HOW TO DEFINE BREEDING GOALS TO ACHIEVE EFFICIENT MARKED ADAPTED PRODUCTION OF TROUT

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KAKO ODREDITI CILJEVE SELEKCIJE DA BI SE DOSTIGLA EFIKASNA PROIZVODNJA PASTRMKE PRILAGODJENA TRŽIŠTU

Abstrakt

U programu veštačke selekcije nam je potreban dobro definisan cilj da bi ukazao na smer i ambiciju uzgoja. Cilj programa treba da uzme u obzir uključivanje osobina koje su važne za datu vrstu i tržište. Osobine koje pratimo moraju pokazivati: značajnu genetičku varijaciju, moraju biti od ekonomske važnosti i moraju biti merljive. Najznačajnije osobine koje se smatraju važnim u akvakulturi pokazuju relativno visoku heritabilnost i zato mogu biti efikasno unapređene kroz proces selekcije. U značajne osobine spadaju prirast, uzrasna kategorija, polna zrelost, nekoliko kvalitativnih osobina, otpornost na bolesti, deformiteti i efikasnost usvajanja hrane. Da bi se izbegli negativni efekti veštačke selekcije, u obzir mora biti uzeta korelacija između ovih osobina.

Ključne reči: *ciljevi uzgoja, selektivni uzgoj, akvakultura*

INTRODUCTION

In developing efficient, competitive and sustainable breeding programmes, definition of appropriate breeding goals is a very important task. The breeding goal can be thought of as the overall objective of the breeding program. It should in terms of relevant characteristics describe what we wish to achieve by selective breeding. It may reflect ambitions related to production efficiency, demands in the market, environmental aspects and animal welfare.

The breeding goal should be oriented towards the future for two reasons. First, genetic changes are permanent and cumulative, and can lead to substantial changes in performance over time. Secondly, there is often a considerably time lag between selection decisions being made and the genetic improvement being utilized. However, rapid changes in market conditions, development of new technologies and production systems, new legislations etc., make it difficult to predict the future of livestock production and thereby to define long-term breeding goals.

For at trait to be included in the breeding goal, the trait must

- Be of economic and ethical importance
- Show genetic variance
- Be possible to measure at reasonable costs

Economic valuation is a major factor in choosing which traits to be included in the breeding goal. A proper assessment of alternative goals and an appropriate weighting of the traits may lead to recommendations of industry actions that are the most profitable and sustainable. Attention to the economics of breeding programmes will result in more accurate valuation of benefits of genetic improvement of fish and livestock in segments of industry and society.

In the past, with a few exceptions, the breeding goals for aquaculture and livestock species have been narrow with selection for a few production related traits with the objective to reduce production costs. However, during the last years it has been shown that such a short-term market strategy may lead to unwanted side effects including deterioration of traits not included in the breeding goal (R a u w, 1998). With more efficient breeding methods and new powerful technologies, larger and faster responses are also to be expected. This may result in an increased risk of unwanted side effects and also increased risk of loss of genetic variation, counteracting further genetic improvement. There is also a growing concern about animals suffering from diseases and disorders, and the use of antibiotics for treatments, including their effects on animals, products and humans. There is no use in applying new and powerful technologies if they just bring us faster in an undesired direction. Hence, it becomes more important to define a breeding goal that reflects a direction in coherence with a sustainable development.

Another consequence of such a narrow, short-term and market focused breeding goal has been that relatively few breeds or strains expand rapidly and supersede other populations focusing on other traits or with less efficient breeding programmes (C h r i s t e n s e n, 1998). In the long-term, this may lead to a considerably loss of genetic variation and has increased our awareness of the importance of securing sustainable use of genetic recourses as a safeguard against future changes in both production and market conditions (H a m m o n d, 1994).

Consequently, an increased focus on both long-term economic as well as ethical and environmental values when defining breeding goals is now evident (O l e s e n et al., 2000). Also, due to the relation between human health and diet and the fact that cost of food constitutes steadily less of peoples income, animal producers can anticipate greater emphasis on product quality and ethical standards. It is therefore likely that the consumers will pay more attention to a broader set of traits implying that breeding organisations have to behave accordingly to be competitive in future food markets.

Traits in a breeding goal; how to meet the future

The overall objective in a breeding program is usually to increase the profit of the firm, industry, or society that are investing in the program.

This is obtained by selection of animals based on a predicted aggregate genotype, a function of the additive genetic values of traits included in the breeding goal weighted by their corresponding economic weight (H a z e l, 1943). The economic value of each trait depends upon the amount by which profit may be expected to increase for each unit of additive genetic improvement in that trait. Economic values are thus among the key factors for deciding which traits to include in the breeding goal (H a r r i s, 1970). However, assigning appropriate economic weights represents a major difficulty for multiple trait selection programmes. Actually, derivation of economic values requires a sound theoretical basis, proper biological modelling of animal production, farm economics and social aspects, and appropriate assumptions on future production and marketing circumstances.

