BIOECONOMIC APPROACH TO INVESTMENT AND REGULATORY POLICY FORMULATION FOR CAGE CULTURE OF TILAPIA IN SAMPALOC LAKE, PHILIPPINES

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RÉSUMÉ[4]

This paper represents a synthesis of the various biological, ecological, economic as well as sociological factors contrived to attain a unifying framework of analysis for lake-based tilapia cage culture. The main concern of this study is two-fold: to improve the efficiency and productivity of the cage culture operations in Sampaloc Lake and to provide practical bases for reassessing the Laguna Lake Development Authority's (LLDA) Fishery Zoning Plan. We have strong reasons to believe that the yield potential of cage culture of tilapia in Sampaloc Lake is still very far from being fully exploited and in general, there is misallocation of investments on the existing large cages and very low stocking densities. Consequently, we hold the position that the 15-ha fishcage belt limit of LLDA can be

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met without necessarily dislocating any of the fishcage farmers in the lake.

Analytical Approaches

To achieve the above objectives, a holistic approach which embodies interdisciplinary areas was applied -- bioeconomics. Technical information ranging from specific to general facts about the cage culture technology, the tilapia species used and the lake ecosystem were examined particularly in the light of the big discrepancy that emerged from the estimated optimum stocking density of 367 fingerlings/m² and the actual average of 19 fingerlings/m². The water quality criteria for *Oreochromis niloticus* and the water quality parameters of Sampaloc Lake were compared to see if the fish is fit for optimal growth in the lake. To check whether the estimated optimum stocking density accords with the biophysical potential and limitation of the fish, this was compared with the stocking densities adopted for intensive cage culture in other countries. Consequently, a distinctive relationship between cage size and stocking density was unfolded. This observation was supported by the income analysis and verified by the frontier and inefficiency analysis.

The primary data used in this study consist of surveys of fishcage farmers' cage culture operations in 1986 and 1990.

Results and Discussions

Poor growth performance and long culture period have promoted the Laguna Lake Development Authority to come up with the Fishery Zoning Plan for Sampaloc Lake and the fishcage farmers to resort to intensive feed application. This shift to intensive feeding has curbed the path towards more optimal lake space allocation.

An in depth investigation of the underlying cage culture technology revealed that feed adjustment is not enough to bring about marked improvement in the industry. In fact, all the econometric analyses employed in this study involving feeds (i.e. covariance analysis, economic optimum analysis and inefficiency analysis) consistently pointed out that feeds are already being applied in excess indicating that it is not the limiting factor. Cage size and stocking density, with the corresponding increases in mesh size of netting and fingerling size at stocking, turned out to be the key factors that will not only improve yield but also compensate for the output that will be given up should the LLDA's 15-ha fishcage belt limit be implemented.

The very low stocking density in Sampaloc Lake can be briefly explained in two ways. First, the basis for this low stocking density is the SPCMB[a] Fisher Folks Federation and Multi-purpose Cooperative's recommendation of 15

[a] *Represents the five (out of seven) lakes in San Pablo City: S - Sampaloc Lake, P - Pandin Lake, C - Calibato Lake, M - Mohicap Lake and B - Bunot Lake*

fingerlings/m^2 which is now stipulated in the implementing rules and guidelines of LLDA. This stocking density was originally derived from the actual yield data prior to intensive feeding and was originally intended for nonfeeding scheme. Input and output prices were not directly considered. Second, due to considerably large cage sizes and small mesh size of netting (due to the practice of stocking relatively small fingerlings), high stocking densities could lead to mass mortalities. On the one hand, in large cages, water stagnation or formation of dead pockets at the center of the cage is likely to occur thereby limiting the dissolved oxygen available for the fish. Much more if mesh size of nets is small, freer water exchange is being inhibited. On the other hand, if the fingerlings stocked are small, mess size cannot be big otherwise the fish would escape. Good water circulation is being indirectly inhibited by small fingerlings size at stocking. Thus, it is understandable why such low stocking densities in Sampaloc Lake continued to be adopted by the fishcage farmers. On the contrary, Coche (1982) and Beveridge (1984) have noted that within the cage, it is the movement of the fish that maintains good water circulation. The more the number of fish to move the water, the better the circulation. These indicate that some form of synergism comes out when the factors (i.e. stocking density and cage size) are in correct proportion. While the big gap between

