Summary of Aquaculture Economics Research at West Virginia University

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March 2003

Research funding from a USDA-CSREES special grant and funds appropriated under the Hatch Act are gratefully acknowledged.

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Cover pictures, clockwise from top left, show a fee-fishing pond; a retail fresh fish and seafood store; trout prior to stocking in a polishing pond near a coal mine; and arctic char in a tank recirculating system, all in various locations around West Virginia.

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Introduction:

Our objective is to determine the expected costs and returns of producing and processing aquaculture products as they pertain to food fish and recreational fishing in West Virginia and surrounding areas. In addition, we are examining such issues as: (a) the feasibility of alternative species (e.g., arctic char, hybrid striped bass, and fathead minnows in addition to trout), alternative production systems (tanks, raceways, etc.), and alternative water supply sources (including non-traditional sources such as coal mines); (b) feed and related waste management issues; (c) economic development impacts, and (d) potential impacts of new technologies (such as genetic modification, for example) on consumer acceptance. This work is motivated by the need to provide aquaculture producers and processors, lenders and policy makers with baseline economic and financial information that can guide the sustainable development of an aquaculture industry in hill country.

Preliminary results from previous phases reveal, for example, that while trout production can be highly profitable under a wide range of circumstances, it is risky as well. This persuaded us to identify specific risk-management strategies such as combining fee fishing and raising food fish, with the chosen proportions of the two activities depending upon the producer's attitude toward risk. Key variables influencing profitability tend to be type of production system (e.g., tank vs. raceway), feed conversion ratio and size of operation. In addition, product mix is found to be a key variable influencing profitability of trout processing. Thus, relatively low volume trout processing (from a few thousand to a few hundred thousand pounds, typical in WV, for example) can be profitable if used with an appropriate product-mix strategy, identified in our research. Results also show that economies of size occur in both production and processing, a finding that is relatively important considering the notion that the aquaculture industry in hill country is poised for growth.

Summary of Findings:

● **Budgets for Food Fish Production**: One of our first accomplishments was the development of a set of enterprise (or cost and return) budgets for two types of trout flow-through systems — fiberglass tanks and raceways. Given our assumptions, costs per pound were lowest for raceways compared to tanks across all sizes investigated (from 2,500 lbs. to 100,000 lbs. per year). This is partly because raceways use resources such as labor, feed, and water more efficiently than tanks (we do not have similar cost and return information for recirculating systems in hill country at this time; however, it might be illustrative to compare these estimates with those for flow-through systems). In addition, we found that as production levels increase, economies of size result for raceway systems, but not necessarily for tanks. In general, results show that trout production in WV and similar hill-land areas can be profitable given current market conditions. Feed typically represents the largest component of total costs. Therefore, profitability is very sensitive to changes in feed costs. For example, given a 100,000 lb.

raceway facility and a 1.6 feed conversion ratio, a 10 cent increase in feed price translates into a feed cost increase of $16,000. Of course, feed management has not only profound implications for profitability but also for waste management, something that continues to be explored in current phases of the project. Costs for flow-through systems are summarized in Tables 1 and 2.

Table 1. Estimated Initial Investment Costs for West Virginia Trout Production, Flow-through systems

	TOTAL INVESTMENT COST		*INVESTMENT COST PER POUND*	
Size of Operation	Tanks	Raceways	Tanks	Raceways
20,000 lbs.	$36,000	$25,000	$1.80	$1.25
50,000 lbs	$52,000	$37,000	$1.04	$0.74
100,000 lbs.	$91,000	$48,000	$0.91	$0.48

Table 2. Estimated Production Costs for West Virginia Trout Production, Flow-through systems

	*ANNUAL PRODUCTION COST**		*PER POUND COST*	
Size of Operation	Tanks	Raceways	Tanks	Raceways
20,000 lbs.	$22,000	$20,000	$1.12	$0.98
50,000 lbs	$61,000	$46,000	$1.22	$0.93
100,000 lbs.	$121,000	$90,000	$1.21	$0.90

* Sum of operating (or maintenance) costs and overhead (including annualized investment) costs.

Note: For purposes of this illustration, total investment costs and annual production costs were rounded off to the nearest thousand dollars.

Source: San, N. D. Miller, G. D'Souza, D. Smith, and K. Semmens. 2001. "West Virginia Trout Enterprise Budgets." West Virginia University Extension Service, Aquaculture Information Series Publication AQ01-1. Morgantown, WV. [http://www.caf.wvu.edu/afmdp/disciplines/ag_econ/publications/aqua_info_series_final.pdf].

