



Sustainability assessment of the Arctic Char (*Salvelinus alpinus*) value chain: A case study in Iceland

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Introduction

Iceland is the largest producer of Arctic char worldwide with a production in 2014 of 3.411 metric tonnes and contributing to approximately 40% of the global supply and a value of \$27 million. The aim of this study was to gain an overview of the development of the land based, flow through aquaculture systems in Iceland and to answer the question whether the Arctic char industry can be regarded a success? This included a vision beyond the farm and “success” was assessed in the context of the sustainability of aquaculture products, which entails a holistic environmental, economic and social lifecycle assessment (Fig. 1).

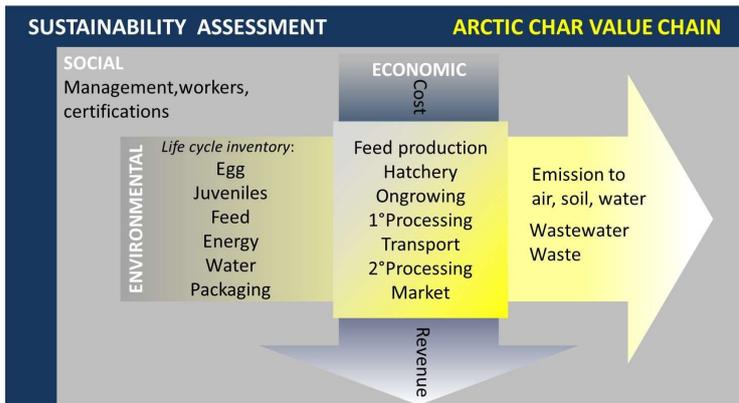


Figure 1. Framework for life cycle sustainability assessment of Arctic char value chain (Adapted from UNEP-SETAC 2011)

Methods

Guiding principles on Sustainable Food Value Chains Development (SFVCD) were conveniently adapted to the study (FAO, 2014). The first phase concentrated on assessing the economic, environmental and social performance of the four largest Arctic char producers in Iceland. The second phase, explored underlying factors which gave insights to understand the performance and considered social impacts. Thirdly, success factors leading to improvements were identified.

Results Phase 1 Economic and environmental assessment

Profitability estimates: The profits the firms made in 2014 according to their estimated profit function and based on their actual production quantities in that year were compared to the results of the maximum profits they can attain based on estimated cost functions (Table 1).

Table 1. Profit maximization vs. 2014 profits based on estimated cost functions $[C(q(i),i)=\alpha_0(i)+\alpha_1(i)\cdot q(i)^{\alpha_2(i)}),i=1,..,4]$

	2014		Profit maximization	
	Quantity (metric tonnes)	Profits (million, USD)	Quantity (metric tonnes)	Profits (million, USD)
Company A	2.017	2,830	6.619	17,95
Company B	190	0,023	1.259	1,82
Company C	235	0,043	1.116	1,47
Company D	155	0,191	307	0,27
Total	2.597	3,089	12.301	21,50

The estimates indicate that each producer is currently producing much less than would be needed to maximize profits. Fish farming of salmonids usually rely on economics of scale to be profitable and competitive. This is clearly observed, for example, in the Norwegian salmon industry (Asche & Bjørndal, 2011). By exploiting the economics of scale identified by the estimates, average costs would decrease and profits could increase by a factor of almost seven (Heimisson *et al.*, 2016).

Environmental impacts: A benchmark for the environmental performance of Arctic char production was based on public Green Bookkeeping reports, Life Cycle Assessment (LCA) studies and results were compared with literature data. Relative to the salmon farming industry with respect to the impacts of feed in aquaculture, the Icelandic Arctic char industry does not exhibit environmental superiority when comparing feed conversion ratio (FCR), energy use and the climate change impact (kg CO₂eq/kg fish) (Table 2). FCR in newly established farms is typically high. High electricity use in some farms is explained by drilling for underground water, while diesel is used for boats in net pen salmon farming.

Table 2. Average annual production at the Icelandic Arctic char companies and key performance indicators compared with Icelandic and Norwegian salmon farms

Company	Years	Average biomass (kg/year)	FCR [kg feed/kg fish]	Diesel [l/kg]	Electricity [kWh/kg fish]	kg CO ₂ eq/kg
Company A1	2011-2015	1.131.104	1,22	0,007	6,34	NA
Company A2	2011-2015	1.130.942	1,29	0,004	3,97	2,4-2,9
Company B	2012	164.112	1,46	0,015	1,48	NA
Company C	2010-11, 2014	458.667	1,78	0,020	0,85	2,7-3,3
Company D	2011-2015	156.778	1,30	0,009	2,80	2,6
Salmon IS	2011-2014	1.747.288	1,52	0,087	0,12	2,6
Salmon NO	2012	11.700.000	1,30	0,017	0,61	2,2-3,0

Phase 2 Exploring underlying factors to explain performance

The industry (based on assessment of the four largest companies) has neither been markedly profitable nor has it grown at a significant rate.

- Since 2009, production increased annually by 6%, value added by 1,8% and profits declined by 5% (compared with increase of 7%, 12%, 13,5%, respectively, in the Norwegian salmon industry). The Icelandic currency has large impact on the results of the economic assessment.
- The limited growth of the industry has been explained by the lack of capital to invest in new facilities, and inefficient administration procedures and infrastructure support from authorities.
- Genetic factors and the inherent growth rate of the Arctic char may also explain the performance of the industry.

Phase 3 Success factors leading to sustainable Arctic char value chain

The prospects for land based aquaculture in Iceland are favourable when considering the access to coastal areas, water and renewable energy as well as the lower risk of escape and diseases compared with marine cages. There is foreseen growth and new licenses have been issued where the industry will benefit from activities in the last years including:

- A regulatory framework (Act no. 71/2008; 49/2014) and requirements based on Norwegian standard (NS 9415:2009).
- Environmental monitoring and uptake of voluntary standards on responsible practices (AquaGAP, IMO, Whole Foods standard)
- Research has been funded on Arctic char:
 - Biological factors (breeding, growth rate, sexual maturation); External factors (feed, salinity, temperature, water quality, rearing density, animal welfare);
 - Marketing studies (US and Europe)

According to stakeholders, the developments towards more sustainable value chain, should focus on breeding, and marketing efforts to differentiate Arctic char products, as well as considering social impacts.

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The SUCCESS project “Strategic use of competitiveness towards consolidating the economic sustainability of the European seafood sector” has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 635188 <http://www.success-h2020.eu>

