Environmental Pollution 219 (2016) 156–165

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Environmental impact of non-certified versus certified (ASC) intensive Pangasius aquaculture in Vietnam, a comparison based on a statistically supported LCA☆

Trang T. Nhu [a,*], Thomas Schaubroeck [a], Patrik J.G. Henriksson [b,c], Roel Bosma [d], Patrick Sorgeloos [e], Jo Dewulf [a]

[a] Research Group EnVOC, Department of Sustainable Organic Chemistry and Technology, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, B-9000 Gent, Belgium
[b] Stockholm Resilience Centre, Stockholm University, Kräftriket 2B, 114 19 Stockholm, Sweden
[c] WorldFish, Jalan Batu Maung, 11960 Penang, Malaysia
[d] Aquaculture and Fisheries, Wageningen University, Marijkeweg 40, 6709PG Wageningen, The Netherlands
[e] Laboratory of Aquaculture & Artemia Reference Center, Ghent University, Rozier 44, B-9000 Gent, Belgium

ARTICLE INFO

Article history:
Received 7 June 2016
Received in revised form
1 October 2016
Accepted 4 October 2016

Keywords:
Aquaculture Stewardship Council (ASC)
Environmental impact
LCA
Pangasius
Vietnam

ABSTRACT

Pangasius production in Vietnam is widely known as a success story in aquaculture, the fastest growing global food system because of its tremendous expansion by volume, value and the number of international markets to which Pangasius has been exported in recent years. While certification schemes are becoming significant features of international fish trade and marketing, an increasing number of Pangasius producers have followed at least one of the certification schemes recognised by international markets to incorporate environmental and social sustainability practices in aquaculture, typically the Pangasius Aquaculture Dialogue (PAD) scheme certified by the Aquaculture Stewardship Council (ASC). An assessment of the environmental benefit of applying certification schemes on Pangasius production, however, is still needed. This article compared the environmental impact of ASC-certified versus non-ASC certified intensive Pangasius aquaculture, using a statistically supported LCA. We focused on both resource-related (water, land and total resources) and emissions-related (global warming, acidification, freshwater and marine eutrophication) categories. The ASC certification scheme was shown to be a good approach for determining adequate environmental sustainability, especially concerning emissions-related categories, in Pangasius production. However, the non-ASC certified farms, due to the large spread, the impact (e.g., water resources and freshwater eutrophication) was possibly lower for a certain farm. However, this result was not generally prominent. Further improvements in intensive Pangasius production to inspire certification schemes are proposed, e.g., making the implementation of certification schemes more affordable, well-oriented and facilitated; reducing consumed feed amounts and of the incorporated share in fishmeal, especially domestic fishmeal, etc. However, their implementation should be vetted with key stakeholders to assess their feasibility.

1. Introduction

Fish play a vital role in human nutrition worldwide, and fish consumption per capita increased 1.6 times (from 12 to more than 19 kg) between 1985 and 2012 and is expected reach 22.4 kg in 2022 (FAO, 2014). Most of this increase has come from aquaculture, a sector that has grown to produce 90.4 million tonnes (live weight equivalent) in 2012, in which the food fish aquaculture production (66.6 million tonnes) had expanded about six times since 1985, while global marine and inland capture fisheries production has remained stable (approximately 90 million tonnes) in a similar period (FAO, 2014). Catfish (*Pangasius hypophthalmus*) production from the Mekong delta, in Vietnam, has made inroads into traditional ground fish markets as a cheaply farmed whitefish species. This sector has achieved a ten-fold expansion by volume and a 14-

☆ This paper has been recommended for acceptance by Dr. Xiang-Zhou Meng.

* Corresponding author.
E-mail address: Trang.nhuthuy@ugent.be (T.T. Nhu).

http://dx.doi.org/10.1016/j.envpol.2016.10.006
0269-7491/

fold increase by value during the period from 1985 to 2012 (FishStatJ, 2016). The number of consumer groups has also increased from 11 importing markets in 2001 to 149 markets in 2014 (VASEP, 2014). This expansion is expected to continue, driven by steadily increasing global demand.

In conjunction with increasing production, environmental impacts, such as mangrove destruction, eutrophication, a continued reliance on wild fish stocks, chemical use and antibiotic use, have garnered increased media coverage. This coverage has come to influence consumer attitudes towards farmed fish, where Vietnamese Pangasius is often considered a controversial product (FAO, 2014). In response, aquaculture certification schemes have been introduced to provide assurances of more sustainable aquaculture practices. In 2009, the Vietnamese government addressed concerns about the use of chemicals, water pollution and biodiversity degradation in a 2020 Master Plan for Pangasius production in the Mekong Delta (Bosma et al., 2011). At that moment, a number of sustainability standards for Pangasius production were at different stages of development, e.g., Naturland, Butlers Choice, etc., covering a range of issues: aquaculture production guidelines, environmental management, social, legal and chain-related issues and food safety (Bush et al., 2009). In 2010, the Vietnam Association of Seafood Exporters and Producers (VASEP) and the Vietnam Fisheries Society (VINAFIS) signed a Cooperation Agreement with the World Wildlife Fund (WWF) to support efforts to improve environmental and social responsibility in the Vietnamese Pangasius sector and to achieve ASC certification. According to the agreement, 100% of farms for export should be under one of the several certification schemes by 2015, with 50% of the exporting farms under the ASC by 2015, and 10% by 2012 (WWF, 2012).

