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# A review of the multiple benefits of mussel farming

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## Abstract

This review analyses how mussel farming can contribute to the challenge of feeding the current and future world population in a more efficient and sustainable way. The analysis lays a foundation of the main issues with current practices of animal protein production, and compares them with the alternative of a massive expansion of mussel farming as a means to produce high-quality protein for human and animal nutrition. The review also covers the ecological goods and services that mussels provide to the ocean and to the atmosphere, the health of mussel products, and the many potential uses of by-products from the mussel industry in agriculture, in wastewater treatment, and in the feed industry.

**Key words:** aquaculture, feed, food, mussel, sustainable.

## Introduction

The world community must provide adequate food and nutritional security to a growing human population, expected to reach 9.7 billion in 2050, which will increase the demands for proteins, by an estimated 70% (FAO, 2016). More than one billion people in the world are estimated to be living in extreme poverty, and hunger remains a persistent problem (FAO, IFAD, UNICEF, WFP and WHO, 2017).

Protein from animals of terrestrial origins are very valuable sources of essential nutrients, but their production consumes resources and produces emissions. Milk, meat (beef, chicken, pork) and eggs are very valuable sources of essential amino acids, minerals and vitamins, but their production consumes some non-renewable resources including arable land (Costa-Pierce 2016; Flachowsky *et al.* 2017). Agrifood systems use a large share of the global energy supply, rely heavily on fossil fuels to meet production targets and contribute to greenhouse gas (GHG) emissions. In 2009, an expert meeting convened by FAO to discuss how to feed the world in 2050 concluded that agrifood systems will have to become 'energy-smart' to meet future food and energy challenges, and that growing scarcity of natural resources may well shape the food sector's future FAO (2009). About 70% of the Earth is covered with water, the most underutilized resource when it comes to food production. About 12% of the 30% of the Earth's terrestrial sphere is occupied by agriculture, and nearly 98% of our food is produced from this small portion of the Earth's surface. Only fisheries and aquaculture systems can utilize the remaining 70% (Leffelaar 2016).

Aquaculture continues to grow faster than other major food production sectors although it no longer enjoys the high annual growth rates of the 1980s and 1990s (11.3 and 10.0%, excluding aquatic plants). Average annual growth declined to 5.8% during the period 2000–2016, with the vast majority of production centered in China (FAO 2018a). Aquaculture offers one of the only opportunities to respond to the global imperative to mitigate the huge environmental and social impacts of terrestrial food production systems, and attend two of the toughest societal challenges highlighted in the UN Sustainable Development Goals: minimizing biodiversity loss and achieving sustainable food production (Blanchard *et al.* 2017). Alexandratos (2005) points out that with increasing population, many countries depend heavily on agriculture to cope with the food projected needs.

The potential to increase aquaculture production is seen as immense, with very positive implications to eradicate the global malnutrition (Phillips 2017). However, Tacon *et al.* (2010) state that like capture fisheries, the development focus of aquaculture in economically developed countries has been primarily based on the high-value species, in particular, carnivorous species. The long-term sustainability of such production systems is questionable unless aquaculture can reduce its overdependence upon capture fisheries for sourcing raw materials for feed formulation. Aquaculture's accelerating use of agricultural meals and oils is also cause for concern; it may be driving the expansion of unsustainable agriculture for feeds, such as soybean farming in both