RAPID ECONOMIC EVALUATION TOOLS

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Final Report

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ABSTRACT

The main objective of the project was to provide a user-friendly rapid economic evaluation tool that allows research and extension personnel to quantify possible outcomes of new tilapia production techniques and assess potential economic risk consequences of these techniques. We developed such a tool, having produced a first version for release. The quantitative tool allows the examination of not only mean response of tilapia production systems as reflected in economic budgets but also the risk associated with them. We present results from using the evaluation tool in the text. These results are based on available literature, a case study from an independent producer in Honduras, and results from the identification of three basic tilapia production technologies in Honduras. These results are not meant to be a diagnostic of the risk situation facing Honduras producers, rather to illustrate the potential uses of the evaluation tool by end users.

RISK: CONCEPTS AND DEFINITIONS

Knight (1921) defined risk as the state of the decision-making process where the probability of occurrence of an event is known. Accordingly, Reilly (1979) defines risk as "the uncertainty of future outcomes, or alternatively the probability of obtaining an adverse economic result." In this report we will concentrate on the second half of Reilly's definition. Traditionally, economists have divided risk into three components: market, social, and production. These components interact in different degrees and change in importance in the decision-making process.

Market risk is associated with the producer's lack of knowledge of future prices and quantities of input and outputs, uncertainty about timely availability of inputs, and inability to forecast changes in consumers' tastes and preferences. Social risk is associated with the producer's lack of knowledge of the availability of labor and the social interactions and conflicts that may affect his or her production. Production risk is associated with the producer's lack of knowledge of the components of the production process and the inherently stochastic nature of agriculture. It is important to point out that as producers learn about production systems, subjective evaluations about risk decrease in importance and objective risk increases.

THE @RISK PROGRAM

We modeled risk in tilapia production systems by using the @Risk add-in for the Excel® program. @Risk generates random numbers from selected distributions and calculates outcomes based on the chosen values. For example, instead of inputting a deterministic value for mortality, 10%, we can input this as a triangular distribution using values for least likely, 5%; most likely, 10%; and maximum, 15%.

The @Risk program allows correlations and dependencies between variables, which is an innovative and useful aspect of @Risk. This implies particular relationships between variables or distributions. For example, we can avoid having results that are not common sense such as having higher stocking density and higher average size or having lower dissolved oxygen and higher yield. The user of the tool inputs his or her own estimation of the degree of association between variables by inputting a correlation coefficient that varies between –1 and 1.

THE RAPID EVALUATION SPREADSHEET

Standard economic use of Excel® is to generate a spreadsheet that calculates budgets. This implies the estimation of fixed and variable costs, net returns, and break-even points. The evaluation tool using Excel® with @Risk requires that users enter subjective estimates of how much a decision variable affects production or other variable(s). The evaluation tool also requires users to enter values for the distributions of key variables. The current version of the evaluation tool uses a triangular distribution, which requires minimum, maximum, and most likely values for prices and quantities in the production system. In addition the user can enter values for distribution and correlations.

VALIDATION OF THE EVALUATION TOOL

We illustrate here and in Hatch and Falck (2001) the evaluation tool using three different methods: 1) replication of published material from the literature (Hatch and Falck, 2001), 2) a case study of a Honduran producer, and 3) evaluation of three tilapia production systems. It is important to note that the version of the evaluation tool that addressed the first two methods was simplified to improve user accessibility and use. It is also important to point out that results presented below

Table 1. Baseline parameters for tilapia stocking density of 4 fish m^{-2}.

Parameters	Unit	Value	Variation
Feed Consumption	%	2	
Harvest Weight	lb	0.48	0.45, 0.50, 0.55
Days to Harvest	d	180	
Mortality	%	11.3	8, 12, 14
Tilapia Price	Lps lb^{-1}	15.17	14.5, 15.0, 16.0
Fingerling Price	Lps each	0.38	0.25, 0.40, 0.50
Feed Price	Lps lb^{-1}	2.98	2.85, 3.00, 3.10
Interest Rate	%	14	10, 14, 18

Table 2. Baseline parameters for tilapia stocking density of 8 fish m^{-2}.

