Biostimulant Roadmap for the European Seaweed Industry

Revision	Description	Author	Date
0.1	First draft	D.Barton	June 10th 2025
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Executive Summary

Biostimulants represent one of the most strategically aligned applications for cultivated seaweed within Europe's evolving food and agricultural landscape. They address a pressing need, enhancing crop resilience under abiotic stress, while aligning with EU policy priorities on sustainability, input efficiency, and Scope 3 emissions reduction.

This roadmap sets out a practical and commercially grounded pathway for scaling cultivated seaweed as a viable source of plant biostimulants by 2050. It does so by recognising the current barriers, cost of production, processing capacity, extract validation, and identifying the system-level actions and operator-level decisions needed to overcome them. Rather than offering abstract projections, it provides decision points and enabling conditions. This roadmap sets out a structured, evidence-based pathway for scaling cultivated seaweed as a viable input for plant biostimulants by 2050. It recognises that cultivated biomass is entering a mature, price-sensitive market dominated by trusted wild-harvested incumbents. The objective is not to disrupt, but to integrate on credible, functional, and regulatory terms

The ambition is clear: enable cultivated seaweed to move from pilot-scale novelty to a mainstream, CE-marked input, delivering agronomic value on the farm while supporting traceable, lower-carbon food systems.

Key takeaways:

- **The regulatory framework is clear.** The EU Fertilising Products Regulation (EU 2019/1009) provides legal clarity. Harmonised CEN standards offer a playbook for claim validation.
- **The commercial bar is high.** Cultivated inputs are significantly more expensive than wild-harvested equivalents and, at best, may match them in performance. They will not reset price expectations or displace incumbents in the short term.
- **Subsidies are essential, not optional.** Without structured public support—especially production-linked subsidies aligned with CAP, EMFAF or Green Deal funding—the economics will remain unviable for most producers.
- **Professional advocacy is critical.** This support must be earned through data and strategic engagement. The upcoming FPR review (2025), CAP reform (2027), and implementation of the Green Claims Directive (2027) represent pivotal political windows for targeted lobbying.
- **The system is not yet ready.** Processing, validation, and distribution infrastructure are underdeveloped. Shared infrastructure models and targeted public subsidies will be critical.
- **Cultivated inputs are not guaranteed a premium.** ESG and traceability can support positioning, but only if underpinned by functional performance. Buyers will default to incumbents unless a clear value proposition is made.
- **Batch-to-batch consistency is the most credible early differentiator.** While it won't guarantee a price premium, greater biochemical stability may support more predictable performance, a factor growers increasingly value. If subsidies can narrow the price gap, reliability could justify a modest premium or supplier preference, provided data supports the claim.
- **Fermentation and postbiotic applications may offer future differentiation.** Using cultivated seaweed as a microbial substrate or in hybrid inputs could help unlock new modes of action and new categories, but this remains exploratory, and will require targeted R&D and regulatory clarity.

This is not a first-mover land grab. It is a strategic play that depends on technical execution, credible validation, and system-level enablement. Without alignment on infrastructure, funding, and advocacy, the opportunity will stall. With it, cultivated seaweed could evolve from an emerging input to a mainstream contributor in the biological agriculture toolbox.

1. Introduction

Cultivated seaweed is often positioned as a sustainable agricultural input—but sustainable does not automatically mean investable. Within the biostimulant category, cultivated biomass faces a clear structural dilemma: it aligns well with EU sustainability policy, but remains economically unviable without support.

This roadmap takes that challenge seriously.

It does not assume cultivated seaweed will outperform or underprice wild-harvested biostimulants. Instead, it explores the conditions; technical, regulatory, commercial, and political, under which cultivated seaweed could become a credible, investable input at scale. It recognises that the sector is entering a mature market, not creating a new one. Performance parity with incumbents is an ambitious goal; biochemical consistency and traceability are more realistic near-term advantages.

Even then, cost remains a barrier. Subsidies are not a bonus, they are a prerequisite. Structured public support through production-linked payments, shared infrastructure, or ESG-aligned procurement schemes will be essential to close the price gap. Crucially, this support must be secured through coordinated, professional advocacy. Political goodwill is not enough. The 2025 review of the FPR, upcoming revisions to the CAP, and implementation of the Green Claims Directive all present time-bound opportunities that must be acted on with discipline.

Cultivated seaweed may never command a premium based on sustainability alone. But it may help deliver what growers increasingly want: predictable performance under variable conditions. If greater biochemical consistency can be proven to reduce agronomic risk, especially in high-value crops, then growers and formulators may be willing to pay a modest premium, particularly if subsidies help narrow the cost differential.

In the longer term, the opportunity may evolve. Fermentation and postbiotic applications, where seaweed serves as a microbial feedstock or is integrated into novel biological formats could support the creation of a distinct sub-category. This potential is not guaranteed, but it is worth exploring.

This report sets out:

- Why biostimulants remain a relevant and policy-aligned application;
- What technical and commercial steps are required to make cultivated seaweed a credible input;
- And what systemic enablers, especially around infrastructure, subsidy, and advocacy, are needed to unlock scale.

This is not a speculative forecast. It is a decision framework for entrepreneurs, investors, policymakers, and research partners to align on what's possible, what's required, and what must happen next.

1.1 Key Terms and Definitions

Term	Definition
Biostimulant	Plant biostimulant means a product stimulating plant nutrition processes independently of the product's nutrient content with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere: (a) nutrient use efficiency; (b) tolerance to abiotic stress; (c) quality traits; or (d) availability of confined nutrients in the soil or rhizosphere.
EU FPR (Reg. EU 2019/1009)	The EU Fertilising Products Regulation, establishing CE-marking for fertilisers and biostimulants, effective since July 2022.
PFC (Product Function Category)	Categorisation used under the FPR to describe a product's function. Biostimulants are defined under PFC 6 (6a = microbial; 6b = non-microbial).

Term	Definition
CMC (Component Material Category)	Classification of input materials under the FPR. Seaweed-based extracts often fall under CMC 1 (virgin), CMC 2 (plant-based), or CMC 7 (microbial).
CE Mark	Certification that a product complies with EU FPR requirements, allowing it to be sold throughout the EU Single Market.
CEN/TS 17700-1	The European standard for trial design and validation of biostimulants under the FPR. It defines the number and type of trials needed for claim support.
Fermentation	A processing method using microbial activity to stabilise biomass or transform extract composition. If microbes are viable in the final product, CMC 7 may apply.
Ensiling	A low-energy method to stabilise fresh seaweed biomass using acid or microbial inoculants (e.g. lactic acid bacteria).
Abiotic Stress	Non-living environmental factors (e.g. drought, heat, salinity) that negatively impact crop yield. Biostimulants help plants cope with these stresses.
Blending (PFC 7)	Combining two biostimulant extracts or a biostimulant with another fertilising productcan help position new extracts via CE-registered partners.
White Label	Selling an ingredient under another company's product name, with no visible branding or attribution.
Co-Label	A commercial agreement where the ingredient supplier is visibly acknowledged (e.g. "Powered by [X]") within another brand's product.
Kerrygold-Style Identity	A shared EU branding model where producers pool under a common identity to achieve market recognition and price leverage.
Biorefinery	A production model that valorises multiple outputs from biomass (e.g. biostimulants, cosmetic ingredients, soil amendments), improving economics and resilience.
CAP (Common Agricultural Policy)	The EU's farm subsidy programme. Cultivated seaweed inclusion here could unlock production-linked support and carbon/nutrient offset credits.
Green Claims Directive	Proposed EU regulation requiring environmental product claims to be evidence-based and independently verified.
Scope 3 Emissions	Indirect greenhouse gas emissions occurring in a company's value chain. Traceable, CE-marked biostimulants may help reduce these emissions.
TRL (Technology Readiness Level)	A framework used to assess the maturity of a technology. Ranges from early concept (TRL 1) to full commercial deployment (TRL 9).

2. 2050 Ambition & Key Assumptions

Cultivated Seaweed Biostimulants: Strategic Inputs for Resilient, Competitive and Lower-Carbon Food Systems

2.1 Why Biostimulants, and Why Now

The European Commission's 2024 *Future of Food and Agriculture* vision[1] calls for a more **resilient and competitive** farming model. Under the pillar **Sustainability and Environmental Stewardship** it aims to reduce emissions and protect natural resources. This can be translated into reduced dependence on synthetic inputs, improved nutrient efficiency, and enhanced climate resilience.

Biostimulants directly support these goals by:

- Helping plants tolerate abiotic stress (heat, drought, salinity)
- Improving nutrient use efficiency (particularly nitrogen)
- Enhancing quality traits and marketable yield

Abiotic stress is responsible for over 70% of global crop yield losses, dwarfing losses from pests and disease (less than 10%). This makes abiotic stress the most significant, yet historically under-addressed, constraint to food production. Figure 1.0 clearly illustrates this substantial yield gap, underscoring the significant opportunity for biostimulants as tools to partially address abiotic stress.

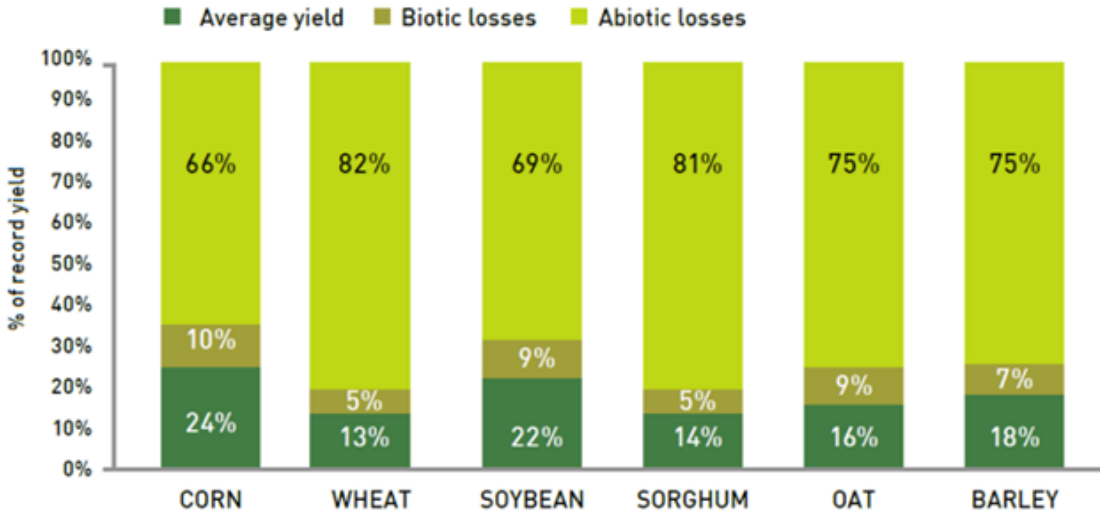

FIGURE 1.0: CROP YIELD LOSSES DUE TO ABIOTIC VS BIOTIC STRESS
Source: Buchanan, Gruissem, Jones (2000); García-García et al. (2020).

