Risk Analysis of Pond Management Strategies

Eighth Work Plan, Marketing and Economic Analysis Research 2 (MEAR2)

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Introduction

Technology adoption occurs at the micro, or farm level. A farmer's decision to adopt a new technology will depend upon many factors that range from simple costs and returns to market factors to complex interactions between the new technology and the farming system practiced by the farmer. The specific objective of this study was to analyze the integration of pond fertilization schemes into farming systems including explicit treatment of risk factors. Environmental factors will be included in a model to fully assess sustainability from ecological, economic, risk, and food security viewpoints.

The nature of fish and livestock production, in conjunction with the adoption of new technologies, changing market structure, and environmental conditions, affects prices and can lead to variations in farmers' income and decision-making. A farmer's expectation of a higher return as compensation for an increase in risk denotes a "risk aversion" behavior. A risk averter can, therefore, diversify his portfolio over different assets. "Unless these risk responses are adequately reflected in planning models, the results generated in empirical analysis may bear little resemblance to actual decisions and may be of little use either in direct decision-making or in policy analysis" (Boisvert and McCarl, 1990).

Risk analysis has been used to analyze several management issues in catfish production. Risk programming mathematical models were developed to compare aeration strategies on catfish farms (Engle and Hatch, 1988). Engle and Pounds (1994) later incorporated risk factors into a two-year model with single- and multiple-batch production systems. This analysis indicated that farmers use multiple-batch strategies, even though profits are lower, rather than single-batch strategies due to off-flavor and cash flow reasons. Engle et al. (1995) extended this analysis to estimate off-flavor costs on catfish farms by including farm-level off-flavor data sets. Hatch and Atwood (1988) used risk programming to analyze catfish production.

Methods and Materials

Theoretical Model

Cost and return data from Thailand for fish and livestock production, along with fish growth models (Springborn et al., 1992) will be used to construct a mathematical model of aquaculture production.

In this type of analysis, a "typical farm" is modeled in terms of key economic parameters. These include: extent of land holdings, quantity of labor available (both family and hired), investment capital, and operating capital available. These are determined from published surveys, from statistical service reports, and in consultation with host country personnel. The set of alternative agricultural crops is again specified in conjunction with host country personnel and extension workers. Annual cost and return estimates from published enterprise budgets are used to develop technical coefficients for the model. In the case of Thailand, these are developed for several types of aquaculture and livestock alternatives. If available, cost and return estimates will be used for horticulture crops; however, if they are not available the analysis will focus on livestock alternatives.

Risk functions will be incorporated to assess the following potential benefits of aquaculture; the direct financial and nutritional benefits of fish production in the event that staple crops produce low yields, and the indirect benefit of a source of irrigation water provided by fish ponds.

Given the risk aversion behavior of farmers and the assumption that decision-makers are concerned about income falling below some minimum level, a "safety-first" model will be developed to conduct the analysis. The model can be viewed as a mean-risk dominance model in which risk will be measured by a probability-weighted function of deviations below a specific target return. In practice, a Target MOTAD or a Mean-Gini model can be developed as a second degree stochastic dominance model which assumes a restriction of risk aversion and includes functions that represent risk averse individuals.

The following is the general formulation for a Target MOTAD model:

Maximize $\sum_{j=1}^{n} T_j X_j$

Subject to

$\sum_{j=1}^{n} a_{ij} X_j \leq b_i$ for all i;

$\sum_{j=1}^{n} c_{kj} X_j + Y_k \geq T$ for all k;

$\sum_{k=1}^{k} P_k Y_k \leq \lambda$

$X_j Y_k \geq 0$ for all j and k

Where

- X_j refers to decision variables;
- c_j refers to uncertain parameters that have means Tj;
- P_k is the probability of the kth state of nature;
- T is the target income level;
- Y_k is a negative deviation of income under the kth state of nature below the target income;
- λ is the maximum amount subject to the normal resource constraints and two new constraints.

The key assumptions of the model are that economic returns are normally distributed and that the expected value of technical coefficients is the mean. Risks are not assumed by the model, but will be determined in consultation with host country and extension personnel. Typically, risk is associated with production, market, or financial factors. Economists define risk as the variability in crop yields, prices, and interest rates. Price and interest rate data will be obtained from secondary sources, whereas the variability in crop yields will be estimated by developing a probability distribution based on CRSP-generated data.

Data

Data will be collected through surveys of shrimp and tilapia growers from Honduras. Survey instruments have been designed and are currently under review. The instruments will, after review, be translated into Spanish, pre-tested, and then administered. The Asociacíon Nacional de Acuicultores de Honduras (ANDAH) and the Federacion de Agroexportadores de Honduras (FPX) have been contacted for support in administering the survey. A follow-up trip to finalize data collection is planned for September 1997.

Data will be coded and entered into a LOTUS 1-2-3 spreadsheet for summarizing and cross-tabulation. The model presented above will be estimated for each set of survey data and the net social gain from CRSP-developed technology will be estimated.

Anticipated Benefits

This study will provide important insights on the integration of CRSP technologies into host country farming systems and is intended to provide recommendations for increasing incomes of farmers and rural communities. These results will primarily benefit CRSP researchers and beneficiaries in Honduras. Future studies will be conducted at other CRSP prime sites. As research is conducted at additional sites, results across studies should reveal more global indications regarding the usefulness and effectiveness of CRSP-generated technologies.

Literature Cited

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