ALGAE CENTER OF EXCELLENCE

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ABO
ALGAE BIOMASS ORGANIZATION

ALGAE FOR FOOD + FEED
THE GLOBAL INITIATIVE

THE FUTURE OF ALGAE

Algae, which includes photosynthetic macroalgae and microalgae, as well heterotrophic microalgae, and other related microorganisms, have been used by humans for a variety of purposes for thousands of years.

Algae are currently used as materials and ingredients in many existing products today, including food, feed, cosmetics, and skin care, nutritional supplements, fertilizers, soil amendments, textiles, plastics, and biofuels. Despite the many uses, algae have yet to reach their full potential.

Research and development (R&D), multi discipline collaboration, and production scale demonstration must continue to occur for algae products to be competitive with existing global markets. Algae have ultra-high productivity and the potential to act as a carbon sink. Production of algal biomass can have low environmental impacts by reducing the use of potable water, arable land, and energy.

A summary report from Center for Climate and Energy Solutions found that algae products, both in the food, feed, fuel, and chemical sector, could reach a potential market size of $320 billion by the year 2030. (1) From a greenhouse gas perspective, by 2030, these industries could help mitigate 3.2 billion metric tons of CO2 into the atmosphere. In addition, algae and algal bioproducts are also utilized to help restore ecosystems through removal of excess levels of nutrients that cause harmful blooms and rescue nutrients from wastewater treatment plants. The algae industry is particularly important to rural communities where many algae farms and production facilities operate and deliver ecosystem services. (2)

Growing the algae industry will help create new rural and agricultural jobs - everything from operators, engineers and scientists to accounting, marketing development and logistics. In addition, algae production is an environmentally safer alternative than most fossil-fuel production, which will help to protect the health of communities in close proximity to facilities, which tend to be disproportionately people of color and economically underserved.

There are truly few other industries that are equipped and able to meet so many of our planet and society's needs such as algae. Investment in this industry would valorize current sustainable US algae products, create breakthroughs in critical processes and goods, provide restoration applications to our precious air, soil, and water resources, and provide economic opportunity and better quality of life to rural, underserved, and disadvantaged communities. The US is currently a global leader in algae R&D, and the opportunity to create the next generation of new, innovative, and sustainable products is in America's heartland - spurring job creation as part of the new bioeconomy. (3)

The first step toward achieving this potential begins with the proposed Algae Center of Excellence (ACE).

1. Bobeck et. al., "Carbon utilization – a vital and effective pathway for decarbonization." Summary Report. Center for Climate and Energy Solutions, August 2019.
2. https://www.biotech-careers.org/company-core-activity/algae accessed Jan 26, 2021.
3. Kim JK, Stekoll M, and Yarish C. "Opportunities, challenges and future directions of open water seaweed aquaculture in the United States. Phycologia 58 (5): 446-461. doi.org/10.1080/00318884.2019.1625611

PARTNER WITH US

The steering committee for the Algae Center of Excellence is currently seeking partners to help launch the Center. Partners would be individuals or organizations that understand the global need to:

- Develop new sustainable products
- Sustainably increase our food and feed supply
- Restore our environment
- Build climate and economic resilience in communities

Partners are motivated to grow the US based algae industry so that it can meet these needs and expand the US bioeconomy.

MISSION OF THE ALGAE CENTER OF EXCELLENCE

The mission of the ACE is to support the development, scale-up, and commercialization of innovative, sustainable and eco-restorative solutions for the production of food, feed, and bioproducts from algae.

ACE will engage academic institutions, National Labs, and industry communities across diverse fields of biology, ecology, climate science, agronomy, chemistry, engineering, nutrition, and economics. A primary objective of ACE is to facilitate the interactions of this diverse set of scientific and business disciplines to tackle the significant research objectives and commercial deployment challenges that cannot be addressed by any one discipline alone.

The Algae Center of Excellence will help facilitate the rapid commercialization of algae, addressing the most important applied research topics, as well as commercial scale-up challenges, while training a workforce essential for global growth in this new industry and providing economic development in rural communities. The Center will also facilitate the transfer of technology from the research community to commercial deployment by including commercial algae producers in all aspects of the Center, including leadership.




PROPOSED STRUCTURE OF ACE

The ACE is envisioned as a "distributed" center, with facilities and labs spread throughout the country – including universities, government laboratories and private companies – all working in close collaboration, coordinated by the ACE leadership team. Having distributed collaborative research at the interface of algal biology and ecology, biochemistry, chemical engineering, food science, animal health, soil health, and economics will allow for more rapid commercialization and development of solutions. We are taking advantage of existing expertise and infrastructure found throughout the country. The approaches described here will require integrative research across multiple research institutions interacting closely with industry to identify and address the most critical challenges facing algae commercialization.