Climate volatility, water scarcity, and soil degradation have become structural realities for European agriculture. As traditional inputs plateau in effectiveness, biostimulants have emerged as the "fourth pillar" of crop inputs, complementing seeds, fertilisers, and crop protection by activating plants' innate resilience mechanisms.

Seaweed-derived biostimulants represent one of the most advanced categories of agricultural inputs, clearly differentiated from traditional fertilisers. Unlike NPK fertilisers, which are typically applied at high rates of 50-300 kg per hectare, seaweed biostimulants are effective at minimal application rates, as low as 1 litre per hectare. This low dose rate highlights their unique mode of action, working independently of nutrient content through bioactive signalling molecules. Specifically, seaweeds contain marine carbohydrates (e.g., oligosaccharides) not found in terrestrial plants. Crops

[1] This Vision marks a shift from the earlier "Farm to Fork" strategy, emphasizing a more balanced approach that considers both environmental objectives and the economic realities faced by farmers. While maintaining sustainability goals, the new roadmap seeks to reduce regulatory complexities and enhance the sector's competitiveness.

perceive these marine-derived molecules as "non-self," triggering natural plant defence and growth responses, enhancing stress tolerance, nutrient efficiency, and crop quality.

The following table (Table 1.0) summarises the key differences between biostimulants, fertilisers, and crop protection products, further clarifying their unique regulatory, functional, and practical distinctions.

TABLE 1.0: BIOSTIMULANTS VS. TRADITIONAL AGRICULTURAL INPUTS

Feature	Fertiliser	Crop Protection	Biostimulant
Primary Purpose	Add nutrients	Eliminate pests	Enhance plant physiology
% Yield Loss Addressed	~10–20%	~10–20% (biotic stress)	~70% (abiotic stress)[1]
Mode of Action (MoA)	Nutrient delivery	Pathogen disruption and pest elimination	Signalling + gene activation
Regulation	EU FPR PFC 1	EU 1107/2009	EU FPR PFC 6
Retailer Value	Baseline	Baseline	Scope 3 / Shelf life / Quality uplift (size, colour, nutrition etc.)
Dose Rate per Ha	50–300 kg/ha	0.5–3.0 L/ha	1.0–6.0 L/ha

[1] Note: Biostimulants realistically mitigate around 10-20% of abiotic stress yield losses; they do not bridge the entire 70% gap alone but significantly enhance crop resilience.

2.2 Function over Composition: What Defines a Biostimulant

Biostimulants are defined by function rather than their nutrient composition. Under the EU Fertilising Products Regulation (FPR 2019/1009):

> *"A plant biostimulant means a product that stimulates plant nutrition processes independently of the product's nutrient content, with the sole aim of improving nutrient use efficiency, tolerance to abiotic stress, quality traits, or availability of confined nutrients in the soil or rhizosphere."*

This functional definition highlights crucial differences:

- They are **not fertilisers** (typically contain very low NPK)
- They are **not pesticides** (they do not address biotic stress (i.e. pests & disease)
- They are biotech products designed to enhance plant physiological responses

The FPR clearly separates biostimulants from pesticides, providing investors and farmers essential clarity and reinforcing biostimulants as a distinct product category. This regulatory certainty has significantly de-risked investment and enhanced credibility across the supply chain.

To visually clarify this distinction, the Dunham Trimmer Biological Matrix categorises biostimulants into microbial and non-microbial segments, explicitly positioning seaweed extracts within the non-microbial category.

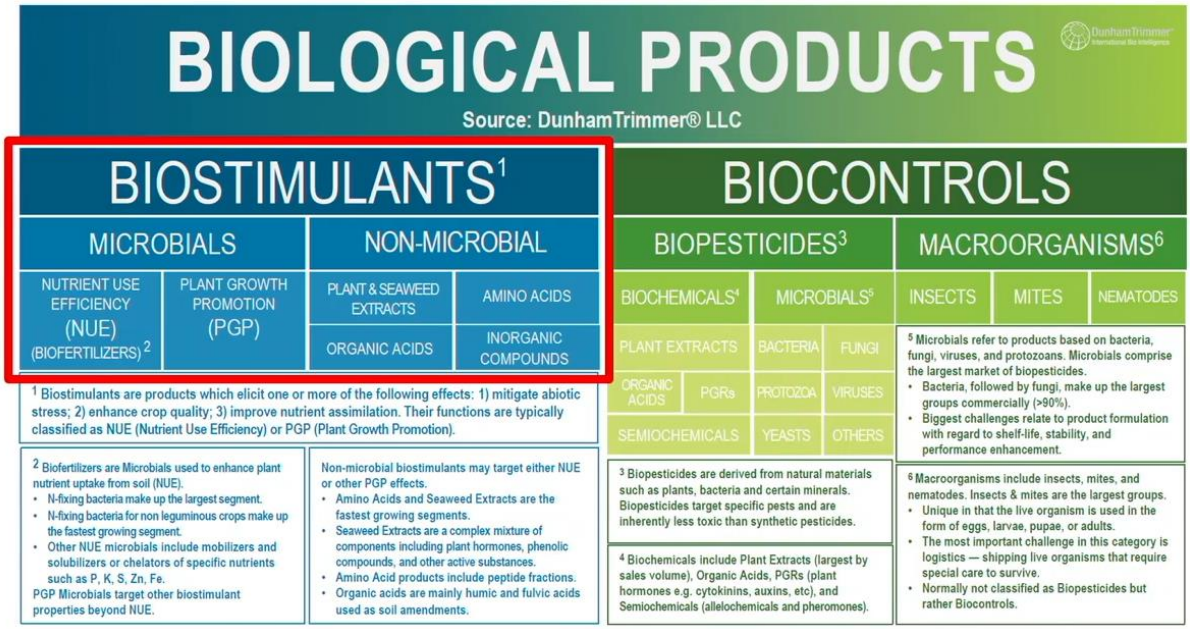

FIGURE 2.0: OVERVIEW OF BIOLOGICAL PRODUCT CATEGORIES AND SUBTYPES
Adapted from DunhamTrimmer® LLC, *Biological Products Classification Framework*.).

Seaweed-based biostimulants operate through unique signalling molecules, activating genes associated with abiotic/climatic stress tolerance, nutrient uptake, and crop quality. These biostimulants can be considered as "biological software" – stimulating existing plant responses without genetic modification (non-GMO). Most seaweed-based biostimulants fall under Product Function Categories (PFC 6: plant biostimulants) of the EU Fertilising Products Regulation (EU) 2019/1009, and meet the criteria of Component Material Categories (CMC 2, plant-based materials) or, in some cases, CMC 1 (Virgin material substances and mixtures). This allows them to be CE-marked and sold freely across the EU Single Market.

High-Tech Marine Biotech Advantage

Seaweed-derived biostimulants can simultaneously trigger multiple beneficial plant responses, offering a flexibility unmatched by single-trait GMO solutions. This capability makes biostimulants highly attractive to major agricultural companies, who increasingly engage through partnerships, licensing deals, or acquisitions.

The clear regulatory framework provided by the FPR offers key market advantages:

- Legal certainty for validated product claims.
- CE-marking and free trade across the EU Single Market.
- Presumption of conformity under harmonised EU (CEN) standards.
- Enhanced retailer and investor confidence due to clear regulatory compliance.

By explicitly distinguishing biostimulants from pesticides (under EU Regulation 1107/2009), the FPR further reduces investment uncertainty, facilitating market growth and positioning biostimulants as an essential and complementary input category alongside fertilisers and crop protection.

2.3 Proven Performance: Field Results and Practical Benefits

Recent meta-analyses have confirmed that biostimulants deliver measurable yield and quality benefits across diverse cropping systems. In particular, a comprehensive study (Li et al., 2022) evaluating over 1,000 paired observations from 180 global field trials found:

- +17.9% average yield increase with biostimulant use.
- Yield increases of up to +25% in arid and equatorial regions.
- Improved fruit size, colour, firmness, and extended shelf life.
- Commercial Seaweed Extracts (SWE) specifically showed an average yield increase of +16.5%.

However, the authors acknowledge that published results may exhibit some bias toward positive outcomes, suggesting caution in extrapolating these figures directly to all commercial settings.

Nevertheless, the meta-analysis concludes clearly:

> *"Biostimulants improve crop yield by reducing yield reductions under stress conditions. This approach can help improve food security for the growing world population under increasing climate change threats."* (Li et al., 2022)

Seaweed extracts thus remain highly valuable inputs, consistently enhancing stress tolerance, nutrient efficiency, and crop resilience, though field-specific validation remains critical.

2.4 Policy-Driven Demand and Scope 3 Relevance

Biostimulants are now actively supported through multiple EU and international policy mechanisms:

Policy Mechanism	Impact on Demand
EU FPR 2019/1009	Legal definition, CE marking, EU Single Market access
CAP Eco-Schemes (2023-2027)	Direct farmer payments (e.g.€20–60/ha in Greece)
Carbon Farming	Inclusion in voluntary carbon credit systems (EU, US, LATAM)
Green Claims Directive (2027)	Mandatory substantiation of environmental claims, favouring regulated biostimulants
Nature Credits (EU)	Rewards measurable, positive actions linked to biodiversity, soil health
ESG & CSRD	Helps retailers/processors reduce fertiliser-derived emissions (Scope 3) in their supply chain

Retailers, in particular, face increased pressure to reduce Scope 3 emissions (fertiliser-related). Biostimulants, improving nitrogen use efficiency by 10-20%, offer immediate, measurable reductions in embedded carbon emissions.

The FAO projects that cereal prices could rise by up to 30% by 2050 due to climate-induced abiotic stress, further underscoring biostimulants' strategic relevance

The proposed **Green Claims Directive** aims to crack down on greenwashing by requiring that any environmental claims made on products be clear, evidence-based, and independently verified. This has direct implications for the biostimulant sector, where sustainability narratives are often used in marketing. Cultivated seaweed extracts may offer genuine ESG

benefits such as traceable sourcing, low-impact cultivation, or nutrient offset potential, but these claims must now be substantiated. Science-led biostimulant development plays a critical role in this context: by linking extract identity to reproducible function and environmental benefit, producers can defend their positioning under future green claims regulation, while avoiding vague or unverifiable messaging that risks regulatory scrutiny.

