Recirculation Aquaculture Systems: Sustainable Innovations in Organic Food Production?

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Abstract
EU regulations explicitly preclude recirculation aquaculture systems (RAS) for aquaculture grow-out from organic certification because they are not close enough to nature (Regulation (EEC) No. 710/2009). Meanwhile, according to another EU regulation, one criterion for organic food production is its contribution to sustainable development (Regulation (EEC) No. 834/2007). Against this background, one might argue that in spite of their distance to nature RAS are innovative solutions to deal with sustainability issues in food production. The paper will deal with the claim that RAS for aquaculture could be one innovative solution to sustainability issues. In this respect, the picture is ambivalent. In the past, the organic movement (OM) has searched for innovative alternatives to industrial forms of agriculture and food production that are non-sustainable. Hence, the majority of the OM cannot warm to industrial RAS, even though one might argue that these systems comply with many of the European OM's founding principles. While there are potential positive effects for a sustainable development, we might still regard these systems as techno-scientific solutions to social problems. This paper discusses innovation narratives related to RAS from the perspective of post-normal innovation critique. It first presents potential contribution to a more sustainable food sector. It then contrasts these arguments within critical assessments of innovation narratives for sustainable development. Finally, it discusses pitfalls that the OM needed to avoid if it wants to lobby for or against organic certification of RAS.

Keywords: recirculation aquaculture systems (RAS), sustainable development, post-normal science, innovation, food systems

1 Introduction

Recirculation aquaculture systems (RAS) are promoted as innovations in the food sector that will (significantly) contribute to a more sustainable development by providing food security for a growing world population and a more environmentally friendly form of food production (Kloas *et al.* 2015, Martins *et al.* 2010). RAS are on-shore "closed-loop production systems that continuously filter and recycle water, enabling large-scale fish farming that requires a small amount of water and releases little or no pollution" (Jenner 2010). Aquaponics combines RAS with plant production by using the processed fish excrements to cultivate plants. Amidst recent technological developments (Kloas *et al.* 2015, Tschirner and Kloas 2017), the organic movement (OM) faces the challenge whether it should embrace RAS and promote their organic certification. Currently, it is making up its mind. When speaking about the OM, we refer to the global movement of organisations and individuals engaged in the promotion of organic farming and products (Bergleiter *et al.* 2017, IFOAM 2017).

From a legal perspective, the case seems clear. The EU regulation on organic aquaculture production explicitly precludes RAS from organic certification. Yet, the regulation binds its exclusion to the discovery of 'further knowledge'. Thus, the OM might embark on producing this evidence, if it was convinced that RAS should be organically certified. Reference to potential contributions to a more sustainable development seems the most promising strategy (Bergleiter *et al.* 2017; Little *et al.* 2015).

There are many ways to engage with RAS, e.g. regarding fish welfare (Seibel *et al.* 2018). In this paper, we aim to contribute to the process of self-reflexion by the OM. Hence, we question narratives of 'innovation for sustainable development' related to RAS and ask what the OM buys into when subscribing to these narratives. In doing so, we discuss these narratives from the perspective of post-normal innovation critique and focus on the EU context. The paper sketches the legal context within the EU (2). It continues with an overview of the potential contributions of RAS to a sustainable development that might support their organic certification (3). The paper subsequently contrasts these arguments within a critical assessment of innovation narratives for sustainable development (4). It concludes by discussing pitfalls that the organic movement needed to avoid if it ever wanted to lobby for or against organic certification of RAS (5).

2 The Legal Perspective

EU regulation on organic aquaculture (Regulation (EEC) No. 710/2009) explicitly precludes RAS from organic certification. Article 11 states that "[due] to the principle that organic production should be *as close as possible to nature* the use of such systems should not be allowed for organic production *until further knowledge is available*" (italics added). Yet, the criterion of 'closeness to nature' is confusing as it leaves implicit what it means by 'nature' and does not provide a scale of what is 'close enough' (Kerr and Potthast 2018). After all, the term 'nature' is highly contested (Castree 2017).

Despite the rational given why RAS are excluded from organic certification, the regulation requires organic food production to contribute to sustainable development and limits RAS "until further knowledge is available". What might this mean then? Either other factual knowledge is found showing that RAS are close enough to nature. For many (epistemic) reasons, this is not a very promising strategy (Bergleiter *et al.* 2017: 47-49). Alternatively, it might be argued that additional values and norms (other than 'closeness to nature') should be considered when evaluating RAS. Advocates of RAS emphasise their positive contributions for sustainable development and point to the EU regulation on organic production and the labelling of organic products (Regulation (EEC) No. 834/2007) according to which organic production 'delivers public goods contributing to the protection of the environment and animal welfare, as well as to rural development'. Against this background and despite their distance to nature, RAS might then be promoted as innovations in the organic sector.