The impact of a single national collaborative center integrating these capabilities would be unique and would powerfully leverage our previous national, state, and regional investments into this emerging field. The ACE already has participating members (see participant list) from these sectors that are committed and enthusiastic about such a joint effort to shape this growing industry and are committed to working with government agencies to make sure our efforts are complementary to ongoing government-sponsored R&D efforts. The Center will act as a catalyst to accelerate the commercial deployment of algae to meet our future food, feed and other needs. ACE will focus the efforts of a diverse community to ensure that this interdisciplinary approach results in major benefits for the nation while training a new generation of scientists, engineers and entrepreneurs in algae science and commerce.

The 501©6 Algae Biomass Organization, will host the ABO Summit (https://www.algaebiomasssummit.org/), which will serve as the annual gathering to review and report ACE progress and make allocation decisions.

ACE DEMONSTRATIONS OF SUCCESS

- Through strategic allocation of funds to critical research and development, ACE will reduce the overall algae farming and production costs for food, feed and associated bioproducts.
- ACE will assist in developing an educated and enthusiastic workforce that will allow for a diverse array of jobs in rural communities. Algae production will aid in providing economic opportunities and jobs to rural and underdeveloped communities whether in the heartland of the US or along coastal areas.
- ACE will facilitate the introduction of multiple algae derived bioproducts to the market, boosting regional and national economies and generating new jobs in rural areas.
- ACE will provide access to equipment, expertise, and testing that will help companies accelerate scale production.
- ACE will provide concerted and well-funded selective breeding and genomic modification programs for production algae that would be industrially integrated with and open up advancements in farm engineering, management and downstream harvesting and processing.
- ACE will accelerate the launch of a modern crop to the global market – a crop that is sustainable, does not compete with existing crops, and uses minimal natural resources.
- ACE will document life-cycle analyses and economic benefits of algae production for food, feed, and bioproducts.
- ACE will facilitate the development and introduction of new algae aquaculture feed ingredients that reduce or eliminate the need for fishmeal and fish oil in feed formulations.
- ACE will facilitate the development and introduction of new algae feed ingredient products with animal health, meat quality and sustainability benefits.
- ACE will facilitate the development and introduction of new algae food ingredients that are nutritious and beneficial to human health.
- ACE will help expand implementation of algae-based environmental restoration activities to combat and mitigate harmful algal blooms, including wastewater treatment, soil amendments, etc.
- Projects funded through ACE will incorporate strong connections between the algae producers, researchers, and product specialists which will drive commercialization.

PROPOSED ACTIVITIES OF ACE

ROAD MAPPING TO IDENTIFY NEW RESEARCH DIRECTIONS AND TECHNOLOGIES

- Identify potential cutting-edge research opportunities for improving commercial farming and production of algae bioproducts through workshops and road mapping sessions with extended stakeholder groups, especially commercial sector partners
- Propose action plans for identified applied research activities
- Identify and incorporate new technologies into applied research projects by integration of scientific disciplines
- Identify innovative technologies that can be scalable to mitigate HAB events

DEVELOP A BIOREFINERY APPROACH FOR MULTI REVENUE STREAMS FROM BIOMASS FOR IMPROVED ECONOMIC VIABILITY

- Develop economic and environmentally sound ways of using the residual process byproducts
- Develop new industrial enzymes and enhanced animal feeds.
- Develop chemical technologies (e.g. pyrolysis, polyol production, fatty acid fractionation, etc.) for conversion of biomass into feed or bioproducts.

FOOD AND FEED APPLICATION DEVELOPMENT

- Develop expertise to support product development, product testing, regulatory and safety guidance, development of analytical standards and methods, and resources to accelerate adoption of algae into food and feed
- Provide testing facilities and expertise to assess flavor, texture, nutrition, color, consistency, functionality, and safety
- Provide publicly available data and information on algae for food, feed and other applications

BIOPRODUCT APPLICATION DEVELOPMENT

- Develop expertise to support product testing, regulatory guidance, development of analytical standards and methods, and resources to accelerate development of algae-based materials and bioproducts
- Provide and recommend testing facilities and expertise for material and product functionality, chemistry, safety, and quality
- Provide testing facilities for biomaterials applications development

