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Overcoming the Challenges of Fish Farming in Africa

By: Angui Christian Dorgelès Kevin ABOUA

Executive Summary

Fish farming is currently considered a complement to fish production in Côte d'Ivoire. However, the level of production remains low, although its full potential can be achieved considering the several water assets the country has. Several factors have been identified as constraints to the development of the aquaculture sector and the slowdown of fish production. These factors include: (i) the unavailability of fingerlings (quality and quantity); (ii) the lack of quality fish feed; (iii) the low level of technical training of fish farmers; (iv) the lack of technical supervision by experienced agricultural extension agents; and (v) the lack of access to credit and poor organization of the sector. All these factors can affect the productivity and lead to economic losses due to poor quality of fish, low weight and a high mortality rate. Thus, in view of the strategic role that fish farming can play in economic and rural development, especially in addressing fish deficit, knowledge of the technical and economic efficiency of fish farmers is vital. This brief is based on a study that analyzed the efficiency of resource use and the economic efficiency of 32 fish farmers in the southeast of Côte d'Ivoire. It highlights the productive and economic potential that fish farmers could realize if they efficiently use resources in the production process.

Context and Importance of the Problem

Figure 1: Tilapia (Oreochromis Niloticus)

Aquaculture was introduced in Côte d'Ivoire during the colonial era. It was developed as an integrated rural activity into the country's agricultural production system. Its establishment and development have been realized through the implementation of the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO) projects on "Aquaculture in Rural Area" and the "Lagoon Aquaculture Project" with French Cooperation. Thus, two types of fish farming are practiced in Côte d'Ivoire: freshwater fish farming (in ponds and basins) and lagoon fish farming. Aquaculture production is dominated by tilapia (*Oreochromis niloticus*).Tilapia represents 90% of aquaculture production), followed by catfish (*Chrysichthys nigrodigitatus*) and sampa (*Clarias gariepinus* and *Heterobranchus longifilis*) (MIPARH 2009).

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However, the contribution of aquaculture to the national fish production remains very marginal and is just about 2%, in spite of the potential of available water resources.

The Strategic Plan for Livestock Development, Fisheries and Aquaculture (2014-2020) underlined some constraints directly related to aquaculture production. These include: (i) low availability of fingerlings; (ii) low availability and quality of feed; (iii) inappropriate water management; (iv) poor knowledge of aquaculture management techniques; and (v) insufficient support of aquaculture extension services. Feed is the essential factor in aquaculture production. Fish farmers use either industrial feed or reformulated feed that they produce themselves from agricultural by-products or leftover food. As industrial feed has high cost and not accessible to all fish farmers, they formulate fish feeds themselves and these are sometimes of poor quality. This practice, where fish farmers formulate fish feeds themselves, can affect productivity and result in significant economic losses as a result of low quality, low weight and high mortality of fish. This explains the importance of measuring the productive and economic efficiency of fish farmers in order to assess their level of performance and identify ways to improve them.

The Approach

The study analysed the resource and economic efficiencies of aquaculture in Côte d'Ivoire. Data Envelopment Analysis (DEA) model was used to analyze the technical and economic efficiencies of fish farmers. The study area included six cities in the South-East of Côte d'Ivoire with a total of 32 fish farmers. DEA model is a mathematical programming approach to efficiency analysis. It refers to the economic agent as a Decision Making Unit (DMU) which converts inputs into outputs in a production process.

To analyze the technical efficiency, four resources (feed, fingerlings, water and land) were considered as the inputs whilst fish output and the weight of fish were considered as the two outputs. The economic efficiency was computed with feed cost, fingerling cost, labour cost, equipment cost and other cost as the inputs and fish revenue as the output. We also analyzed the resources efficiency by the optimization of the DEA model following three scenarios: input-oriented, output-oriented and slacked-based model, to determine the slacks in the production (excesses in the resources and the shortfall in the output). Finally, a cost-benefit analysis was used to determine the profitability of the fish farms through the gross and net profit margins and the returns on investment (ROI).

The estimated average scores of technical and economic efficiencies were low, 0.575 and 0.533 respectively. However, about 40% of fish farms were technically efficient and 25% were economically efficient. Only four fish farms were found to be both technically and economically efficient.

Key Findings

Feed Types and Efficiency
Fish farmers using industrial feed were more technically efficient than those who formulated their own fish feed, with average scores of 0.695 and 0.598 respectively. However, they record nearly the same economic performance, with average scores of 0.605 and 0.615, respectively (see table 1 on the next page).

Further analysis of efficiency scores showed that trained fish farmers using industrial feed were the most technically and economically efficient, with mean scores of 0.739 and 0.724, respectively. They were followed by untrained fish farmers who formulated their own fish feed, but with more years of experience in fish farming. Their respective average efficiency scores were 0.618 and 0.632. These results imply that fish farmers' access to training and quality of feed could allow them to further increase their production and income.

