Rev. Sci. Tech. Off. Int. Epiz., 2017, **36** (1), 323-329

Social and economic aspects of aquatic animal health

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Summary
Aquaculture is an increasingly important source of animal protein for a growing global population. Disease is a major constraint to production, with resultant socio-economic impacts for individuals, communities and economies which rely on aquaculture. Aquatic animal health is also strongly influenced by human factors, ranging from international trade regulations to the behaviours of individuals working in aquaculture. This article summarises the human factors associated with aquaculture production using international examples for illustration.

Keywords
Aquaculture – Aquatic animal health – Bangladesh – Chile – Disease – Economic loss – Employment – Food security – Trade – Zoonosis.

Introduction

Aquaculture has been practised for millennia, with the earliest records of carp aquaculture in China dating from prior to 1000 BC (1). Aquaculture production remains concentrated in Asia, with China as the world's largest aquaculture producer by a substantial margin, producing almost ten times the quantity of the next-largest producing country, India. In the late 20th and early 21st centuries, global aquaculture production has increased steadily, reaching more than a billion tonnes in 2014, with a value of approximately US $166 billion (2). There are 262 recognised aquaculture species, including 151 fish species, 39 crustacean species and 72 mollusc species, but 30 principal aquaculture species account for 63% of production globally (3). Aquaculture production has now overtaken capture fisheries in terms of production and is an increasingly important source of animal protein for a rapidly expanding global population (4).

One of the major challenges for production and trade in aquaculture is diseases of aquatic organisms (5). Aquaculture systems can create an ideal environment for infectious disease to flourish, with large numbers of animals kept at high density and under potentially stressful conditions (6). The aquatic environment creates its own specific challenges for disease control, with the spread of pathogens through water creating different patterns of disease to those observed in terrestrial animal production. Disease epidemiology also varies globally, with outbreaks of aquatic animal disease at lower latitudes progressing more rapidly and resulting in higher mortality (7). As new species are cultivated, new diseases emerge and require effective control systems to be developed.

Aquatic animal health therefore has major social and economic impacts on the people, businesses, communities and economies that rely on aquatic animal production. Given the diversity of species, systems and business models within aquaculture, these socio-economic impacts clearly vary widely. This article aims to describe both the socio-economic effects of aquatic animal disease, and the human factors that influence the health of aquaculture species.

Socio-economic impact of disease

At a macroeconomic level, seafood is the most traded food commodity globally (8), with transboundary disease a barrier to international trade (9) that can have severe consequences for exporting countries. At a microeconomic level, losses due to disease have financial implications for aquaculture businesses. Direct losses can result from increased mortality, reduced productivity, product condemnation and lower product prices due to disease lesions. Early harvest may be necessary in some cases, either due to compulsory controls or to avoid further losses in the presence of disease, and control costs such as medicines,

doi: 10.20506/rst.36.1.2632

increased labour and depopulation of infected sites can be substantial. Disease outbreaks may also damage public perceptions of aquaculture, with negative consequences for consumer demand for aquaculture products.

Disease is one of the major threats to the profitability of large-scale commercial aquaculture systems where production is dominated by large international businesses, such as Atlantic salmon production (10). A number of parasites are of economic concern to the salmon industry, including sea lice, which are one of the most important constraints to production. The associated costs are estimated at 6% of the value of production across salmon-producing countries (11). Bacterial diseases such as furunculosis were widespread in the early days of salmon aquaculture, but many are now effectively controlled by vaccination (12). Viral diseases such as infectious salmon anaemia (ISA) are of ongoing concern and can cause high mortality on affected farms. Outbreaks of ISA have occurred in all of the main salmon-producing countries, but the most economically important to date was the devastating Chilean outbreak between 2007 and 2010, which threw the national salmon industry into crisis and was estimated to cost in the region of US $2 billion dollars (13).

In addition to the large-scale commercial production of salmon in coastal areas, inland fisheries are also important means of providing food and income for millions of people worldwide (14). For example, in Bangladesh, carp and other freshwater species such as catfish are produced in small-scale, independently owned freshwater ponds (15). This type of aquaculture production is mainly for domestic and local consumption and delivers benefits for communities, such as creating employment opportunities and diversifying and increasing household income. A number of diseases affect pond aquaculture in Bangladesh, with epizootic ulcerative syndrome considered to be the greatest threat. On average, economic losses to farmers from fish disease have been estimated at US $344 (approximately 15% of production value) per annum (16).

Although the financial impact of disease is the impact that is most commonly quantified and reported, the consequences of aquatic animal health issues are not always purely economic. Disease in aquaculture species can also have social and health impacts for the people associated with aquaculture, whether directly as workers or indirectly as consumers of aquaculture products.

