RECIRCULATION - IS IT VIABLE ? IS IT INSURABLE ?

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Philippe PAQUOTTE*

ABSTRACT

Recirculation techniques in aquaculture exist and are applied at an industrial scale in sea-bass, sea-bream and turbot rearing for short (incubation, larval rearing, weaning) or long (broodstock) rearing phases whatever the biomass. Experiments are carried out by IFREMER in partnership with producers and equipment makers to develop super intensive fish production in closed system. From the economic viewpoint, recirculation makes it possible to reduce fingerling production cost while it is still unknown in the case of ongrowing. From the insurance viewpoint, recirculation will make risk appraisal and risk management easier.

INTRODUCTION

Development of marine finfish aquaculture is now restrained in most European countries because of lack of available sites. The coastline is the place of interest conflicts between tourism, urbanisation, industry, harbour activities, agriculture and fisheries. Offshore rearing facilities in unsheltered areas are not commonly used because of technical constraints, high investments, on board manpower management and landscape conservation movements.

The recent development of sea-bass production around the Mediterranean sea has induced a drastic fall of selling price, and consequently financial difficulties for most of the enterprises (fig 1.). Therefore, looking for competitiveness has become a key issue in the international competition, and IFREMER has been considering as one of the top priorities for ten years the development of recirculating methods for fish farming. Work has been focused first on early stages (reproduction, incubation, larval rearing, fingerlings), on Mediterranean species like sea-bass (Dicentrarchus labrax) and sea-bream (Sparus aurata).

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* Economist, IFREMER, Marine Economics Service, 155 rue J.J. Rousseau, 92138, Issy les Moulineaux Cedex

I. STATE OF ART AND INDUSTRIAL DEVELOPMENT

The principle of the recirculation is to re-use after treatment all or part of the water already used in the rearing tanks. Four main operations are involved (fig. 2) :
- mechanical filtration to eliminate particles over 15 microns,
- UV. irradiation to reduce the quantity of germs (vibrio anguillarum),
- biological filtration to eliminate ammonia (nitrificating bacteria),
- control of oxygen level thanks to aeration or to oxygen injection.

1.1. technique already in use at an industrial level

With an aeration device only, biological parameters are kept under control for fingerling production in the following conditions (Blancheton and Covès, 1994) :
- individual weight growth from 1g to 5g,
- density 4-8 kg/m3,
- temperature between 18°C and 21°C
- eradication of 99% of bacteria population
- total ammonia under 1,5 mg/l (over 90% of the nitrogen is eliminated)
- dissolved oxygen around 7 mg/l,
- renewal of the total circulating water once a day by sea water pumping.

This kind of equipment is widely used at an industrial level in the sea-bass and sea-bream hatcheries all around the Mediterranean. In France, in 1993, eleven hatcheries have produced more than 20 millions fingerlings by using recirculation. As for the rest of the Mediterranean sea, almost 70% of the whole production (around 150 millions fingerlings) is coming from closed system installations, particularly in Greece and Italy.

1.2. new developments and research programs

The recent decrease in fingerlings selling price and the growers' demand for larger fingerlings have pressed the producers to increase density in rearing tanks with the help of greater oxygen supply (Covès and Gasset, 1994). To achieve this aim, a packed column has to be used as super oxygenator by injecting pure oxygen in the tank (fig 2.). Oxygen has to be injected too just before the biological filter, because of the high oxygen demand for nitrification.

In that case, rearing density may reach 20-30 kg/m3 for fingerlings from 7 to 20 g each. As oxygen fish demand varies with individual weight, temperature, feeding and swimming activity, a computerised regulation system for O2 supply coupled with O2 level control has been developed. Moreover, taking into account the risk of accident with such a biomass, this procedure is linked to an integrated failure management system. Such a technique is now in the process of being transferred to some producers in France.

To develop this new super-intensive technology, a project group has been created, including IFREMER, aquaculture enterprises, oxygen suppliers and equipment producers. Such a research program is mainly aimed in the next five years at :
- extending this technique to the whole ongrowing phase,
- increasing the biomass to 50-100 kg/m3,

- getting a better knowledge of the impact of the biological parameters inside the closed system (O2, CO2, PH, nitrates, temperature...) on the fish growth,
- reducing the supply of external sea water to one renewal of the total volume in ten days.

