Farming with the Ocean's Bounty: The Rise of Seaweed

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Abstract

Seaweed, often called the "ocean's gift to farming," is rich in nutrients, minerals, vitamins, amino acids and plant growth hormones that enhance soil fertility, plant growth, yield and stress resistance. It is widely used in agriculture as a biofertilizer, bio stimulant, soil conditioner, foliar spray, seed treatment and a key input in organic and climate resilient farming. Globally, countries like China, Indonesia, Japan, Korea and the Philippines lead in seaweed cultivation, while India, particularly Andhra Pradesh, is promoting it through government support and coastal livelihood opportunities. Despite challenges like limited infrastructure, seasonal constraints, low awareness and policy gaps, improved technology, training, financial aid and strong policies can unlock seaweed's potential to boost productivity, sustainability, and rural livelihoods.

Introduction

Agriculture today faces major challenges such as declining soil fertility, climate change, rising input costs and environmental damage caused by excessive chemical use, creating an urgent need for sustainable alternatives. Seaweed-based bio-stimulants, derived from marine macroalgae, have emerged as a promising natural solution, supplying essential nutrients, growth-promoting substances, vitamins, amino acids and other bioactive compounds. Unlike chemical fertilizers, seaweed extracts enhance plant metabolism, root growth, nutrient uptake, flowering, fruiting and overall yield, while also improving tolerance to drought, salinity, and temperature stress. In addition, they enrich soil organic matter, stimulate beneficial microbial activity and improve soil structure, thereby supporting long-term soil health. With the growing demand for sustainable and organic farming practices, seaweed-based inputs offer an eco-friendly approach that reduces chemical dependence and promotes resilient, environmentally safe agriculture.

Seaweed production needs fewer resources and inputs to make seaweed, so it has a lower export face than regular fisheries when it first comes out. Unfortunately, seaweed is not fully recognised as a separate industry yet, as it is often mixed with fishing and other aquaculture operations. Because of this, its importance for economic growth, especially for women, might be overstated. Uses of seaweed on the other hand, the products that are created by seaweed farming have the potential to replace fossil fuels in industries such as the production of plastics and products for the textile industry. In addition, the capacity of seaweed farming to provide environmental services such as nitrogen cycling and carbon sequestration has the potential to improve the socioeconomic situations of coastal communities that are resilient.

Nutrient Composition of Seaweed

Seaweed is a rich source of macro- and micro-nutrients, vitamins, amino acids, natural hormones, polysaccharides, and bioactive compounds that support plant growth, soil health and stress tolerance.

1. Macro-nutrients: nitrogen (leaf growth, chlorophyll), phosphorus (roots, flowering), potassium (water balance, disease resistance, fruit quality).
2. Micro-nutrients: zinc, iron, manganese, copper essential for enzymes, photosynthesis, protein synthesis, and overall plant health.
3. Natural hormones: auxins (root growth), cytokinins (shoot growth, delayed leaf aging), gibberellins (stem elongation, fruiting).

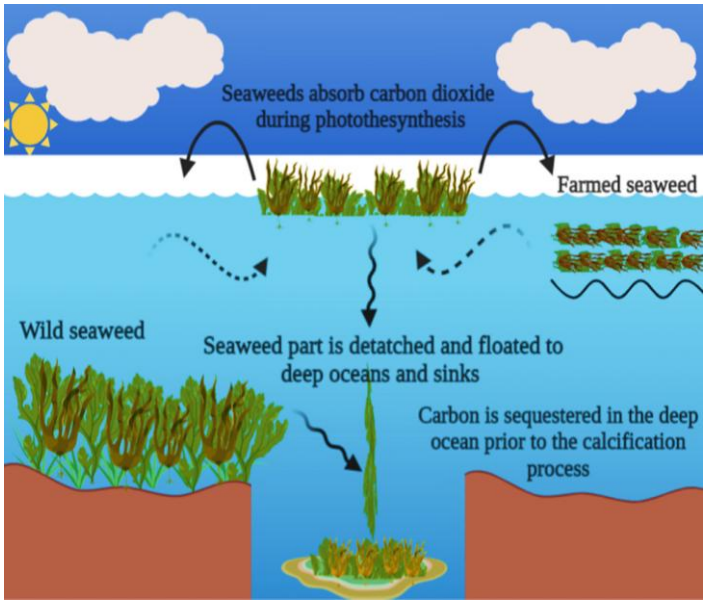
Benefits of Seaweed in Farming

Seaweed-based bio-stimulants offer multiple agronomic, physiological and environmental benefits, making them valuable for sustainable agriculture. They enhance root development, nutrient uptake and overall plant growth through natural hormones like auxins and cytokinins. Seaweed improves flowering, fruit set, yield and crop quality while boosting stress tolerance against drought, salinity, heat, frost and pests. It also enhances soil health by increasing organic matter, microbial activity, water-holding capacity, and soil structure. Being eco-friendly, biodegradable and non-toxic, seaweed reduces dependence on chemical fertilizers and supports organic farming.