Employment

Aquaculture employs around 23.4 million full-time equivalent workers worldwide. It was estimated that in 2005, aquaculture contributed through employment to the livelihoods of 1.8% of the world's population, with most jobs generated in Asia. The majority of aquaculture workers are located in low- and middle-income countries where labour productivity is low. Fewer people are employed in regions with more industrialised aquaculture systems where there is less of a requirement for manual labour (17). However, salmon production is an important source of employment in remote areas of Chile, Norway and Scotland, where it helps to support fragile rural economies. Disease outbreaks can therefore have far-reaching social repercussions in communities which rely heavily on aquaculture: for example, it is estimated that approximately 25,000 jobs were lost as the result of the Chilean ISA crisis (18).

Nutrition

Aquaculture is becoming increasingly important as an efficient means of supplying high-quality protein and a range of essential micronutrients (19) for a growing global population. This is particularly true in developing countries with limited scope for expansion for terrestrial agriculture such as Bangladesh, where aquaculture provides 63% of animal protein consumed (20). Fish production for domestic consumption enhances food security and nutritional status, especially for women and children (21). Fish are also a popular gift in parts of Bangladesh and increased production through better fish health can help households to increase their social standing. Losses due to disease in these production systems therefore result in a loss of food and status as well as income (16), with a negative impact on household food security (20).

Human health

Aquatic animal health can also affect human health directly. Zoonotic pathogens are transmitted from aquaculture species to people via food or contact with aquatic animals and can cause severe human disease (22). Antimicrobial resistance is also a growing global concern and the use of antibiotics in production animals has been linked to the development of resistant bacteria in people (23). The probability of resistance developing increases with the quantity of antibiotics used, and antimicrobial use in aquaculture varies widely between countries, species and production systems (24). In Atlantic salmon production, the quantity of antibiotics used in the Chilean salmon industry, mainly to treat salmonid rickettsial septicaemia, is substantially higher than in Scotland and Norway, where antibiotic use is comparatively low. In many low-income countries, and lower-middle-income countries such as Bangladesh, farmers' access to antibiotics is poorly regulated, which increases the risk of inappropriate use and the development of resistance (25).

The importance of a person's mental as well as physical health is becoming increasingly well recognised, and the consequences of aquatic animal disease outbreaks (e.g. the loss of large numbers of fish, massive financial loss, etc.)

have the potential to affect the mental health of the people involved in aquaculture. The repercussions of some disease outbreaks in terrestrial species are now known to have had negative psychosocial effects on many of the people involved; for example, farmers and their families affected by an outbreak of foot and mouth disease in the Netherlands suffered severe post-traumatic stress after witnessing mass culling (26). There has been little research conducted to date to assess whether similar effects occur in people involved in disease outbreaks in aquatic species, but the potential for negative psychological impact clearly exists.

Impact of socio-economic factors on aquatic animal health

Aquatic animal health affects the people involved in aquaculture, and conversely, human factors also influence the health of cultured aquatic animals. These factors range from international trade standards to the decisions and behaviour of the individuals working in aquaculture production. Economic and social science research relating to aquatic animal health has tended to focus on the impacts arising from fish disease, but the importance of socio-economic factors in improving animal health and controlling disease is a growing research area in both terrestrial and aquatic animal production.

Innovation

Scientific and technological advances have had an overwhelmingly positive impact on the health of aquaculture species in recent years. The development of effective vaccines against bacterial diseases in farmed salmon has achieved dramatic reductions in the use of antibiotics (12). Selective breeding also holds great potential to increase aquaculture production. Although it is currently underutilised in aquaculture in comparison to terrestrial animal and crop production (4), advances have been made in the use of selective breeding for disease resistance in aquatic species (27). Further scientific breakthroughs will continue to deliver technical solutions to disease in aquaculture. Acceptance and implementation by producers is then required for their full potential to be realised and this is not necessarily a straightforward process.

Regulation

The regulatory frameworks around aquatic animal health are an essential means of controlling notifiable disease and its spread through international trade (28). The ISA crisis in Chile is an example of how the rapid growth of the industry in the absence of effective regulations can result in a major disease outbreak. Policy-makers and those working in the industry did not develop an appropriate regulatory framework as they did not have sufficient experience of salmon production and did not consider the potential disease threats (13); however, even appropriate regulations will not be effective without the commitment of the regulated individuals to behave as required by the regulation (29). A 'people–policy' gap has been identified in the development of aquaculture policy globally, and an understanding of the needs of all stakeholder groups is required for effective policy development and enforcement (30).

