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Short Communication

# The Benefit of Using Selective Breeding for Aquatic Species

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**Submitted:** 24 August 2016

**Accepted:** 06 October 2016

**Published:** 08 October 2016

**ISSN:** 2379-0881



**Keywords**

- Breeding program
- Selection
- Genetic gain

**Abstract**

Results from selective breeding of aquatic species is very encouraging. Estimates of genetic gain per generation for key traits like growth rate is in the order of 13%, implying that it can be doubled in 6 generations. Results are also promising for other traits particularly for disease resistance. Aquaculture farmers should be stimulated to start breeding programs for major breeds. This will increase productivity and better utilizing of natural resources. In addition, the welfare of the animals will be improved.

## INTRODUCTION

Aquaculture production is increasing 7% per year [1]. Most aquaculture is produced in Asia (89%) and in China (62%). However, little of this production is based on genetically improved stocks. In 2008 only 8.2 % of the production of fish and shellfish was based on family breeding programs [2,3,4]. In addition, there are some breeding programs using phenotypic selection and crossbreeding, but the number of such breeding programs is unknown. This low figure has hopefully increased over the last few years. In contrast, almost all meat producing farm animals are genetically improved stock although the genetic gains achieved for meat producing live stock at 3-5% per generation are relatively less than for fish and shellfish [4]. So why not more of the farmed aquatic species are genetically improved? Some of the reasons are:

Breeding programs are rather new in aquaculture and family based breeding programs started only 40 years ago [4].

There is a number of aquatic species farmed, potentially 300 species and only halves of them produced more than 1000 tons per year in 2005 [5].

A considerable production is needed to cover the running cost of a family based breeding program, 40,000 – 50,000 tons has been mentioned (Rye, per. com.). Therefore, small aquaculture farmers should be organized in cooperatives to start breeding programs while companies with high production may start their own programs.

The farmers may not be aware of the high economic benefit gained by using genetically improved stocks.

In the following, I will discuss the economic benefit derived from the application of some efficient breeding programs.

### Genetic gain

In a review paper, Gjedrem and Rye [4], studied the genetic gain obtained in aquaculture breeding programs. For harvest body weight, the genetic gain per generation was 12.7% on average for 67 estimates. The genetic gain for growth rate in multi-trait breeding programs was 11.9% for 19 estimates. This means that it is possible to double growth rate in 6 to 7 generations of selection, as has been obtained for Atlantic salmon (*Salmo salar*) [6], and Nile tilapia (*Oreochromis niloticus*) [7]. High genetic gain was also reported for some diseases: 18.7% for infectious pancreatic necrosis (IPN) resistance, 19.0% for *Vibrio salmonicida,* 11.0% for Sydney rock oyster and 11.0% for Marteilia Sydney. However, some of the genetic gains were low: 0.1% for filet yield, 4% for fat content, 4.9% for overall survival and 4.0% for white spot syndrome white spot syndrome virus (WSSV).

A selection experiment for growth rate in Atlantic salmon at AKVAFORSK, Norway also recorded feed intake, which allows to calculate feed efficiency. Some of the results are given in Table (1).

These results show that growth rate (the target trait for selection in this instance) was more than doubled after 5 generations of selection and that a positive correlated response was obtained for both protein and energy retention. Last but not least, FCR was reduced by 23%.

### Economic effects

The reduction in feed per kg growth was expected since the

**Table 1:** Genetic gain in Atlantic salmon over 5 generations of selection [6].

| Trait | Selected over wild (%) |
|---|---|
| Growth rate | +113 |
| Food consumed | +40 |
| Protein retention | +9 |
| Energy retention | +14 |
| FCR* | -23 |

*Feed conversion ratio or feed per kg body weight produced.

age of salmon at harvest was halved, Table (1). If FCR is 30% improved by selection after 11 generations compared with the wild base population this means that the Norwegian salmon production today saves 0.7to 0.8 billion US$ in feed cost because of efficient breeding programs.

According to Neira [3], and Rye et al. [4], Atlantic salmon is the only aquatic species where close to hundred percent of the fish produced are genetically improved. Back in the 1970s it took 4 years to produce a 4 kg of Atlantic salmon, now it takes less than 2 years. Selective breeding has contributed considerably to positive economics. Not only are there savings in feed costs, which usually represent about half of the total production cost, but also the following benefits are gained because production time is halved:

Production is doubled using the same infrastructure.

Loss due to mortality is reduced (because length of life is shortened).

Cost of labor per kg fish produced is markedly reduced (close to halved).

By providing such benefits, the breeding programs have revolutionized salmon production.

### Domestication

During these generations of selection, a domestication process of Atlantic salmon has taken place. This has been most visible in the freshwater period. The alevins and fry from wild parents were very shy and during the early generations the fry were cannibals. A hierarchy was obviously established in the tanks because the weight of parr became upwardly skewed during the culture period [8]. The body weight of 5 to 8g parr had a coefficient of variation of about 80% and it took 4 to 5 generations before the distribution become close to normal levels of about 30% [9]. Cannibalism was not observed after smoltification. The distribution of the body weight of salmon at harvest was little changed during the following generations. After some generations of selection, the fish show a lower level of stress [10].

## CONCLUSION

In general, wild animals do not thrive in production environments. Therefore, a species brought in from the wild for farming should be domesticated as soon as possible. It has been shown that breeding programs improve productivity and welfare of aquatic animals. Selection for economic important traits facilitates the rate of domestication [11].

To improve the sustainability of aquaculture and welfare of the animals, it is imperative to increase their productivity through selective breeding. Large genetic gains achieved with selective breeding are well documented [12,4].

### How can more breeding programs be implemented for aquatic species?

1. Scientists and aquaculture organizations should inform the farmers about the great benefit of using genetically improved stocks. Further, encourage them to form cooperatives and start breeding programs.
2. Local government should stimulate as well as financially support establishment of breeding programs.
3. Number of farmed species should be reduced because running a breeding program has a cost.
4. Every year, a sector continues not using selectively bred stock is a wasted opportunity.

## ACKNOWLEDGMENTS

I am grateful to Panya Sae-Lim for valuable contribution to the paper.

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**Cite this article**

*Gjedrem T (2016) The Benefit of Using Selective Breeding for Aquatic Species. Ann Aquac Res 3(2): 1021.*