2.5 Market Size and Margins: An Attractive Segment

Segment	2023	2030 (proj.)	2050 (proj.)
Global Biostimulants	€4.0B	€10B	€20–25B
EU Biostimulants	€900M–1B	€2.5–3B	€5–6B
Seaweed Share (EU)	~20%	~23%	~25%

Seaweed-based biostimulants could exceed €1.25B in EU value by 2050, requiring 90,000–130,000 tonnes of dry cultivated seaweed annually, or 450,000–650,000 wet tonnes, assuming 80% moisture.

This is not a niche market, it's a strategic €1B+ opportunity. High gross margins are essential, supporting technical sales, registration costs, continuous R&D, and extensive field trials:

Margins across the value chain are attractive:

- Manufacturer: ~50% gross margin
- Distributor: 30-40% gross margin
- Typical trade multiple: 3-3.5x

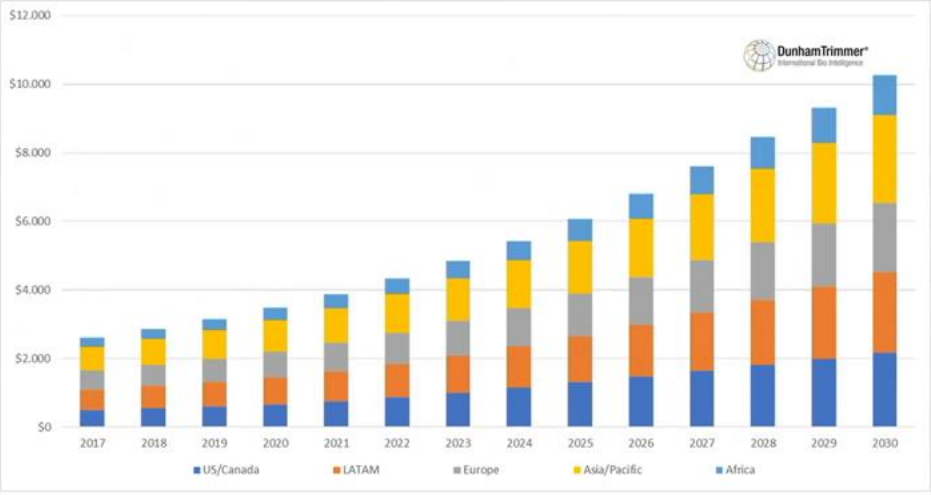

FIGURE 3.0 – PROJECTED GROWTH OF THE GLOBAL BIOLOGICALS MARKET BY REGION (2017–2030)

Source: DunhamTrimmer®, *International Biointelligence Report*, 2024

2.6 Mainstream Adoption: From Niche to Mainstream

Biostimulants initially gained traction in organic agriculture, subsequently expanded into high-value horticultural crops, and are now widely adopted in conventional row-crop farming.

This evolution from niche markets to mainstream agriculture highlights substantial untapped market potential, supporting robust growth forecasts, estimated at around 10.5% CAGR over the coming decade. This growth is driven primarily by broader adoption in conventional agriculture rather than solely organic farming practices.

McKinsey's 2024 Global Farmer Insights survey reinforces this trend, finding that 90% of farmers plan to maintain or increase their use of biological inputs. Importantly, nearly two-thirds of respondents indicated their future use of biostimulants would not be significantly influenced by fluctuations in fertiliser prices.

As mainstream agriculture increasingly drives biostimulant demand, the influence of niche consumer segments (such as vegan or specific organic preferences) is expected to diminish significantly.

This mainstream transition, underpinned by strong farmer acceptance, proven ROI, and regulatory incentives, positions biostimulants as an increasingly essential component of resilient, productive, and sustainable agriculture.

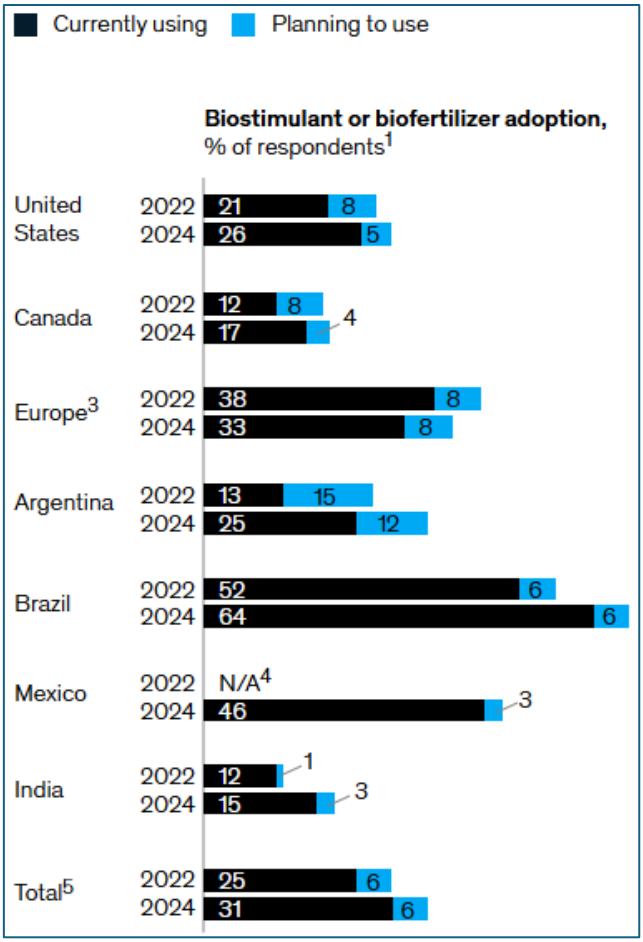

FIGURE 4.0 – FARMER UPTAKE OF BIOSTIMULANTS IS GROWING

Question: Are you using biostimulants or biofertilisers in your fertiliser protocol? (2022, n = 4,474; 2024, n = 4,382). Source: McKinsey Global Farmer Insights 2024 https://www.mckinsey.com/industries/agriculture/our-insights/global-farmer-insights-2024

2.7 Seaweed's Strategic Role in the Greener Revolution

Seaweed biostimulants are uniquely positioned to bridge the "yield gap" left by conventional inputs. It's scalable, traceable, and circular, aligning perfectly with the EU Green Deal's sustainability priorities.

Seaweed biostimulants enable:

- Reduced fertiliser and chemical input requirements
- Improved crop resilience and yield quality

- Lower agricultural carbon footprint
- Enhanced value-chain sustainability and profitability

The EU's March 2025 Future Vision for Agriculture & Food further amplifies seaweed biostimulants as strategic tools to achieve these sustainability goals.

Nutrition, Shelf Life, and Grower Profit
Biostimulants don't simply boost yield, they significantly improve crop nutritional quality (vitamins, antioxidants), enhance visual appeal (colour, firmness), and extend shelf life.

These benefits directly translate into higher returns for growers, reduced food waste along supply chains, and increased resilience across the broader agricultural value system.

Conclusion

Biostimulants are no longer peripheral to agricultural strategy. They address some of the most urgent constraints facing European farming, from abiotic stress and nutrient inefficiency to Scope 3 emissions. This is not theoretical: recent meta-analyses confirm real-world performance gains, and clear regulatory frameworks (e.g. EU FPR 2019/1009) have de-risked market entry.

Seaweed-derived biostimulants stand out within this category. Their ability to activate plant resilience, combined with low dose requirements and alignment with EU policy tools (CAP Eco-Schemes, Green Claims Directive, Scope 3), gives them both technical relevance and market pull. While sustainability and traceability provide useful narrative differentiation, their long-term success will depend on measurable, consistent performance.

With proven demand, supportive policy, and investor confidence growing, the biostimulant sector represents a rare convergence of regulatory clarity, functional need, and commercial growth. For cultivated seaweed in particular, this is a high-margin, high-growth segment with clear strategic alignment, if developed with discipline and evidence.

Notes:

- **Fertiliser** dose rates are high due to bulk nutrient delivery (e.g. 100–150 kg/ha of urea)
- **Crop protection** inputs are typically more concentrated with lower rates (~1 L/ha common)
- **Biostimulants**, especially seaweed-based products, vary:
    - Highly concentrated or co-formulated biostimulants may be effective at 1-2L L/ha
    - Less concentrated biostimulants typically are applied at 3-6L/ha
    - Typically applied 3-4 times throughout growing cycle

4. Regulatory & Market Context

4.1 Introduction to the Regulatory Context of Plant Biostimulants

A clear understanding of Europe's regulatory framework for plant biostimulants (PBs) is essential. It directly influences product development timelines, go-to-market strategies, investor confidence, and grower trust. Historically, PBs occupied an unclear regulatory position, ambiguously situated between fertilisers and plant protection products (PPPs). This ambiguity has previously complicated their commercialisation, market acceptance, and regulatory compliance efforts.

4.2 Optional Harmonisation: EU Fertilising Products Regulation (FPR) and National Routes

The EU Fertilising Products Regulation (FPR; Regulation (EU) 2019/1009), adopted in June 2019 and fully applicable from 16 July 2022, introduced a harmonised route for placing fertilising products, including plant biostimulants, on the EU

market. It operates under the principle of optional harmonisation, which allows manufacturers to choose whether to place a product on the market under the FPR or under national legislation. This system of optional harmonisation provides flexibility depending on a company's target market and commercial goals.

- **FPR Route (CE Marking):** Products undergo conformity assessment and, if compliant, are CE marked. This grants access to the entire EU and EEA market without additional national approvals. Claims must be supported by data generated in line with recognised EU standards, such as those published by CEN (e.g. for nutrient use efficiency or abiotic stress tolerance).
- **National Route:** Products may also be registered under the rules of individual Member States. This path may be quicker for local market access, particularly for well-known product types. In theory, products authorised nationally can circulate freely across the EU under mutual recognition. In practice, however, mutual recognition is often limited and/or inconsistent.

This dual-pathway system allows companies to start where it makes most sense, whether building market presence locally or preparing for broader EU expansion. However, for those companies aiming to scale, aligning early with FPR requirements and CEN standards is the best way to future-proof product development.

