Potential of Aquaculture to Meet the 'Fish Protein' Consumption in Trinidad and Tobago

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Abstract

Commercial aquaculture is a viable and growing industry around the world. While there may be continuing decline in fish stocks in the inshore/coastal waters in Trinidad and Tobago, the demand for high quality fish protein continues to grow. Aquaculture has been viewed by many as a means to address the gap between seafood availability and consumer demand.

This paper reports on a study, which was conducted to assess the potential of aquaculture in Trinidad and Tobago. Based on interviews with aquaculture operators, policy analysis matrices were developed for aquaculture production. For comparison policy analysis matrices were also developed for sheep and goat production based on a recent survey of the sheep and goat industry of Trinidad and Tobago.

The study found that the DRC and EPC values for tilapia production, coupled with the lower cost per unit of protein compared with other sources of animal protein, indicate that tilapia production has a comparative advantage, especially as compared to sheep and goat production.

The paper also discusses measures that need to be taken to unlock the potential for commercial aquaculture, mainly in the form of tilapia production in Trinidad and Tobago, to meet this country's demand for fish protein.

INTRODUCTION

In their paper 'Fish Landings in Trinidad and Tobago: Trends and Nutritional Impacts' Pemberton and Fridie (2002), tested the hypothesis that there has been a trend of declining fish landings by the artisanal fleet in Trinidad. They contended that since this artisanal fleet is spread throughout the island and its production is sold almost exclusively on the local market, a decrease in fish landings by this fleet would cause a loss of income, especially in rural communities, and also result in a nutritional loss of high quality protein on the island.

Their study, therefore, examined fish landings in Trinidad from 1969 to 1994 to test the hypothesis of declining trends. This series was also used to "forecast" or simulate fish landings in Trinidad for the period 1995 to 2001. The nutritional consequences for the country of any

changes in fish landings were also assessed.

The results showed that there was no support for the hypothesis of declining trends in fish landed in Trinidad. However, they found evidence to suggest that there may have been a decline in the per capita availability of traditional coastal fish in Trinidad, caused by the combination of population growth and stable fish landings. Per capita availability of fish fell from a high of 4.12 kg/person/annum in 1975 to a low of 1.75 kg/person/annum in 1995 and a forecasted value of 2.27 kg/person/annum for 2000.

Commercial aquaculture is a viable and growing industry around the world. While there may be continuing decline in fish stocks in the inshore/coastal waters in Trinidad and Tobago, the demand for high quality fish protein continues to grow. Ramnarine (1998 p.144) states that the trend in nominal fish catches in Trinidad and Tobago is "...virtually that of stable production, even with increasing fishing efforts ..." suggesting that fish stocks are either fully exploited or overexploited.

As consumers become more health conscious, the demand for fish is increasing because of its nutritional value and low fat content. Human consumption of fisheries products has increased from 70.8 metric tonnes in 1990 to an estimated 92.5 million metric tonnes in 1997 (FAO 1999). Aquaculture has been viewed by many as a means to address the gap between seafood availability and consumer demand.

Benn (1992) believes that tilapia can be profitably reared in Trinidad and Tobago provided that production is organized and co-ordinated among the various specialists. Improvement in management techniques will lead to improved feed conversion ratio, growth rates and ultimately a reduction in the cost of production and enhanced financial returns. According to Chakalall (1993), aquaculture development in the region is being justified because of the need to diversify the economy, reduce imports of fish and fish products, increase protein supply, and earn foreign exchange. Further, the limited possibility of continued growth in production from captured fisheries and the variety of culture possibilities that exist present opportunities for small-scale rural farmers, fishermen and private entrepreneurs as well as multinational companies.

This paper reports on a study which was conducted to assess the potential of aquaculture in Trinidad and Tobago. Based on interviews with aquaculture operators, policy analysis matrices were developed for aquaculture production. For comparison, policy analysis matrices were also developed for sheep and goat production based on a recent survey of the sheep and goat industry of Trinidad and Tobago.

APPROACH TO STUDY

Overview

This study examined the food fish element (specifically, tilapia production) of the aquaculture industry to determine its competitiveness and comparative advantage and to compare these characteristics with those for small ruminant production in Trinidad and Tobago. The technology examined was the subsistence level, since

the majority of farmers interviewed in tilapia production operated at this level of technology. The subsistence level is characterized by low capital investment and operating costs, is labor intensive, uses low stocking densities and external inputs, employs low level of management and is expected to provide only low level of yield per unit area (Pillay 1997).

