Sustainable Energy

The aim of this project is to build capacity in South Africa, Namibia and Ghana to create sustainable non-food renewable bio-oil supply chains for bioenergy and in the future, the chemical feedstocks needed to replace fossil fuels. Partners hail from university (the Universities of Namibia, Ghana, Greenwich (UK) and Palermo – Corissia (Italy)), research (the Marine Biological Association, Plymouth) and commercial (Turner & Townsend, and Goldex (South Africa) and Jatropha Africa (Ghana) backgrounds. The project commenced in 2010 with workshops in South Africa, Namibia and Ghana to which science and technology academics, professionals, decision-makers and support scheme managers in each locality were invited. The aim was to inform, identify, support and shape local initiatives that aligned with global developments in sustainable energy as well as scope the opportunities for new global partnerships so that research, training and business capacities to cultivate and process non-food biomass for biofuels and chemicals could be developed in an environmentally-sustainable yet socially-sensitive manner. Two exemplar supply chains for the project were identified, the first based on jatropha oil produced from farming *J. curcas*, which was seen at the outset of the project as a feedstock for biodiesel manufacture with potential to provide rural communities with decentralised electricity and hot water as well as support agricultural economies. The second was based on microalgae as a vastly under-exploited feedstock that could also be developed using non-potable water for cultivation, and that could process waste water before its discharge and recycle nutrients.

Focus on these two apposite supply chains has provided a wealth of insight into the 'hype' versus 'hope' aspects of bioenergy. In the case of jatropha oil, it quickly became clear that reports of substantial oil yields able to support global trade were misplaced: having been hailed as a drought resistant crop that could be grown almost anywhere and which would adapt well to marginal soils with low nutrient content, it was found to require irrigation to yield oil and moreover could not be intercropped with crops such as maize due to competition for soil nutrients. In South Africa and Namibia its cultivation was banned in the course of the project and in Ghana many plantations have now ceased operation. Jatropha cultivation is recommended only as a hedge or living fence.

This contrasts with microalgae, where an important focus on glycerol as a biofuel emerged when a UK company Aquafuel, defying conventional engine combustion technology, developed an ingenious way to burn glycerol in conventional diesel engines. Glycerol is a water-soluble bio-degradable, non-toxic, odourless liquid and naturally occurring compound with an energy density equivalent to that of ethanol on a volumetric basis. It is also non-volatile, produces virtually no combustion particulates and has the best emission profile of any engine fuel. It is also a by-product in the manufacture of biodiesel from plant oil. The ACP Partner team was quick to seize the opportunity. Since most sources of biodiesel utilise edible plant oils, they began to search for new sources of glycerol and unearthed early research by the Israelis which showed that there were salt-loving algae that could produce up to 80% of their dry mass as glycerol.

Aquafuel representatives were invited to meet ACP stakeholders at Namibia, Ghana and Italy workshops and remarkable progress in scoping the opportunities for cultivating halophytic microalgae for glycerol has now been made. Staff from all partner countries have been trained by the MBA to identify and cultivate microalgae for glycerol. In Namibia halophytic algae have been identified from the very prevalent highly saline salt pans, and a preliminary characterisation of the glycerol-producing species *Dunaliella* and *Asteromonas* (Fig 1) undertaken. A research programme aimed at cultivating halophytic microalgae has been initiated at the Ministry of Fisheries and Marine Resources (Fig. 2), and a Namibian-based company is in the process of being established in order to take advantage of their highly-prevalent saline waters and cultivate naturally-abundant microalgae for glycerol (Fig 3). If successful this will mark an important landmark in global progress to establish the necessary environmentally-sustainable biorefineries of the future.

Fig 1 (a): Three SEM images of strains of *Dunaliella* ((A) and (B): x 5120; (C) x 2130)