Parameters	Unit	Value	Variation
Feed Consumption	%	2.5	
Harvest Weight	lb	0.42	0.36, 0.42, 0.48
Days to Harvest	d	180	
Mortality	%	12.8	9, 14, 16
Tilapia Price	Lps lb^{-1}	15.17	14.5, 15.0, 16.0
Fingerling Price	Lps each	0.38	0.25, 0.40, 0.50
Feed Price	Lps lb^{-1}	2.98	2.85, 3.00, 3.10
Interest Rate	%	14	10, 14, 18

are not diagnostic of risk production practices in Honduras or elsewhere. Results presented are meant to illustrate the potential uses of the evaluation tool.

Method 2: Case Study of a Honduran Producer

We used data collected during the 2000 workshop "La Cria Exitosa de la Tilapia" held at the Escuela Agrícola Panamericana (Zamorano). In this workshop we identified a small independent producer from Olancho, who has 5,000 m^2 of total pond surface, with 800 m^2 being cultivated at the time of the meeting. The producer sold whole fish and cultured only tilapia. The temperatures of his pond were 25 to 28°C at the surface and 23°C at the bottom. Seventy percent of his production is red tilapia and 30% is *T. nilotica*. For the purposes of this exercise, we allowed only a change in population density from 4 to 8 fish m^{-2}.

The baseline parameters are presented in Tables 1 and 2 for tilapia densities corresponding to 4 and 8 fish m^{-2}, respectively. Figure 1 presents the distribution of net returns from a density of 4 fish m^{-2}. Because of the very low density, the probability of having a loss is almost certain. Mean net returns were –5,795 lempiras per lot. In contrast, Figure 2 presents results from the distribution of net returns from increasing density to 8 fish m^{-2}. Mean net returns increased to –327 lempiras per lot; however, there is a 43% probability that the producer would obtain a positive net return.

Because one of the secondary objectives was to diffuse the technology as much as possible, the decision was made to simplify the complexity of the evaluation tool as used in methods 1 and 2. In effect the revised tool would be easier and more flexible to use.

Method 3: Case Study of the Application of the Rapid Evaluation Tool

Popma (pers. comm., 2001) identified three production practices for small-scale tilapia production. The three included production practices are:

MF-1 = Manure + Low Quality Feed–Low
MF-2 = Manure + Low Quality Feed–High
INT-1 = Tilapia-Broiler Integrator

Note: The following descriptions are based on the assumption of 100-m^2 ponds. Extrapolation above or below this size (50 to 300 m^2) is generally valid for harvest and nutrient inputs, but labor requirements will likely be distorted because larger ponds generally require proportionally less labor than smaller ponds. After the pond is full, the only water added is just sufficient to compensate for losses from evaporation and seepage—no water exchange.

Unless otherwise indicated, the duration of most production cycles is six months but is affected by climate (possibly requiring only three to four months at temperatures near 30°C and up to eight months at temperatures near 23°C).

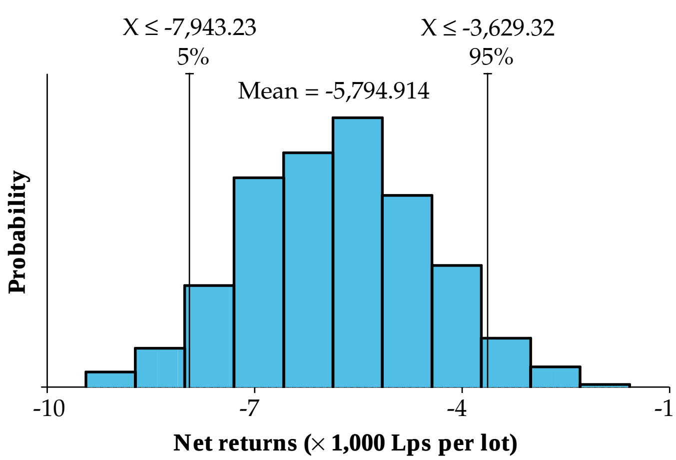

Figure 1. Distribution of net returns from a Honduras case study for tilapia density of 4 fish m^{-2}.

