CONSTRAINTS AND FINANCIAL PROFITABILITY TO THE EXPLOITATION OF NATURAL RESOURCES: THE CASE OF AQUACULTURE FISH PRODUCTION IN CAMEROON.

Meke Soung Pierre Nolasque,
Ministry of Livestocks, Fisheries and Animal Industries, Cameroon.
Email: PierreMeke @ yahoo.com

ABSTRACT

Aquaculture was introduced in Cameroon by the Eighties through mainly barrage ponds grown with Tilapia, *Heterotis niloticus*, Catfish, and common carp. The government, to encourage the activity, built 33 fish farms stations (43,75 ha) in six provinces. Aquaculture fish production is estimated at 55 m tons, FAO, 1996 (1). This situation contrasts with the huge potential in natural resources (favourable climate, foods crops, agriculture by – products and industries; hydrographical network. This study was conducted to examine the constraints that prevent full Aquaculture development as well as financial profitability. A random sample of 31 fish farms was interviewed and data from the operating accounts for the period 1997/1998 were analysed. The Net Present value (NPV) and profitability index were calculated, while the constraints were identified and analysed using the FAO, 1998 (2), Strengths, Weaknesses, Opportunities and Constraints (SWOC) analysis, compared to a suggested commercial model developed. Findings of the study indicate that Aquaculture in Cameroon, a small scale integrated fish farming is profitable. Profitability is high when using commercial techniques. Simulations, with the potential stocked 7 fish/sq.m, show that, Aquaculture can contribute to close the gap between demand and supply with a production of 420 000 m. tons/annum, reduce fish imports estimated at 70 000m.tons/year; to employment and income, and shift the pressure on sea water where up-welling are lacking. Aquaculture can thus be used as a tool for Economic development in a context of liberalization of the economy. Fish-farmers should focus on small and medium sizes ponds between 850sq.m and 1 ha while, the government in the short-term should implement appropriate policies (land titles for Aquaculture sites; loan scheme and fingerlings production in fish-farm stations).

Keywords: Aquaculture economics; economic development; natural resources.

INTRODUCTION:

Cameroon has experienced a real economic growth whose rate was estimated at 5 % during the year 1997/1998, just after the devaluation of the Cfa franc in January 1994, but many aspects are at standstill . These include: poverty, underemployment and malnutrition. Poverty expansion in the urban areas was estimated at 23,9% for the women and 20,4% for men, with young graduates most affected (33 %) (3).This situation was aggravated with the civil servants` exclusion as well as the public enterprises failure, which resulted in the release most of the labor force in the underground sector. This labor force can be involved in other income generating activities with an efficient use of working time estimated at 40 hours per week in the public and private sector. In the rural sector, the working time is 25 hours, ie 265 days per year compared to 300 days in industrialized countries for the agricultural sector alone (Cameroun, 1987(4). The economic liberalization in the banking sector is effective but with high interest rates standing between 22 and 24 % (Jeune Afrique Economie) (5), for short-term loans while the micro-finance sector with cooperatives of savings and loans is developing with almost 658 micro-finance establishment (MFE). It is in that context of liberalization that this study was conducted. Aquaculture, generally diluted in the fishery, is included in the primary sector with agriculture employing 70 % of the population (14,1 million inhabitants (FNUAP, 1996)) for a contribution of 27 % to GDP in 1993 and 0,15 % for the Fishery (Kebe et al, 1993) (6).Fish products represent 28 % of total protein supply for a consumption estimated at 12.6 kg per annum, one of the smallest in the gulf of Guinea, leading to a protidic gap of 3 % (Perevet, 1991, quoted by Bamou, 1997) (7). Thus, affections due to malnutrition are more effective in sensitive groups of the population, such as children and pregnant women leading to dwarphism and cretinism with heavy consequences on human capital.

Compared to other protein sources, fish products are the most affordable to every group of the population. In 1995, the gap was 9100 for meat and egg and 47 620 metric tons for fish products. As a result, the

country fish products imports average is 70 000m tons per annum since the eighties due to poor productivity of the coastal area, leading to a gap of 20 billions in the trade balance while for the chicken legs, the imports are estimated at 20 000 tons with a ban on meat.

