65,000	65,000
2. Trays (for drying prepared feed)	10	5,000	50,000
3. Oven for drying prepared feed	2	350,000	700,000
4. Hormone	100g	42,100/g	421,000
Total			1,236,000

APPENDIX 16

Expected recurrent expenditure (Project administration)

Description	Number	Unit annual salary (¢)	Total annual salary (¢)
A. Human Resource			
Manager	1	6,952,408	6,952,408
Training supervisor	1	4,949,962	4,949,962
Technician	2	4,949,962	9,899,962
General duties (secretarial, book-keeping, purchasing etc.)	1	2,986,534	2,986,534
Security	2	2,021,750	6,065,625
Driver	1	2,021,750	2,021,750
Messenger/Cleaner	1	1,732,421	1,732,421
Social Security Contribution @ 20 per cent of total salary			10,051,026
Perquisities @ 20 per cent			10,051,026
Total salary			
B. Operating Expenses			
Fish stock			2.500.000
Feed			10,000,000
Bills			
- water			600.000
- electricity			2,000,000
- telephone			1,000,000
Chemicals			
- alcohol			375.000
- hormones			2.200.000
Fuel, oil, grease, etc. (grinding mill)			4.000.000
Repairs and maintenance (grinding mill)			5.000.000
Vehicle operating cost (Appendix 17A)			23,497,500
Motorcycles operating cost (Appendix 17B)			54,250,000

APPENDIX 16

Expected recurrent expenditure (continuation)

Description	**Number of persons**	Number of visits	Unit cost (£>)	Total Cost (*)
C. Project Coordination				
Field allowance (coordinators)	10	12	100,000	12,000,000
Field allowance (Technical staff)	10	12	50.000	6,000,000
Field allowance (Driver)	10	12	50.000	6,000,000
D. Rehabilitation Works				
Existing public ponds and facilities in participating fisheries - establishments				100,000,000
Credit input for selected farmers to rehabilitate ponds and other facilities	110		10,000,0 00	110,000,000
E. Credit Input				
Hormone incorporated feed to farmers for fry feeding	110		10,000	1,100,000
F. Workshops, seminar etc. on the dissemination of proposals for policies, regulation and control measures for seed production	10		5,000,00 0	50,000,000
G. Organizational cost				10,000,000
H. Contingencies 5 per cent				22,761,660
Total				477,994,874

APPENDIX 17

Vehicle and Motorcycle Operating Costs

	Quantity	No. of Days	No. of Litres	Cost per Litre (0)	Total Cost (0)
A. Project Administration	1	260	27	900	6,318,000
* Fuel consumption					
* Oil and lubricants		-	-	-	1,579,500
@ 25 per cent annual fuel cost					
* Maintenance and repairs		-	-	-	15,000,000
@ 25 per cent historical cost of vehicle					
* Insurance @ 1 per cent historical cost					600,00
Total					23,497,500
B. Motor Cycle					
* Fuel consumption	10	260	5	1000	13,000,000
* Oil and lubricants	10	-	-	-	3,250,000
@ 25 per cent annual fuel cost					
* Maintenance and repairs					25,000,000
@ 25 per cent historical cost of motorcycle					
* Insurance @ 1 per cent historical cost					10,000,000
Total					54,250,000

APPENDIX 18

QUESTIONNAIRE USED TO GATHER INFORMATION FROM FARMERS

1. Name of respondents...

   Date of enumeration............................... Enumerator..

2. Address of

   respondent...

   Location of farm.. Village/Town..................................

   District/Region... ....

In what year was your fish farm established?...

Please provide the following:

POND	DIMENSION	AREA (M^2)	NUMBER OF FINGERLINGS STOCKED
1			
2			
3			
4			
5			
TOTAL			

3. How long have you been involved in fish farming?...

4. What type of fish do you grow in your pond(s)?

   Tilapia alone..................(1)

   Catfish alone......................(2)

   Tilapia and Catfish together.........................(3)

   Any other... (4)

5. What local knowledge/belief do the people of this society or ethnic group have about the

fish you
cultivate?

6. In practical terms are there indigenous technologies developed by the community to produce fish in ponds or existing water bodies? Yes (1) No (2)

If yes, briefly describe:

7 .Have you ever had practical training in fish farming?

Yes.................... (1) No......................**(2)**

If yes, indicate where, when and organizers..

...., and ....

8. Indicate your source of fmgerlings?

From other farmers............................(1)

From the wild (rivers, streams and ponds)............................**(2)**

From government hatchery..(3)

Other (indicate).. (4)

9. Indicate whether they are transported.

Yes.................... (1) No..................... **(2)**

10. For how long do you allow your fmgerlings to acclimatise prior to stocking?...(hrs)

11.