The methodology was composed of the following steps:

- Analysis of the current production status with respect to structure, cost and profitability at the farm level for aquaculture and small ruminant production.
- Analysis of competitive and comparative advantage for the aquaculture and small ruminant sub-sectors.

Why Small Ruminants?

Even though there are a few large, commercially-operated farms in the industry, sheep and goat farming has traditionally been done at the subsistence level in association with other types of farming activities, mostly by family units and largely on a part- time basis. It is thus a significant source of income generation for small farm families. Thus, small-scale tilapia production can be usefully compared to small ruminant production for small producers.

In the past, incentives were granted to the small ruminant industry in Trinidad and Tobago. These included subsidies on feed inputs, market protection through licensing and tariffs and duty-free concessions with respect to inputs. They were intended to encourage the expansion of the industry by attracting new producers so as to ensure a ready supply of meat at reasonable prices. Domestic production, however, did not increase significantly. In fact, mutton imports during the1981-1990 period increased almost 100% representing a significant outflow of foreign exchange. Most of the subsidies, however, were withdrawn in the mid 1980s.

Although the meats of goat and sheep have increased in popularity among consumers in the Caribbean, local production has not kept pace with this increasing demand. According to Central Statistical Office data, domestic production of mutton and goat meat in Trinidad and Tobago make up only a small fraction (2-6%) of total consumption, with a larger supply coming from foreign sources namely New Zealand and Australia.

A comparison of trends for imported and locally-produced mutton during 1990-1997 showed that domestic production of mutton and goat meat increased from 57,000 kg in 1990 to 62,000 kg in 1997 - an increase of 8% over eight years. On average therefore, domestic production of mutton and chevron (goat meat), as recorded in the official statistics, increased by about 1 percent per annum. An examination of import and local production data shown in Table 1 revealed that Trinidad and Tobago is dependent on extra-regional markets for more than 95% of its consumption of mutton and goat meat.

There is concern among livestock producers in the Caribbean about the influx of foreign supplies of livestock products, which has continued to frustrate efforts to develop the local industry. The imported

Table 1. Comparison of Trends for Imported and Locally-produced Mutton (1990 - 1997)

Year	Quantity (000 kg)			
	Local	Imports	Total	Imports as % of Total
1990	57	1191	1248	95.4
1991	58	1923	1981	97.0
1992	55	1493	1508	99.0
1993	46	2086	2132	98.0
1994	57	1092	1149	95.0
1995	69	871	940	93.0
1996	62	731	793	92.1
1997	62	980	1042	94.0

Source: CSO and Overseas Trade Statistics

supplies now dominate the market place. Hence the same concerns for competitiveness and comparative advantage exist for small ruminant production which provides another reason for their comparison.

Why Tilapia?

The freshwater fish industry in Trinidad and Tobago can be broadly divided into food fish aquaculture, which includes red hybrid tilapia, cascadu, and Malaysian prawns, and ornamental aquaculture made up of numerous aquarium fish.

Although much time, and a considerable amount of money, have been spent, Ramnarine and Ramnarine (1998), state that the food fish industry is still at an embryonic stage.

Aquaculture was introduced into Trinidad at the Bamboo Grove Fish Farm in 1951 as a research and demonstration unit of the Ministry of Agriculture for the pond culture of non-indigenous African fish species the Java tilapia (*Oreochromis mossambicus*) (Francis 1997). Much research was conducted on the species but no commercial development took place. This was due in part to poor consumer acceptance of the fish and the subsistence culture that was encouraged. There was also little understanding of pond management and monosex culture was not practised. The initial focus at that time was to promote small-scale backyard subsistence culture using small family ponds. The use of extensive culture systems resulted in low production and the commercial potential of freshwater fish was never adequately realized. After much experimentation with appropriate species of fresh water fish, the industry concentrated on the production of red hybrid tilapia, Malaysian prawns and the local cascadu for domestic consumption.