PROBLEM AND JUSTIFICATION OF THE STUDY:

One of the key point of Cameroon`s economy is the huge potential in natural resources. These include: the climate, vegetation and fertile sole favourable for agriculture; the hydrographic network which includes 360 km of coastal area (13000sq.km of continental shelf, 41 000 sq km of inland waters (Satia, 1991a) (8) with 55 % of wetlands, 30% of lakes and 15 % of rivers (Balarin, 1985), quoted by Satia, 1991a)..

Aquaculture (fresh water) was introduced in Cameroon in the early fifties by the missionaries mainly in barrage ponds as a subsistence activity in the farm.(Satia, 1991b) (26). The American Peace Corps introduced the Cameroon Intensive fish farming (PIC), mainly as small diverted or dugout ponds, stocked with Tilapia (1 fish/sq m), fertilized with farm or household wastes, for 4 to 6 months period. Conscious of the role of aquaculture as a potential source of protein and a tool for economic development, the government, (through the Ministry of Livestocks, Fisheries and Animal Industries) launched a program of 33 fish - farm stations for fingerling supply and extension services in the eighties. Four species were grown as monoculture or polyculture: *Tilapia niloticus*, *Cyprinus carpio*, *Clarias gariepinus* (species commonly grown and which perform very well, Coche, Muir and Laughin, quoted by Aguilar and Nath, 1998) (9) and *Heterotis niloticus* in barrage ponds mainly or in diverted ponds. Stocking density was 1 –2 fish/sq m. in almost 6 provinces in the country. Due to the lack of funding, poor extension services, the economic crisis, the fishing training center was almost closed, resulting in no new technicians recruited in the ministry. The program did not go a long way since most of the ponds were abandoned, including fish farm stations.

As a result, the production was estimated at 55 m. tons (FAO, 1996) and most of the concern stems from whether aquaculture is a business venture. Profitability is the first condition of the development of any economic activity, thus the study was conducted to examine the constraints that prevent full aquaculture development in Cameroon as well as the profitability of the actual exploitations and to provide guidelines to farmers and policy makers. The study fits with the goals of Cameroon economic policy, which aims at developing all types of production by full exploitation of natural resources and creating processing industries (Gankou, 1985) (10).

Objectives and Hypotheses of the Study:

Three hypotheses are examined:

- Aquaculture development can be achieved when natural conditions are favourable, the constraints reduced and appropriate policies implemented;
- Aquaculture is profitable at the artisan or commercial level and can contribute to the increase of fish supply if adequate quantity is produced with reduced costs of investment, funding scheme and appropriate extension service;
- Implementing commercial techniques can contribute to economic development in terms of protein, income and employment.

Objectives of the study:

The study aims at contributing to the increase of fish production in Cameroon through aquaculture development, which can be used as a tool of economic development with the following specific objectives:

- Diagnose and analyze the reason why despite the availability of a huge of potential in natural resources, government intervention, aquaculture is at a standstill;
- Examine the profitability of actual production systems compared to the theoretical model designed to support aquaculture investment;
- Highlight the importance of aquaculture as a source of proteins, income and employment.

METHODOLOGY:

To diagnose and analyze the constraints that prevent full aquaculture development in Cameroon as well as the profitability, the constraints were examined following the SWOC analysis (Strengths, Weaknesses, Opportunities and Constraints) developed in the case of food security special programme of FAO, 1998 (11). The financial profitability is obtained by the *(NPV) and profitability index (p.i)* of fish farmers operating accounts, where the discount rate is the average between various funding sources and the banking system interest rate. The comparison of the mean values between the actual situation and the theoretical suggested model and prediction of the profit, quantity produced and employment than follow.
Data for the study were collected from an overview of the Cameroon economy and rural development, natural resources management, observations and a survey conducted over 31 fish farms for the 1997/1998-production cycle. Two situations are to be examined: the current situation, observed (without the project) and the suggested commercial situation, with the model (with the project). A test of the model is also conducted.

Data collection and study area:
The channels of the extension services of the Ministry of Live stocks (MINEPIA) was used to inform and sensitize fish farmers about the survey for the five provinces of the country, the most representative of the activity, from a random sample of 31 farms, 6 on average. The data include management techniques, invested capital (pond construction), experience of the fish farmer (number of years), quantity produced, stocking density, duration of the production cycle, cost of feeds, price of market size, labour cost, pond size and problems encountered. The study focussed mainly on urban and suburban areas due to limited time around *Bertoua* (East province), *Yaounde* (Centre), *Ebolowa* (South), *Bamenda* (North-west) and *Bafoussam* (West). These towns among the bigger ones in the country are also characterized by a high demand in fish products due to their distance from Douala, the main port of fish supply in the country.

