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A bioeconomic evaluation of a commercial scale recirculating finfish growout system — An Australian perspective

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Abstract

This study, based on 3 years of commercial data, presents the results of an economic analysis of a 20-tonne per annum (TPA) commercial recirculating aquaculture system (RAS) facility located in Warrnambool, Victoria, Australia. Based on the assumptions of the analysis, results highlight the non-viability of the facility, with a 10-year projected negative cumulative cash flow of −\$648,038, and negative net present value (NPV) of −\$707,546. Economies of scale were assessed by the development of economic models for hypothetical 50-TPA and 100-TPA facilities, based on the actual figures obtained from the 20-TPA case study. These analyses highlighted marginal viability for the 50-TPA facility (with a ten-year projected cumulative cash flow of \$1,030,300; negative NPV of −\$167,651 and internal rate of return (IRR) of 11.75%), and an economically viable 100-TPA facility (with a ten-year projected cumulative cash flow of \$3,176,750; NPV of \$522,200 and IRR of 21.03%). Sensitivity analysis highlighted that the greatest gains to be realised in improving profitability were those associated with increasing the productive capacity of the facility, increasing the sale price of the product, and decreasing the capital costs of RAS facilities. Contradictions between the results from the present study to similar studies clearly highlight a need for further economic analyses of commercial RAS facilities, using commercial data sets and standard economic analysis procedures.

Keywords: Recirculating aquaculture systems; Economics; Murray cod; Production; Profitability

1. Introduction

The aquaculture industry has benefited from over four decades of research aimed at developing technically viable production systems (Kazmierczak and Caffey, 1995). Improved nutrition, species selection, disease prevention, water quality management and systems development have allowed not only widespread establishment of pond systems, but also the emergence of recirculating aquaculture systems (RAS) (Kazmierczak and Caffey, 1995).

RAS are a relatively new technology designed for holding and growing a wide variety of aquatic species and are defined as production units that recycle water by passing it through filters that remove metabolic and other waste products (Kazmierczak and Caffey, 1995). In comparison to traditional aquaculture practices (i.e. pond and cage culture), RAS offer more independence from the external environment (i.e. increased levels of control), which can provide a basis for improved risk management (Rawlinson, 2002).

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The commercialisation of RAS technology has only begun to show signs of maturity in recent times and the industry is widely accepted as being in its infancy in comparison to other aquaculture production techniques. For example, in Australia in 2001–02, reported aquaculture production in RAS amounted to 549 tonnes, with an approximate value of AUD $6.5 million, this representing approximately 1.24% of the total Australian aquaculture market share by yield and 0.88% by value (Love and Langenkamp, 2003).

As a result of the infancy of the RAS industry, there has been a great deal of emphasis on biological and engineering developments, but a shortage of useful research which combines this information with the economics of RAS. Hence, these developments have not generated widespread economic success for commercial producers (Kazmierczak and Caffey, 1995; Honda, 1998).

Previous studies have demonstrated the following areas to have had the greatest potential economic impact on the profitability of RAS: biological variables (feed conversion ratio, FCR; survival and growth rates); operating cost variables (cost of feed; labour; power and oxygen); engineering performance variables (filtration efficiency; level of intensification); system and fixed cost variables (capital costs; economies of scale; total production); and revenue (sale price).

However, due to the difficulties and costs of conducting economic experiments on commercial scale operations (Kazmierczak and Caffey, 1995), the majority of these previous studies have been based on bioeconomic models incorporating hypothetical data sources. In many cases, models have been developed assuming best practice husbandry techniques, maximum production and sale of all output once stock have completed their growout period. As most experienced aquaculturists understand, these kinds of best-case scenarios are rare in practice. Accordingly, most information summarised from these studies should only be taken as a general and theoretical guide. Powless (1998) criticised the validity of bioeconomic modelling and theoretical data sources; stating that, "'Paper fish', those that are grown in models, don't distinguish between mediocre and superior feeds. They don't require good water quality and they never die. Unfortunately, there is no market for 'paper fish'."

These statements highlight the need for more economic analyses based on "real" commercial data sets for RAS facilities. This will provide the industry and potential investors with a more accurate understanding of the economic viability of RAS ventures, hence potentially reducing the number of future economic failures.

Thus, the primary objective of this study is to analyse RAS from a bioeconomic framework and provide industry with a detailed economic analysis of an actual, commercial scale RAS facility. It is hoped that these results will provide a quantitative technique to assist managers to understand and interpret many of the interrelated processes in RAS and the economic constraints faced by profit seeking producers.

2. Materials and methods

2.1. Study site and data collection

All data for this study was collected from a commercial RAS facility located in Warrnambool, Victoria,

Table 1
Summary of all parameters monitored between July 1, 2002 and June 30, 2005 (Years 1 to 3) at the WTF facility

Income
Net fish sales ($, excluding wholesaler's commission and market dues)
Number of fish sold
Average weight of fish sold (g)
Total production (kg)
Costs
Capital and infrastructure costs
— RAS facility
— Shed
— Vehicle
Operational costs
— Depreciation
— Electricity
— Equipment
— Feed
— Freight/packaging
— Gas/diesel
— General administration, office expenses
— Stock insurance
— Legal fees
— Maintenance
— Marketing/advertising
— Oxygen
— Permits
— Phone/internet
— Plumbing/pipes/fittings
— Salaries
— Chemical/cleaning products
— Security
— Stock purchases
— Travel/conferences
— Vehicle costs
— Water quality, fish health assessment
Biological variables
Feed conversion ratio (FCR)
Feed consumption
Mortality
Weight gain