Tilapia is well-suited for aquaculture due to their hardiness or tolerance to adverse conditions, ease of culture, good growth rate, good quality flesh (which influences the international market demand for the fish) and its moderately high price on the international market (Watanabe, 1997). In 1996, the total quantity of finfish produced globally via

aquaculture amounted to almost 16 million tons with 800,000 tons being tilapia. There has been a steady increase in global tilapia production during the period 1986 to 1996. During this period, tilapia production has increased by 350%, making it the fastest growing group of fish in terms of global aquaculture production (FAO, 1998). Ramnarine (1998) contends that ...the red tilapia hybrid seems to be very popular in the Caribbean probably due to their resemblance to the red snapper... (*Lutjanus campechanus*).

In the Caribbean where tilapia farming is still not fully developed, commercial freshwater tilapia farming has become successfully established in Jamaica and Puerto Rico, where consumers prefer the red hybrid strains (Watanabe et al 1997).

DATA COLLECTION PROCESS

Tilapia Survey

Primary data was obtained by personal interviews with tilapia farmers. The objectives of the survey were:

- to analyze the details of production costs -fixed and variable- and the returns from tilapia production on various farm sizes and in different locations in Trinidad
- to identify the major factors affecting the productivity and profitability of tilapia production in Trinidad

The questionnaire for the survey obtained information on the following areas for tilapia farming:

- cost of production
- level of production
  - nature and quantity of inputs
  - yield
  - production technology
  - problems of production
- revenue
- attitude of farmers towards aquaculture industry particularly
  - investment and expansion
  - product quality and yield
  - subsidies obtained.

The method of data collection was by personal interviews using recall questionnaires. Recall questionnaires, however, are particularly susceptible to measurement errors in quantifying the inputs used and output attained. Most of the farmers interviewed did not keep records. Due to the costs involved, multiple visits to farmers could not have been done to confirm data.

Sampling Method: There was no up-to- date comprehensive list of aquaculture producers in Trinidad and Tobago at the Fisheries Division of the Ministry of Agriculture Land and Marine Resources. The procedure for registration of aquaculture farmers consists of an expressed interest in aquaculture by the farmer. The farmer fills out a fish-farming questionnaire. Officers of the BGFF then do a site visit to look at parameters that would affect aquaculture operations. The farmer is then registered. A technical report is prepared giving an indication of site suitability for aquaculture. Thereafter, the operator may or may not proceed to get involved in aquaculture production. However, he remains a registered operator. The activities of these registered operators are not monitored and are therefore unknown (Personal communications,

Fisheries Division). It is not known how many are actually involved in aquaculture and information related to the level of involvement is very limited.

Consequently, this researcher compiled a list of 160 aquaculture farmers from information obtained from the Sugarcane Feeds Center, the Ministry of Agriculture Land and Marine Resources Regional Offices and Extension Divisions, the Project Coordinating Unit, Agricultural Sector Reform Program of the Ministry of Agriculture Land and Marine Resources and the Bamboo Grove Fish Farm as well as referral from farmers involved in tilapia production.

Attempts were made to contact each farmer on the compiled list. A maximum of three attempts were made to contact each farmer. About 75% of the list comprised farmers who were previously, or at present, involved in tilapia production, 12.5% were ornamental fish farmers while the other 12.5% were either never involved in aquaculture or could not be contacted. One hundred and twenty farmers and institutions were contacted with the large majority, approximately 87.5%, indicating that they were out of production for various reasons.

Data were obtained from fifteen respondents via personal interviews using structured questionnaires. Since the majority of the respondents (67%) were operating at the small-scale level the study focused on these farmers. The largest commercial producer in Trinidad, Caroni (1975) Limited, went out of production in May 1998 as part of the Company's Financial Improvement Initiative. There are two other commercial tilapia operators in Trinidad, one at Plum Mitan and the other at Cunupia. A separate cost of production was calculated to reflect this level of technology but no comparative profitability analysis was done using this data. The two state enterprises and the commercial producers were therefore left out of the analysis. The data analyzed consisted of ten responses from tilapia producers in the various counties of Trinidad. The production period for this study was January 1998 to December 1998. The interviewing of small-scale tilapia farmers was conducted during the period July to September 1999 using the questionnaire described above.

Survey Analysis: The data for the aquaculture questionnaires were analyzed using the statistical package SPSS. The data for aquaculture (tilapia) operators, sheep and goat operators were entered into the statistical package SPSS.