11. Do you hire labour?

Yes........................(!) No.......................... **(2)**

12. If yes, how much do you pay per growing season for hired labour?

£..

13. Indicate the quantity/value of the following pond inputs per growing period:

POND INPUTS	QUANTITY (Kg)	VALUE (0)
Lime		
Organic fertilizer		
Inorganic fertilizer		
Feed		

14. Indicate miscellaneous operating costs (0):

Repairs and maintenance cost...(1)

Food for labourers (but not labourer wages) (2)

Interest (on loan).. (3)

Other fees...(4)

15. How much do you pay for fish fingerlings stocked (input)?.................................... ....

16. Indicate type of seed (fingerling) used.

-All-male Tilapia seed from Water Research Institute.................... (1)

-Catfish seed from Fisheries Directorate(FD)................................ (2)

-All-male Tilapia from WRI +catfish seed from FD...................... (3)

-Tilapia seed from other sources +tilapia from hatchery................. (4)

17. Did you use the above this year?

Yes.........................(1) No.............................(2)

18. If No, why?

19. What have been your yield since you started using the seed indicated in question 16 ?

POND	YEAR	QUANTITY OF FISH HARVESTED	NUMBER OF HARVESTS	TOTAL HARVEST/YR	VALUE (₵)
1					
2					
3					
4					
5					

20. How much do you sell your fish (output)? 0..

21. What changes have you observed in the following as a result of using the seed (product from the hatchery)?

	Increased	Same	Decrease
(a) Output (quality)		....	....
(b) Output (quantity)		....	....
(c) Income		....	....
(d) Profit		....	....
(e) List any other relevant area			

22. Did you comply by the recommended practices that go along with the use of the fish seed?

Yes...............................(1) No.............................(2)

23. If No why?

24. In your view, how effective has the technology been?

Impact noint **Level of effectiveness**

a. In providing stocking material at the appropriate/requisite time

Very effective (1)
.... Effective (2)
...........................Somewhat effective (3)
.....................................Not effective (4)

b. In reducing cost/risk involved in obtaining stocking material

Very effective (1)
......................................Effective (2)
.... Somewhat effective (3)
Not effective (4)

c. In providing quality/marketable fish at harvest.

Very effective (1)
Effective (2)
Somewhat effective (3)
Not effective (4)

25. Did you have any problem with the use of the impact point (seed)?

Yes.................. (1) No...................(2)

26. If yes, describe the problem encountered:

27. What do you think can be done to improve the level of effectiveness of the impact points?..

28. If you had more money will you buy more of the fmgerlings?

Yes (1) No (2)

29. State reasons: ....

30. Do you have any problem(s) in selling your fish?

Yes (1) No.................. (2)

31. If yes, what in your opinion could be done to improve upon sales?

SUMMARY SHEET FOR REVIEWING CRITICAL FACTORS IN FISH FARMING

1 ..Name of respondents.. ....

2. Address of respondent.. ....

Location of pond.. ....

Review criteria:	Variables	Rank of suitability	Score or code
Resources	Suitable land area	a) Available for expansion	
		b) Limited for expansion	
		c) Not available for expansion	
			Sub-score or code=
Value* of land		a) Low	
		b) Average	
		c) High	
			Sub-score or code =
	Water supply	a) Adequate year round	
		b) Seasonal shortage	
		c) Not available	
			Sub-score or code =
6. Environmental suitability	Water temperature	a) Well-suited	
		b) Suited after manipulation	
		c) Not suited	
			Sub-score or code =

Ph a) Well-suited

b) Suited after manipulation

Sub-score or code

Biological factors Reproduction a) No reproduction problem

b) Reproduction occurred

Feeding a) Appropriate feed available

b) Appropriate feed unavailable

Pond drainage a) Inlet and outlet present with screens

b) Inlet only with screen

c) Outlet only with screen

d) Inlet, outlet present but with no screens

e) No inlet nor outlet

Crowding a) Not visible ....

b) Visible

Sub-score or code

♦Refers to suitability of land for fish farming.

APPENDIX 19

List of farmer-respondents, location and pond size.

A: Farmers interviewed within the Akwapim-North and some other South-eastern districts of the country.

