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EXPECTED SELECTION RESPONSES IN BREEDING PLANS AIMING TO LIMIT ENVIRONMENTAL IMPACTS OF TROUT FARMING

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With the growing societal concerns about the sustainability of food production systems, there is increasing interest in considering not only economic gains but also environmental impacts in the selective breeding of farmed species. In this study, we compared expected selection responses for alternative breeding programs aiming to limit the environmental impacts of the production of rainbow trout, one of the most important farmed fish species in Europe. The consequences of genetic improvement based on optimal selection indexes derived to minimize various environmental impacts were investigated in a simulated rainbow trout farm producing constant annual production volumes.

A cradle-to-farm-gate life-cycle assessment was performed to evaluate the environmental value of each trait that has been used in the breeding goals (H). The tested H included three different traits: the thermal growth coefficient TGC), the daily feed intake (DFI) and the survival rate (SR). Due to a lack of knowledge about the genetic links across these traits, we tested two correlation scenarios between the traits (A and B). We explored different impact categories as various environmental H and focused on freshwater eutrophication, terrestrial ecotoxicity and water dependence. Selection based on these H allowed an annual reduction of eutrophication and terrestrial ecotoxicity of 2 and 3%, respectively. For water dependence, the volume of water requires for the production was only reduced by < 0.1% annually. For the traits, annual genetics gains, expressed in % of genetic standard deviation (σ_g), ranged from -0.52 to +0.17 for TGC, -0.49 to +0.15 for DFI and -0.19 to +0.36 for SR.

TABLE 1. Annual genetic gains (AGG) expressed (1) in physical units for the different breeding goals (H) with under brackets the gains expressed as % of the average environmental impact of the hypothetical farm and (2) expressed in % of genetic standard deviation (σ_g) for the three traits (TGC, DFI and SR) under selection according to two scenarios considering (B) or not (A) genetic correlations between SR and the other traits.

	Units	A	B
H freshwater eutrophication			
AGG_H	kg P eq	0.43 (3.2%)	0.45 (3.4%)
AGG_{TGC}	σ_g	-0.49	-0.52
AGG_{DFI}	σ_g	-0.46	-0.49
AGG_{SR}	σ_g	<0.01	-0.19
H terrestrial ecotoxicity			
AGG_H	kg 1,4-DCB	84.4 (1.9%)	88.7 (2.0%)
AGG_{TGC}	σ_g	-0.49	-0.52
AGG_{DFI}	σ_g	-0.46	-0.49
AGG_{SR}	σ_g	<0.01	-0.19
H water dependence			
AGG_H	m^3	77.4 (0.1%)	69.3 (0.1%)
AGG_{TGC}	σ_g	-0.10	+0.17
AGG_{DFI}	σ_g	-0.10	+0.15
AGG_{SR}	σ_g	+0.36	+0.36

We demonstrated interest in using environmental values (ENV) in H to minimize environmental impacts at the farm level, while maintaining high genetic improvements especially in feed efficiency-related traits. Nevertheless, we found high variability depending on the environmental impact category. Another selection strategy should be considered to avoid negative consequences on SR when considering possible negative correlations between survival and production traits. Although our results are promising, their interpretations have to include the economic repercussions of such a selection strategy.