Small Ruminant (Sheep and Goat) Survey

Secondary data for the analysis of the small ruminant subsector were obtained from a 'Small Ruminant Cost of Production Survey' conducted by the Department of Agricultural Economics and Extension, Faculty of Agriculture and Natural Sciences, The University of the West Indies, St Augustine for the Ministry of Agriculture Land and Marine Resources. The production period used in this survey was January 1996 to December 1996. All costs were adjusted to 1998 levels to facilitate production comparisons. This adjustment was done using an average inflation rate of 4.6%

representing the average rate of 3.6% for 1997 and 5.6% for 1998 (CSO Economic Indicators of Trinidad and Tobago, January to December 1998). It was assumed that inflation would affect all prices to the same extent, so that prices would retain their same general relations. The total number of small ruminant farmers interviewed was 251. Of this number 68 reared sheep only, 95 reared goats only and 83 reared both sheep and goats. Farmers with both sheep and goats were left out of the analysis.

Analysis of Cost of Production

Cost of production was calculated on a per kilogram basis for tilapia and compared with the calculated values for sheep and goat production. A t-test was conducted to test whether the costs were significantly different from each other. Total disposal or output from tilapia refers to the quantity harvested. This figure includes tilapia consumed at home, given away, as well as amount lost to predators and theft. The total output, therefore, reflected all tilapia harvested from ponds-marketed as well as non-marketed. Similarly, total output for the small ruminant industry included all disposal-marketed and non-marketed.

The Policy Analysis Matrices: Competitive and comparative advantage for aquaculture and the small ruminant industry were measured using the Policy Analysis Matrices (PAMs) on a per kilogram basis. The Policy Analysis Matrix is a tool designed to analyze market distortions and policy interventions in terms of their effects on a vertical commodity system (Harrigan et al 1992). The PAM is a product of two accounting identities, one defining profitability as the difference between revenues and costs and the other measuring the effects of divergence as the difference between observed parameters and parameters that would exist if the divergences were removed. The main purpose of the PAM is to measure the impact of government policy on the private profitability of agricultural systems and on the efficiency of resource use.

Two major steps are involved in preparing a PAM. The first is building budgets in private prices for each of the inputs. A summarized form of this private budget information on revenue and costs is entered into the first row of the PAM. Use of the profit identity allows for calculations of private profits or competitiveness. The second step in building the PAM is the conversion of the entries for revenues and costs in private prices to social (efficiency) prices. Social profit or efficiency is obtained from the application of the profit identity to the social valuation of revenues and costs (Pemberton, 1993).

Coefficients of Protection: Coefficients of protection allow for the comparison of domestic prices to foreign prices and can be used to determine both the implied structure of taxation and subsidization and the divergence between incentives (returns) that are generated by policies and incentives (returns) that opportunities for foreign trade would have provided (Harrigan 1992). The PAM also allows for the computation of the following protection coefficients in this study:

- Nominal Protection Coefficient (NPC) which shows the relationship between domestic prices and border prices of the output. The NPC, defined as the ratio of private commodity prices to social commodity prices, evaluates the net impact of government policy for tradable commodities or the level of output price distortions. The social prices are reflected by the opportunity cost of imports, which, in turn, reflects the commodity's border price. The border price is estimated using world prices plus freight and insurance to Trinidad as well as domestic handling and marketing charges. Both prices in the NPC refer to prices at the retail level. This relationship reflects the influence of implicit and/or explicit taxes and subsidies. The NPC was calculated using the formula

  $NPC = P_i^d / P_i^b$

  P_i^b =border price of commodity.

  where P_i^d = domestic price of commodity (the official exchange rate).
- Effective Protection Coefficient (EPC) estimates the net distortion arising from intervention. The EPC therefore compares value added in domestic prices with value added in border prices

  $EPC = V_a^d / V_a^b V_a^d$
  = value added in domestic prices
  V_a^b = value added in border (social) prices

- Domestic Resource Cost Ratio (DRC) measures the relative efficiency or comparative advantage of production (i.e. domestic production versus imports). It is the ratio of private domestic factors at social prices to social prices for inputs and outputs.
  DRC = Cost of domestic factors of production / (revenue-costs of tradable inputs)

The DRC thus measures the ratio of the costs of domestic resources used by the industry to the value added of the system (at social prices). The value added of the system is its total revenue minus the cost of tradable inputs. Efficient domestic production of tradable goods - for export and for import substitution - is an important policy consideration for planning and investment purposes. An economy has a comparative advantage in the production of a tradable commodity if that production is efficient. If not, it has a comparative disadvantage.

