

The Algal Production group is focused on providing practical and cost effective Algal Production Systems (APS) for use in aquaculture, nutrient remediation, nutraceuticals, bioenergy and in biofixation of carbon. The group is committed to delivering to its clients concept design, laboratory testing, proof-of-concept scale trials and pilot commercial scale trials. This is achieved using in-house skills, collaborations and specialised infrastructure.

### Overview

Post Kyoto, there is a growing need for greenhouse gas reduction and abatement systems and technologies. Many greenhouse intensive industries are looking to offset carbon emissions through in situ carbon sequestration or emission avoidance technologies. APS provide a viable alternative.

EPA water quality standards and environment protection measures are causing industries to clean up wastewater and tailings ponds. APS can be used as an alternative or to supplement traditional engineering solutions.

There is also considerable interest in developing APS for biofuel feedstocks as it has the potential to create a new oil major in its own right, independent of petroleum based production. Many start-up companies in the US have developed their own technology in this area but most of them are around five years away from full commercial production. Australia has great potential for this technology as it has marginal lands not suitable for agriculture with large areas of saline groundwater and high solar potential.

### Algal Production Systems R&D

To meet longer-term and larger-scale feedstock requirements, research commenced in 2006 to develop microalgae-based feedstock production for biofuels including biodiesel. While it is yet to be shown that this technology can work on a commercial scale, the potential is enormous. From laboratory scale work, it is known that the yields of feedstock oil per unit area are at least 10 times higher than crop-based production. Full life cycle analysis also reveals that biodiesel produces around 70% less greenhouse gases than mineral diesel.

Production systems could be developed in remote locations by making use of non-arable land and saline ground water with microalgae growing in aqueous suspension where they have more efficient access to water, CO<sub>2</sub> and dissolved nutrients. Microalgae are capable of producing large amounts of biomass and oil in either high rate algal ponds or photobioreactors. Both technologies are being researched at SARDI, particularly with respect to their ability to utilise poor quality saline or eutrophic water sources.



SARDI is bioprospecting and selecting native high lipid microalgal strains as a feedstock for biodiesel production. The Algal Production Group of SARDI has now formed a major collaborative research alliance through the Algal Fuels Consortium™ with Flinders University and CSIRO to develop a >10 ha pilot and precommercial scale production facility on Torrens Island. This research consortium brings together more than 65 accomplished interdisciplinary experts in microalgal physiology, carbon capture and delivery, bioprocess technologies, biodiesel chemistry, life cycle analysis, dewatering, harvesting and extraction technologies. Pilot scale microalgal production systems will be developed in conjunction with industry and community stakeholders, including SANCON Recycling Pty Ltd., a major investor on this project. SARDI is interested in seeking potential investment partners in this area. The research group has commenced the southern hemisphere trials for General Atomics through the Defence Advanced Research Projects Agency (US Department of Defence) to develop JP-8 jet fuels from microalgae.

SARDI is also investigating metabolic pathways and genetic optimisation in microalgae and means to optimise it under various growth conditions for high lipid and growth yields. This project is being developed in collaboration with the Australian National University, Canberra and the University of Manitoba in Canada.

In addition to the microalgal biofuels related research, the group is actively involved in research into nutrient remediation using macroalgal production systems. In partnership with carbon and nutrient constrained industry stakeholders, the research group is involved in developing efficient macroalgal nutrient scrubbing systems. The solution is developed using native macroalgal strains.



## Current Projects

South Australian Premier's Science and Research Fund 2008-08: 'Developing a proof-of-concept facility for microalgal biodiesel feedstock and value-added products to pioneer a sustainable South Australian biofuels industry', 2008-2011, with an overall budget of A \$4,031,871.

The Department of Resources, Energy and Tourism: 2nd Generation Biofuels Programme, Australian Government, DRET 'A pilot scale second generation biorefinery for sustainable microalgal biofuels and value-added products', 2009-2012, with an overall budget of A\$9.913

General Atomics: 'Phase 1 DARPA JP8 jet fuels from microalgae', 2009-10, sub-contract from General Atomics on a grant from the Defence Advanced Research Projects Administration, US Department of Defence.

Governments of South Australia and Manitoba: 'Metabolic and genetic optimisation of microalgae for biofuels production.

## Recent Publications

Fernández, W., Bergvall-Kåreborn, B., Djordjevic, M., Lovegrove, K. and **Nayar, S.** Design as a boundary-crossing object in climate change mitigation projects. Australasian Journal of Information Systems (In Press).

**Nayar, S.** and Loo, M.G.K. 2009. Phytoplankton and phyto-benthic productivity along a salinity gradient in the Coorong and Murray Mouth. CSIRO: Water for a



equipment on stress levels in Pacific oysters, *Crassostrea gigas* (Thunberg). Aquaculture Engineering. 40 : 11-16.