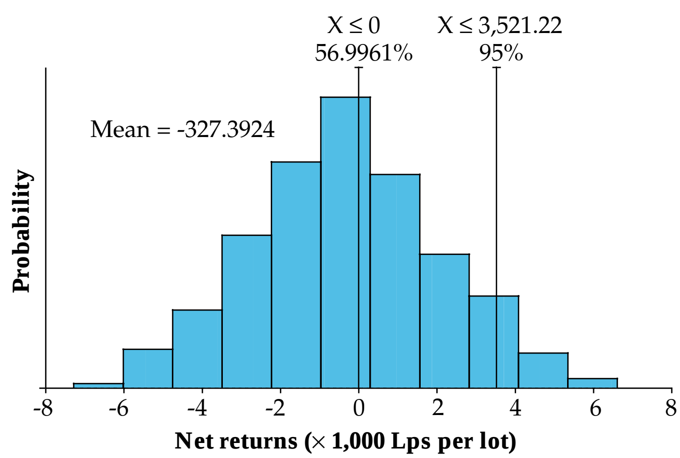

Figure 2. Distribution of net returns from a Honduras case study for tilapia density of 8 fish m^{-2}.

Manure + Low Quality Feed–Low, Management Code: MF-1
Nutrient inputs for this management practice are generally available on-farm, including mostly animal manures and low-quality supplemental feeds such as rice bran, spoiled corn, and household leftovers. The quantities added are less than optimum, usually because they are of limited availability. Average labor requirements are about two hours per week. Approximately 15 kg of fish will be harvested per cycle from a 100-m^2 pond.

Tilapia fingerlings (about 5 g each) are stocked at 2 m^{-2} (200 fingerlings in a 100-m^2 pond). Predator fish may be added (usually 10 to 20) to prevent overpopulation and stunting; the use of a predator will increase the final weight of the harvested fish, but the total weight of fish at harvest is about the same whether or not a predator is added. The nutrients (mostly manure but also some agricultural by-products, if available) are added at a rate of 0.5 to 1.0 kg about two to three times per week.

After four to eight months, and depending on whether a predator fish was added, the producer may decide to harvest. If fingerlings are difficult to obtain for the next production cycle, the best time to harvest is about one month after reproduction begins. At this time new fingerlings will be available for restocking as long as the producer has a place to keep them until the pond refills. Harvest will be about 15 kg. It is very common for most fish (possibly 80% of total weight) to be < 15 cm in length, but a higher percentage will be larger if predator fish are present.

Manure + Low Quality Feed–High, Management Code: MF-2
Nutrient inputs for this management practice are generally available on-farm, including mostly animal manures and low-quality supplemental feeds such as rice bran, spoiled corn, and household leftovers. However, in contrast with the previous management practice, the amount of nutrients added is near optimum for this class of nutrients. Average labor requirements are about 4 h wk^{-1}. Approximately 23 kg of fish will be harvested per cycle from a 100-m^2 pond.

As in the previous management scheme, tilapia fingerlings (about 5 g each) are stocked at 2 m^{-2} (200 fingerlings in a 100-m^2 pond). Predator fish may be added (usually 10 to 20) to prevent overpopulation and stunting; the use of a predator will increase the final weight of the harvested fish, but the total weight of fish at harvest is about the same whether or not a predator is added. The nutrients (a mixture of manure and some agricultural by-products, if available) are added at a rate of about 1.5 kg two to three times per week.

After four to eight months, and depending on whether a predator fish was added, the fish are harvested. If fingerlings are difficult to obtain for the next production cycle, the best time to harvest is about one month after reproduction begins. At this time new fingerlings will be available for restocking as long as the producer has a place to keep them until the pond refills. Harvest will be about 23 kg. It is very common for most fish (possibly 70% of total weight) to be < 15 cm length, but a higher percentage will be larger if predator fish are present.

Tilapia-Broiler Integration, Management Code: INT-1
The primary nutrient input for this management practice is fresh manure from chickens that are housed in a coop above the pond and fed a chicken concentrate. Fresh chicken droppings are a concentrated nutrient supply, making this management scheme more productive than the previous two non-integrated schemes. Three 7-week batches of broilers are produced during a six-month fish production cycle. When broilers are small (consuming less feed), some manure and agricultural by-products are added to maintain good nutrient loading into the pond. The integrated system has higher costs, greater labor requirements, and higher potential profitability than the previous two non-integrated systems. It is a more risky management practice because of the higher capital requirements and may have greater marketing problems. Average labor requirements are about 5 to 6 h wk^{-1}. Approximately 30 to 40 kg of fish and a total of 190 to 200 kg of broilers (from the three batches) will be harvested per six-month fish production cycle from a 100-m^2 pond. Note that no cost has been assessed for construction of the broiler coop.