4.3 Historical Context of National Registrations

Historically, numerous biostimulants, particularly seaweed extracts such as those derived from *Ascophyllum nodosum*, were registered nationally primarily based on their nutritional composition (e.g., NPK values such as 0-0-8). However, nutritional composition alone frequently provides limited direct insights into actual agronomic performance or functional efficacy. Consequently, manufacturers following national registration pathways have traditionally faced a greater marketing burden to effectively communicate functional benefits and product performance to growers.

4.4 EBIC's Role and the FPR Definition of Plant Biostimulants

Since its founding in 2011, the European Biostimulants Industry Council (EBIC) has significantly contributed to regulatory clarity within the biostimulant industry, culminating in the explicit inclusion and definition of plant biostimulants within the EU Fertilising Products Regulation (FPR; Regulation (EU) 2019/1009), effective since July 2022.

The FPR explicitly defines a plant biostimulant as:

"An EU fertilising product, the function of which is to stimulate plant nutrition processes independently of the product's nutrient content, with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere:

- nutrient use efficiency,
- tolerance to abiotic stress,
- quality traits,
- availability of confined nutrients in the soil or rhizosphere."

Ref: Regulation (EU) 2019/1009, Annex I, Part II, Product Function Category (PFC) 6

This definition clearly distinguishes PBs from traditional fertilisers and plant protection products, focusing specifically on functional claims supported by scientific validation rather than solely compositional characteristics. Thereby providing companies with a stable legal identity and a foundation for building performance-based value propositions across the EU Single Market.

4.4.1 PFCs and CMCs – What Defines a CE-Markable Biostimulant

The EU FPR categorises plant biostimulants under **Product Function Category 6 (PFC 6)**, divided into microbial (6a) and non-microbial (6b) subtypes. Inputs used in biostimulants must also comply with an eligible **Component Material Category (CMC)**, such as CMC 1 (virgin materials), CMC 2 (plant-based extracts), or CMC 7 (microorganisms). The combination of PFC and CMC designations determines CE-marking eligibility and labelling obligations.

4.4.2 Extraction Method and CMC Eligibility

Extraction Method	Typical Use	CMC Classification	Notes
Cold aqueous extraction	Seaweed, plant materials	CMC 2	Must be <80°C, no chemical derivatisation
Hot/alkaline hydrolysis	Seaweed (e.g. *Ascophyllum*)	CMC 1	Allowed under CMC 1 if inputs are virgin plant material
Enzymatic hydrolysis	Plants, seed extracts	CMC 1 (if no derivatisation)	Case-specific; depends on transparency of inputs/process
Fermentation (no viable cells)	Seaweed or plants for breakdown	CMC 2	If microbes not viable in final product
Fermentation (viable microbes)	Microbial biostimulants	CMC 7	Only 4 genera allowed under current rules
Suspension milling	Seaweed or blended extracts	CMC 2	Based on physical treatment; no chemical change

Products derived from fermentation require careful classification. If fermentation is used solely for biomass breakdown or stabilisation, and no viable microbes remain, the extract may fall under CMC 2. However, if viable microbes are present and claimed, CMC 7 applies, currently limited to four permitted genera.

4.5 Global Influence and Harmonisation

The EU's regulatory approach now serves as the global benchmark, influencing PB regulations in North America, China, India, and beyond, enhancing international trade opportunities and investor confidence.

4.6 Conformity Assessment and Role of Notified Bodies

The FPR mandates a rigorous two-step conformity assessment process:

- **Type Examination**: Independent verification of technical documentation, empirical trial data, product samples, and compliance by accredited Notified Bodies.
- **Internal Production Control**: Manufacturer-managed ongoing quality assurance, CE marking, and issuing declarations of conformity.

This process not only opens the door to the EU market, but also offers external validation of your product's claims. For buyers, distributors, and investors, this adds a layer of trust and encourages adoption.

4.7 Relevant CEN Standards for Plant Biostimulants

Compliance under the FPR is guided by standards from the European Committee for Standardisation (CEN), Technical Committee 455:

- **prEN/TS 17700-1:** General principles
- **prEN/TS 17700-2:** Nutrient use efficiency
- **prEN/TS 17700-3:** Abiotic stress tolerance
- **prEN/TS 17700-4:** Determination of quality traits
- **prEN/TS 17700-5:** Availability of confined nutrients

These standards define trial design, crop groupings, and statistical thresholds. They are available for purchase through National Standardisation Bodies such as NEN (Netherlands), BSI (UK), DIN (Germany), and AFNOR (France), and are published in the official languages of the European Union, ensuring broad accessibility.

4.8 Value of CE Marking for Claims

Central to the FPR framework is the CE mark, obtained through structured conformity assessment involving independent third-party verification. Achieving CE marking means a product's claimed benefits, such as improving nutrient use efficiency or abiotic stress tolerance, are backed by robust, independently validated scientific evidence. This rigorous validation process reassures growers that biostimulant claims are scientifically robust, validated, and verified through standardised procedures set by CEN Technical Committee 455.

The value of CE-marked claims lies not only in regulatory compliance but also in clear market differentiation. CE-marked products transparently demonstrate scientific robustness, significantly reducing perceived risks (although no guarantees can be absolute given agriculture's complexity). CE marking provides a clear signal to farmers that the product has undergone credible, independent validation. From an investment perspective, CE-marked biostimulants offer additional confidence, potentially increasing attractiveness to both institutional and private investors.

4.9 Strategic Considerations: FPR vs. National Routes

Choosing the right regulatory route is a strategic decision. The decision to pursue CE marking under the FPR or follow national regulatory routes is fundamentally a strategic choice influenced by market scope, product innovation, distribution strategy, and available resources.

- If the target market is primarily local or limited to a few national markets, or if a product aligns closely with local needs, national routes might be simpler, quicker, and less costly.
- Conversely, companies targeting broader EU markets or international trade will find substantial advantages in CE marking despite the higher upfront investment and regulatory timeline.

Historically, many plant biostimulants (notably seaweed extracts) were nationally registered primarily based on compositional claims (e.g., NPK values), providing limited insight into agronomic efficacy. In contrast, the FPR fundamentally shifts the focus from "what products are" (composition) to "what products do" (functionality). Consequently, CE marking confers strategic marketing advantages, clearly communicating credible and validated claims to growers, helping products effectively reach the farm gate.

However, the value of CE marking should not be overstated. While it provides initial credibility, biostimulants remain inherently technical products. Their sustained success ultimately depends on thorough grower education and technical support, including detailed guidance on appropriate timing, dosage, application methods (e.g., foliar vs. soil), and abiotic stress priming strategies. Realising biostimulants' full agronomic potential requires sustained, proactive technical engagement, regardless of regulatory pathway.

Thus, companies must strategically weigh the long-term marketing advantages offered by FPR compliance against potentially simpler initial hurdles of national routes, mindful that robust education and ongoing technical support are essential to long-term market success.

4.10 Minimum Trials Required for Claim Validation

Under the FPR, any product claim must be supported by scientifically credible data. The minimum trials required under the FPR, as clearly defined in the **CEN/TS 17700-1:2022 General Principles**, are structured based on specific crop or crop groupings, ensuring scientifically credible demonstration of product claims:

Crop Groupings:

- **Broadacre Crops (combinable and processing products):** Annual and non-annual crops typically grown extensively and harvested mechanically (e.g., wheat, maize, potato, sugar beet).
- **Woody Perennials:** Non-annual crops with woody stems, producing fruit or nuts (e.g., apple, grape, olive).

- **Vegetables, Ornamentals and Aromatic and Medicinal Plants (AMP):** Annual and perennial crops linked with seasonal cycles, typically intensive in nature (e.g., tomato, lettuce, basil).

Required Number of Trials:

Claim Scope	Minimum Trials Required
Single Crop	3 trials on the specific crop
Entire Crop Group	6 trials covering at least 2 different crops within the group
Two Entire Crop Groups	8 trials (4 per group) covering at least 2 crops per group
All Crop Groups	9 trials total (3 per group), covering at least 2 crops per group

Worked Example:

If claiming improved abiotic stress tolerance for potato (Broadacre):

- **Single Crop claim (potato only):** Minimum 3 trials specifically on potato.
- **Broadacre Crop Group claim:** Minimum 6 trials in total, including potato plus at least one other Broadacre crop such as maize or wheat.
- **Two Crop Groups (Broadacre + Vegetables):** Minimum 8 trials total - 4 trials with at least two Broadacre crops (e.g., potato and wheat), plus 4 trials with at least two Vegetable/AMP crops (e.g., tomato and lettuce).
- **All Crop Groups:** Minimum 9 trials total -3 per group, each group including at least two different crops, for instance:
    - Broadacre: potato and maize
    - Woody Perennials: apple and grape
    - Vegetables/AMP: tomato and basil

These numbers represent baseline requirements; however, companies often exceed them to enhance market confidence and differentiation. This structure also allows companies to plan claims in tiers, starting with one market and gradually building a portfolio of claims across crops and regions. It also helps justify premium pricing or investor valuation by demonstrating functional performance at scale.

4.10.1 Time and Cost Considerations for Trial Planning

For seaweed cultivators considering the biostimulant route, it's important to understand what the CE-marking process means in practice. Not just in regulatory terms, but in time and cost.

Under the FPR, biostimulant claims must be backed by trials conducted in line with CEN standards (e.g. CEN/TS 17700-1:2022). You are not required to outsource these trials to a contract research organisation (CRO), but if you don't yet have in-house capacity (agronomic design, crop monitoring, data collection, statistical analysis), then outsourcing is often the only viable option at early stages.

A typical CRO-led trial, assuming one treatment vs an untreated control with 3–6 replicates and basic yield or stress tolerance endpoints, will cost around €10,000 per trial. Some may be cheaper (€7,000) for simpler trials, or more expensive (€12,000–15,000) if abiotic stress modelling, physiological markers, or multiple locations are involved.

Claim Scope	Minimum Trials Required	Indicative Cost (€10k/trial)
Single crop	3	€30,000

Crop group	6	€60,000
Two crop groups	8	€80,000
All crop groups	9	€90,000

You don't have to go for all crops. A more strategic approach is to start with a single target crop or crop group that aligns with your intended market. You can build your claim set in stages, expanding later.

Also bear in mind that building a full dossier takes time. Even with a clear plan, delays from weather, failed trials, or limited funding are common. Expect it to take 1 to 3 seasons to build a complete CE dossier, more if you're working with limited resources.

If you're doing trials in-house, even at small scale, follow CEN design principles as closely as possible, even if you don't meet all statistical thresholds yet. This increases the utility of your early data and avoids having to repeat work later.

