The Economics of Recirculation Aquaculture

1. INTRODUCTION

Recirculation (intensive) aquaculture systems are a relatively new technology for holding and growing a wide variety of fresh water and marine finfish in Australia. These systems come in an array of capacities and efficiencies. Through the effective management of production variables, recirculation technology offers relatively more independence from the external environment. This translates to an increased level of control, which can provide a basis for improved risk management.

2. AQUACULTURE PRODUCTION

2.1 World Production

Within a global context, aquaculture is the primary means by which the shortfall in world fish production will be met. Aquaculture production has grown at an average rate of 10% since 1984 compared with captured fisheries at 1.6% and livestock meat at 3%. Overall global production of aquaculture production (including finfish, shellfish and aquatic plants) is 34 million tonnes (valued at US$46.5 billion) of which the majority is finfish and shellfish (59%) (FAO 1998)

In addition, the tendency that has been observed lately towards healthy nutrition is going to significantly increase demand for seafood since fish is considered one of the healthiest foods. By the end of this year cultured fish is expected to account for 30% of total world fishery. (FAO 1995)

2.2 Australia

Australian aquaculture production is relatively small compared with world production with 32,000 tonnes (worth AUD$602 million) being produced in 1998/99. Production is largely marine based using extensive aquaculture systems (85% of total production, consisting of Pearl Oysters 30%, Blue Fin Tuna 28%, Atlantic salmon 12%, Edible Oysters 8% and Prawns 7%)(ABARE 1999)

3. INTENSIVE AQUACULTURE SYSTEMS

3.1 Advantages

Recirculation (intensive) systems represents relatively new technology with a wide variation in system design and quality. Through the effective management of production variables, recirculation technology may offer relative independence from the external environment.

Recirculation aquaculture systems are receiving increasing interest in intensive fish culture operations as technological advances in closed systems technology. Small business ventures in particular are attracted to enclosed and modular recirculation systems. The closed system offers several advantages, including:

- water and heat conservation
- waste management control
- fish health control
- stock management
- site flexibility
- increase stocking density

Improvements in feed formulations, nutrition, water chemistry, disease prevention and treatment, and selection of species with economically desirable traits could well lead to continuous production improvements. The identification of species with economically desirable traits include those which have the following important aspects:

- Established markets
- High value
- Tolerance for poor water quality
- High stocking densities
- Feed on pelleted food
- Efficient food Conversion ratio (FCR)
- Available from local sources (hatcheries or wild)

4. THE MURRAY COD PROJECT

4.1 Introduction

Murray Cod (*Maccullochelli peelli peelli*) is becoming a premium species for aquaculture in Australia, especially Victoria. In 1999 trials were carried out by the Marine and Freshwater Resources Institute (MAFRI) which indicated that stocking densities of over 100k/g per cubic metre could be obtained with little mortality and a grow out period to plate size (500-1000gms) in 10 months. This was despite previously held views that the species were territorial and aggressive and therefore unsuitable to high density stocking. See figure

Murray cod is one of the largest freshwater fish in the world and is an endemic Murray-Darling river system. It is valued for recreational, commercial and conservation purposes. In the wild they attain maturity at 4-5 years weighing between 2.5 and 5 kg and can grow up to 113 kg. A female can produce between 14,000 and 30,000 eggs (Kaiola 1994).

It is highly sought after as a table fish (with a high protein content) and up until recently has supported a lucrative but otherwise relatively small commercial fishery for many decades. However, the distribution and abundance of the species have declined markedly since European settlement, and commercial fisheries production is now restricted to small quantities of Murray Cod being landed from within South Australia and Victoria on an irregular basis. New South Wales has recently banned commercial fishing for Murray Cod.

4.3 Fish Farming

Murray Cod is proving to be a very suitable species to grow in recirculation aquaculture farms. The adoption of European enclosed recirculation systems for on-growing Murray Cod has from the outset produced promising if not outstanding results in recent years.
Preliminary investigations have been completed into nutritional requirements and development of artificial diets for Murray Cod at the Marine and Freshwater Resources Institute and Deakin University.

Some private fish farms are beginning to commercially produce market-size Murray cod in tanks and ponds with both natural and artificial diets under a range of intensive/semi-intensive and ambient/controlled environmental conditions.