As in the previous management schemes, tilapia fingerlings (about 5 g each) are stocked at 2 m^{-2} (200 fingerlings in a 100-m^2 pond). Predator fish may be added (usually 10 to 20) to prevent overpopulation and stunting; the use of a predator will increase the final weight of the harvested fish, but the total weight of fish at harvest is about the same whether or not a predator is added.

When broiler chicks are able to tolerate the cooler overnight temperatures (two to four weeks old), about 40 to 50 chicks are placed in the coop (0.1 m^2 of coop per chick) and fed a commercial broiler diet to satiation. About 2.2 to 3.0 kg of feed will be needed to produce a 1.5-kg broiler in seven weeks.

The primary nutrients for the fish are the droppings from the broilers. During the first week or two of each broiler cycle, additional nutrients should be added to the pond (about 1 kg of manure and agricultural by-products three days per week). After a couple weeks of the broiler cycle, no additional nutrients are added to the pond.

After six months, and depending on whether a predator fish was added, the fish are harvested. If fingerlings are difficult to obtain for the next production cycle, the best time to harvest is about one month after reproduction begins. At this time new fingerlings will be available for restocking as long as the producer has a place to keep them until the pond refills. Fish harvest will be about 30 to 40 kg. These fish are in a very productive environment and growing rapidly; about 60 to 70% of the total fish weight at harvest will be individuals > 15 cm length.

Evaluation of Production Systems
The labels for production practices (MF-1, MF-2, and INT-1) identify the individual evaluation tools.

The assumptions are that the producer already owns the land, has been or is willing to invest about 20 person-days for hand construction of a 100-m^2 pond, and considers his fixed costs to be zero. His primary concerns are total cash investment required and the expected return on his labor. In this tool the type and quantity of input and output line items are fixed, based on previous experiences. A default value has been assigned for the per unit value of each line item. The user of the tool can use these default values or can insert a more accurate value in the “actual unit price” column. Results, given for a 100-m^2 pond, include total variable cost, total net return to labor, and daily rate of return to labor (assuming an 8-hour work day).

Figure 3 presents the distribution of returns above variable cost and labor (RAVCL) for production system MF-1. Mean RAVCL are 23.09 lempiras per lot produced. A producer has a 30.8% probability of having negative RAVCL and a 5% probability of having RAVCL higher than 88 lempiras per lot produced. Figure 4 presents the distribution of RAVCL for production system MF-2. Mean RAVCL are 74.77 lempiras per lot produced. A producer has a 10% probability of obtaining negative RAVCL and a 5% probability of having RAVCL higher than 157 lempiras per lot produced. Figure 5 presents results from the INT-1 production system. In this production system, mean RAVCL per lot produced are 637 lempiras. There is a 27% probability of having negative RAVCL and a 5% probability of having RAVCL above 2,071 lempiras per lot produced.

In rural economies it is important to present the returns to labor of the activities undertaken. In the specific case of Honduras, the 2001 minimum wage salary in rural areas stands at 1,200 lempiras per month. This is equivalent to 8.75 lempiras per day or 1.09 lempiras per hour. This salary is adjusted to incorporate current Honduran labor laws, which demand the payment of fourteen months of salary per year. Of course, in rural areas minimum salary laws are not well enforced, and thus in some areas rural labor is not paid even the minimum salary.

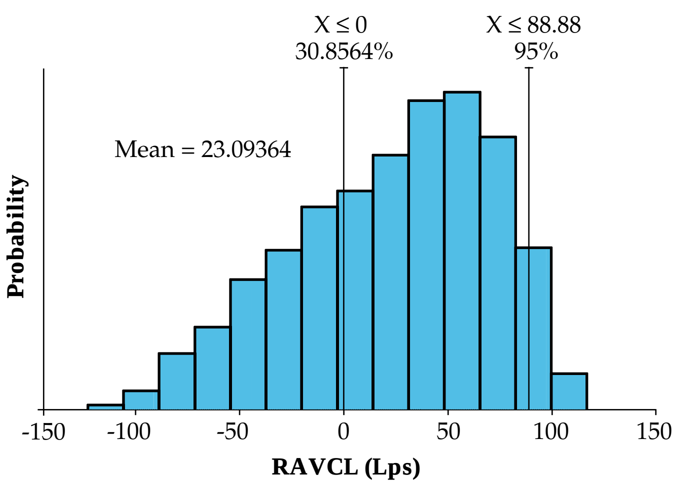

Figure 3. Distribution of returns above variable cost and labor (RAVCL) for the MF-1 production system.