Note: If targeting abiotic stress claims, trials can sometimes be run under controlled conditions (e.g. growth rooms or chambers), allowing faster turnaround - limited only by crop cycle duration. This makes it possible to build a targeted claim set around a specific crop or stress factor, which can be a valid and efficient strategy for early market entry. Each path (crop-based, stress-based, or crop-group claims) is viable depending on your commercial priorities and available data.

Once your dossier is complete and submitted, most CE assessments take 60–90 days, but this depends on the quality and completeness of your submission. The bottleneck is rarely the Notified Body, it is the time needed to run the trials.

For cultivators aiming to enter the market as extract suppliers or through co-label arrangements, having even a partial dataset can help unlock early partnerships, while you build the full regulatory file in the background.

4.11 Marketing, Communication, and Education

Regulatory approval, whether through CE marking or national authorisation, gets a company's product on the shelf. But for PBs, real success happens on the farm.

These are not passive products. Their performance depends on proper timing, correct dose rates, and alignment with local agronomic conditions. A seaweed extract or microbial product that performs brilliantly under abiotic stress in tomatoes may not work the same way in grapes without adaptation.

That's why effective PB commercialisation is built on:

- Clear labelling and instructions
- Distributor and agronomist training
- Field demonstration programmes
- Targeted communication that explains both "what it is" and "how to use it"

Companies that combine a strong regulatory position with structured technical education are more likely to see repeat use, grower advocacy, and long-term revenue.

4.12 Continuous Regulatory Evolution

The EU Fertilising Products Regulation (FPR; Regulation (EU) 2019/1009) is subject to structured, periodic review. Article 49 of the Regulation requires the European Commission to conduct a comprehensive evaluation by 16 July 2026, and every five years thereafter. In practice, this process has already begun. A contractor has been appointed and preparatory work is underway in 2025 to assess the regulation's effectiveness and identify areas for improvement, including feedback from stakeholders and data on market uptake, innovation, and administrative burden.

In parallel, the EU Agri-food Simplification Package, launched in 2023, aims to reduce regulatory complexity and streamline compliance obligations across the agri-food sector. While not focused solely on biostimulants or fertilising

products, it has the potential to influence aspects of the FPR, particularly in areas such as labelling, conformity assessment procedures, and product documentation.

Given the evolving policy environment and formal review cycles, it is strongly recommended that manufacturers and innovators in the biostimulant sector maintain close alignment with industry associations such as the European Biostimulants Industry Council (EBIC). Membership provides access to timely regulatory intelligence, early visibility on proposed changes, and a voice in consultations that shape future revisions. For companies not directly involved in Brussels-level advocacy, association membership is often the most effective way to stay informed and strategically represented in a shifting regulatory landscape.

Section 5: Strategic Scaling Framework – Capability Pillars, Infrastructure, and Investment Milestones

The development of cultivated seaweed for biostimulant use involves multiple interdependent constraints. These include limited biomass volumes, underdeveloped processing capacity, and a lack of validated extract functionality. These factors do not lend themselves to a linear sequencing of cultivation → extraction → market entry. Instead, progress will need to occur in parallel across several areas.

This section proposes a structured framework based on four interdependent capability pillars. Each pillar addresses a distinct bottleneck in the current system: production, processing, validation, and positioning. The intention is not to set fixed targets or prescribe a single path, but to clarify the enabling conditions and infrastructure required to support commercialisation over time.

Key components of this section include:

- A breakdown of each pillar and the infrastructure required to support its development
- Cultivation thresholds, TRL benchmarks, and extract readiness criteria
- Observations on public subsidy alignment and Fertilser Products Regulation (FPR) positioning
- Shared infrastructure models and investment logic
- A tiered TRL framework to support staged investment decisions

Strategic Context

The current European ecosystem for cultivated seaweed biostimulants is fragmented. Cultivators are progressing in biomass production but face challenges in stabilisation and extraction. Extract developers are moving ahead on process optimisation but lack the trial data and regulatory infrastructure to position products in the market. Buyers, including formulators and distributors, are signalling interest, but require a clearer view of performance, pricing, and availability. Meanwhile, policymakers and funders still lack a cohesive picture of how this category will scale, and what it requires in practice.

This situation creates a capability trap. Without processing access and data, product validation is limited. Without validation, pricing and route-to-market decisions remain speculative. And without downstream certainty, upstream investments in cultivation remain difficult to justify.

The following roadmap sections aim to break this deadlock, not through top-down direction, but by offering a realistic view of the technical, financial, and organisational steps needed to advance.

Pillar 1: Establish the Biomass & Processing Base

The foundational challenge for cultivated seaweed biostimulants is not validation or formulation, it is affordability. Despite growing interest in scaling production, the cost of cultivated wet biomass remains several times higher than wild-harvested equivalents(basically because cultivating anything is more expensive than collecting it from nature for free). In

addition, current small-scale operations, fragmented logistics, and limited processing infrastructure are not helping either.

A reliable, stabilised supply of biomass is a precondition for product development, CE-marking, and route-to-market decisions. Without it, there is no extract to trial or validate, and no data to underpin pricing, claims, or partner engagement. This pillar focuses on what infrastructure, processing logic, and investment are required to make cultivated seaweed a viable raw material for biostimulant manufacture.

5.1.1 Biomass Supply and Cost Disparity

Reported costs of cultivated seaweed range from €2,000–3,000 per wet tonne (insert Ref), depending on species, location, and harvesting method, a 5–6x premium over wild harvests, which typically sell at €400–600 per wet tonne.

Yields vary widely depending on gear and site: long-line systems produce 5–12 kg/m, with some cases reporting 18 kg/m near salmon farms (BIM, 2023). However, without consistent access to processing or drying within hours of harvest, much of this biomass cannot be valorised.

5.1.2 Wet Processing vs Dry: Implications for Biostimulants

Given drying's energy intensity and cost, wet processing is generally preferred for biostimulants, provided logistics can support it. However, this introduces other constraints:

- **Seasonality**: Harvest periods are often short (e.g. 4–6 weeks), meaning large volumes arrive over narrow timeframes.
- **Throughput pressure**: Small-scale operators often lack equipment to process peak loads, leading to bottlenecks and spoilage.
- **Transport and shelf-life**: Without on-site or nearby stabilisation (e.g. ensiling, pressing), biomass degrades rapidly.

A recent BIM estimate placed the drying cost alone at **up to 80% of total cost of production**, making it the single largest cost driver (BIM, 2023). Wet processing is only feasible where infrastructure allows immediate conversion to extract or intermediate. Where this isn't possible, drying remains the fallback, despite its cost burden.

An emerging alternative is fermentation-based stabilisation (e.g. microbial ensiling), which can extend shelf-life without drying and may also generate novel extract profiles.
Depending on process conditions, fermentation can hydrolyse complex carbohydrates and lower pH, reducing spoilage while potentially enhancing bioactivity.

If no viable microbes remain in the final product, such extracts may still qualify under CMC 2. If viable microbes are retained and claimed, CMC 7 applies (see Section 4.5.1).
Fermentation presents a lower-CAPEX pathway for early-stage producers to pilot wet biomass valorisation, though batch variability and regulatory limits must be considered.

5.1.3 Processing Tiers and Extraction Methods

Biostimulant manufacturing involves several levels of processing. Drawing from the structure introduced in Section 3.2, these can be grouped into three tiers:

Tier	Function	Example Operations
Primary	Biomass stabilisation	Washing, chopping, drying, pressing, ensiling, fermentation (for preservation)
Secondary	Extraction of soluble fractions	Cold water, hot/alkaline, acid hydrolysis, enzymatic, fermentation (for hydrolysis or transformation)
Tertiary	Post-extraction refinement	Filtration, suspension milling, blending, QA

Each method has implications for extract concentration, compatibility with other actives, and CE-marking complexity. These options are still under-evaluated for cultivated species.

5.1.4 Harvest Timing and Processing Bottlenecks

Processing capacity must align with seasonal biomass availability. Cultivation in Northern Europe typically yields one or two harvests per year, with most biomass landing over a 4–6 week window.

This seasonal compression means:

- Extraction facilities must be sized for peak load, not annual average
- Batch scheduling is critical for QA and trial replication
- Storage strategies (ensiling, freezing, wet storage) must be evaluated regionally

Processing infrastructure should be located within 2-3 hours of harvest sites to limit degradation. Without this, even high-yield farms face value loss.

5.1.5 Shared Infrastructure Models and Governance

Given the capital required and low throughput of most farms, shared infrastructure remains the most realistic near-term solution. Options include:

- **Mobile modular extractors** (cold or hot) shared across multiple farms
- **Regional drying and ensiling hubs**, potentially co-located with seafood processors
- **Centralised processing centres**, designed for multi-user access

To function, these require:

- Agreed governance (e.g. co-operative model, service model, JV)
- Transparent cost-sharing and scheduling
- Technical support for QA and regulatory readiness

Outsourcing models (where cultivators supply wet biomass to third-party processors) are already emerging, driven by farmers exiting cultivation due to management and logistical overhead.

5.1.6 Biorefinery Logic: Design for Diversification

As demonstrated by MacroCascade and other research projects, processing infrastructure is more viable when designed to support multiple product streams, not just biostimulants. While this roadmap focuses on biostimulants, shared assets should allow future fractionation into:

- Cosmetic and nutraceutical ingredients
- Soil amendments and organic fertilisers
- Food-grade hydrocolloids

The long-term opportunity lies in cascading biorefineries. In the short term, shared wet processing hubs with the flexibility to handle diverse outputs are a pragmatic step.

Pillar 2: Validate the Extract and Define Functionality (Final)

The development of a seaweed biostimulant begins not with formulation or trial design, but with a clear understanding of the extract's composition. Without this, it is difficult to interpret trial data, assess batch consistency, or build a functional case for use. Compositional characterisation allows producers to distinguish between processing variables and genuine biological effects, and is foundational to building a reliable product profile over time.

This section outlines the core variables that influence extract identity and function, and how they relate to market positioning and regulatory strategy.

5.2.1 Compositional Characterisation: Understanding What You're Working With

The functional profile of a seaweed extract is shaped by:

- **Species**: Biochemical composition varies significantly between brown, red, and green macroalgae.
- **Harvest conditions**: Depth, temperature, tidal exposure, and season all affect bioactive content.
- **Processing method**: Extraction technique determines solubility, concentration, and carbohydrate profile.