Identification and Constraints analysis:
The identification of constraints was obtained from a synthetic question form and analyzed with the SPSS computer program. The constraints are divided into three categories:
Socio economic constraints: identified from the age, civil status, religion, training, experience in fish farming, funding source, and price of fish, quantity produced.
Technical constraints, identified from the existence of extension service to fish farmers, number of technical personnel, fingerlings source and price, fish farming techniques (stocking density, feeding). At the level of fish farming stations, the interview aimed at checking the budget allocated, the number of technicians available.
Institutional constraints obtained from rules and regulations on the activity, land regulations, trade.

Profitability analysis: NPV, Profitability index and risk:
Using the NPV, ie the difference between the initial cost and actual value of net cash flows awaited during the life cycle of the investment, was not enough to compare the two situations. Thus profitability was also calculated, measured by the profitability rate, which is a ratio between benefits and the capital invested; if greater than one the project is profitable. As Vizzavona, 1996,(12) puts it, *an investment is profitable, when it produces more money than it coasted.* Even though aquaculture presents some risks such as predation, poaching, cost of inputs, the idea behind is that for a private enterprise, the greater the risk, higher the rewards.

Theoretical considerations on explaining variables and the suggested commercial model:
The stocking density (*S.D*): which is the number of fingerlings per square meter is considered to be one of the key factor affecting profitability in relation with the pond size. The higher the stocking density, the better. This varies from 1-2 fingerling in artisanal to 20 per sq. m in commercial aquaculture.
Pond size (spf): the greater the pond, the better for oxygenation of the system. Since, the land is not always available, small and medium sizes of ponds are suggested for better management. In the study, the ponds are classified into three categories: small ponds are sized less than 2500 sq.m; medium ranging between 3000 and 6000 sq.m and big ponds, greater than 1 ha (10 000 sq.m).

Cost of fingerlings (C.fg): The cost of fingerlings has a negative impact on stocking density, mainly for bigger ponds and thus profitability (Shang, 1981) (13).
Cost of feeds (C.fd): in artisanal farming, natural productivity of the pond from water rain -fall carriage and fertilization with household wastes contribute to phytoplankton and zooplankton production suitable to grow fish. But in commercial aquaculture as suggested in the model there is a need to combine both which increases the production costs and affect profitability. The use of fertilizers contributes also to improve the production.
Marketable fish price: (f.p) The higher the price of the fish, the better it is for profitability. In the survey, the average price of fish was 700 fCfa ^^ 1€ per kg. The same price is used in the commercial model.
Total cost (Ct) including variable and fix costs in the artisanal situation, the land belongs to the farmers and no administrative tax or insurance. Variable costs include, feeds, fingerlings, and labour force.
Construction cost (CCt) is the main investment for building the pond (dam and monk), or digging. Well done, the investment can stay for up to 30 years, depending on the site, the material used and technical assistance given. This cost affects profitability negatively when the norms are not respected. It is the initial investment (Io).

Inflation (p), the interest and discount rate (i) :
Cameroon is in the Cfa zone, under monetary control regime, the official rate of inflation was 2.8 % in 1997/1998, which is used to take into account the effects of monetary erosion on profitability. But the interest rate from the banking system is high and this rate is used like the opportunity cost of capital as the best proxy of alternative use of the capital (Koffi,1987) (14). In the suggested model, where an loan scheme is introduced for five years period while in the observed situation, the discount rate is the average of various funding sources (9.5%), (Gittinger, 1985 (16); Conso, 1985 (17);Cohen,1991(18); Vizzavona,1996 ; Mansfield 1996, (19)).Using the highest interest rate, one can assess its impact on investment and profitability, thus the rate to apply in aquaculture.