A PAM was constructed for each of the industries under consideration in the study and their respective NPCs, EPCs, and DRCs calculated.

RESULTS

Results of Survey of Aquaculture Farmers

The survey of aquaculture operators was conducted during the period July to September 1999. A list of 160 operators located throughout Trinidad was compiled for this study. Of the 160 operators, 120 were previously, or at present, involved in tilapia production, 20 were involved in ornamental aquaculture (aquarium)

production, two were involved in 'cascadu' (*Hoplosternum littorale*) production only, 12 were never involved in any aquaculture activities although they were registered as aquaculture producers, and 6 could not be contacted.

The total number of current or former tilapia farmers/operators contacted was therefore 120. One hundred and five of these operators were out of production. Responses were therefore obtained from 15 operators. Of the 15 responses obtained 2 were commercial producers, one produced cascadu only while 2 were state enterprises. Ten of the respondents operated at the subsistence level therefore the study was done at this level. Responses from 10 subsistence tilapia farmers/operators were therefore used in the analysis.

Of the farmers interviewed, the average number of ponds per farm was 2.7 with a range of 1 to 6 and an average pond size of 0.045 ha. The minimum size was 0.006 ha and the maximum size 0.135 ha (Table 3). In cases where farmers had more than one pond available for use all were not generally utilized for tilapia production.

Family labor made up a large portion of the labor used by the ten tilapia operations. The average number of weeks worked, 16.9, was more than twice that of hired labor, 6.58. The major problems experienced by farmers were lack of government support and losses due to predators. Praedial larceny, lack of technical services and floods were also identified as problems.

Competitive and Comparative Advantage

The border price for Tilapia was US$1.00 per pound. This information on border price was obtained from Ramnarine et al, "A Policy for the Development of an Aquaculture Industry in Trinidad and Tobago" (Draft 1997).

PAM Outputs: The private profits for tilapia production indicate that the enterprise is earning supernormal returns and suggests the future expansion of this sector, while the positive social profit indicates a

Table 2 Small Scale Tilapia and Ornamental Operators in Trinidad by County

County	No. ornamental operators	*No. tilapia operators	No. out of tilapia production	No. of respondents	Total (ornaments + tilapia)
St. Andrew/St. David	1	3	2	1	4
St. George	10	10	9	1	20
St. Patrick	0	30	27	3	30
Caroni	8	33	27	6	41
Nariva/Mayaro	0	27	25	2	27
Victoria	1	17	15	2	18
Total	20	120	105	15	140

** Previously or currently involved in tilapia production*

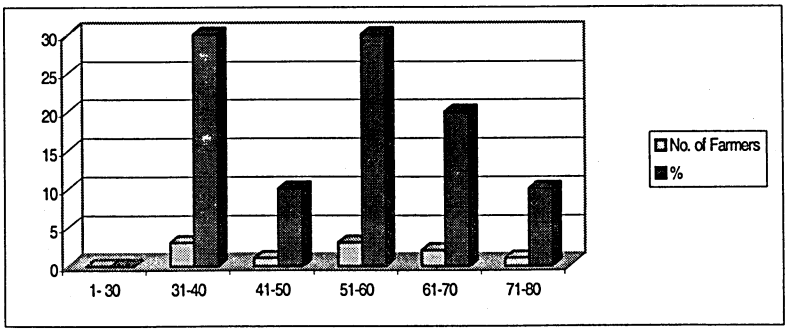


Figure 1. Age Distribution of Tilapia Farmers in Trinidad 1998

Table 3. Characteristics of Production

Total Area of Production	1.22 ha
Number of ponds per farm	2.7
Number of ponds in use	1.7
% producers in full time farming	60
% producers in part time farming	40

Table 4. Respondents' Future Plans for Production of Tilapia

Future Plans for Production	Respondents	
	No.	%
Increase number of ponds/production level	5	50
Decrease number of ponds /production level	2	20
Go out of production	1	10
Do not know	1	10
Other	1	10
Total	10	100

Table 5. Disposal of Harvested Fish (Tilapia) January - December 1998

Disposal / Sales	Amount in kg	%
Sales to Supermarkets	0	0
Sales on Farm	481.5	8.97
Amount consumed on farm	542.1	10.1
Amount given away	2893.6	53.9
Loss due to predators	1415.3	26.4
Loss due to theft	35	0.68
Other disposal	0	0
Total	5367.5	100

Table 6. Policy Analysis Matrix and Coefficients of Protection for Tilapia

Tilapia Production	Total Revenue	Tradable Inputs	Domestic Resources	Profits
Private Prices	13.20	0.87	6.58	5.76
Social Prices	13.77	1.35	4.01	8.41
Transfers	-0.57	-0.49	2.56	-2.65
NPC	0.96			
EPC	0.99			
DRC	0.32			

comparative advantage since the value of the output exceeds the cost of production after the causes of inefficiencies have been removed. The negative revenue transfer suggests that producers are being taxed overall in the production of tilapia.