the estimated optimum stocking density (367 fingerlings/m^2) and the actual stocking density (19 fingerlings/m^2) already poses controversial issues. When compared with the stocking densities adopted by the other fishcage farmers engaged in intensive culture of the same fish species (*O. niloticus*) in countries like China, Ivory Coast, Belgium and Central African Republic, the estimated optimum stocking density even turned out to be low. For example, in China, the suggested stocking density is 2,000-2,500 fingerlings/m^3. These figures make the actual average stocking density looks impractical (if not absurd). Since the growth related factors, i.e. daily feed ration, protein content of feeds, culture period and survival rate are just about the same in Sampaloc Lake and the other countries, the enormous difference in stocking densities can be explained by the big disparity in cage sizes (i.e. 1,669 m^3 and 868 m^3 in 1986 and 1990 respectively in Sampaloc Lake, 1 m^3 in Ivory Coast and 8 to 37.5 m^3 in China) and is taken as the prima-facie justification for corrective policy reform.

Apparently, the fishcage farmers in Sampaloc Lake do not have sufficient information (if not totally unaware) regarding the practices in other countries. Their technical know-how have been confined to their actual experiences which is in dire need of a dramatic overhaul.

Based on our findings, we have substantiated with strong evidences that overcrowding can be remedied without

necessarily reducing the number of the existing fishcage farmers while at the same time significantly improving yield and their income. And this could be done through significant cage size reduction and increase in stocking densities, along with increasing mesh size of nets and fingerling size at stocking *ceteris paribus*. Raising productivity in a manner accorded by both economic theory and the biophysical potentials and limits of the lake ecosystem, and ensuring the security of expectation of the fishcage farmers are considered good bases for conservation policy in Sampaloc Lake.

Conclusions and Policy Implications

This study has provided an aura of objectivity which circumvents the traditional fishcage culture practice in Sampaloc Lake and sets out a good basis for the derangement of the prevailing technological milieu. Nevertheless, experience will tell that bold ideas based on these findings will not gain easy acceptance from the immediate parties concerned (i.e. fishcage farmers particularly the members of the Cooperative, and the LLDA). For one, to the extent of our knowledge, this is the first time that fishcage culture operation of tilapia in a volcanic lake has been analyzed much beyond the usual descriptive cost and return analysis. Also, this is the first attempt to measure the level of inefficiency of the individual fishcage farmers and consequently, the application of stochastic frontier total

cost function. Being the baseline information, we have none vel to compare our results with and the seemingly radical changes that are being proposed would certainly trigger much skepticism and be hotly contested by the said parties. To clarify this point, both the cage size reduction and higher stocking density being proposed run counter to the implementing guidelines under the LLDA's Fishery Zoning Plan which were the product of their own research and about 6 years of consultation with the fishcage farmers and local officials.

As perceived, much time and effort will be needed to hurdle the obstacles in putting across the findings of this study. One of the main challenges foreseen is how to convince the fishcage farmers to give up a large part of their cherished spaces in the lake. Granted that this can be done, how will they (and other potential investors) be deterred from constructing more units considering that the investment cost per cage will be lower. While the former is a matter of technology adoption, the latter concerns the crucial role of the government in enforcing the operating guidelines and in protecting property rights. The latter is considered the most difficult challenge confronting the proposed changes. For without efficient control measures, ironically speaking, the changes could exacerbate rather than improve the situation. That is, with higher potential incomes and lower investment costs, fishcage farmers will be

enticed to put up more cages. Furthermore, unless more efficient method of feed application are employed, at higher stocking densities (given smaller cages and larger mesh size of nets), stronger water movement will be created by the fish during feeding thereby increasing the possibility of feeds getting washed out of the cages (higher feed losses). This may not only erode profitability but may also accelerate eutrophication. Unconsumed feed particles that may accumulate at the bottom sediments could stir toxic environment especially in times of upwelling or overturning.

In addition, the impact of our recommendations can easily be extended to the neighboring localities. Sampaloc Lake represents only 0.05 % (104 ha) of the total lake area (200,000 ha) in the Philippines, a large part of which are now also experiencing the same problem of cage and/or pen congestion. With its geographical location (situated at the heart of San Pablo City and is accessible by any land transportation), technology transfer is inevitable. If the authorities are not quick and bold enough to respond to the situation, these modifications can even aggravate the current overcrowding problem. Surely, we do not want to be accused of being the culprit for something beyond our control and against our will. We therefore hope that our findings will be used for the same purpose as we have conceived them (i.e. increase efficiency in fishcage operation with corresponding provisions for fishcage belt

limitation and control measures that work). In other words, both the potential good and evil of the proposed changes are very evident depending on how the authority will be able to manage the risks involved. We would like to stress therefore that our prescriptions go with a 'handle-with-care' caveat.