The suggested commercial model:
The fundamentals of the model are the following:
1) Artisanal or small scale aquaculture uses poor stocking density, where fish production depends on natural productivity of the ponds (Satia,1987, (20); Aguilar and Nath,1998 , the production is thus inefficient and the profitability is low. Thus, increasing the stocking density in the same pond size and fertilizing the pond regularly, with more or less feeds is likely to improve upon the situation (see, feed habits of tilapia): stocking density 7 fishes per sq.m ie (3 Tilapia*25 Cfa F)+ 2 Clarias* 25 Cfa F +2 Carps or Heterotis*25 Fcfa) = 175 Fcfa/sq.m (a)
2) Polyculture creates complementarities along the food chain of the fish leading to productivity gain (Moses, 1987 (21); Little and Muir, 1987,(22).
3) To avoid any problem with artificial feeds and based on phytoplankton and zooplankton production induced by fertilization (b) the quantity of fertilizer is maintained 11000Kg/ha /yr, while the food is 500 kg/food/ha/yr for a duration of 9 to 11 months production for a cost of 65 to 80 Cfa F /sq. m. The awaited production is 3.3 Kg/sq.m (Aguilar and Nath, 1998).
4) On labour force, Lietar, 1983 (23) estimated at 8 h/day the time allocated to the maintenance, and a cost of 960 Cfa F for 24.2 are (2420 sq.m) and 300 working days.
5) The funding scheme, implementation of commercial aquaculture requires financial support to fish farmers in terms of fingerlings directly paid to suppliers. A 30 % own funds for running cost is required to farmers. Thus, total investment is 41 % of own funds for pond construction and 59 % loans.

Limits of the Study

Aquaculture economics is very recent in Africa and in Cameroon as a whole. The lack of accurate statistics on fish farmers in the areas surveyed was not conducive to decide on the adequate sample size. Regression (c) could have been use to predict the change of the quantity due to an increase of the pond size or the stocking density, or the revenue and the cost, but this study could not find time series data from the farmers.

RESULTS OF THE STUDY AND DISCUSSION:

Activity of Government fish farm stations:

Two fish farm stations were likely to supply fish farmers with fingerlings (Bamenda and Bertoua): 150 000 fingerlings of tilapia, 22000 catfish, 25000 Common carp/year at Bamenda,
which is very low, while the rest of farms even not operating 80 % of the infrastructure can be renewable.

Socio cultural aspects:

All the ponds belong to the farmers 43 years old on average, 83.87 % are married with 6 children on average. Fish farming is a secondary activity behind agriculture and 12.9 % of farms belong to common initiative groups, 61.29 % have never received any training in Aquaculture.

Socio – economic and technical aspects:

-Two types of ponds are encountered: *diverted ponds* with size ranging between 100 and 1000 sq.m mainly in the western and North-west provinces, *barrage ponds* with big size in the East, Centre and South provinces).-84% of fish farmers buy their fingerlings at fish farm stations while 12.9 % from other fish farmers, which contributes to improve their revenue. 3.2% grow their fingerlings. The species encountered are. Tilapia, Common carp and catfish in the Northwest and West provinces, while The South, East and Centre provinces perform better with Tilapia, Catfish and Heterotis. -None of the farmers keeps an accountability of the operations, only the construction cost, the fingerling, production is mentioned; - 48 % of the production is for self –consumption. The major cost of production is the construction of the pond between 25 000 and 3000000 Cfa F (38 to 4573 €); 64.5% of barrage ponds were built from own funds; 25 % from FIMAC loan scheme; 3% got loans from the late FONADER and 6.5% got subsides from MINEPIA for monk construction. -The stocking density varies from 0.5 to 2 fishes/sq.m on average and most of fish farmers fertilize irregularly their ponds with cow or pig dung, chicken droppings, 16.1 % don't give anything and 3,2% give NPK.

Institutional aspects:

80 % of fish farmers are not regularly under extension service; suggest training, financial support, fingerlings supply and fish feeds. None of them has any land title (since fish farm perform in swampy areas).

THE SWOC ANALYSIS:
Following FAO (d) definitions and methodology the results are presented on the table.

Table 1 : Selected Strengths, weaknesses, opportunities and Constraints of fish-farmers.

Strengths	**Potential**
• Abundant natural resources suitable for aquaculture (rivers,climate,lakes) • Real interest of the population to fish farming; • Possibility to increase fish production; • Low inputs and high returns; • Fish farm stations available for fingerlings production; • Abundant agriculture wastes and by-products; • Labour force available; • Cooperatives of savings and loans	• High demand for fish products • Employment • Price of meat higher than fish products • -Existing of Fishery and Aquaculture training center. • The fishery cannot sustain national demand due to the lack of up –wellings.
Weaknesses	**Constraints**
• Poor knowledge in fish farming techniques; • Artisanal methods (low stocking density, no feeding, no accountability) • No land title for Aquaculture sites; • Aquaculture is a subsistence activity; • Poor fingerling availability.	• High level of imports of fish products; • No credit scheme for aquaculture; • No university for aquaculture or fishery • Poor personnel for extension services (e) • Poor production of fingerlings in fish farm stations.