3 RAS – Innovative Solutions for a Sustainable Development

3.1 Sustainability Issues Related to Aquaculture

Advocates of aquaculture and RAS stress the potential contributions of these production systems to many urgent challenges of sustainable development (cf. e.g. ECF Farmsystems 2018, Kloas *et al.* 2015, Tschirner and Kloas 2017). In particular, two problems are repeatedly stated. First, it is expected that the global demand for animal proteins will significantly increase because of the growing world population as well as the rising and thus more meat-intensive living standards in many parts of the world. The bottom line is: *More people will eat more meat.* Fish is expected to play a key role in meeting this increasing demand for animal proteins. Besides, compared to other forms of animal proteins, the ecological impact of fish production is considerably lower. Yet, and here comes the second sustainability challenge, many fish stocks worldwide are already overfished, some close to collapse. Against this background, aquaculture seems a promising way to provide valuable nutrition to a growing world population and to protect marine fish stocks. The aquaculture sector is already one of the fastest growing sectors in the food industry, potentially increasing ecologically and socially damaging effects; this can range from animal welfare in exposed cages and overstocked densities, the abuse of pharmaceuticals resulting in residues in the final product and the natural environment, to the transmission of diseases from farm to wild animals, to the destruction of coastal ecosystems or the neglect of neighbouring stakeholders' interests, to long-distance transport of goods (Bergleiter and Meisch 2015; Folke *et al.* 1998). One solution to these problems is organic certification aiming to improve current production (Bergleiter and Meisch 2015); RAS rate as another one.

3.2 Recirculation Aquaculture Systems

Advocates of RAS claim that this technology has the potential to significantly reduce the shortcomings of other forms of aquaculture. Before discussing RAS, we acknowledge that we would have to differentiate between fish species and production systems, which we unfortunately cannot do within the scope of this paper, and are well aware of this deficit (cf. e.g. Bergleiter *et al.* 2017).

With regard to fish welfare and biosafety, RAS claim to have advantages over conventional forms of aquaculture. Farmed fish require suitable densities in order to prevent stress from territorial behaviour (too low stock) or overpopulation (too large stock). Given the control options, suitable stocking densities can be achieved in RAS. This controlled environment also favours other important factors for fish welfare, e.g. water quality and the absence of external stressors such as predators. The same applies to the use of pharmaceuticals. The controlled environment makes it easier to keep diseases out and avoid drug applications. In the event of illness, pharmaceuticals can be applied more easily and specifically. As these are on-shore, the spread of diseases to wild fish or the escape of fish, ill or healthy, can be excluded in principle. Finally, if a fish species lives in the water column and does not need a particular environment such as substrate, the closeness to nature becomes a difficult question and ponds are not necessarily more desired than tanks (cf. Seibel *et al.* 2018; Bergleiter *et al.* 2017).

Moreover, RAS are expected to have a reduced ecological impact compared to conventional organic aquaculture. As closed on-shore systems, they can be built in areas with low land pressure and thus avoid conflict with land for food and energy production and reduce pressure from precious coastal ecosystems such as mangrove forests. This independence from a particular ground constitutes an advantage over conventional organic aquaculture because there is simply not enough land to substitute the current marine-based fish production with existing forms of organic aquaculture (Bergleiter *et al.* 2017). RAS are water efficient and can hence be installed in arid areas. Being closed systems, they do (ideally) not pollute water bodies at all. Fish excrements can be filtered out or processed and used for plant production in aquaponics. Recently, an aquaponics system – the so-called 'tomato-fish' – was developed that might even work as a CO_2 sink because it uses more CO_2 than it emits (Kloas *et al.* 2015, Suhl et al. 2016). The organic concept of closed matter and energy cycles comes close in some RAS such as aquaponics but is largely absent in conventional organic aquaculture.

A consumer review indicated that fish produced in RAS might appeal to the desire of consumers in the Global North as it can allow regional production, which they seem to value more than organic ones (Bergleiter *et al.* 2017). A prominent example is the 'capital-city perch' ('Hauptstadtbarsch') grown in a RAS in Berlin (Rushe 2016). Furthermore, regionality might have the additional advantage as consumers can come and see how their fish is grown. Production sites close to consumers thus tend to profit from increased trust and reduced long-distance transportation.

4 RAS – Yet Another Technological Fix?

What can we make of the abovementioned claims that RAS are a step towards an 'environmentally neutral agriculture' (GGN 2018) and, hence, an innovation for sustainable development under the EU regulation on organic aquaculture? In recent years, post-normal science (PNS) scholarship has critically engaged with narratives of *innovation for sustainability*