II ECONOMIC ASPECTS

Despite higher amount of investment, recirculation has proved to be profitable for 1g fingerling production. Indeed, recirculation makes it possible to increase the number of production cycles per year and to reduce the energy costs for water heating.

The breakdown of operating costs, before taking account of depreciation, reveals the low energy consumption, which represents only 3% of the amount in the case of recirculation (fig. 3). Once the depreciation costs included (around 0,15 F/fingerling), the production cost is still 50% less than in a traditional hatchery (Gasset, 1993).

As for the profitability when applied to ongrowing, it is too early now to give an answer. Nevertheless, the research program carried out by IFREMER and its partners includes a project analysis to assess the financial viability of a farm using recirculation. Preliminary results should be available at the end of the year. In first approach, the advantages of recirculation are low heating energy consumption, faster growth and better food conversion rate due to control of biological parameters and better labour productivity. The constraints are higher on-shore investments and important maintenance for all electronic equipment.

III RECIRCULATION AND INSURANCE BUSINESS

3.1. Theoretical aspects

Aquaculture is an activity the characteristics of which make it difficult for an insurance company to :
- calculate the probability of loss because of youth of the activity and lack of data series,
- assess the claim because of difficulty in counting fish and in valuing stock,
- apply the law of the large numbers by pooling many identical and independent risks. Not only is there a very small number of aquaculture enterprises, but they are different and interrelated as well. They are different because they depend on the natural environment and they are interrelated because there are faced to production externalities through the collective use of water (Antona and Paquotte, 1993).

On certain points, recirculation undoubtedly brings improvements :
- it is much easier to appraise a living stock in tanks than in offshore net-cages,
- the plants are more standardised and are independent for they do not depend any more on the environment,
- the underwriter's and broker's appraisal of the particular risk of each farm is possible and easy.

3.2. analysis by type of risk

From a practical viewpoint, it is possible to consider advantages or constraints given by onshore closed system compared to offshore cage farming, for each type of risk. This analysis is presented in table1.

Table 1 : Comparison of risks between onshore closed systems and offshore cage farming

⇑ good points ⇓ weak points

	onshore closed system	offshore cage farming
Pathological risks	⇑ UV. filtration at the entry and/or in the loop ⇑ curative antibiotherapy possible ⇓ risks linked to living bactarian populations (reduced if split in independent closed systems	⇓vaccination is the only possible treatment
Climatic risks	⇑ no incidence of rough sea conditions ⇑ thermoregulation	⇓ risks due to storms and gale winds
Ecological risks	⇑ very small supply of new water	⇓ red tides, predation, chemical pollution quite unpredictable
Technical risks	⇑ solidity of the tanks ⇑ easy control of the equipment ⇑reliable and efficient failure management device ⇓ highly qualified maintenance required	⇓ net-cages very fragile ⇓ more difficult to operate and to communicate in case of emergency
Human risks	⇓ higher complexity of the system, especially for ongrowing ⇑ better protection against thieves ⇑ automatisation of the control processes	⇓workers exposed to bad weather conditions
Commercial risks	⇑ possibility to keep stocks longer in farm if necessary (adequacy to demand) ⇑ less risk of market reject due to presence of antibiotics ⇓ bad image of closed system farming	⇓ fish avaibility (storms...)

An other point to be taken in account is the real diminution of risks caused by aquaculture to the environment. Most of the wastes are re-used, and the enterprise keeps control of anything going out of the farm. This aspect is all the more important as the obligation to monitor and control the waste figures in the recent French regulation concerning impact of aquaculture on the environment.

CONCLUSION AND PROSPECTS

Reliable, predictable and efficient closed recirculating system is no more a challenge.

Research is carried out by IFREMER in close partnership with aquaculturists and equipment producers to apply recirculation on ongrowing phase, at high density (over 100 kg/m3), to perfect fine tuning of biological parameters for best growth results, to reduce water input and to achieve the treatment of all waste.

From the insurance viewpoint, the main advantage of onshore farming compared to offshore farming is easy access to information and to intervention. Recirculation makes it possible to be free from environmental constraints, to optimise the production in order to fit demand and reduce the operating costs. Moreover, it is a good way to produce fish environment friendly.

BIBLIOGRAPHY

Antona M. and Paquotte P., 1993 - Risques en aquaculture et implications pour un système d'assurances : éléments de réflexion - *Equinoxe* n° 44, 19-24.