Profitability and test on mean values:

Table 2 :NPV, Profitability index, additional profitability in groups of pond sizes:

	Observed situation Groups of ponds size in sq.m			**Commercial suggested model** Groups of ponds size in sq.m		
	233-2500	**3000-6000**	**1ha-20ha**	**233-2500**	**3000-6000**	**1ha-20ha**
Stocking density (S.D)	1.07	1.21	0.91	7	7	7
Production (Q) in kg	272	674	2193	3040	13794	84296
Invesment(Io) in Cfa F	4787.05	1138400	1877778	478705	1138400	1877778
Total cost	140170	643469	2360488	1128867	3633601	22205246
NPV at 5%	-	-	-	14963085	78065139	527071294
NPV at 24%	-	-	-	13793107	63614989	393830768
Profitability index (p.i) 9.5%	-	-	-	165.4	189.29	487.76
24 %	--	-		117.5	134.47	346.49
(p.i) in the observed situation	0.38	1.48	1.75	-	-	-
Additional profitability	1.81	11.24	31.23			

Table 3: Test on mean values and gross value added in the two situations:

Variables	Fish price in Cfa F	Stocking density (S.D)	Pond size in sq.m	Production (Q) in kg	Labour cost in Cfa .F	Gross added value in Cfaf
Observed Situation	700	1.04	8595	878	49161	865955
Suggested commercial	700	7	8595	28365	1052512.5	10,705886
Statistical-t	-	5.447	-	2.60	2.52	2.59*

*critical value of statistical-t=2.47; α=0.01 and ν= n-1=30 degrees of freedom.(From Baillargon, 1984.) (25), (f).

Simulations at national level:

Table 4: Estimates of Employment, Revenue and fish Production (proteins) from exploitation of full aquaculture potential (20 000ha):

	Stocking density (number of fingerlings)	Production in metric tons (12 months growth)	Employment and salaries	Revenue at 700 Fcfa/kg.	Fingerlings demand and value, 50 Fcfa/piece.
2000 ponds of 850 sq.m size.	7	510	702	357000000	1190000
Full potential with 20000 ha.	7	420000	82644 (29752066115)	294000000000 (448170731)	1400000000 (70000000000)

From the author**.**

DISCUSSION

Socio-economic constraints :

The average experience of nine year on the sample of fish-farmers interviewed versus 43 years old age shows that fish-farming is not a traditional activity. The ponds small sizes in the North-west and West provinces can be explained by the landscape with mountains and a high density of the population more focused in agriculture and husbandry, compared to the East, Center, and South, forest areas, less populated. The lack of financial support and the actual policy favourable to fish imports whose average price is 700 FCFA is not likely to boost Aquaculture development (Hypothesis 1).

Technical Constraints:

The lack of accountability and poor stocking density partially explain the profitability of fish ponds. This can also be explained by the availability of fingerlings whose actual price cannot favour high densities , as observed in big ponds (Stocking density 0.5 fish/ sq.m). Poor extension services relates to the freezing of recruitment by the government; the budget allocated to fish-farmers mostly retired civil servants, due to the time awaited for saving money.

Institutional Constraints:

Wetlands, swampy areas are usually suitable sites for barrage ponds, cages or pens; theses areas however are not eligible to land title, one of the main guarantees required by banking system for any kind of loan. As result, only personal funds are used in Aquaculture investment, which can explain the low level of investment and the poor profitability, the age of fish-farmer mostly civil servants, due to the time awaited for saving money.