(Benessia *et al.* 2012, Benessia and Funtowicz 2016, Rommetveit *et al.* 2013). Strand (2017: 288) characterises PNS as "a critical concept originally developed to describe situations in which there are important or controversial public decision problems informed by an incomplete, uncertain or contested knowledge base". The challenges concerning RAS correspond well to this problem description. PNS scholars have identified different innovation narratives. In their reading, innovation is "a dynamic system of forces that constantly and necessarily redefine the boundaries between science, technology and the normative sphere of liberal democracy" and "a phenomenon which is on a path-dependent trajectory, with origins in the scientific revolution and the emergence of the modern state in the 16th and 17th centuries" (Benessia and Funtowicz 2016: 71). The latest narrative presents innovation, on the one hand, as a way out of various crises in Western capitalist economies and their saturated markets. On the other hand, it evokes an ambiguous sustainability narrative calling for a pause in the human consumption of finite natural resources and at the same time believing that accelerated science-based innovation can manoeuvre humanity out of this crisis by means of smart, marketable technologies (Rommetveit *et al.* 2013). With this, the "very same *cause* of the […] extreme vulnerability of our life-supporting systems on the one side, and of the massive expropriation and deterioration of natural and cultural systems on the other, is considered as the main and only possible *cure*" (Benessia *et al.* 2011: 77, italics in original). This narrative promotes innovation as the pathway to secure the survival of humans and the planet within an unquestioned Capitalist market economy (Leese and Meisch 2015). So, first, post-normal scholarship critically analyses if innovations really deal with the sustainability challenges themselves or if they simply develop consumer products with the vague message that they would meet these challenges. Second, it looks at the forms of citizenship these narratives create: Can members of society only act in their capacity as consumers or passive recipients of products? Or can they participate actively as citizens in the development of their environments such as food production (Rommetveit *et al.* 2013, Strand *et al.* 2017)?

Against this background, RAS appear as a silver bullet to multiple social and environmental predicaments, such as food security, local production, reduced pollution, increased animal welfare or reducing the pressure of destruction of marine habitats. Yet, it remains unclear how they really relate to the solutions of these challenges. Furthermore, their implementation might raise serious issues of justice and democratic citizenship. The stereotypical RAS narrative simply accepts the local desire for global products as well as the global meat consumption continues to increase from its already unsustainable level. At least, advocates of this technology do not make an explicit effort to challenge dominant imaginaries related to meat. With this, they seem to imply that fish products from RAS can fully substitute the current meat consumption. Even if one assumes that humans will never become vegetarians or vegans and continue to eat animal proteins, for RAS to be effective, consumers would have to change their diets radically and eat fish instead of other meat types (poultry, pork, beef etc.). Convincing people to eat differently is a legitimate aim and constitutes a building block of sufficiency strategies. Yet, this change would have to be a part of democratic deliberations on the good life – and not just the (perhaps desired) side effect of a new food technology. The same applies to the socio-economical context. In order to address sustainability issues, current forms of aquaculture would have to terminate and be replaced by RAS. Again, there are good reasons for a reform of these sectors. Yet, strictly applied, this substitution would turn existing fishing and aquaculture communities upside down by radically altering the ownership structure, knowledge and power base and access rights in the newly designed sector; presumably with a shift from the Global South to the Global North Thus, if RAS were to make its promised contributions to sustainable development, it would by no means be socially neutral and absolutely require democratic deliberation and a social reform that goes beyond the simple installation of a food production facility. Last, but not least, RAS narratives envision members of society as mere recipients or consumers of a technology that might radically change their way of living, working and eating. However, as citizens, they have the capacity and agency to innovate their own food systems.

5 RAS: An Option For The Organic Movement?

Proponents usually present RAS as solutions to urgent sustainability challenges. While we do not deny that RAS have the potential to produce marketable food products that are low in residues, produced in a less polluting, more efficient and animal-friendly way, we wonder whether they can really keep their promises. Against this background, should the OM, its collective and individual members then lobby for the organic certification of RAS? On the one hand, it began as a movement against the technologisation, intensification and economization of agriculture and food production. By contrast, it promoted a holistic approach to agriculture, the creation of largely closed matter and energy cycles, the care of soil life, a diversified crop rotation, the adaption of livestock breeding to site conditions, the regard for the needs of the livestock, the production of nutritionally valuable foodstuff, the avoidance of environmental pollution and the lowest possible power consumption of non-renewable resources (Storhas 1988: 23). The OM's principles relate well to the post-normal critique. Consequently, embracing RAS might feel as a betrayal of core beliefs. On the other hand, the OM originally intended to create new food production systems. Counter-intuitively, RAS conform to OM's aims –particularly, if we concede that many fish species in nature do not live in closeness to sediments and thus references to soil do not apply. In addition, veterinarians suggest controlled RAS to be more in line with animal welfare aims than some of the existing organic systems such as cages. This observation touches on the self-conception of the OM and raises the question what organic certification means after all. Last, but not least, the OM reminds us that agriculture is socially embedded. In this regard, RAS might be tools in order to achieve a more sustainable aquaculture in some places at some times but also tools whose social consequences need to be ethically reflected and democratically deliberated. Yet, this deliberation needs to be embedded in a more encompassing rethinking of current organic systems and (environmentally, socially, globally) valuable innovations.

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