4.4 Marketing

There is considerable interest in farmed Murray Cod (both plate size and larger). Producers, wholesalers and retailers see Murray Cod as an ideal species to satisfy a significant latent domestic and export demand. Such a demand is in part driven by the premium and associated ongoing demand placed by Asian markets in cultured grouper, and the perception that Murray

Cod are a like species which could be equally well marketed throughout Asia (Stoney 2000). A recent preliminary market appraisal of Murray Cod in Taiwan, Hong Kong, Singapore and Japan has indicated positive market response. On product quality parameters, Murray Cod was considered highly competitive with other premium freshwater finfish present in those export markets.

5. ECONOMIC ANALYSIS OF RECIRCULATION AQUACULTURE FARMS

Recirculation systems come in many shapes, sizes and cost (depending on the quality of the system). AQUAFarmer V1.1 was loaded with three fish farm examples. The examples represent a small (25 tonne), medium (50 tonne) and large (150 tonne) scale operation.

(i) Small Scale Farm
A 25 Tonne Farm small scale diversification venture. This type of venture is best suited to a diversified venture (eg. Land based farmer utilising water resources to supplement main farm operations). Land is assumed to be in place but the cost of specialised buildings are assumed to be part of the capital setup cost. The system consists of 20 final grow tanks. The salary component is $40,000.

(ii) Medium Scale Farm
A 50 Tonne medium scale specialised single venture where fish farming is the only activity of the enterprise. Land is assumed to be in place but the cost of specialised buildings are assumed to be part of the capital setup cost. The system consists of 39 final grow tanks. The salary component covers two staff at a cost of $80,000.

(iii) Large Scale Farm
A 150 Tonne large scale specialised single venture where fish farming is the only activity of the enterprise. Land is assumed to be in place but the cost of specialised buildings are assumed to be part of the capital setup cost. The system consists of 119 final grow tanks. The salary component covers five staff at a cost of $190,000.

The data used to produce the results have been estimated from industry sources and should be taken as a guide only. The grow out period is 10 months with product ranging from 500g to 1kg (see figure 7 for growth details of the cohort streams). It is assumed that stocking occurs after complete sale of fish, therefore in years 4, 7 and 10 there are two growouts within a financial year. Based on industry data 10% mortality occurs in the first 2 months of growth only and 85% is recovered for HOGG product.

Recirculation technology consists of the following capital goods items, however smaller farms may not employ all of the components:

- Mechanical and Biological Filtration Systems
- Fractionator
- Degassing Equipment
- Ozone and Oxygen Equipment
- Ultra violet Equipment
- Pumps
- Monitoring and Control Systems
- Backup Equipment
- Plumbing
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The building required to house the fish farm is a purpose built insulated design to ensure that temperatures are kept as stable as possible and that systems maintenance and harvesting are optimally designed into the floor plan.

7. CONCLUSIONS

The main conclusions that can be drawn from this paper include the following:

- Recirculation systems offer greater control of key production and economic variables and afford improved risk management control.
- Key bio-economic variables influencing viability include:
  - Scale of the farm
  - Species biological attributes (mortality and growth)
  - Species market attributes (products and price)
  - Feed Conversion Ratio
- There are significant opportunities for improved risk management in larger systems.
- Achieving optimal output requires total system control including bacterial growth in biofilters.

Fisheries Victoria, while a small producer of aquacultured products, is leading Australia in its research of Murray Cod in terms of fish health, feed developments, product and marketing development. The improvement in investment during the last year reveals a promising future for Murray Cod throughout the range of farm scales. Victoria, like the rest o Australia, is searching for ways to improve water utilization and environmentally friendly systems to produce food products. Recirculation aquaculture provides an manageable solution to farm diversification and stand alone ventures.

Each of the farms analysed reveals very strong indicators of financial success. The profit margins and the return on assets rival the best performing sectors in the economy. However it must be remembered that the data is dependent on best practice husbandry and recirculation technology. It presents a best case scenario that assumes optimal production (100% production through out the ten year project) and sale of all output once fish have completed their grow out period. This may not be the case in reality, as real time data will change from year to year. However, the model farms do give an indication of the inherent viability of growing Murray Cod in recirculation aquaculture systems.

The influence of production scale on the cost of production (per kilo) reveals that 8% fall in the cost from a 25 tonne farm to a 50 tonne farm and a 3% fall from a 50 tonne farm to a 150 tonne farm. Overall the reduction in the cost of production from moving from a 25 tonne farm to a 150 tonne farm is in the order of 8%. The Profit Margins, on the other hand, show an increase of around 20% when moving from a 25 tonne farm to a 150 tonne farm.