Veterinary Services

National animal health services play an important role in controlling disease in aquatic species through disease surveillance and outbreak response. In the event of disease outbreaks in commercial aquaculture industries, such as the recent outbreaks of ISA in Scotland and Chile, partnerships between government and industry have been highly effective at controlling disease and assisting recovery (18, 31). As aquaculture continues to grow, it is likely that demand for animal health services will also increase and this must in turn be reflected in veterinary education (32). However, aquaculture remains a niche activity for private veterinary businesses and the services provided by veterinarians in terrestrial animal production are often carried out by paraprofessionals in the aquatic sector. For example, in the United Kingdom, only a veterinarian may diagnose or treat disease in terrestrial production animals, but fish are not covered by the relevant legislation and only medicine sales are a protected veterinary activity (33).

Farm management

The behaviours of individuals responsible for the management of aquatic animals will influence the health of animals under their care. In the Chilean ISA crisis, poor husbandry and biosecurity standards facilitated the spread of the virus and amplified the epidemic (18). It has been demonstrated in terrestrial animal production systems that biosecurity and animal husbandry practices are determined by the actions of farm workers, which are influenced in turn by their knowledge, attitudes, beliefs and perceptions, as well as broader social, regulatory and economic factors (34). The links between human behaviour, biosecurity and animal health are increasingly well recognised, and while biotechnology is often the focus of efforts to improve health, strategies such as codes of practice are widely used to improve the implementation of biosecurity practices at farm level (35).

Fish farmers in Bangladesh cite a lack of knowledge, limited resources and access to credit as the main barriers to improving the health of their fish. However, the low-input, extensive production systems used help to mitigate disease losses and very few farmers describe their losses as

unacceptable (16). Intensification of production increases profitability and yield and is a goal of agricultural extension services (36), but it has the potential to reduce the resilience of pond aquaculture systems and leave small-scale farmers more vulnerable to the impact of disease in their fish (37). This example demonstrates the complex and interrelated nature of the associations between aquatic animal health and the people and institutions involved in aquaculture production.

Conclusions

Aquaculture production is likely to grow dramatically in the future as the human population and its demand for animal protein expands. Understanding and accounting for human factors in this process of expansion is essential for the development of sustainable aquaculture industries producing safe food and supporting local economies and communities globally (38). The quantitative economic impacts of disease in aquaculture species must be known to allow for effective decision-making around disease surveillance and control (39), although a lack of data is a key constraint to the use of economic analysis in support of aquaculture management (40). Previous research has tended to focus on the impact of disease in aquaculture species on people, whereas the impact of human factors on disease in aquaculture appears to be less well understood. In general, research in small-scale production systems in developing countries tends to be more participatory and to consider human factors in greater detail than studies carried out in commercial aquaculture production systems. The application of social sciences such as sociology, anthropology and psychology to improve the health and welfare of production animals is a growing area of interest in terrestrial animal production and holds great potential for aquaculture in the future.

Aspect sociaux et économiques de la santé des animaux aquatiques

K.E. Adam & G.J. Gunn

Résumé

L'aquaculture est une source de protéines animales de plus en plus importante compte tenu des besoins d'une population mondiale toujours plus nombreuse. Les maladies sont un obstacle majeur pour la production du secteur, avec des effets socio-économiques importants pour les individus, les communautés et les économies dépendant de l'aquaculture. La santé des animaux aquatiques subit également l'influence de facteurs anthropiques, depuis les réglementations applicables au commerce international jusqu'au comportement des personnels des fermes aquacoles. Cet article résume les facteurs anthropiques associés à l'aquaculture, à partir d'exemples observés dans divers endroits du monde.

Mots-clés

Aquaculture – Bangladesh – Chili – Commerce international – Emploi – Maladies – Pertes économiques – Santé des animaux aquatiques – Sécurité de l'approvisionnement alimentaire – Zoonoses.

Aspectos sociales y económicos de la sanidad de los animales acuáticos

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Resumen
La acuicultura constituye una fuente de proteínas animales de creciente importancia para una población mundial que aumenta sin cesar. Las enfermedades, que son el principal factor limitante que pesa sobre la producción, tienen también efectos socioeconómicos para las personas, comunidades y economías que dependen de la acuicultura. La sanidad de los animales acuáticos se ve igualmente muy influida por una panoplia de factores humanos, que van desde los reglamentos de comercio internacional hasta el proceder del personal de las instalaciones acuícolas. Sirviéndose de ejemplos tomados de diferentes países, los autores resumen los factores humanos que influyen en la producción acuícola.

Palabras clave
Acuicultura – Bangladesh – Chile – Comercio – Empleo – Enfermedad – Pérdida económica – Sanidad de los animales acuáticos – Seguridad alimentaria – Zoonosis.

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