

Further strategies for reducing GHGs in aquaculture

Strategies and practical options for GHG reduction
in the fisheries and aquaculture sector

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Introduction

- Significant global and regional growth expectation from aquaculture sector – including aquatic products and possible switch away from resource intensive proteins
- Wide diversity of species, systems, production methods, supply chains
- Increasing focus on key sectors, locations, expansion and sustainable intensification
- Feeds identified as major area of GHG interaction and potential footprint gains; justify primary attention (see accompanying review/presentation)
- Strategic question of total mix of aquaculture production
- Range of other factors contributing to GHGs which may be feasible to manage and control
- Overview of options, possible priorities, means of response

Table 1 Major GHG-related elements in aquaculture

<i>Component</i>	<i>Key GHG characteristics</i>	<i>Note/issues</i>	<i>GHG reduction options</i>
Land clearance for inland or coastal ponds	Potentially significant one-time release of CO ₂ and CH ₄ as surface vegetation and soils are broken up and exposed to atmosphere	Relatively unrecorded, but analogous to land-clearing role in agriculture, may add significantly to overall impacts. May also reduce longer-term sequestering potential	Avoidance of land clearance in GHG-sensitive conditions, compensatory planting for carbon capture, good GHG management/high value in ponds created.
Feeds	Primarily related to CO ₂ links with energy for fish capture, fishmeal/oil production, or fertiliser and other inputs for terrestrial raw materials, energy for process wastes, plus compounding energy, etc.	A key factor; varies widely with sources/combinations of raw materials, use and application, and effective food conversion ratios (FCRs). The current shift to terrestrial feed sources may in some cases raise potential GHG impacts	Greater focus on raw material sourcing, efficient formulation and manufacture, better FCRs, increased overall yields; move to less feed-demanding species
Fertilisers	Mainly energy and CO ₂ related to inorganic fertiliser production, also source, collection, transport of organic fertilisers	Primarily in extensive to semi-intensive pond aquaculture systems; small overall role, depends on application rates and productivity	Raw material sourcing, efficiency of manufacture, collection, distribution; storage management, application rates, pond and sediment management
Solid wastes	CH ₄ from anaerobic decomposition of food wastes, sediments in pond bottoms or below cages; some energy and CO ₂ links with transport/disposal	In some circumstances could be a notable contributor to GHGs but most waste carbon is taken up in aerobic processes, very limited evidence of major direct CH ₄ release.	Reduce solids levels – feeds, species mixes; integrate into terrestrial soils, disperse and dilute to minimise anaerobic processes, movement to sequestering zones

Table 2 (1) Secondary GHG-related elements in aquaculture

<i>Component</i>	<i>Key GHG characteristics</i>	<i>Note/issues</i>	<i>GHG reduction options</i>
System structures	Primarily related to CO ₂ links with energy and materials in construction – soils, cement, bricks, tiles, metals, plastics etc,	Relatively modest, reduces with system intensity as output/area or volume increases. Can use industry conventions for GHG content, but wear/depreciation rates may be higher in cases	Sourcing raw materials and components, modified system design, component/system reuse; improved system productivity, better maintenance, repairs.
Soluble wastes	Might in some circumstances drive enrichment of process/surrounding water, possible added CO ₂	Very limited evidence of effect, unlikely to be a significant GHG contributor per se, unless a tipping factor to necessitate specific treatments.	Species selection, feed quality, monitor receiving ecosystem status, possible integration in multi-trophic systems
Water exchange	Mainly energy and CO ₂ related to pumping/circulating water	Many systems use natural water exchange – otherwise varies with production intensity, pump head/efficiency	Better site selection/system design; improve water planning /stock management, improve pump head/efficiency, possibly recycle process water

Table 2 (2) Secondary GHG-related elements in aquaculture

<i>Component</i>	<i>Key GHG characteristics</i>	<i>Note/issues</i>	<i>GHG reduction options</i>
Gas management	Mainly energy and CO ₂ related to aeration, oxygenation, sometimes water treatment, occasionally including CO ₂ stripping	Only in more intensive systems including recycle (RAS) units, usually a relatively small GHG impact	Better system design, stock/water quality management, improve aerator design, oxygen management
Temperature control	Energy and CO ₂ related to heating or cooling aquaculture water or surrounding air volumes.	Limited use and importance, usually only for high value stock, hatchery broodstock etc.	Closer control/management of temperature; heat pumps, heat recovery, solar energy devices, other system options
Ancillary functions	Energy and CO ₂ related to vehicle, vessel use, office, staff functions, materials, power for feeders, controllers, handling devices, ice, packing materials, cool storage etc	Varies widely with production system and operating conditions, may have important effect on overall system efficiency and GHG performance, limited GHG impacts in themselves.	Specific function and performance of systems/components, better design, use – assessment of impacts on overall system performance.
Other wastes	Energy and CO ₂ related with collection and disposal of domestic and process waste materials	Usually an insignificant GHG contributor within total aquaculture enterprise	Assess, monitor and reduce where feasible.

Actions and prospects

- Production and profitability models – scenarios of fuel and energy prices, potential for action
- Costs of change – practice and systems, and predictability of outcome – risk perceptions
- Implications – shifts in incentives for species, systems and production approaches
- Possible reduction in output in some systems? Compensation with other factors of production?
- Technical innovation in developing improved systems and products – incentives for suppliers?
- Role of industry structure – technical and management capacity – barriers or opportunities for new entrants?
- Communicating good practice, building capacity across specific aquaculture sectors