Currently, many local Pangasius producers are keen to meet one or several certification schemes recognised by international markets since this opens doors to new markets in the European Union and the United States. It also reinforces their will to embrace environmental and social sustainability in aquaculture practices. Of the many schemes currently available for Pangasius, the following three are generally considered to be the most widespread: Global Partnership for Good Agricultural Practices (GlobalG.A.P.), Pangasius Aquaculture Dialogue (PAD) and Best Aquaculture Practices (BAP) (Belton et al., 2011). GlobalG.A.P. began in 1997 as EUREPG.A.P., an initiative by retailers belonging to the Euro-Retailer Produce Working Group, pledging commitment to good agriculture, livestock and aquaculture farming practices. The BAP scheme, an initiative by the Aquaculture Certification Council (ACC), is aquaculture specific and promotes responsible practices across farms, feed mills, hatcheries and processing facilities. The PAD scheme, certified by the Aquaculture Stewardship Council (ASC), is the most recent and was established in 2010 by the World Wildlife Fund (WWF) and the Dutch Sustainable Trade Initiative (IDH). Today, it is an independent non-profit organisation with the goal of raising the global standards of responsible aquaculture. Presently, there are 37 ASC-certified farms (ASC, 2016), 27 GlobalG.A.P.-certified producers (GlobalGAP, 2016) and 15 BAP-certified (13 farms and 2 hatcheries) Vietnamese Pangasius facilities (BAP, 2016). However, by 2016, all Pangasius farms and companies are required by the Vietnamese government to meet the standards of one of the certification schemes operating in Vietnam, including these three schemes (Marschke and Wilkings, 2014).

Aquaculture is a highly diverse activity with respect to technologies and cultivated organisms. Therefore, as a way to better understand and identify more environmentally sustainable practices, the life cycle assessment (LCA) approach has been increasingly applied to aquaculture, particularly facilitating comparisons between the efficiencies of competing production systems (Pelletier and Tyedmers, 2008). LCA has emerged as a widely used and recommended framework to assess the environmental impact of a product through its life cycle, i.e., from resources extraction until final disposal (ISO, 2006a). LCA research covers global-scale impacts, resulting in new insights into the environmental impact of seafood products (Ziegler et al., 2016). This tool has also been applied to assess the environmental performance of conventional (i.e., intensive non-certified) Pangasius aquaculture and its processing into other products (i.e., frozen and modified atmosphere packaging fillets), evaluating global warming, acidification, eutrophication, and toxicity impacts (Bosma et al., 2011; Henriksson et al., 2015b), as well as resource use (Huysveld et al., 2013; Nhu et al., 2015b). Moreover, to assess the LCA results of 12 different feed types at 10 non-certified and 10 certified farms, equations were developed to easily estimate the cradle-to-gate resource footprint of Pangasius feeds and aquaculture (Nhu et al., 2016). The latter study was limited to the quantification of resource use and did not address concerns about resource use on the certified farms is better than on the conventional farms.

In the present study, we aimed to evaluate the environmental performance of ASC-certified and non-ASC certified Pangasius systems using LCA. A crucial part of comparing production systems is to include data uncertainty, already specifically applied to aquaculture products (Henriksson et al., 2015a, 2015b). In the LCA context, a number of studies have been performed to better assess uncertainty, identifying and taking into account different types of correlation (Lloyd and Ries, 2007). Different types of uncertainty include those relating to parameters (e.g., data inaccuracy, data gaps, and unrepresentative measurements), and those concerning the (LCA) model (e.g., the deviation of characterisation factors or missing of temporal/spatial characteristics in inventory analysis) and the scenario choices (e.g., choices of functional unit, allocation approach, characterisation/weighting methods) (Huijbregts, 2002). Regarding uncertainty at the parameter level, correlations have been addressed among the input parameters, as well as between them and the outcome (Bojaca and Schrevens, 2010), or when comparing production systems controlled by the same parameter set (Henriksson et al., 2015a). Here, we will mainly focus on data uncertainty but will also assess the influence of some model choices. An overview of the key criteria considered in the ASC standard scheme as well as covered in this study can be found in the Supporting information 1 (SI1), Table S1. The environmental categories considered included resource-related (water, land, total resources) and emissions-related (global warming, acidification, freshwater and marine eutrophication) categories.

2. Materials and methods

2.1. Goal and scope

The LCA comparison between Pangasius produced on ASC-certified farms (ASCs) and non-ASC certified intensive farms (NFs) in this study was based on data from three independent studies on intensive Pangasius production, i.e., Bosma et al. (2011), Henriksson et al. (2015b) and Nhu et al. (2016). Bosma et al. (2011) evaluated the environmental impact of Pangasius NFs using LCA on the primary data surveyed at 28 farms and 7 feed production companies between 2008 and 2009. Henriksson et al. (2015b) applied LCA, coupled with statistical tests and uncertainty analysis, to compare the environmental impact of Pangasius NFs produced at different farm-scales (i.e., small, medium, large). The primary data were randomly gathered at 110 small-, 64 medium- and 38 large-scale farms from 2010 to 2013. Both of these studies focused on emissions-related categories (e.g., global warming, eutrophication, toxicity impacts, etc.). Nhu et al. (2016) constructed equations to simply predict the resource footprint of both NFs and ASCs by