Nominal Protection Coefficient (NPC): An NPC greater than one indicates that the domestic market price for output exceeds the social price and the farmer implicitly receives an output subsidy, i.e. the domestic production is protected.

An NPC less than one on tradable goods indicates that the market price of outputs fall below the border price, which is the price that would prevail in the domestic market if there were no distortions as a result of trade policies. This ratio indicates the presence of output subsidies, taxes, or trade restrictions. An NPC of 0.96 for tilapia production implies that a tax of 4% is being placed on the commodity, which can be viewed as a reflection of the 55% duty attached to the price of imported fingerlings. Trinidad is therefore competitive in the production of tilapia. The tilapia industry, however, has negative protection.

Effective Protection Coefficient (EPC): Where significant market distortion may exist for inputs, the NPC may not reveal the true extent to which domestic production is competitive with imports. In this case, the Effective Protection Coefficient (EPC) may be more informative since it estimates the net distortion arising from intervention. An EPC of less than one, as occurs in the aquaculture sector, suggests that the economy is under-producing the commodity and the resources could have been earning higher returns if measured at border prices. Thus, the efficiency of resource allocation could be improved by the removal of distortions and moving towards border prices.

Domestic Resource Cost (DRC): DRCs of less than one for tilapia production indicate that the economy saves foreign exchange by producing the commodity domestically because the opportunity cost of its domestic resource is less than the foreign exchange required for imports, that is, it would gain from exporting tilapia. The DRCs also indicate efficiency and international competitiveness. The calculated DRC value implies that Trinidad and Tobago has a comparative advantage in the production of tilapia and hence should produce and export tilapia.

Details of Sheep and Goat Farming Survey

The survey of the small ruminant industry of Trinidad and Tobago was conducted for the period January 1996 to December 1996, by the Department of Agricultural Economics and Extension, Faculty of Agriculture and Natural Sciences, UWI, for the Ministry of Agriculture, Land and Marine Resources. Of the 251 farmers surveyed 95 reared goats only, 68 reared sheep only and 83 reared both sheep and goat. Farmers with both sheep and goat were left out of the analysis. Analysis of the size of farm by county showed that in the counties of Caroni, St. George (E), Nariva/Mayaro and St. Patrick, 77.78%, 53.33%, 27.50% and 38.89% of the farmers, respectively, had greater than five

acres. The counties of St. George (W), Victoria, St. Andrew /St. David and Tobago had percentages of 90.00, 27.42, 30.77 and 26.42, respectively, with less than or equal to one acre. In addition 30.5% of farmers involved in sheep production had 1-10 sheep, and 25.8% of the farmers had 11-20 sheep. The majority of the farmers with goats (54.5%) had 1-10 goats, and 26.4% had 11-20 goats. The majority of small ruminant farmers in the survey were therefore considered small-scale producers.

The positive revenue transfer (Table 6) indicates that consumers are effectively subsidizing the revenues of producers in the small ruminant enterprise.

Border prices used were obtained from CSO and Overseas Trade Report 1998 import prices for sheep and goat meat.

Nominal Protection Coefficient (NPC): An NPC greater than one indicates that the domestic market price exceeds the social price and the farmer implicitly receives an output subsidy, i.e. the domestic production is protected. This occurs in the small ruminant sub-sector. The fresh mutton segment of the market received protection of 49%. Given the CET on mutton is 15%, this indicates that the local trade in mutton earns 34% in profit over the border price. This ratio indicates protection on output or preference by consumers for fresh product. Trinidad is therefore not competitive in the production of sheep and goat meat.

Effective Protection Coefficient (EPC): EPC allows one to capture the incentive impact of policy on the production structure of the sheep and goat enterprise. An EPC of 1.83 for sheep, and 1.20 for goat, suggests that domestic producers are receiving a greater return on their resources given intervention than they would without intervention i.e. they are enjoying positive protection. Thus the efficiency of resource allocation could be improved by removal of distortions and moving towards border prices.