Table 1: Efficiency scores by feed types, training and year of experience

	Industrial feed			Formulated feed		
Training	Technical	Economic	Experience (Years)	Technical	Economic	Experience (Years)
Yes	0.739	0.724	**4.09**	0.560	0.597	**3.16**
No	0.643	0.468	**6.58**	0.618	0.632	**6.18**
Mean	**0.695**	**0.605**		**0.598**	**0.615**	

Resource Efficiency

The aim of the optimization was to analyse the efficiency of the resources being used (feed, fingerlings, water and land). We used this approach to determine excesses (s-) in the use of resources and the shortfall occurred in the fish output (s+). Three scenarios were performed. In scenario 1, the farmer minimizes the resource use subject to achieving a given level of output. In scenario 2, he maximizes its level of output given the amount of resources. Finally, in scenario 3, the farmer chooses to minimize the resources while seeking to maximize its production level.

The results of the optimization (Table 2) showed that farmers generated waste (s^-) in resources utilization. Waste generated was higher when the farmer's objective was to achieve a maximum of output given the resources (scenario 2). However, if farmers minimized their excesses in feed, fingerling, water and land, aiming simultaneously to increase their production levels, they would realize a surplus of 58,361 kg, about 16.18 % of total production (scenario-3).

Table 2: Resources optimization

All unit	Feed (s^-)	Fingerlings (s^-)	Water (s^-)	Land (s^-)	Output (s^+)	Projection Output
Total	1,317,452	2,633,034	552,410.2	651,761.1		360,509
Scenario 1	102,811	1,646	257,491	201,556	822	365,570
Oriented-inputs	**(7.80%)**	**(0.06%)**	**(46.60%)**	**(30.92%)**		**(0.22%)**
Scenario 2	418,560	103,424	442,297	331,958	2,780	363,289
Oriented-outputs	**(31.77%)**	**(3.92%)**	**(80%)**	**(50.93%)**		**(0.77%)**
Scenario 3	25,797	284,783	298,089	327,004.6	58,361	418,870
Slack Based Model	**(1.9%)**	**(10.81%)**	**(52.51%)**	**(50.17%)**		**(16.18%)**

Profitability

A cost-benefit analysis indicated that fish farms achieved a gross profit margin of 32.7% and a net profit margin of 16.38%. The cost analysis showed that variable costs are high, with 80.44% of total cost. Fixed costs represent only 19.56%. Figure 1 shows that feed costs represent the largest share of total costs, with 47%. The costs of other inputs represent 24.81% for labour, 1.2% for fingerlings (showing that farmers have low access to fingerlings) and 7.8% for other costs. As for the fixed cost, they consist of ponds (7%), cages (5.7%), seines (0.53%) and other accessories (6.31%).

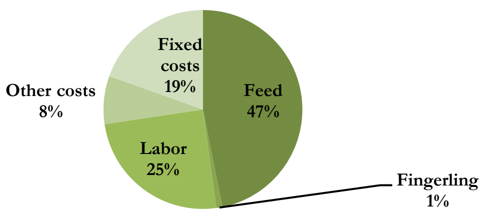

Figure 1: Distribution of production cost

A spatial distribution analysis showed that a small number of fish farms achieved high levels of net profit margin and return on investment (ROI). This study has shown that a productive and economic potential can be realized in fish farming. Therefore, an efficient management of resources reducing the waste in the production process is the best way to increase fish output.

Policy Options

This policy brief recommends the following:

(1) Policymakers should consider facilitating fish farmers' access to quality and affordable feeds. The support could be by encouraging scientific research in the formulation of local feeds from agricultural by-products. Some support is also needed for the supply of fingerlings and this could be achieved through more commitments to public-private partnership. In addition, there is the need to strengthen cooperation with private sector partners to enable aquaculture extension agents acquire new production technologies for dissemination to fish farmers.

(2) Creation of more awareness, on best practices and effective management of fish ponds, is required. Aquaculture extension agents could be empowered to play this important role.

(3) Fish farmers need to adopt good practices of sustainable production by optimizing resources to reduce waste and increase production. This will require that they choose optimal levels of feed conversion and stocking density of fingerlings in water ponds.

References

MIPRAH, 2009. Plan directeur des pêches et de l'aquaculture, 2010-2025, Abidjan: Rapport après atelier.

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ABOUT THE AUTHOR

Angui Christian Dorgelès Kevin ABOUA is at the Department of Economics and Management, University of Felix Houphouet-Boigny, Cocody-Abidjan, Côte d'Ivoire

He produced this paper as a PhD Intern of UNU-INRA.

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This policy brief and the working paper are available at collections.unu.edu

OUR CONTACT

United Nations University Institute for Natural Resources in Africa (UNU-INRA)
Location: Second Floor, International House, Annie Jiagge Road, University of Ghana, Legon, Accra, Ghana
Address: PMB, KIA, Accra, Ghana

Tel: +233-302- 213850. Ext. 6318
Email: inra@unu.edu
Website: www.inra.unu.edu

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