

Review Article

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Evaluation of Sustainable Farming Models for Nori Cultivation

Qiong Wang, Chengmin Sun, Liqing Chen ✉

Tropical Marine Fisheries Research Center, Hainan Institute of Tropical Agricultural Resources, Sanya, 572025, Hainan, China

✉ Corresponding author: Chen.liqing@hitar.org

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Abstract As a vital marine economic seaweed in my country, *Porphyra* (nori) cultivation has expanded significantly, playing a crucial role in ensuring the supply of high-quality seaweed products and driving the development of coastal fishery economies. However, while traditional cultivation models have grown rapidly, they face challenges such as excessive stocking densities, low resource utilization efficiency, mounting environmental pressure, and accumulating ecological risks, all of which constrain the industry's sustainable development. Green cultivation models have garnered widespread attention in recent years as a key pathway for the transformation and upgrading of the *Porphyra* industry. This paper systematically reviews the theoretical foundations and technical characteristics of green *Porphyra* cultivation, focusing on the application status of typical models such as eco-friendly management, Integrated Multi-Trophic Aquaculture (IMTA), and digital intelligent cultivation. On this basis, a comprehensive evaluation indicator system-encompassing ecological, economic, and social benefits-is constructed to assess the effectiveness of green cultivation models in terms of yield and quality improvement, resource utilization optimization, environmental load reduction, and enhanced industrial competitiveness. Furthermore, using typical *Porphyra* production regions as case studies, the paper analyzes changes in ecological and economic benefits following the implementation of green cultivation technologies, summarizing experiences in their promotion and identifying existing issues. The study concludes that green cultivation models can effectively enhance the stability of cultivation systems, promote efficient resource use and ecological improvement, and achieve synergistic gains in both economic and ecological benefits. Future efforts should focus on fostering key technological innovations, refining standardized management systems, and strengthening policy support mechanisms to drive the *Porphyra* industry toward high efficiency, environmental sustainability, and long-term viability.

Keywords *Porphyra*; Green cultivation; Sustainable development; Comprehensive evaluation; Integrated multi-trophic aquaculture (IMTA); Ecological benefits

1 Intruction

Porphyra-commercially known as nori or laver-is among the most economically important cultivated seaweeds in the world, with especially strong production and consumption bases in East Asia. Modern cultivation technologies introduced since the 1960s, including artificial seeding, floating-net systems, and improved processing, enabled rapid increases in annual nori yield and helped transform *Porphyra* into a major mariculture commodity. Its market value is tied not only to production volume but also to its role as a premium edible seaweed: *Porphyra*/*Pyropia* accounts for about 8.6% of global cultivated seaweed output, and *Porphyra* species have been reported to achieve some of the highest fresh-weight values among cultivated seaweeds, reflecting their importance in food markets and aquaculture-based coastal economies (Da Silva et al., 2025).

The industry's economic significance is further reinforced by the nutritional and commercial versatility of nori. *Porphyra*, *Pyropia*, and *NeoPyropia* are widely cultivated and consumed because they combine high food value with nutraceutical potential, containing proteins, minerals, lipids, and bioactive compounds that support expanding consumer demand in both traditional and emerging markets (Da Silva et al., 2025). Historically, this value has been substantial: as early as 1992, global production reached approximately 15 billion sheets, or about 45,000 dry metric tons, with an annual value of US\$1.8 billion, illustrating that nori had already developed into a high-value marine crop decades ago. Continued demand growth, together with market expansion beyond Asia, has kept nori strategically important for food supply diversification and value-added marine product development.