Domestic Resource Cost (DRC): The Domestic Resource Cost coefficient measures the relative efficiency or comparative advantage of production (i.e. domestic production versus imports). DRCs of less than one for sheep and goat production indicate that the economy saves foreign exchange by producing the commodity domestically because the opportunity cost of its domestic resource is less than the net foreign exchange it saves in substituting for imports.

The calculated DRC values imply that Trinidad and Tobago has a comparative advantage in the production of mutton, chevron and food fish, namely tilapia.

Comparison of Tilapia and Sheep and Goat Production, Cost of Production and Profitability

Tilapia production had the lowest cost of production per kilogram, and the highest return on investment. Cost of production per kilogram was highest for sheep. However goat production showed the highest return for all profitability indicators used in the study with the exception of return on investment and cost per unit of protein. In all cases, except return on investment, profitability

indicators for sheep were lower than for goat and tilapia. Total cost per unit of protein was lowest for tilapia and highest for sheep. Overall the most profitable enterprise was goat production followed by tilapia production.

The variable and total costs were highest for sheep production and lowest for tilapia production.

Competitive and Comparative Advantage

A comparison of the tilapia and small ruminant enterprises, with respect to NPC, show that there are market or output price distortions in the production of mutton and chevron but not in tilapia production.

Effective Protection Coefficient EPC: In the case of tilapia production the EPC of less than one suggests that the economy is under-producing this commodity and the resources could have been earning higher returns if measured at border prices. For the small ruminant industry, domestic producers are receiving a greater return on their resources given intervention than they would without intervention. Producers could receive higher returns if they faced border prices instead of domestic prices. Thus the efficiency of resource allocation could be improved by removal of distortions and moving Nominal Pro-action Coefficient (NPC) towards border prices.

Domestic Resource Cost: The calculated DRC values imply that Trinidad and Tobago has a comparative advantage, or is internationally competitive, in the production of mutton, chevron and food fish, namely tilapia. An estimated DRC of less than one, therefore, represent a necessary but not a sufficient condition for successful entrance and participation in the market place. A comparison of the protection coefficients for sheep, goat and tilapia can be seen in Figure 2 below.

Cost Per Unit of Protein

Tilapia production showed the lowest cost per kilogram followed by goat. Where government policy is to provide a cheap source of protein for the population, tilapia production provides a viable option.

CONCLUSION

The cost of production per kilogram for tilapia was $7.44 making it the cheapest to produce when compared to a cost of production per kilogram of $8.83 for goat and $17.11 for sheep.

The major interest of the fish farmer lies in the profitability of his farm rather than production per se. Although supplemental inputs may have to be used to improve the productivity of tilapia ponds, the uncertainty of output response due to input affects a producer's decision on the use and rate of use of such inputs. As a result, the producer is naturally interested in knowing the costs and benefits involved in increasing inputs.

Profitability was highest for the goat sub-sector. Operating profits for goat was more than twice that for sheep and higher than for aquaculture. All indicators of profitability used in the study showed goat to be the most profitable enterprise followed by

aquaculture. This may be attributed to its relatively low cost of production and favorable retail price.

Government policy toward small-scale tilapia farmers should assist farmers to overcome the problems of high operating capital. The reluctance of producers to use more input and to pay more attention to management of their tilapia farm may be due to the price of inputs and outputs. Perhaps if there is government subsidy for inputs and price support for tilapia, producers may be encouraged to intensify their production.

Based on the values obtained for NPC, EPC, and DRC for tilapia production the industry should be expanded.

Since the majority of tilapia fish farmers in Trinidad and Tobago are small-scale operators, meeting the needs of the small-scale farmers should be emphasized in institutional lending. If aquaculture is socially profitable but unattractive to private investors, promotion of it through subsidies may be appropriate. Subsidies on credit, marketing, cost of certain types of inputs and even on consumer price of fish can reduce the cost of production and increase revenues.

The coefficient of protection, NPC and EPC, showed positive protection to the small ruminant industry. The Effective Protection Coefficient (EPC) estimates the net distortion arising from intervention. In the case of tilapia production, the EPC of less than one suggests that the economy is under- producing the commodity and the resources could have been earning higher returns if measured at border prices. The EPC suggests that efficiency of resource allocation can be improved by moving toward border prices for aquaculture inputs.