Name/Address	Location of ponds	Number	Total pond area(M2).
1. Anakwa Ofei, *do.* P.O.Box 14, Adawso.	Mtuam		48
2. Kofi Mantey, P.O.Box 14, Tinkong via Adawso.	Tinkong		
3. John Ahiable, P.O.Box 37,Abor V/R.	Abor	2	
4. Samuel Addo, P.O.Box 13, Adawso.	Mampong-Nkwanta		10
5. Kwafo Brothers, P.O.Box C92, Koforidua.	T imber-Nkwanta		80
6. Tony Baetse P.O.Box 233, Koforidua.	Effiduasi		252
7. Mante Kwame,	Mampong-Nkwanta		105

P.O.Box 13, Adawso.			
8. Yawga Adorsu, P.O.Box 13, Adawso	Mampong-Nkwanta	1	130
9. E.O.Koranteng, P.O.Box 663, Koforidua.	Dawu-Safo	1	55
10. J.N.K.Budu, P.O.Box C92, Koforidua.	Timber-Nkwanta	1	55
11. E.K.Agyare, P.M.B.,Nuaso.	Nuaso	1	900
12. M.K.Eghan, P.O.Box 53, Somanya.	Somanya	1	560
13. Bossman Kwapong, P.O.Box 11, Adawso.	Obom	1	215
14. Ofei Akunnor, P.O.Box 663, Koforidua.	Asempanaye	2	110
15. Lawrence Quaye, P.O.Box 14,Tinkong via Adawso	Tinkong	1	84

16. G.M.Osei-Bonsu, P.O.Box 323, Koforidua.	01d-Estate,K'dua.	1	50
17. Yaw Arko, c/o P.O.Box 663, **Koforidua.**	Asempanaye	1	71
18. Nana Wontumi, P.O.Box 14, Tinkong via Adawso.	Tinkong	2	78
19. J.K.Amoafro, P.O.Box 26,Senchi.	Senchi	1	900
20. Agyei Hall, P.O.Box 40, Mamfe-Akwapim.	Saforo	21	1756
21. S.Y.Twumasi, P.O.Box 24, Mamfe-Akwapim.	Kwamoso	2	126
22. E. Otu-Asante, c/o S.D.A. Church, Aboabo.	Aboabo	1	81

APPENDIX 19 (continuation).

List of farmer-respondents, location and pond size

B: Fanners interviewed within the Kadjebi district

Name/Address	Location of ponds	Number	Total pond area (M^2)
1. Adamu Bare, P.O.Box 1, Dodi-Papase.	**Ahamansu**	**1**	^
2. Elias Boateng, c/o P.O.Box 64, Dzamonome.	Dzamonome	1	500
3. George Yiboe, P.O.Box 75, Dodi-Papase.	Konsuaso	5	
4. Clemence Dzah, P.O.Box 24, Dodo-Amanfrom.	Dodo-Amanfrom	1	
5. SenaNyabi, P.O.Box 22,Titiaka, via Poase-Cement.	Tiiaka		
6. Mohammed Alhassan, P.O.Box 25,Akum, via Dodo-Amanfrom.	Akum	2	250
7. Anthony Okrah, c/o P.O.Box 30 Kadjebi.	Asato	2	140
8. **G.K.Ahlidjah,** P.O.Box 28,	**Ahamansu**	1	250

Ahamansu.

9. E.T.Kumordzi, Ampeyo

P.O.Box 4,

Ampeyo.

APPENDIX 20: An enterprise budget for the culture of all-male tilapia *Oreochromis niloticus* stocking the fish as fingerling and feeding with mainly rice bran

Respondent.. Location..

Amount in Cedis.

a. Gross income(sale of fish)

b. Variable cost

Cost of fingerling plus transportation

Cost of feed plus transportation

Cost of lime plus transportation

Cost of manure and/or transportation

c. Operating income [a - b]

d. Capital cost

Pond construction

PVC pipe fittings

Grassing of pond dykes

e. Fixed and opportunity cost

Depreciation of pond

Depreciation of PVC pipes

Depreciation of fence

Opportunity labour cost (operator)

f. Total cost [b + e]

g. Net returns (benefits)

to management & land [a-f]

h. Percentage returns (benefits)

[g/a* 100]

APPENDIX 21: Cost and return (Cedis per square metre per culture period) from all-male pond culture for selected respondents

Name	Gross Income	Total Cost (0)	Net Return to Management and Land (jf)	Percentage Returns (%)	Rate of Return on Operating Cost
A.					
1. Samuel Addo	285.71	652.38	-393.67	-128.34	
2. Kwafo Brothers	215.4	1280.00	-1064.37	-493.62	
3. Tony Baetse	1279.76	778.77	500.99	39.15	0.64
4. Mante Kwame	975.89	775.89	200.00	20.49	0.26
5. YawgaAdorsu	276.92	788.46	-723.08	-54.13	
6. E.O. Koranteng	626.67	745.45	-118.78	-18.95	
7. J.N.K. Budu	609.09	945.45	-336.36	-55.22	
8. E.K. Agyare	406.67	416.11	-9.44	-2.32	
9. M.K. Eghan	1,214.29	692.41	680.43	52.10	0.98
10. Bossman Kwapong	325.58	439.53	-113.95	-35.00	
11. Ofei Akunnor	127.27	422.73	-295.45	-232.14	
12. Lawrence Quaye	46.00	46.66	-0.66	-1.46	