**Bott, K.** and **Nayar, S.** 2008. Biodiesel from microalgae. Issues 84 : 39-41 (Invited article)

Cheshire, A. and **Nayar, S.** 2008. A pre-feasibility study of the use of a macroalgal phytoremediation system for the treatment of Penrice effluent water. Prefeasibility report prepared for Penrice Soda Holdings Ltd, Adelaide. p. 26. (Commercial in Confidence)

**Nayar, S., Bott, K., O'Loughlin, E.** and Williams, K. 2007. Production of biodiesel from microalgae : Historical overview and challenges. Microalgal Biofuels Group Technical Report 1 prepared for AusIndustry and Center for Natural Resource Management. South Australian Research and Development Institute Research Report Series Number 203, Adelaide. p. 95. (Commercial in Confidence)

**Nayar, S.** and Williams, K. 2007. Microalgal biodiesel production initiatives in the USA, Europe, India and China : A travel report. Microalgal Biofuels Group Technical Report 2 prepared for AusIndustry and Center for Natural Resource Management. South Australian Research and Development Institute Research Report Series Number 233, Adelaide. p. 56. (Commercial in Confidence)

## Staff

The APS group can draw on research capabilities from selected SARDI staff from various strategic research areas of Aquatic Sciences. SARDI also has a strategic relationship with *Balance Carbon Pty Ltd* and *Science to Manage Uncertainty* which provides additional research capability as well as market focus and commercialisation strategies.



Healthy Country National Research Flagship and South Australian Research and Development Institute (Aquatic Sciences) Publication No. F2009/000263-1, Adelaide. 19pp.

**Nayar, S.,** Collings, G.J. Miller, D.J., Bryars, S. and Cheshire, A.C. 2009. Uptake and allocation of inorganic carbon by temperate seagrasses *Amphibolis* and *Posidonia*. Journal of Experimental Marine Biology and Ecology, 373 : 87-95.

Qu Y., Li X., Yu Y., Vandeppeer M., Babidge P., Clarke S., **Bott K** & Li H. 2009. The effect of different grading



## **Dr Sasi Nayar**

### **Program Leader, Algal Production Systems**

Dr. Sasi Nayar leads the Algal Production Group at the South Australian Research and Development Institute. He has a PhD in Marine Ecology and Ecotoxicology from the National University of Singapore (2003) and a Masters Degree in Fisheries Science from the University of Agricultural Sciences, Bangalore (1998). He has significant experience of over 15 years in handling ecological research projects in mangroves, coral reefs, estuarine reefs, seagrass meadows, coastal and oceanic waters in the tropics and temperate environment. He has 25 publications in reputed peer reviewed international journals, 16 of them on phytoplankton biology and ecology. As a principal investigator, he has been successful in securing >\$13.6 million in grants from Federal and State governments, and industry for a total of 9 projects, 6 of them on research and development of algal production systems for biofuel production in collaboration with biodiesel producers, universities and other agencies. He has played a key role in securing \$5 million from state and federal governments to develop the NCRIS microalgal photobioreactor facility at SARDI, a unique state-of-the-art national facility. He is regularly invited to review for 15 high ranking and impact international aquatic science journals, 2 major international grant agencies. For his academic contributions, he has been awarded 10 awards.

## **Mr Kriston Bott**

### **Senior Technical Officer, Algal Culture**

Mr Bott has a Bachelor of Applied Science with a major in Aquaculture from James Cook University. During his time with SARDI he has provided technical assistance on numerous research projects including shellfish health, bivalve genetics, abalone selective breeding and microalgal biodiesel. Mr Bott is also involved with various aspects of microalgae culture, both batch culture systems and continuous production systems. He has managed the SARDI aquaculture microalgae photobioreactor and marine microalgal culture collection for over 3 years. He is a co-author on 4 journal articles published in reputed peer reviewed international journals. Mr Bott brings to this group significant experience in management of microalgal culture facilities and running the physiological experiments under controlled conditions.

## **Ms Michelle Braley**

### **Technical Officer, Algal Culture**

Michelle Braley has been working on temperate marine ecosystems since 2005, gaining valuable skills and experience in a variety of areas including Marine Environment & Ecology, Wild Fisheries & Inland Waters. She obtained a Bachelor of Science at Flinders University and Honours in Marine Ecology at the Adelaide University. For the past 2 years, Michelle has worked as a Research Services Officer in Environmental Chemistry for the Marine Environment & Ecology Program. In this role she has been focused in the field of Marine Environmental Chemistry, providing support to numerous projects primarily in the context of assessing environmental impacts (e.g. Aquaculture, Spatial Footprint of Wastewater) and risk assessment of exotic marine pests (eg. *Caulerpa*). From this she has developed skills in various aspects of marine environmental chemistry, including the preparation and analysis of sediment, water and biological samples for the analysis of organic content and composition, nutrient levels and sediment particle size distribution. She also has experience in providing field based support to numerous projects, data entry/database management and writing scientific literature.

### **Current collaborators**

Professor Chris Franco, Flinders University, Australia  
Associate Professor Wei Zhang, Flinders University, Australia

Associate Professor Michael Djordjevic, Australian National University, Australia

Dr Tom Beer, CSIRO Energy Transformed Flagship, Australia

Professor Anthony Cheshire, Science to Manage Uncertainty, Australia

Associate Professor David Levin, University of Manitoba, Canada

Associate Professor Richard Sparling, University of Manitoba, Canada

Dr Hal Streckert, General Atomics, USA

### **Contact**

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