Blancheton J.P. and Covès D., 1992 - Closed system in intensive marine finfish hatcheries. State of the art and future prospects - Communication at Bordeaux Aquaculture, March 1992

Covès D. and Gasset E., 1994 - Super intensive seabass (*Dicentrarchus labrax*) fingerling production in closed system - Oxygen supply and failure integrated management and water quality evaluation - Communication at Bordeaux Aquaculture, March 1994.

Gasset E., 1993 - Elevage intensif du loup (*Dicentrarchus labrax*) en circuit fermé en phase d'alevinage : trois essais marqués et transformés - *Equinoxe* n° 50, 24-32.

Figure 1 : Evolution of production, production costs and selling price in Mediterranean sea-bass aquaculture

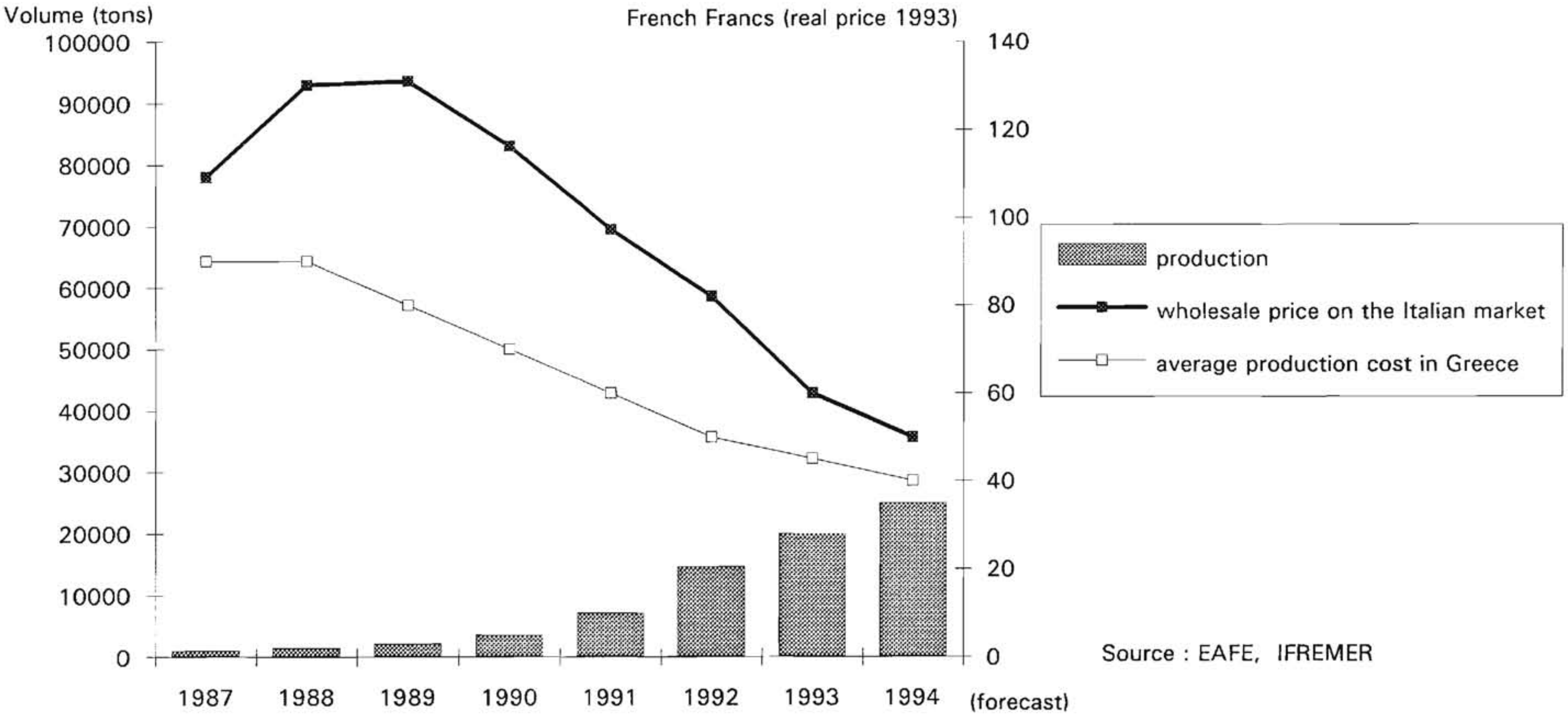

FIGURE 2 : CLOSED SYSTEM GENERAL ORGANIZATION

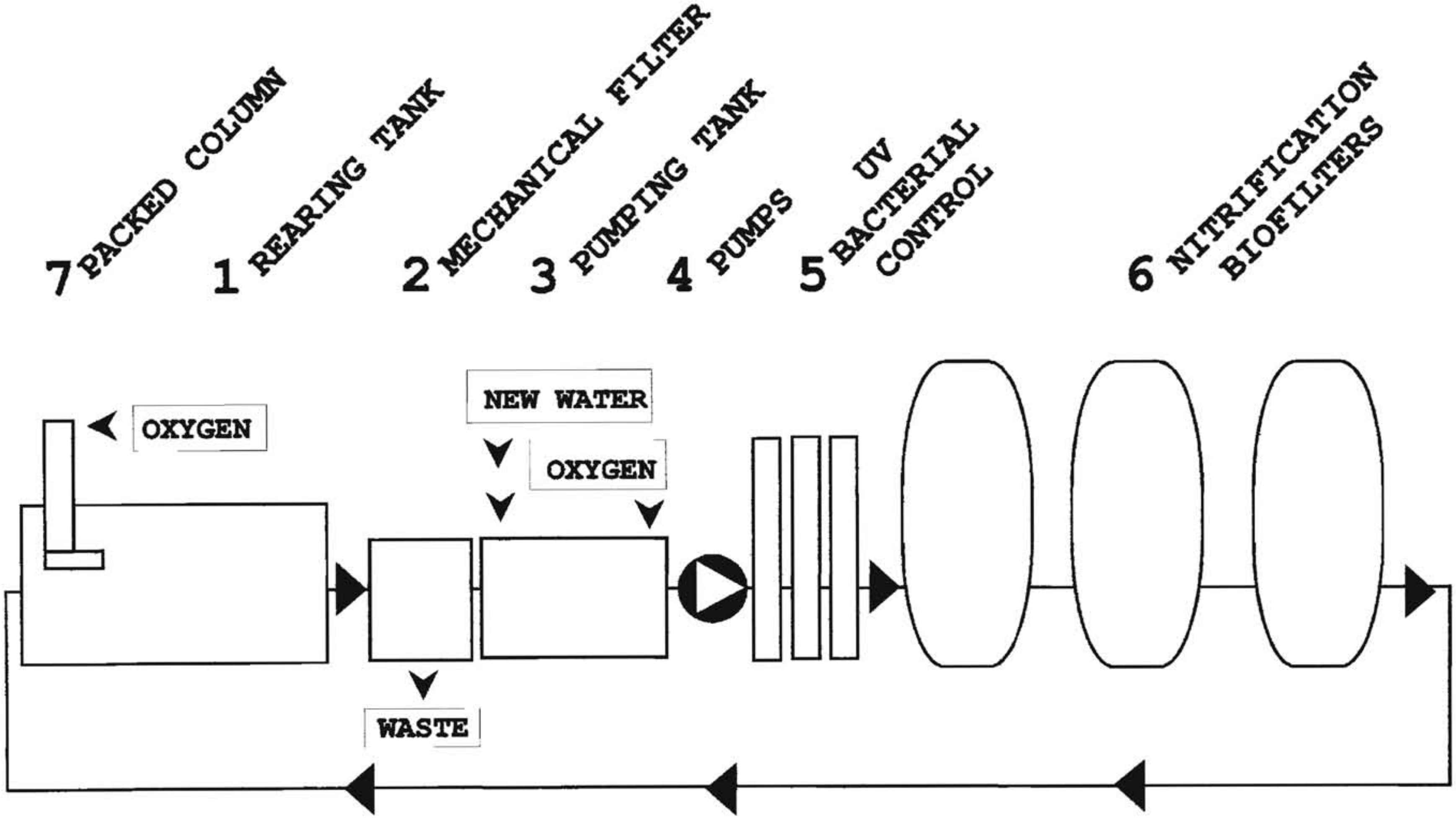

Figure 3 : Comparison of production costs in hatchery between open and closed systems (direct production costs for 100 000 fingerlings of 1 g)