We study fundamental aspects of plant physiological responses and adaptations to environmental stresses and environmental variation, including global change. Our research focuses on the interactions between biochemical, developmental and genetic control of plant growth, stomatal conductance, carbon and nitrogen assimilation and water-use efficiency.

Our work includes a strong theoretical component and spans from the molecular to the whole plant, to canopies and, in a few instances, the globe. Using model plant systems, agricultural or native species, we combine physiological, biophysical and functional genomic approaches to decipher: stress signalling mechanisms, root/shoot communication, water uptake and transport mechanisms, nitrogen fixation, and the mechanisms involved in coordinating water, carbon and nitrogen use for growth. We also seek to apply this understanding to whole stands of plants by combining process level understanding with remotely sensed imagery in models.

Our aims are to identify genetic targets for improved plant performance and water use efficiency. The emphasis is on drought, drought-induced soil stresses, and atmospheric conditions (CO_2 concentration, humidity, wind-speed and solar radiation). We also aim to understand how the environment will change with time, and concentrate here on evaporative demand.

This challenging area of research holds the key to the development of plants tailored to harsh environments and an optimum use of scarce resources. It may also contribute to a more appropriate management of biological diversity.

Wheat is being used as a model species to investigate the genetic controls of drought signalling.

ENVIRONMENTAL BIOLOGY

Group Leader: Prof. Graham Farquhar

HIGHLIGHTS

- Following our discovery that the Arabidopsis ERECTA gene is involved in the regulation of plant transpiration efficiency (*Nature* **436**: 866-870), that gene was chosen as a target for an international initiative within the Generation Challenge Program aiming at searching for, and sequencing, homologous genes in major crop species essential to Africa and Asia's food supply. The goal is to establish whether allelic diversity of these ERECTA-like genes could be used for breeding more-water use efficient and drought tolerant crops.

- Rice is a major food staple. A bold initiative is developing to engineer a C_4 photosynthetic pathway into rice with the ultimate aim of significantly increasing yields. Two key components necessary for this are to manipulate CO_2 permeability within cells to increase the efficiency of any CO_2 concentrating mechanism, and to balance the capture of light with the metabolic demands. These concepts were presented at a meeting held at the International Rice Research Institute in the Philippines.

- A new method was developed to separate cell wall material in leaves to investigate the role of structural nitrogen in photosynthesis.

- Published an hypothesis that the key autotrophic enzyme, Rubisco, makes a compromise between selectivity for carbon dioxide versus oxygen, and the maximum catalytic rate. We suggested that the compromise depends on the enzyme's local environment (temperature and partial pressures of CO_2 and O_2) and involves a transition state for CO_2 addition in which the CO_2 moiety in more selective Rubiscos closely resembles a carboxylate group. The hypothesis, with accompanying evidence, was published in the *Proceedings of the US National Academy of Sciences*, and attracted commentaries in that journal and in *Nature*.

- Questioned a high profile report that suggested methane release from vegetation reduced the efficacy of CO_2 sequestration. We showed that the report's estimated global impact of putative methane release was far too large.