● **Aquaculture Processing Economics**: We also analyzed the economics of trout processing in hill country. Two plant sizes were investigated, small and large. Results identify break-even processing quantities and illustrate the conditions under which processing can be profitable. We found labor to be the major component of processing costs, second only to the actual outlays for the fish itself. In addition, we found that given their current product mix, break-even quantities were relatively large. One strategy to reduce break-even quantities – and increase profits – is to increase the proportion of high-profit products (such as boned-head removed in the case of the small plant) and/or value-added products (such as smoked fillet or pate in the case of the large plant) in the product mix. Alternatively, on the cost side, reducing labor costs -- or increasing labor productivity – represents a strategy for enhancing processing profitability and thus financial performance [http://etd.wvu.edu/ETDS/E1794/Fincham_R_Thesis.pdf]

● **Risk-Return Tradeoffs**: In examining the risk-return characteristics of on-farm trout production in hill country, we find that specializing in fee fishing is not only the most profitable among the alternatives examined, but is also the riskiest. A risk-reducing strategy is to diversify by selling to alternative outlets such as processors, or by selling alternative products such as fingerlings [http://etd.wvu.edu/ETDS/E1630/Fidler_Frank_Thesis.pdf]

● **Mine Water Aquaculture**: Based on assumed conditions, mine water aquaculture is financially feasible as shown in Table 3. The net present value is relatively large and positive, and the internal rate of return is fairly high, both desirable characteristics of an investment.

Table 3. Financial Feasibility Analysis – Mine Water Aquaculture

1. Net Present Value (NPV):

Assuming a 5-year planning horizon and 100,000 lb. annual trout production:

Cost of Capital	Net Present Value
7%	$54,424
9%	$48,460
11%	$43,379

Note: ***Net present value (NPV)*** *is defined as the discounted value of a project's net annual cash flows less the initial investment cost. Simply put, it gives the difference between returns and costs when compared in today's dollars; thus, if the NPV is zero, then the investment will exactly break even. A higher NPV indicates a more profitable investment.*

2. Internal Rate of Return (IRR):

Time Period	IRR
5 yrs.	12%
10 yrs.	19%
15 yrs.	21%

Note: ***Internal rate of return (IRR)*** *is basically the compound interest rate of the investment. If the IRR equals the borrowing rate, then the investment will exactly break even. Like the NPV, the higher the IRR, the more desirable the investment.*

Source: http://www.caf.wvu.edu/gdsouzawww/MineWaterAquaculture.pdf

● **Economic Development Impacts: (a) Food Fish -** According to the WV Department of Agriculture, commercial food fish sales (mostly sales of trout to processors) across the state amounted to over $800 thousand in 2001, a 35% increase from the previous year. An additional $1.4 million of trout was stocked for conservation and recreation, making the aquaculture production sector in WV an over $2 million annual activity. By virtue of its linkages with other sectors of the economy, we find through an input-output analysis that a $1 million increase in annual aquaculture production increases total output in the state by an estimated $2 million annually, generates an additional $1 million in income and business taxes, and adds 55 jobs. [For details on how aquaculture or other sectors of agriculture together contribute to statewide economic development: http://www.caf.wvu.edu/gdsouzawww/agricultureinWVeconomy.pdf].

● **Economic Development Impacts: (b) Recreation** - In terms of recreational impacts, our results suggest that every 20,000 additional anglers -- or additional visits by existing anglers – will increase statewide output by $2.5 million, income by $1.5 million thousand, and add 59 jobs.

● **Waste Management**: A preliminary analysis of waste management options shows that factors such as the type of feed (pelleted vs. extruded), and how and when the feed is administered are important determinants of the amount of waste and therefore, the cost of waste disposal. Previous studies in this area show that filtration was the most cost-effective waste disposal option, adding approximately $0.05 per pound to trout production cost; alternatively, if untreated, downstream costs (or external costs) could be substantially greater, amounting to $0.22 per pound of trout. This has implications for both producers and policy makers. Further analysis of waste disposal options for the study area, and costs thereof, depend on the availability of data from the on-going waste management studies by other participants in this project.

● **Consumer Preferences**: Preliminary results from a national household telephone survey of aquaculture and seafood consumption preferences (there were a total of 800 respondents to date) reveal that: (a) almost half of all households consume fish or seafood at least once a week; among the 9% of households who do not consume fish, the main reason given was taste; (b) two-thirds prefer eating ocean-caught fish (c) 61% prefer eating fish or seafood products at home rather than in a restaurant; (d) over half of respondents reported reading the package label when purchasing fish, with over 60% of them indicating that information on such attributes as nutrition, production and processing techniques, location of production, and freshness were important; (e) 70% felt that fish and seafood should also have a country of origin label; (f) over two-thirds prefer buying their fresh fish “unprepared”; (g) half of all households would not consume genetically-modified (GM) fish; the likelihood of consuming GM fish would increase if it were found to be safer (52%), cheaper (37%), tastier (52%), or environmentally friendlier (54%). These results can be used to formulate marketing strategies and guide industry development.