Applications of Seaweed in Agriculture

Seaweed and its bio-stimulants are versatile inputs used across field crops, horticultural crops, plantation crops, and organic farming systems. They improve seed germination, seedling growth, nutrient uptake, stress

tolerance, flowering, fruiting and yield. Seaweed products are applied as seed treatments, foliar sprays, soil amendments, or through drip irrigation, and are available in liquid, powder or granular forms.



Global Scenario of Seaweed in Agriculture

Global seaweed production has expanded rapidly, reaching about 35.8 million tonnes in 2019, with nearly 97% produced through aquaculture. This growth almost a 1,000-fold increase since 1950 reflects rising global demand for seaweed, especially in agriculture as bio-stimulants, organic fertilizers, and soil conditioners. Asia dominates production (97%), led by China (56%), followed by Indonesia and other East Asian countries. The global seaweed and extract market is growing strongly, valued at USD 16.5 billion in 2023 and projected to exceed USD 30 billion by the early 2030s, driven by sustainable farming, environmental benefits and diversified applications in agriculture, livestock nutrition and climate-smart solutions.

National Scenario of Seaweed in India

India is an emerging seaweed-producing nation, producing about 72,385 tonnes in 2023, yet contributing less than 1% of global production despite having a long coastline of over 8,000 km. Seaweed farming mainly involves species like kappaphycus and gracilaria, supporting coastal livelihoods and offering strong scope for agricultural uses such as bio stimulants and organic inputs. The Indian seaweed industry is currently valued at around ₹200 crore, with projections of growth up to ₹3,277 crore in the next decade, and farmer earnings reaching ₹13.28 lakh per hectare. Strong policy support under PMMSY, research by ICAR-CMFRI and CSIR-CSMCRI, and an estimated 9.7 million tonnes production potential highlight India's vast untapped capacity for future expansion.

Opportunity and Cooperatives

Seaweed is used in many different fields and businesses, including food, textiles, medicine, cosmetics, fertilizers, animal feed and animal feed in China and Japan. The "medical food of the twenty-first century" seaweed is a super food that is rich in bioactive chemicals, protein, minerals, vitamins, fibre, calcium and omega-3 fatty acids provides a rich source of raw materials for businesses that make medications, health foods, fertilisers, textiles, and pharmaceuticals. Carrageenan, agar and alginates are all made using this.

Chemicals such as mannitol, fucoidin, laminarin, iodine and alginic acid are commercially extracted from brown seaweeds. Seaweeds are transported in two distinct forms: unprocessed (either fresh or dried) and processed. Carrageenan, a soluble fibre extracted from red seaweed, is a naturally present and beneficial food element that can be utilised as a substitute for sugar or salt to enhance the stability of food in organic meals. Even nutritional supplements that adhere to kosher and vegan standards, such as fish oil, which we use for its numerous health benefits, including promoting cardiovascular and cognitive health, can be manufactured using it. (Seaweed Cultivation and value chain Development in India, International webinar, 2021).

Economic benefit

The growing global market for products made from seaweed is giving coastal farming communities hope for socioeconomic advantages. They are the primary raw material for numerous industries, and seaweed farming may undoubtedly help coastal farmers by bringing in extra revenue and enhancing their standard of living. Seaweeds are a key component of animal feed, fertilizer and food. Nowadays, a lot of enterprises rely on imported seaweed phycocolloids (agar, alginate and carrageenan) or natural seaweed resources from other nations. Outside of the established industries, the most promising potential in this industry are in the relatively new and emerging seaweed uses.

Forecasts indicate that the most potential emerging industries, including those for bio-stimulants, animal feed, pet foods and additives that reduce methane, will reach $4.4 billion by 2030. Textiles, biomaterials, bioplastics, dietary supplements and alternative proteins are all examples of medium-term opportunities with a possible value of $6 billion (World Bank, 2023a). Therefore, both the income of fisherman and the national income can be enhanced with the appropriate implementation of seaweed farming on an appropriate scale.

Constraints of Seaweed Use in Agriculture

1. Damage risk due to storms, cyclones and seasonal variations.
2. Lack of processing facilities and quality standards.
3. High initial investment and unstable market prices.
4. Limited awareness and technical knowledge among farmers.
5. Inadequate training, extension support and skilled manpower

Conclusion

Seaweed-based bio-stimulants offer a sustainable and eco-friendly solution to key challenges in modern agriculture. Rich in nutrients, natural growth regulators and bioactive compounds, seaweed enhances crop growth, yield, stress tolerance and soil health while reducing reliance on chemical fertilizers. Strong global market growth reflects its rising importance, and in India, abundant coastal resources, supportive policies and high-income potential highlight promising future prospects. With improved infrastructure, farmer awareness, research, and policy support, seaweed can significantly contribute to resilient agriculture, improved farmer livelihoods, and environmentally sustainable food production.

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