These factors influence the levels and forms of:

- Carbohydrates (e.g. alginic acid, laminarin, fucoidan)
- Mannitol
- Phenolic compounds
- Inorganic ash and residual solids

For most producers, the first step is to establish a compositional baseline: total solids, organic vs inorganic ratio, and quantification of key constituents. This provides the basis for batch comparability, dose-response analysis, and process refinement.

Over time, this builds toward an internal specification, allowing extract performance to be linked to molecular characteristics, not just field trial outcomes.

5.2.2 Impact of Processing on Extract Identity

Extraction method has a material impact on both yield and functionality. In particular, **hot alkaline hydrolysis** breaks down structural polysaccharides (e.g. laminarin, alginate) into shorter-chain oligosaccharides, increasing extractable solids and likely altering plant response profiles.

Extraction Type	Solids (% w/v)	Functional Consideration
Cold aqueous	~5–10%	Preserves high-MW polysaccharides; slower activity; often applied to soil
Hot alkaline	30–50%	Hydrolyses structural polysaccharides; higher carbohydrate yield; faster uptake potential

These differences are not necessarily about superiority, but about mode of action, timing, and target. A cold extract may persist in the soil and interact with microbial enzymes, whereas a hot extract may act more directly on plant physiology when applied foliarly. Understanding these distinctions is key to product positioning, especially when comparing batches or explaining results to buyers.

5.2.3 Standardisation and Comparability

Natural extracts are inherently variable. Composition will shift based on species, harvest conditions, and process. This variability must be understood if trial results are to be interpreted meaningfully or if product consistency is to be claimed.

Producers should aim to:

- Create reference profiles for key extract types
- Map how batch variability affects plant response
- Use compositional fingerprinting to guide harvest, drying, and extraction decisions

This does not require disclosure under the FPR, but it is necessary for building a knowledge base that supports CE-marking, sales, and future formulation work.

5.2.4 Functional Claims and Regulatory Framework

The EU Fertilising Products Regulation (FPR) does not assess biostimulants based on composition. Instead, it evaluates their functionality, requiring manufacturers to support one or more permitted claims under PFC 6b:

- Nutrient use efficiency
- Tolerance to abiotic stress
- Improved quality traits
- Nutrient availability in the soil/rhizosphere

These claims must be substantiated with efficacy trials conducted under CEN/TS 17700-3. There is no obligation to provide a mode of action or disclose the full extract composition.

That said, understanding composition remains critical for:

- Interpreting trial outcomes
- Justifying application rates and timing
- Ensuring the reproducibility required to support CE-marking and partner trust

5.2.5 Positioning Strategy: Blending as a First Step

Given the current pricing differential between cultivated and wild seaweed extracts, a direct head-to-head market entry is not realistic. A more tactical approach is to:

- Offer cultivated extracts as complementary inputs to existing CE-marked products
- Develop differentiated blends under PFC 7 that combine performance familiarity with ESG traceability
- Support these products with compositional and trial data that demonstrate added value

The goal is to provide a functional or narrative enhancement, not to displace incumbents on unit cost or specification.

Over time, as scale increases and the knowledge base around cultivated species grows, producers may choose to develop standalone CE-registered products. For now, blending offers the lowest-risk entry point, provided the differences in composition and performance are well understood and substantiated.

Pillar 3: Define the Product and Route to Market

The development of a biostimulant extract from cultivated seaweed is not simply a matter of manufacturing, it also requires identifying where that extract fits commercially, who will buy it, how it will be positioned, and what evidence is needed to support claims. Given the current structure of the market, a direct-to-market approach is not realistic for most cultivated seaweed producers. Instead, entry will require tactical use case selection, partnership-driven distribution, and functional differentiation that can be backed by data.

This pillar addresses the central commercial questions:

- What is the product?
- Who is the buyer?
- Why should they choose this extract over better-established alternatives?

5.3.1 Market Structure: Incumbent Dominance

The biostimulant market is already dominated by inputs based on wild-harvested species such as *Ascophyllum nodosum* and *Ecklonia maxima*. These extracts have been on the market for over 20 years, and continue to set the benchmark for performance, scalability, and market access.

Three extract types broadly frame the incumbent landscape:

- **Cold-extracted Ascophyllum**
- **Hot alkaline extracts of Ascophyllum**
- **Cold-extracted Ecklonia maxima**

Cold-extracted *Ecklonia maxima* is typically used in straight formulations. This reflects the characteristics of the extraction process, which yields a relatively low solids content—around 3%. At this concentration, achieving a meaningful inclusion rate in a finished product can occupy most of the available formulation space, leaving limited room for additional components such as micronutrients, macronutrients, or other biostimulant classes.

By contrast, extracts of *Ascophyllum nodosum*, particularly those produced using alkaline extraction, can reach solids contents of up to 50%. This enables their use both as stand-alone products and as functional components in more complex, multi-ingredient formulations. These differences reflect distinct processing methods and product profiles, each with its own use case.

5.3.2 The Double Disadvantage

Cultivated seaweed producers face two disadvantages:

1. **Cost**: Wet biomass is 4–6x more expensive than wild-harvested equivalents
2. **Trust**: Cold-extracted cultivated seaweed products have not yet been widely validated in field trials or formulations

In most cases, cultivated producers will be using cold extraction, which typically yields <10% solids, and results in a high-molecular-weight extract with slower activity. Buyers familiar with hot extracts may view this as a lower-efficacy option unless it can be positioned correctly (e.g. longer lasting or soil focused alternative).

5.3.3 Tactical Market Entry: White Label or Co-Label Supply

- Given the structural disadvantages outlined above, most cultivated seaweed producers will not be in a position to launch their own branded biostimulant directly to market — at least not in the early stages. The more realistic entry path is to supply your extract to companies that already have products, sales channels, and market trust. This can be done through:**White label supply**, where your extract is used as an ingredient in another company's product, without your brand being visible
- **Co-label partnerships**, where your identity is retained (e.g. "powered by…" or listed on technical materials), providing some visibility and a degree of commercial lock-in

These approaches are common in the biostimulant sector and offer a low-barrier route to market. They enable early cash flow, reduce regulatory burden, and give access to trial infrastructure and distribution channels. However, they also carry substitution risk, if the extract is not functionally distinct or compositionally understood, buyers may switch suppliers based on price or availability.

The main risk is invisibility: white label suppliers are easily replaced if their extract isn't clearly differentiated or reliable. To reduce this risk and build leverage over time, producers should focus on measures that increase perceived value and switching cost:

- **Provide batch-level QA and composition data** – builds trust and lowers risk for the buyer
- **Concentrate to ≥30% w/v** – improves handling and allows higher inclusion in formulations
- **Develop a basic technical datasheet** – supports marketing and helps position the product
- **Negotiate co-label terms** – retains visibility and makes substitution less attractive

This route allows producers to piggyback on established players, generate early revenue, and build the credibility needed to later pursue their own brand or licensing strategy.

5.3.4 Functional Positioning and Extract Concentration

Extract concentration affects both performance and marketability. Cold extracts from cultivated seaweed typically contain 5–10% solids. In contrast, hot alkaline extracts can reach 30–50% solids. This matters for two reasons:

1. **Formulation space**: Lower solids reduce how much of the extract can be used in a concentrated product. For example, blending a 10% *Saccharina* extract with a 50% *Ascophyllum* extract at a 1:1 ratio would yield a formulation with 5% and 25% solids respectively, offering a novel combination, but reducing room for other components.
2. **Volume and logistics**: Low-solids products require higher dose rates and greater shipping volumes. Some buyers prefer high-solids inputs for this reason.

From a positioning perspective, such a blend can still be valuable, if the combination provides functional complementarity or a clear compositional point of difference. The key is to understand what the lower-solids extract contributes, and whether that value is discernible in field performance or compositional profile.

Concentration does not always correlate with efficacy in a linear way, and trial sensitivity varies. What matters is clarity about what the product is, how it works, and how it compares, not just in the lab, but in field conditions that reflect end-user expectations.

5.3.5 2025–2030: Functional Differentiation and Market Maturation

Between 2025 and 2030, producers will need to:

- Begin benchmarking their extract against known commercial inputs
- Identify use cases where performance is comparable or differentiated (e.g. improved rooting under saline conditions)
- Explore CE-marking either via standalone registration or through PFC 7 blends
- Engage in comparative field trials in partnership with distributors or ag retail groups

This period should also be used to refine positioning, not simply in terms of species, but based on:

- Molecular composition and concentration
- Field performance per unit of active compound
- Compatibility with existing fertiliser and foliar programmes

Sustainability (e.g. cultivated origin, traceability) can support positioning, but should be used as a secondary value driver, not a substitute for agronomic effect.

5.3.6 Recommendations

- Use white-label or co-label partnerships to enter the market without overextending resources
- Define a clear application use case, based on trial data and practical performance
- Concentrate extracts where possible to ≥30% w/v to reduce dose rate and improve compatibility
- Frame cultivated origin as a point of differentiation, not a claim of superiority
- Collect comparative data to support blends under PFC 7, focusing on complementary effects
- Plan for standalone positioning only when scale, data, and cost structure allow

Pillar 4: Regulatory Compliance, Market Legitimacy & Value Realisation

Cultivated seaweed biostimulants will not be scaled on narrative alone. Their adoption hinges on regulatory approval, validated performance, and a defensible route to market. These inputs must meet not only EU legal requirements under the Fertilising Products Regulation (FPR), but also the procurement expectations of distributors, retailers, and ESG-driven buyers.

This pillar sets out how producers can formalise extract legitimacy through CE-marking, build trust through traceability, and unlock policy and funding mechanisms by demonstrating functionality, compliance, and co-benefits. Public funding and subsidies can help, but they only come after one key step: proving that your product is legitimate; meaning it complies with regulations, shows evidence of performance, and meets the basic expectations of safety, and quality required to enter the market.

5.4.1 Regulatory Readiness: PFCs, CMCs and CE-Marking Pathways

Seaweed-based biostimulants are most commonly placed on the EU market under:

- **PFC 6b**: Plant biostimulants
- **PFC 7**: Blends of biostimulant components (e.g. seaweed + microbial or multi-seaweed)

The applicable **Component Material Category (CMC)** is determined by the processing method and source material:

- **CMC 1**: Virgin plant materials, covers thermally or chemically processed materials (e.g. hot alkaline extract)
- **CMC2**: Plant-based materials, old or aqueous extracts without chemical modification
- **CMC 7**: Microorganisms – currently limited to four permitted genera, applicable only when viable microbes are present and claimed

Products combining microbial and non-microbial components remain within **PFC 6. PFC 7** applies only when a biostimulant is combined with a different fertilising product type (e.g. fertiliser, liming material).