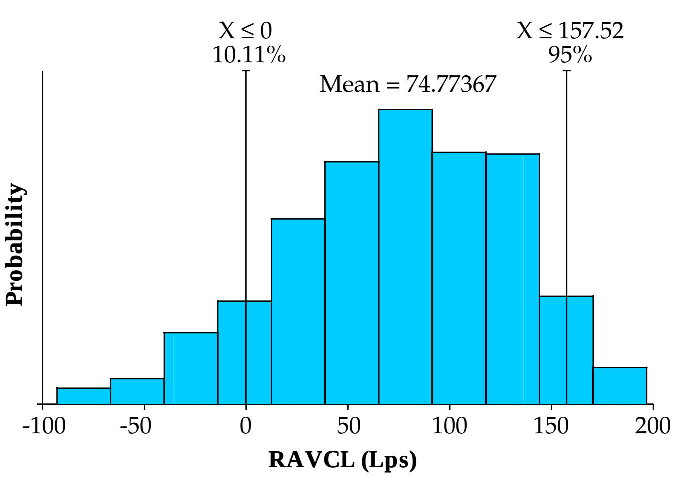

Figure 4. Distribution of RAVCL for the MF-2 production system.

Figure 6 presents the distribution of returns to labor (RTL) for production system MF-1. In this production system, RTL have a mean value of 0.74 lempiras per hour. There is a 30% chance that RTL will be negative. There is also a 5% chance that RTL will be higher than 2.87 lempiras per hour. From the standpoint of a small-scale farmer there is a very good chance that he or she will not earn as much as working as a second-hand laborer for other persons. A small-scale farmer working as a second-hand laborer may earn around 1.09 lempiras per hour. In the case of the MF-2 production system, the mean RTL are not very different from the previous example (Figure 7). Mean RTL are 0.79 lempiras per hour. However, the probability of having negative RTL decreases to 10%, whereas the probability of having a return higher than 1.68 lempiras per hour is 5%. The MF-2 production system is composed of manure as well as low-quality feeds added in amounts near optimum. The inclusion of high amounts of feed serves to decrease the variability of production at the lower scale of results; however, it is not enough to increase overall mean production.

In contrast, Figure 8 presents results for RTL for the broiler-tilapia integration. Mean RTL for this production system are 4.61 lempiras per hour. The probability of having negative RTL

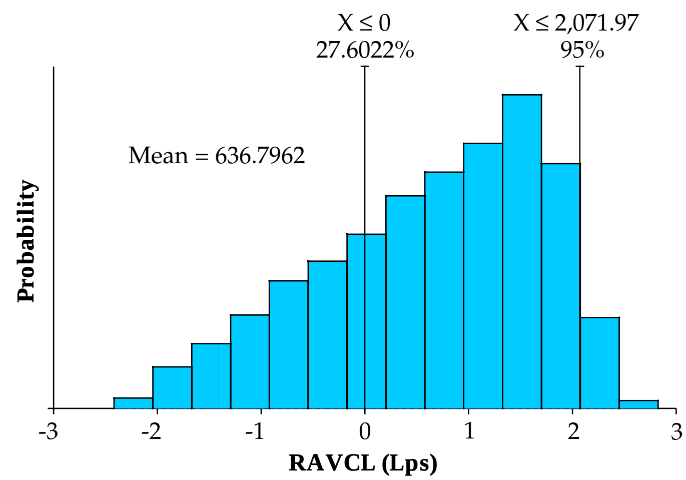

Figure 5. Distribution of RAVCL for the INT-1 production system.

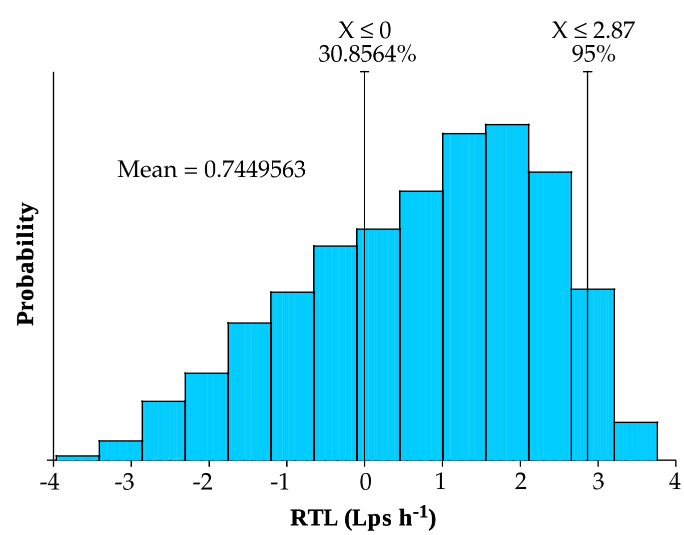

Figure 6. Distribution of returns to labor (RTL) for the MF-1 production system.