BIOFERTILIZER/SOIL AMENDMENT AND BIOSTIMULANTS APPLICATION FOR SOIL AND PLANT HEALTH

- Develop expertise in soil health characterization and response to algal biofertilizers and soil amendments.
- Develop expertise in rapid in-situ measurement of soil biological activity, organic soil carbon and humic substances
- Develop methods and expertise in carbon life-cycle analyses (LCA) of biofertilizer/soil amendment applications on conventional crops
- Provide development and testing facilities for application of biofertilizers/soil amendments and biostimulants to conventional crops to quantify productivity response and soil health response

PROPOSED ACTIVITIES OF ACE

RESTORATIVE AND ECO-INDUSTRIAL RURAL DEVELOPMENT

- Develop mitigation and removal strategies for algal blooms to reduce nutrient pollution resulting from air pollution, septic systems, agriculture, animal, and industrial waste disposal
- Accelerate the safe use of algae wastewater treatment for concentrated animal feeding operations, and industrial wastewater being produced at food/feed manufacturing and processing facilities
- Develop new markets of algal biomass produced in the above processes
- Identify and develop technologies that can valorize the mitigation of HABs by creating usable algae biomass feedstock for commercial use

DEVELOP AGRONOMIC STRATEGIES

- Serve as a technology core for the advancement of algal products (from seed to sale) from all system types
- Develop and expand use of integrated pest management (IPM) and environmental mitigation strategies for a variety of commercially important strains and cultivars
- Advance de-integration of individual production systems to foster increased algal biomass production
- Advance research in developing more productive and sustainable feedstock options for heterotrophic systems
- Advance macroalgal hatchery technologies and integration with seed planting technologies
- Advance mechanization and automation of macroalgal farming, monitoring and harvesting to enhance safety and productivity

DEVELOP A GENETIC TOOLBOX FOR METABOLIC ENGINEERING AND BREEDING TECHNIQUES FOR COMMERCIALLY RELEVANT ORGANISMS

- Develop new methods to control gene expression and cell viability
- Create methods for genetic transformation of heretofore non-transformed species
- Develop combinatorial genetic manipulation for directed evolution in algal species
- Develop genomic tools for accelerating classic selective breeding in algae spp.
- Develop methods of producing sporeless macroalgae to mitigate possible impact on natural resources
- Improve methods of cryopreservation of algal species, and expand support for and capabilities of a distributed National Algal Genetic Resource Center

DEVELOP METABOLIC AND MICROBIOMIC ENGINEERING, AND ENHANCEMENT TECHNIQUES FOR IMPROVED INDUSTRIAL CHARACTERISTICS

- Employ a systems-based strategy to optimize feedstock production and supply
- Define metabolic networks controlling carbon flux and modify metabolic pathways
- Use modern genomics, proteomics, microbiomics, and metabolomics technologies to define target pathways and regulatory systems

OPTIMIZE ECONOMICALLY VIABLE FARMING, HARVESTING, PROCESSING, AND STORING TECHNOLOGIES

- Optimize efficient farming, harvesting, processing and storing technologies
- Develop standardized best practice procedures for the industry
- Employ genetic engineering and breeding techniques to increase productivity of industrially important strains for facilitating downstream processing
- Work within the industry, and specifically academic and National Labs, to increase access to small to midsize equipment to help scale production

PROPOSED ACTIVITIES OF ACE

LIFE CYCLE AND TECHNOECONOMIC ANALYSIS OF ALGAL PRODUCTION

- Define system boundaries, specific requirements, and identify product pathways including potential co-products for a variety of algal organisms
- Develop life cycle inventory (LCI) data for algal production

SUPPORT CONSUMER RESEARCH AND MARKETING

- Work with federal and state agencies and non-governmental organizations to assess algae for the potential of global food and feed applications and food security
- Conduct consumer research on attitudes and acceptance of algae in food, feed and bioproduct applications and disseminate results through awareness campaigns

PROMOTING RURAL DEVELOPMENT AND AN EQUITABLE, DIVERSE WORKFORCE

- Work with industry, the Algae Foundation (thealgaefoundation.org), The GreenWave Organization (greenwave.org), academic institutions and state and federal agencies to further develop education and workforce development programs for the algae industry
- Work with economic development agencies, NGOs, enterprises, and state and federal agencies, to extend seaweed farming into rural and tribal communities in Alaska and Maine, for example
- Identify and prioritize efforts, research, and initiatives that actively address diversity, equity, and inclusion in the algae workforce and communities

ACE PARTICIPANTS

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https://www.futureofalgae.org