Fermentation-based products may fall under CMC 2 if microbes are used only for processing and are no longer viable. If viable microbes are claimed and permitted, CMC 7 applies.

Producers should identify the appropriate CMC and PFC early, based on how their extract is sourced, processed, and intended to function. The EU Fertilising Products Regulation offers a harmonised route to access all 27 Member States through CE-marking. However, this is optional, national authorisation remains a valid alternative, particularly for companies targeting specific regional markets or using inputs not yet fully covered by the FPR.

5.4.2 Blending as a Strategic Route to Market

Given the significant cost differential between cultivated and wild-harvested seaweed, blending offers the most pragmatic route to commercialisation.

- Wild *Ascophyllum nodosum* biomass costs €400–600/t dry, while cultivated species may exceed €2,000–3,000/t wet
- Blending with CE-registered extracts allows for immediate PFC 6b or PFC 7 conformity
- Formulators are familiar with *Ascophyllum*-based products and may be hesitant to adopt novel inputs without bridging data

Functionally, blending allows producers to:

- Leverage the performance credibility and CE-readiness of *Ascophyllum*
- Introduce cultivated origin as a differentiator, not a replacement
- Build a “2-is-better-than-1” value story, supported by complementary composition (e.g. oligosaccharides, soluble nutrients, mild extraction profiles)

- Position their extract as a product extension opportunity for incumbents, allowing them to differentiate SKUs by species rather than concentration or micronutrient tweaks

How to do this:

- Identify formulators or manufacturers offering CE-marked *Ascophyllum* extracts
- Prepare a short data pack highlighting your extract's composition and potential functional or narrative contribution
- Propose limited blending (e.g. 5-30%) to create a differentiated product
- Frame your cultivated extract as a commercial white space opportunity, enabling their distributors to offer something new without altering core regulatory status
- Emphasise species distinction, ESG credentials, or compositional traits as key selling points

Blending allows producers to move now, while building the data needed for future standalone cultivated products.

5.4.3 Traceability and ESG Differentiation

Cultivated seaweed provides intrinsic traceability advantages:

- Cultivated seaweed is produced at known locations, using controlled methods, and harvested on a planned schedule — which makes it easier to trace and document than wild-harvested biomass Lower exposure to environmental contaminants
- Potential to support batch-linked ESG metrics (e.g. carbon intensity, nutrient offset)

This may support:

- Green claims substantiation (aligned with EU Green Claims Directive)
- ESG-aligned procurement strategies (particularly for distributors supplying ag-retailers, co-ops, or vertically integrated brands with Scope 3 tracking obligations
- CE documentation (batch conformity, SOPs, reproducibility)

However, ESG and traceability alone are unlikely to command a price premium. Their commercial value depends on how they're used to unlock channel access (e.g. distributors with green portfolio targets) or support buyer segmentation (e.g. regional markets where sustainability narratives influence purchasing).

5.4.4 Subsidy Alignment and Public Funding Logic

Scaling cultivated seaweed for biostimulant use is not commercially viable without transitional support. Cost of production at pilot scale is multiple times higher than wild harvest, and the time to CE-marking and product-market fit often exceeds investor horizons.

Recommended public funding levers include :

- **EMFAF**: Up to 50% funding for aquaculture, processing, and innovation infrastructure
- **Interreg / Blue Bio CoFund**: Sea basin and transnational project support
- **Horizon Europe (Cluster 6)**: Biostimulant efficacy, composition-function studies, digital traceability
- **Smart Specialisation Strategy (S3)**: Regional innovation funding

Suggested production subsidy envelope: **€500-1,000 per wet tonne**, benchmarked against offshore wind support models. Structured as a tapering subsidy to offset early capital and operational disadvantages, with reductions triggered by processing scale thresholds, CE-marked product status is achieved, co-benefits (e.g. nitrate offsets, carbon metrics) are verified.

Mechanism:
This could be structured as a:

- Per-tonne grant administered via a blue bioeconomy programme (e.g. BIM, Department of Agriculture/Marine)
- Results-based payment linked to verified ESG performance
- Time-limited scheme (e.g. 5–7 years) to support infrastructure amortisation

Precedent:
Modelled on subsidy frameworks from offshore wind and early-stage renewables, where capital intensity and ecosystem alignment justify high initial public support tapering with maturity.

NSF should work with national and EU policymakers to adapt the offshore wind subsidy model to marine biomass cultivation.

5.4.5 Co-location for Infrastructure and Permitting Efficiency

Multiple feasibility studies, including BIM–IMAS Strategic Review of Seaweed Cultivation in Ireland (2023) conclude that the most cost- and permit-efficient route to seaweed processing scale is co-location with:

- Seafood processing plants
- Shellfish depuration centres
- Aquaculture or harbour logistics hubs

Benefits include:

- Existing discharge permits and floor drainage
- Utilities, cold storage, and trained labour
- Lower CAPEX due to shared infrastructure

NSF could conduct a scoping exercise to identify candidate sites in key regions, prioritising areas with >200 wet tonnes/year cultivation potential.

5.4.6 Governance: Realistic Structures for Shared Infrastructure

While the concept of a cooperative remains attractive, the geographic dispersion and maturity level of the sector make more flexible models preferable in the short term:

- Co-operative model to manage infrastructure, extraction units, or CE dossiers
- Service model
- Processor–farmer joint ventures
- Limited liability companies (CLG, BV, GmbH) with shared equity and access tiers

These models allow:

- Public-private investment without centralised control
- Tiered access to shared assets (e.g. modular extractors, drying hubs)
- Transparent performance monitoring and pricing frameworks

NSF can act as a neutral design partner to help structure, convene, and seed-fund these models, but should avoid becoming a central operator.

Tiered TRL-Based Decision Framework: Staged Progression for Market Readiness

Seaweed biostimulant development is capital- and time-intensive. Without a clear, staged approach, producers risk over-investing in extraction or formulation before functional and economic feasibility is demonstrated. To address this, the roadmap proposes a tiered framework, mapping technical readiness levels (TRLs) to biomass thresholds, trial requirements, regulatory milestones, and investment logic.

This model enables producers to progress toward market entry in structured steps - with clear go/no-go points and guidance on when to scale, partner, or pivot.

5.5.1 Commercialisation Stages and Milestones

Stage	Primary Objective	Key Activities	Decision Criteria (Go/No-Go)
Stage 0 – Exploration	Understand basic feasibility	Estimate yield/ha, cost/tonne, species characteristics	Is biomass compositionally suitable and harvestable at the right time? Is landed cost likely to fall below €1,200/t wet at scale (with subsidy)?
Stage 1 – Proof of Extract	Demonstrate basic extractability & composition	Choose processing method (cold, hot, fermentation); solids %, initial composition analysis	Can a stable extract be produced and repeatable composition?
Stage 2 – Functional Screening	Demonstrate biostimulant activity under lab conditions	Growth chamber trials, abiotic stress models, early root/shoot assays	Is there reproducible functional response in >2 growth/abiotic stress models at realistic dose (l/Ha)?
Stage 3 – Regulatory & Product Strategy	Align with FPR and market fit	Identify CE-mark pathway, define use case, begin batch validation	Can product be framed under PFC 6b or PFC 7 with eligible CMC(s)?
Stage 4 – Field Trials & Buyer Engagement	Prove agronomic performance & secure early buyer validation	GEP trials, co-funding with growers, draft tech sheets, initiate procurement pilots	Is effect consistent across ≥3 trials? Are distributors interested in trialling?
Stage 5 – Launch or License	CE-marked product with route to market	Regulatory submission, brand/white label offer, partner negotiations	Can product be manufactured at scale and sold with validated benefit/ha?

Indicative TRL mapping: Stage 0 = TRL 2–3; Stage 1 = TRL 3–4; Stage 2 = TRL 4–5; Stage 3 = TRL 5–6; Stage 4 = TRL 6–7; Stage 5 = TRL 8–9. This provides a reference point for alignment with Horizon Europe funding and investment frameworks.

5.5.2 Infrastructure Alignment by Stage

TRL Stage	Biomass Needs (t wet/year)	Required Infrastructure
0–1	<100	Access to drying or ensiling unit (shared or mobile)
2–3	100–500	Pilot-scale batch extractor (cold or hot), basic lab access

4–5	500–2,000	Shared dryer, milling, hot/cold extraction, fingerprinting
6–7	2,000–10,000	Full batch line, CE-prep analytics, QA system, trial budget
8+	10,000+	Semi-continuous plant, formulation room, logistics platform

These ranges are indicative, based on BIM biorefinery data, consultation with processing experts, and actual CAPEX budgets from NSF member interviews.

5.5.3 Funding Alignment by Stage

Stage	Recommended Funding Sources
0–1	EMFAF, local blue economy pilots, private seed grants
2–3	Interreg, Blue Bio CoFund, national aquaculture funds
4–5	Horizon Europe (Cluster 6, Soil Mission), regional S3
6–7	Private equity, infrastructure co-finance (EMFAF + Co-op)
8+	Strategic partnerships, ESG-aligned ag distributors

5.5.4 Priority Actions by Stage

Stage	Critical Early Actions
Stage 0	Select species with known agronomic potential or compositional promise.
Stage 1	Conduct extractability trials under multiple harvest conditions (early/late season, wet/dry biomass).
Stage 2	Partner with an academic or CRO lab to run root/shoot assays and abiotic stress screening under harmonised protocols.
Stage 3	Determine appropriate CMC , confirm eligibility, and select whether to pursue CE-mark solo or via blending (PFC 7).
Stage 4	Identify distributors or cooperatives willing to co-fund field trials, ideally in crops with clear biostimulant adoption potential (e.g. horticulture, vines).
Stage 5	Lock in route to market: white label, B2B sale, or co-label formulation. Finalise tech sheet, SDS, and trial summary.

This framework should serve both as a commercial due diligence tool and a grant alignment reference, enabling NSF members and funders to calibrate expectations, avoid misallocation of capital, and identify strategic intervention points.

Section 6: Roadmap Milestones to 2050

6.1 Translating Strategy into Actionable Timelines

The commercialisation of cultivated seaweed as a viable input for plant biostimulants will not follow a straight line. However, based on current maturity, known bottlenecks, and existing infrastructure, a set of broad milestones can be outlined. These are not rigid gates, they are indicative timeframes for the convergence of key conditions, supported by parallel progress across the four strategic pillars outlined in Section 5.