Financial profitability:
As expected in the observed situation, 42 % of the ponds are profitable, the NPV is positive and the profitability index (*p.i*) is greater than one. In the commercial situation suggested, with an average discount rate of 9.5 %, all the farms are profitable . The NPV and (*p.i*) decrease with the interest rate of the banking system, best proxy of the opportunity cost (hypothesis 2). Investigating the groups in the two situations : Total Cost (TC), Gross added value, NPV and (*p.i*) increase with stocking density, pond size; quantity of fish produced, while the price of fish remains constant. The average additional profitability induced by the implementation of commercial techniques is significant as confirmed by the test on mean value of the quantity produced (Q), Labour-force and Net added value. The model is thus valid and can be used for strategic purpose.
Looking at the cost structure , labour and cost of feed is 69 590 FCFA in the profitable ponds against 156 346, average of the 31 farms in the observed situation. Seven over ten ponds have a cost null for labour. The average construction cost is 662 119 FCFA for thirteen farms versus 991 290 the average of all the ponds. That cost, one of the most important, depends on the site selection which is a technical issue (extension services) and an important determinant of the profitability, thus the success or the failure of the project.
In the case of non profitable ponds, the pond no (23); 13 700 sq.m , 2p/sq.m performs a production of 1199 Kg, with low fish price 500 FCFA, and an investment of 5 000 000 FCFA just like pond no (20) (6000 sq.m; 165 Kg). The stocking density even, higher than 2 fishes/sq.m with a small pond size (600) sq.m for no (6); pond no (14) (1200sq.m) and pond no (16) (2000 sq.m), are not profitable.

In the theoretical model, as expected, all the ponds are profitable due to the increase of the stocking density, loans scheme and better management which improves the profitability of personal funds associated (levier effect), (Darbelet et Lauginie, 1978) (24).
The cost structure is interesting: over 10 000sq.m, the cost of fingerlings shifts from 175 000 FCFA (2 668 €.) in the observed situation to 17 499 825 FCFA (120667 €) for the pond of 99 999 sq.m, while the average is 4 081 369 FCFA for big ponds. The sake of profitability may explain such a cost for the fingerlings alone in the expenditure side , but this amount is not affordable for the mean farmer. Fish-farmers should thus compromise between profitability and production efficiency by substituting fertilisers to pond size (more fertiliser, high stocking density and small pond size), (Shang, 1981). The net added value is high in first production year, which confirms, high returns and Aquaculture as a short-term recovering investment.

CONCLUSION AND RECOMMENDATIONS
Findings of the study indicate that Cameroon Aquaculture, a profitable business venture, is a small scale integrated polyculture fish-farming (low stocking density, poor profitability). Despite the huge potential in the natural resources, some constraints prevent full Aquaculture development. The profitability is significant with commercial suggested techniques. Aquaculture can contribute to the reduction of the gap between demand and supply of fish products and represents a potential source of proteins, income and employment and can be used a tool for economic development. To achieve these goals, fish-farmers should invest in ponds sizes lying between 850 and 10000 sq.m, with commercial techniques, while the government should find a specific loan scheme with low interest rates between 5 and 10 %, redeem the production of fingerlings in the fish-farm stations; issue land titles in Aquaculure sites and control the level of fish imports in the short-sun.

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END NOTES

a) (note that, the actual price for Clarias , Common carp and Heterotis is 50 Cfa F per fingerling. The model assumes that, fish farms stations are renewed for fingerling production with the same price in a support programme by the government).

b) Tilapia has a high electivity to phytoplankton and prefers phytoplankton to artificial feed.
A supply of 800mg/m^3 of chlorophyll a can save 74.7 % of the artificial feed needed to obtain the maximum growth rate, and bring tree times gross profit in the Tilapia culture . It can be concluded that the utilization of microcystis , an untouched resource, for Tilapia culture would be important not only for increasing the profit by saving the feed cost, but also for improving the quality of the lake or pound water. (**Toshiaki Yada, 1982**) (27).

c) For a single set of observations, the arithmetic average (mean) will produce a smaller sum of squared errors than other measure of central tendancy including the median, mode, any other single value or any other more statistical measure. See Joseph F Hair and al., 1995 in Multivariate data analysis with readings, 4th edition, pp 86-87, 745 pages. (25).

d) FAO, 1998 in the context of Special programme for food security defined strengths and weaknesses as internal factors to an organization manageable by the persons affected. These factors can be addressed locally. Potential (opportunity) and Constraints are external factors affecting the farmers or the area of the project and prevent the improvement of the production and the solutions come out of the area.

e) Since the year 2002, MINEPIA has started to recruit new technicians)

f)The test on mean values is usually conducted with dependant samples, since the treatment is applied to the same pond (increase of the stocking density and regular fertilization). It is the couple method applied on Xi1 and Xi2, i = 1,….,n. For every even value, make the difference di =Xi2 –Xi1 of the two measures with the assumption that, the difference follows the normal distribution where μd (unknown mean), the variance σd (unknown). The test aims at comparing α (critical value), the mean difference d to the theoretical value Ho:μd=0.(Baillargon, 1984, pp 333-359.)

