Tailor made low-cost breeding programs for fish

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For quality of life

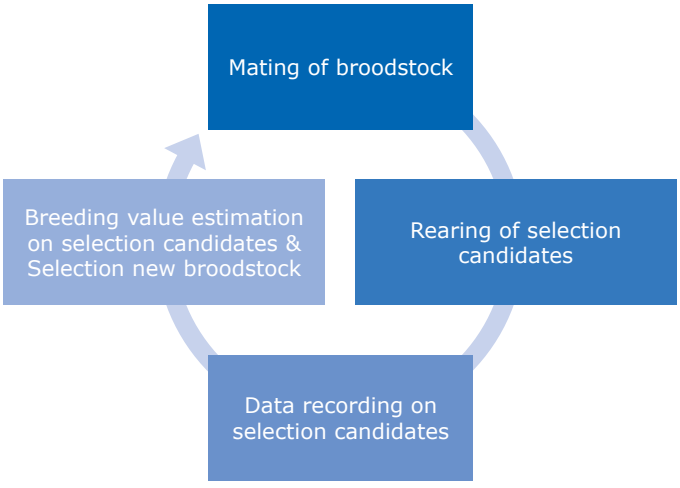
Inpractice, fishbreeding programs yield improvement of growth rate with 10-15% per generation. Conventional breeding programs are however designed for large scale production and therefore costly. Small aquaculture farms can implement tailor made low-cost breeding programs that do not require large investments or separate facilities. The benefits then easily outrun the investments.

Why setting up a breeding program?

Breeding programs help to improve productivity by selecting animals on their genetic (breeding) value for heritable traits. The merits that selective breeding can bring are demonstrated by the performance of commercial breeds of poultry, dairy cattle and pigs.

Selective breeding programs have also been implemented to domesticate Atlantic salmon, rainbow trout, sea bass, sea bream and tilapia. Next to targeted improvement of growth, selected strains typically show improved adaptation to composed feeds, less variation in growth,

The basic structure of breeding programs consists of several steps from mating of the current broodstock to final selection of new broodstock for the next generation. The general structure of a breeding program is shown in the figure below.



Control of inbreeding

Next to improvement of production, breeding programs are needed to control inbreeding (i.e. mating of kin). High levels of inbreeding can result in increased disease susceptibility, higher frequency of malformations, loss of production and ultimately loss of potential for genetic improvement. Once levels of inbreeding are unacceptable, famers will need to refresh their genetic pool with other, often wild genetic material which will immediately undo all improvements that were made in the previous generations of selection.

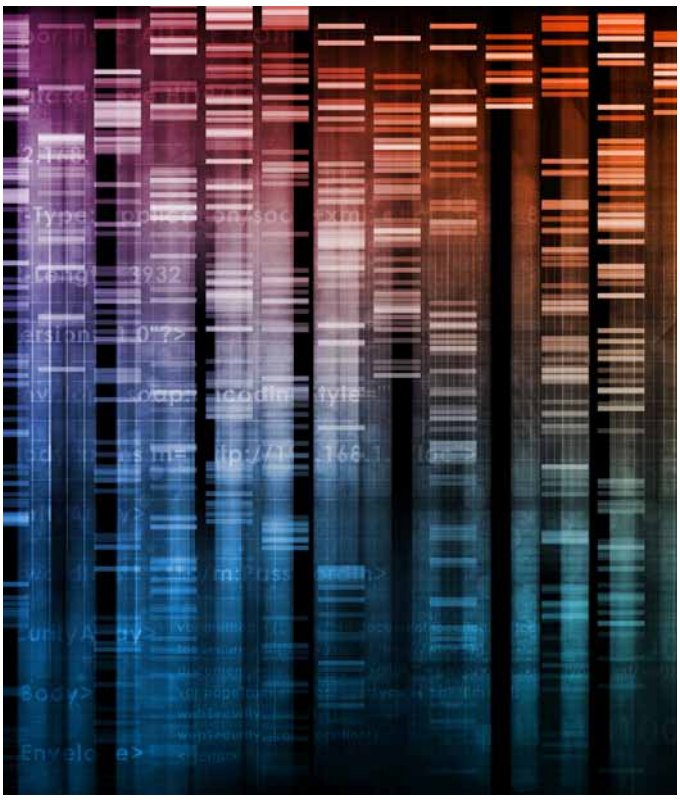
Tailor made low-cost breeding programs

Large scale breeding programs as used for salmon and trout with recording of many traits, extensive tagging and genotyping, family rearing facilities etc, are expensive and not likely to be profitable for smaller farms. Such companies can do better with a tailor-made, low-cost breeding program.

The basic principle of low-cost breeding programs is to minimise the number of facilities and to integrate breeding activities with existent farm infrastructure as much as possible. Tailor made low-cost breeding programs may also be used for species that are dependent on natural mating in groups, such as yellowtail kingfish, soles, tuna etc.

The different steps of a typical tailor made low-cost breeding program (see figure) have the following characteristics:

1. Mating of broodstock
   - Specific smart mating protocols for tagged broodstock to reduce the number of required selected parents.
   - For production of selection candidates, a minimum number of parents is required to control rates of inbreeding.
   - Grow out production populations may be produced by only a few parents.
2. Rearing of selection candidates
   - Production and rearing of fry for selection candidates integrated with normal fry production: few extra efforts, no family rearing.
   - Grow out of mixed families in existent production facilities along with production populations: no extra facilities but real life testing.
   - Batches of selection candidates of different ages (if applicable) are kept separate.
   - No tagging until the moment of testing and selection.
3. Data recording and collection
   - A sample of selection candidates is tagged, traits are recorded, and DNA of individuals is analysed.
   - DNA-based pedigree reconstruction on tagged selection candidates to control inbreeding.
   - Non used selection candidates are sold along with production animals.
4. Breeding value estimation & Selection
   - Computer analysis to predict breeding values of tagged selection candidates.
   - Selection of new parents for the next generation, based on best genetic performance and levels of inbreeding.



Cost-benefit

Costs for selective breeding can be considerable when using conventional breeding structures with extensive tagging, separate family rearing etc. Tailor made low-cost breeding programs focus on cost reduction by decreasing broodstock size due to smart mating protocols, mixed family rearing in normal production circumstances and restricted genotyping.

Although there is always a cost for selective breeding, returns are considerable. In practice, breeding programs have shown improvement of selected traits, e.g. growth rate, of 10-15% per generation. Benefits of selective breeding therefore are likely to outrun the investments.

Tailor made low-cost breeding programs are developed by IMARES and the Animal Breeding and Genomics group (ABGC), Wageningen University and Research centre.

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