A comparison of the tilapia and small ruminant sub-sectors, with respect to NPC, indicate that with respect to sheep and goat production, the domestic market price exceeds the social price and the farmer implicitly receives an output subsidy, i.e. the domestic production is protected. No such protection exists in the tilapia enterprise, in fact this industry has negative protection. Although Trinidad is competitive in the production of mutton, chevron and tilapia production, there is still the need to review the policy toward tilapia production. Removal of restrictions and other distortionary practices may make tilapia production more attractive to entrepreneurs. In Trinidad, the tilapia producer is discriminated against since producers are receiving a lower price than they would without policy intervention. Sheep and goat producers, however, are being protected and are receiving a higher price than they would without intervention.

The calculated DRC implies that Trinidad and Tobago, as a nation, has a comparative advantage in the production of mutton, goat and tilapia. The Domestic Resource Cost coefficient measures the relative efficiency, or comparative advantage, of production (i.e. domestic production versus imports). The DRC measures the competitiveness of a given enterprise by evaluating social profitability and net foreign exchange earning potential. If, based on the calculation of DRC, an enterprise is considered to be socially profitable and generates positive net earning of foreign exchange, then the enterprise is considered to be competitive

within a given market. The DRCs also indicate efficiency and international competitiveness. Antoine (1992) believes that an export thrust is of particular significance for the agriculture sector where the elimination of preferential access to the markets of industrialized countries has hastened the search for alternatives to traditional agricultural exports. He defines competitiveness in terms of profitability. It is defined as '...the sustained ability of a given firm to participate profitably in a given domestic or foreign market...' By defining competitiveness in terms of profitability, the definition encompasses more than cost-based measures and allows for the identification and analysis of factors influencing the ability of an enterprise to sustain or improve its competitive position

Rana (1997) is of the view that the nature and extent of government assistance to aquaculture will depend on the current status of aquaculture in the country, projected plans for further development, the size of communities involved, the already-existing or projected services in related sectors and the available financial resources. The government involvement would normally conform to the overall political, social and economic development program of the country. Depending on the status of aquaculture development in the country, the development plan also need to take into consideration the existing or potential large-scale aquaculture enterprises in the private or public sector and the nature and extent of support that need to be given to them.

Government policies may determine the amount of emphasis on production of cheap fish for the populace, in relation to the production of highly- priced fish and other aquaculture products for the luxury market or export. An important factor is that initial investment and operating costs of the subsistence level or small production units of the rural farmer is likely to be minimal with family members contributing to the labor required.

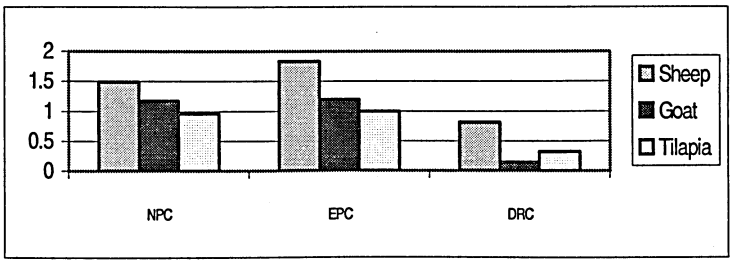
Table 7. PAM and Co-efficient of Protection for Sheep and Goat

Sheep	Total Revenue	Tradable Inputs	Domestic Resource	Profits
Private Prices	22.00	10.70	6.41	4.89
Social Prices	14.76	9.13	4.59	1.04
Transfers	7.24	1.57	1.82	3.85
NPC	1.49			
EPC	1.83			
DRC	0.82			
Goat				
Private Prices	22.00	6.12	2.68	13.20
Social Prices	18.75	5.52	1.83	11.40
Transfers	3.25	0.60	0.85	1.80
NPC	1.17			
EPC	1.20			
DRC	0.14			

Table 8. Cost Per Unit of Protein for Tilapia and Small Ruminant Enterprises

Enterprise	Cost per kg	% protein per kg[1]	Cost per kg protein TT $
Tilapia	7.44	18.8	1.40
Sheep	17.11	20.3	3.47
Goat	8.83	20.6	1.81

Figure 2. Protection Coefficients for Sheep, Goat and Tilapia



Food Composition Tables for use in the English Speaking Caribbean (1998)

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