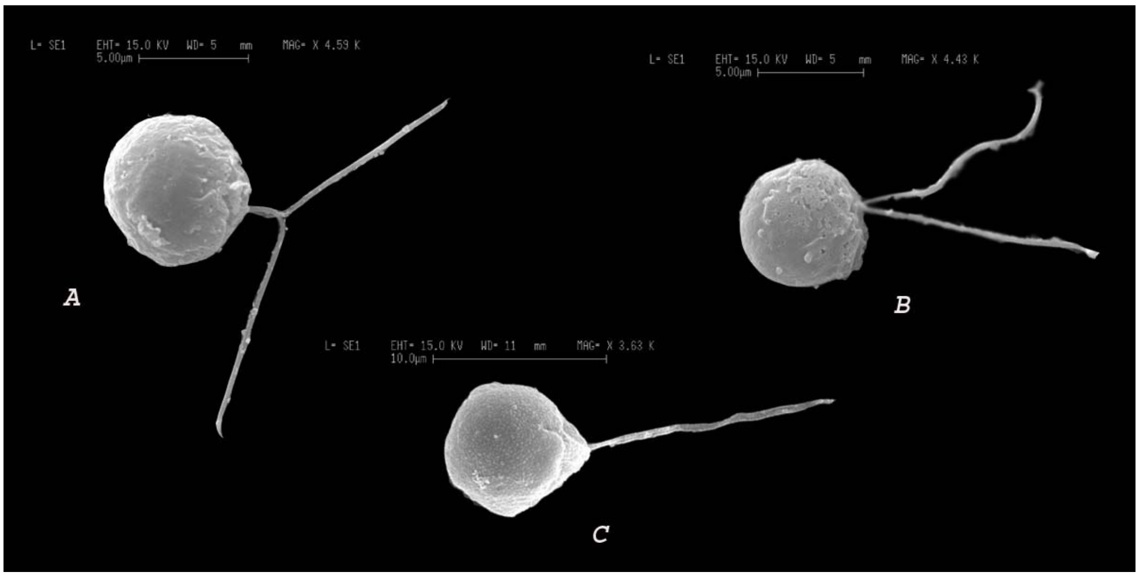

Fig 1 (b): Three SEM images of strains of *Asteromonas* ((A): x 8130, (B): x 4120; (C) x 1140)

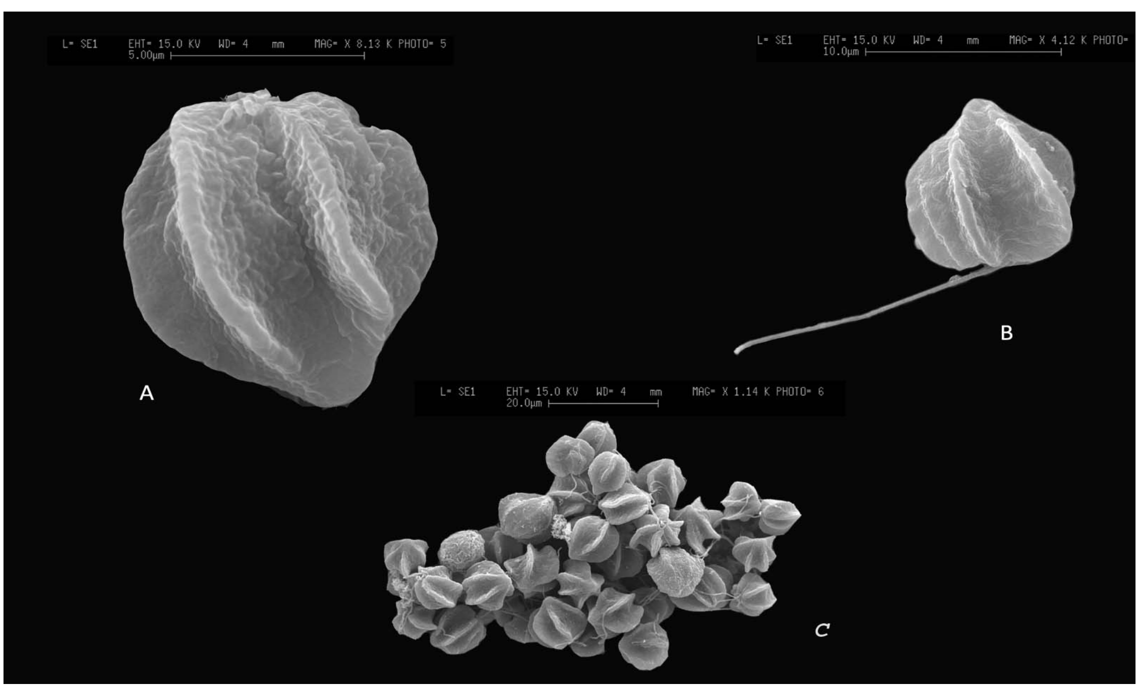

Fig 2: Staff from the Ministry of Fisheries and Marine Resources in Namibia discuss microalgae sampling techniques with Dr Declan Schroeder of the MBA and Philip Hooks of Geo Pollution Technologies (Pty) Ltd in Namibia.

Fig 3: Saline waters in Namibia coloured pink due to the prevalence of glycerol-bearing halophytic microalgae