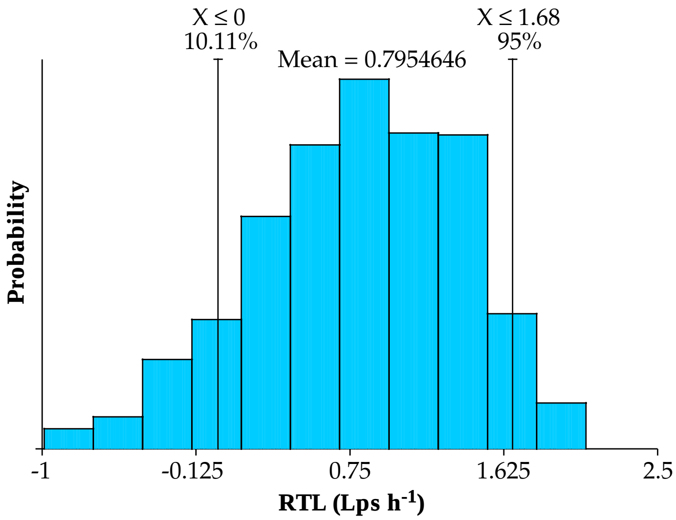

Figure 7. Distribution of RTL for the MF-2 production system.

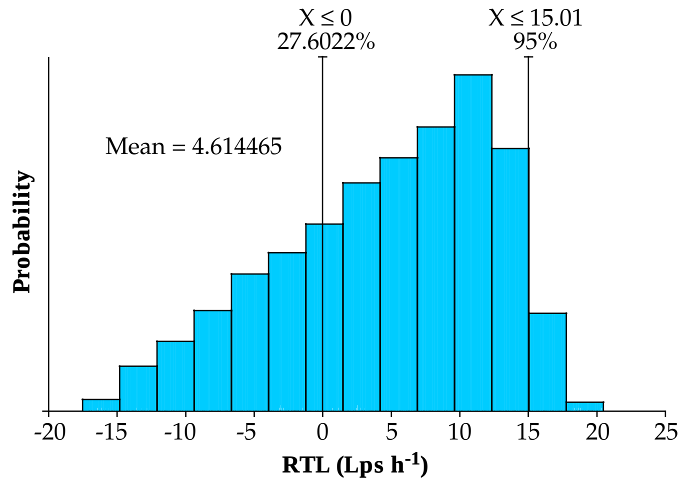

Figure 8. Distribution of RTL for the INT-1 production system.

is 27%, and there is a 5% probability of having RTL greater than 15 lempiras per hour. As expected, mean returns from the broiler-tilapia integration yield a significantly higher return to labor; however, these results do not seem to indicate that risk is higher, except perhaps for production system MF-2.

It is important to point out that the current version of the tool does not take into consideration fixed costs and that the baseline values for the price and quantity variables may not hold when departing from the baseline size of 100 m^2 as indicated in the description of the technology.

The current version of the tool provides a very simple and flexible way to examine production risk in small-scale tilapia production systems. By inputting data on the minimum, most-likely, and maximum values for prices and quantities, the user is able to model risk through a systematic procedure of simulations.

Anticipated Benefits

We anticipate that there will be strong interest in the availability of a user-friendly rapid economic evaluation tool that allows research and extension personnel to quantify possible outcomes of new tilapia production techniques and assess potential economic risk consequences of these techniques. The quantitative tool allows the examination of not only mean response of tilapia production systems as reflected in economic budgets but also the risk associated with them. This tool will have benefits for instruction to provide a more realistic picture of the feasibility of any selected production system in that it estimates the negative possibilities as well as the "average or typical." These negative potential outcomes are very useful for decision makers to gain a better understanding of the "economic risk" they may face associated with alternative production decisions. Results presented here are intended to be illustrative of the Honduran growing conditions and would need to be revised for other locations.

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