This should decide how to compose the breeding goal, i.e. which traits to include.

In family based genetic improvement program for salmonids several traits are included in the breeding goals: harvest body weight, sexual maturity, disease resistance traits, survival, filet quality traits, skin colour, deformities and egg size. The mentioned traits are also included in the selection criterion. Table 1 presents traits included in known family-based breeding programs in rainbow trout.

Table 1. Traits included in 9 family-based breeding goals in rainbow trout (2006).

Traits	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Harvest body weight	X	X	X	X	X	X	X	X	X
Age at sex maturity	X	X	X				X		X
IPN					X				
F. psychrophilum						X			X
Diplostomum (par)							X		
V. anguillarum		X							
Stress, cortisol									X
Fillet yield		X							
Fillet colour	X	X					X		
Fillet fat								X	
Skin colour	X	X	X				X	X	
Skin spottiness							X		
Body shape	X	X					X		
Deformity	X	X							
Egg size					X				

Body weight at a given time, or growth rate, is for meat producing animals considered the most important economic trait. Fast growth increase production through faster turnover and reduced proportion of fixed costs per unit production. Also, faster growing animals reaches a higher weight before sexual maturation. Consequently, this should be an important part of the breeding goal if the purpose is to produce more within a production unit. Generally this is a trait which shows sufficient genetic variation (h2~0,25 (e.g. K i n g h o r n, 1983; R y e & R e f s t i e, 1995) and is easily measured on the breeding candidates.

Age at sexual maturation is also recorded at the breeding candidate. Early sexual maturation is considered a disadvantage is some species as feed is converted into gonads instead of meat. Generally, sexual maturation reduces growth, meat quality and increase mortality. Significant genetic variation is documented for this trait (h2~0,07-0,34 (e.g. G j e r d e & G j e d r e m, 1984; G j e r d e, 1986; K a u s e et al., 2003). The breeding goal is often defined as 'reached market size before sexual maturation'. In salmon this has been achieved. Early maturation may not be a problem when market size is much less than mature size of the fish in question, i.e. inland production of rainbow trout.

Quality traits: The specific demand for quality varies between markets and species. Some important quality characteristics are size, fat percentage, fat distribution, flesh colour, fillet yield, texture, body shape, condition factor and dressing percentage and skin colour. Also, intra muscular bones may be a problem which can be solved by selective breeding, e.g. in carp, silver barb and sea bream. A challenge in a selective breeding program is to measure quality on live fish. Most often this is measured after slaughter permitting only family selection for this trait. Some market pays little attention to product quality traits as long as the traits are within certain minimum or maximum acceptable standards. Pricing according to quality may be constrained by lack of appropriate technology for quality grading of the fish. Quality traits show generally high heritabilities (h2~0,25 (e.g. R y e & G j e r d e, 1996;G j e r d e & G j e d r e m,1984)

Disease resistance: Traits such as disease resistance are receiving increasing attention by fish farming industry world wide as disease poses probably the greatest worldwide risk to the success of intensive aquaculture through its effects both on production and animal welfare. In the case of disease resistance, the evaluation method (challenge testing) is commonly used in modern breeding programs. Due to negative impacts on animal welfare, alternative approaches are continuously considered like the recent development of high throughput gene expression profiling (eg. using DNA microarrays). This technology can be used to study how the expression level of a large number of genes in a tissue changes with the challenge of an environmental stressor (eg. in carp exposed to cold water1). Also the search for single genes with major impact is given large attention. Some important genes has been found (<20). In fish, unlike farmed animals, most disease resistance show significant and large heritabilies and can be improved efficiently by selective breeding.

Deformities are considered an unwanted side effect of selective breeding. It does however often appear at an early stage of a breeding program, before environmental conditions are fully understood and adjusted, and before the fish is adjusted to production conditions. Some of these problems disappear after some generations of selection. However, due to unwanted correlations found between growth and deformities (K o l s t a d et al., 2005), this must be taken into account a breeding program to ensure the welfare of the fish and the quality of the product.

Feed efficiency is improved by indirect selection through selection for improved growth, as genetic correlations between growth and feed efficiency is high and positive (K i n g h o r n, 1981). A direct selection asks for cost efficient methods to record feed intake. Those are yet to be found. Genetic variation in feed efficiency has been found in salmon (T h o d e s e n, 1999; K o l s t a d et al., 2005). Some studies have proven rather high heritabilites for feed intake (h2=0.41 (S i l v e r s t e i n et al., 2001).

Can all traits be improved simultaneously?

Some traits are favourable correlated, and efficiently can be improved for both traits simultaneously through selective breeding. There are however several examples of unwanted correlations, i.e. between growth and deformities and between growth and disease resistance (Kolstad et al., 2005). As long as the unwanted correlations are less than unity, it is possible to achieve improvements in traits that are unfavourable with the use of family selection schemes with sufficient pedigree information and recordings. The improvement will however be much slower compared if the correlation was non-existing or favourable.

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