Variables and financial profitability in the observed situation														
Provinces	Pond size	Stock.dens	Prod.	Fish Price	Feed cost	Finglg.cost	Labour	Const.cost	Tisv	Total cost	Revenue	Net added	p.i	Group.pi
	(in sqm)	(S.D)	(Q)	(p)	Fd.C	Fg.C	L	Ct (Io)		T.C	R	NAV	(p.i)	(p.i)grp
NW	233	2	277	600	73800	58250	0	100000	1135	133185	304065	170880	1,72	.38
East	446	.40	18	800	28000	1561	0	40000	90	29651	17561	-12090	-0,3	
NW	450	.20	52	600	24000	12375	15000	600000	260	51635	53663	2028	0	
NW	480	.10	392	600	40600	76416	180000	500000	1960	298976	509220	210244	0,42	
West	580	.80	544	500	48000	147900	42000	683000	2720	240620	495900	255280	0,37	
NW	600	2,1	99	600	0	24000	180000	25000	495	204495	110700	-93795	-3,75	
Centre	623	.70	126	600	0	28035	0	100000	630	28665	100926	72261	.72	
West	650	.50	202	500	72000	107900	120000	300000	1010	300910	195975	-104935	-0,35	
East	700	1	210	600	0	18667	0	100000	1050	19717	210000	190283	1,9	
West	750	.33	321	500	72000	80625	30000	1050000	1605	184230	345094	160864	0,15	
South	1000	.80	45	500	8400	10000	24000	200000	225	42625	36000	-6625	-0,03	
NW	1000	.10	60	1100	14000	15000	8000	400000	300	37300	74250	36950	0,09	
South	1000	1,5	413	1200	36000	45000	0	300000	2065	83065	540000	456935	1,52	
West	1200	2	338	500	113000	180000	15000	1005000	1690	309690	411750	102060	0,1	
West	1450	1,2	685	500	48000	174000	0	190000	3425	225425	890663	665238	3,5	
East	2000	3,5	360	500	5000	32000	60000	2500000	1800	98800	360000	261200	0,1	
South	2500	1	28	500	0	6250	0	45000	140	6390	22500	16110	0,36	
South	3000	2,3	696	500	0	63750	30000	350000	3480	97230	966600	869370	2,48	1,48
South	3000	2,1	1226	1200	56000	160500	0	292000	6130	222630	1485000	1262370	4,32	
Centre	3900	0,75	1053	1000	120000	195000	240000	4000000	5265	560265	1303088	742823	0,19	
East	5000	0,8	225	500	0	20000	10000	300000	1125	31125	225000	193875	0,65	
East	6000	0,1	169	1000	10500	8500	0	750000	845	19845	168750	148905	0,2	
South	10000	0,1	2625	500	50000	350000	180000	2500000	13125	593125	3150000	2556875	1,02	
East	10200	0,78	1595	500	56000	78030	70000	1000000	7975	212005	1595025	1383020	1,38	
East	13700	2	1199	500	0	68500	30000	5000000	5995	104495	1198750	1094255	0,22	
NW	15000	0,5	731	1100	78000	187500	60000	500000	3655	329155	978750	649595	1,3	
East	16000	1	690	800	0	48000	0	600000	3450	51450	690000	638550	1,06	
East	20000	0,7	3094	500	122000	150000	0	900000	15470	287470	3093750	2806280	3,12	
South	20000	0,4	4125	1000	24000	450000	36000	3500000	20625	530625	5400000	4869375	1,39	

South	25000	0,9	281	1000	20000	25000	144000	1800000	1405	190405	225000	34595	0,02	
South	99999	1,8	5400	800	0	499995	50000	1100000	27000	576995	7469925	6892930	6,27	1,75
Mean values	8595,52	1,296818	879,97	696,7742	36106,45	107185,6	49161,29	991290,3	4391,8	196845,1	1052513	855667,935	0,981	
St.Dev	18069,2	0,821105	1251	242,9441	37069,97	123880,3	66372,41	1226814	6259	173003,8	1633431	1511230,85	1,724	
t-stat	2.601	7.09	3.837	15.687	5.327	4.732	4.051	3.524	3.096	4.419	3.837	6.223	3.135	