These milestones reflect the actions and investments required at the system level; from industry bodies, public funders, research institutes, and policymakers to unlock the conditions under which cultivated seaweed biostimulants can scale. They are not about building products directly, but about removing friction, building shared capacity, and reducing risk for those who do.

In parallel, operators such as seaweed cultivators exploring the biostimulant market will play a defining role in validating biomass, producing extract and engaging early stage partners. Where relevant, this roadmap highlights the actions required at the operator level to capitalise on system enablers and avoid duplication of effort.

System-Level Roadmap to 2050: Enabling Cultivated Seaweed Biostimulants This roadmap outlines the system-level actions that could enable cultivated seaweed biostimulants to scale, across infrastructure, coordination, regulatory support and public funding. These milestones are not intended as rigid prescriptions but rather as strategic directions to explore, acknowledging that the path to scale will differ depending on local conditions, actor roles and partnership models. While the primary focus is on biostimulants, this roadmap does not exclude broader biorefinery strategies and acknowledges that multiple revenue streams (e.g. food, feed, materials) may be essential for long-term viability.

Year / TRL	System-Level Milestone
2025	Map cultivation capacity, stabilisation methods, and seasonal availability across members. Facilitate discussions on species alignment. Begin development of CE trial protocols aligned with CEN/TS 17700-1. Launch early engagement with policymakers and funding agencies regarding subsidy needs..
2026	Support pilot processing using low-CAPEX methods (fermentation, ensiling, suspensions, extractions). Introduce biorefinery design thinking to extract development. Begin controlled-environment trials for abiotic stress claims. Provide guidance for non-cooperative operators to access shared infrastructure or analytics.
2027	Draft and publish a sector-wide policy white paper making the case for production-linked subsidies. Encourage joint trial funding applications. Prepare data infrastructure to track composition and performance. Support pre-CE trial cohorts through data standardisation. Initiate early exploration into the feasibility of using cultivated seaweed as a fermentation substrate or postbiotic base. Frame as an optional path to differentiate cultivated inputs, recognising both its promise and uncertainty.
2028	Submit first CE dossiers based on 3–6 trial data sets. Submit national-level subsidy proposal backed by functional data and traceability metrics. Begin pre-commercial buyer engagement and distributor outreach.

2029	Finalise formulation access for compliant batches. Launch co-label pilot agreements. Begin compositional and techno-economic assessment of side-stream valorisation potential (biorefinery feasibility).
2030	Launch first national subsidy pilot co-financed by EU. Disseminate CE trial learnings and dossier experience. Establish initial technical benchmarks comparing cultivated extract performance, dose rates, and cost-per-hectare against incumbent wild extract baselines.
2035	Sector consolidation. Cultivated biostimulants are no longer novel; multiple producers are CE-marked or integrated in co-label portfolios. Shared infrastructure models and coordinated batch identity systems are standard. Kerrygold-style platform identity is explored to secure traceability, buyer trust, and fair value.
2040	Focus shifts to optimisation: product differentiation, co-formulation, and branding. Regional biorefinery capacity emerges as co-products and side-streams are valorised across feed, cosmetics, and materials. Support international scaling strategies and policy alignment beyond the EU
2050	Cultivated seaweed biostimulants are embedded in the global bio-based input system. Value chain maturity enables ongoing innovation, policy stability, and multi-output optimisation through fully integrated biorefinery models.

Not every producer needs to participate in a formal cooperative to benefit from shared infrastructure or regulatory progress. Entrepreneurs can engage via:

- Toll processing agreements
- Shared access to batch-level analytics or trial data
- Alignment with a lead applicant for CE dossier reference
- Opt-in participation in public-private funding bids coordinated by NSF

This approach ensures flexibility while supporting coordinated progress across the sector.

6.2 Operator Lens: Entrepreneur Milestones Within the System Roadmap

Many of the milestones described above, particularly those related to extract development, validation, and early market access, depend directly on actions taken by seaweed entrepreneurs. This roadmap assumes that a cohort of producers will take the initiative to stabilise biomass, run pilot extractions, generate trial data, and engage partners.

The table below outlines the entrepreneur-specific deliverables embedded within the wider system roadmap.

Year / TRL	Entrepreneur Actions
2025	Select species; trial harvest and stabilisation methods (e.g. ensiling, fermentation); produce cold extract batches; evaluate feasibility of B2 vs own-brand route.

2026–2027	Begin structured extract screening with CRO or institute; consider biorefinery design early, even if biostimulants remain primary output; apply for public funding; develop draft technical specs.
2028–2029	Conduct CE-aligned field trials (3–6); ensure batch traceability; prepare dossier or engage formulator for co-label route. Keep multiple value pathways open. Where feasible, begin early scoping of fermentation or postbiotic applications using cultivated biomass, without displacing the primary focus on extract validation.
2030	Launch initial product through partner or co-label model; build supply/demand match; refine pricing and formulation fit. Establish market credibility; contribute to regional infrastructure or brand identity (e.g. Kerrygold® butter style franchise).
2035	Optimise inputs and formulations; participate in biorefinery-linked models that valorise residual biomass; explore scaling opportunities beyond the EU. Shift from generic supply to functionally positioned inputs (e.g. drought, NUE).
2040+	Mature as full CE-marked producer or strategic co-supplier; participate in policy-led market mechanisms (e.g. CAP, carbon schemes, retail input programmes).

6.3 Conclusion: From Roadmap to Realisation

This roadmap outlines a credible pathway to scale cultivated seaweed biostimulants by 2050. The key milestones, from biomass stabilisation and extract validation to regulatory maturity and subsidy alignment are achievable, but not automatic. They require parallel progress: system-level coordination to reduce barriers and build infrastructure, and operator-level commitment to invest in technical validation and market engagement.

For entrepreneurs, this means acting early to prove feasibility and build credibility. For enablers including NSF, public agencies, and policymakers - it means removing friction, aligning incentives, and ensuring that the effort to scale cultivated seaweed is matched by the support to do so.

The next steps will determine whether cultivated seaweed becomes a marginal story, or a mainstream input in the future of biological agriculture.

Section 7: Do's and Don'ts

Lessons from the Field – What Helps, What Hinders

This section distils practical advice gathered through interviews, trial experience, and industry observation. It is designed to help producers, researchers, and partners avoid costly mistakes and focus effort where it matters most.

Do

- **Secure a technical partner early.** Work with an institute experienced in seaweed extracts. They can support extract refinement, wet-lab characterisation, and plant trials. If you don't have in-house capability, this type of partnership is a prerequisite, and helps bridge gaps in both credibility and capacity.

- **Understand what makes your extract different.** Differentiation is not just about species, it is about demonstrating how your extract composition or performance offers something competitors cannot.
- **Start screening with what's practical.** *Arabidopsis* or model species can give you a fast read early on. But transition quickly to commercial crops grown under controlled conditions. That's where future buyers will focus.
- **Retain and document every batch.** Batch tracking allows you to later connect composition to trial outcomes. Even if you can't explain why something worked, you'll know what was in it.
- **Use peer-reviewed literature as scaffolding.** Early-stage positioning can be supported by published studies, but your product must perform on its own terms. Build a dataset that reflects your extract.
- **Let the grower decide.** If your product doesn't deliver in the field, it won't be used. Early phenotypic signals (yield increase, fruit uniformity, rooting), matter more than theoretical mode of action (MoA).
- **Build your value story with your customer in mind.** Help formulators and distributors understand what your extract adds to their portfolio. *"More of the same"* won't justify a premium or a switch.
- **Design trials with FPR/CEN in mind.** If you're investing in a trial, run it to a standard. That way, results can support both marketing and CE-marking later.
- **Use fermentation or ensiling tactically.** These can serve as low-CAPEX ways to stabilise biomass and may open the door to functional differentiation, but only if you track inputs and outcomes closely.
- **Invest in process control if fermenting.** Without stable pH, temperature, and microbial load, fermentation becomes a liability. Variability kills credibility in early-stage B2B supply.
- **Aim to concentrate, where possible.** Higher solids (% w/v) improve formulation flexibility and reduce cost per hectare. So try to work towards formulations with a higher % of solids but but don't let perfection stall early efforts, i.e. it can be an optimisation effort.
- **If you're targeting formulators, concentrate your extract where possible (≥30% w/v)** – formulation space is limited, and if your product takes up too much volume, it may be excluded regardless of price or performance. **Position your product based on function, not just story/context.** ESG credentials matter — but functional performance is the core value driver.
- **Pursue public funding early** – it's non-dilutive, aligned to TRL stage, and helps build feasibility before engaging private investors, giving you greater control and leverage.
- **Explore cooperative models.** Don't go at it alone on extraction, drying, or trial infrastructure. Shared assets can improve access, reduce capital needs, and accelerate learning.
- **Invest in advocacy.** Like offshore wind, cultivated seaweed will need public support to scale. Back the case for subsidies with data or risk being left behind.

Don't

- **Don't confuse stabilisation with market-readiness.** Just because biomass is preserved doesn't mean you've got a saleable extract. Stabilisation is step one, functionality still has to be proven.
- **Don't treat model species results as conclusive.** *Arabidopsis* can help screen extracts, but commercial adoption depends on performance in field crops.
- **Don't assume narrative alone will carry the product.** Buyers may be interested in cultivated seaweed, but without compositional clarity or a performance edge, they'll default to what they know.

- **Don't wait for perfection before engaging buyers.** Early conversations with formulators or distributors can help shape your extract development and give you useful commercial feedback, even if the product isn't final.
- **Don't over-rely on literature.** Published data helps frame your value proposition, but your extract must be tested on your process, your batch, your conditions.
- **Don't delay trials waiting for compositional perfection.** Start testing. Building a functional dataset takes time, but it starts with trying something and tracking it well.
- **Don't expect to link composition directly to performance.** You may never isolate a single molecule responsible for yield increases. Focus on consistency, not over-simplification.
- **Don't oversell early data.** Small plots or greenhouse wins are promising, but not market-ready proof. Be transparent about what's known and what's still exploratory.
- **Don't ignore formulation constraints.** In concentrated blends, space is limited. Low-solids extracts may not be attractive unless clearly differentiated.
- **Don't cut corners on trials.** If you're spending money, spend it on well-designed experiments that meet SEND standards and generate usable data.
- **Don't duplicate infrastructure.** Processing, growth rooms, lab facilities - if others have it, use it. Focus investment on your differentiator.
- **Don't assume support will come without asking.** Production-linked subsidies won't be handed out - they must be secured through compelling evidence, coordinated messaging, and professional EU-level advocacy. Engaging the right partner can make the difference between being heard and being overlooked.