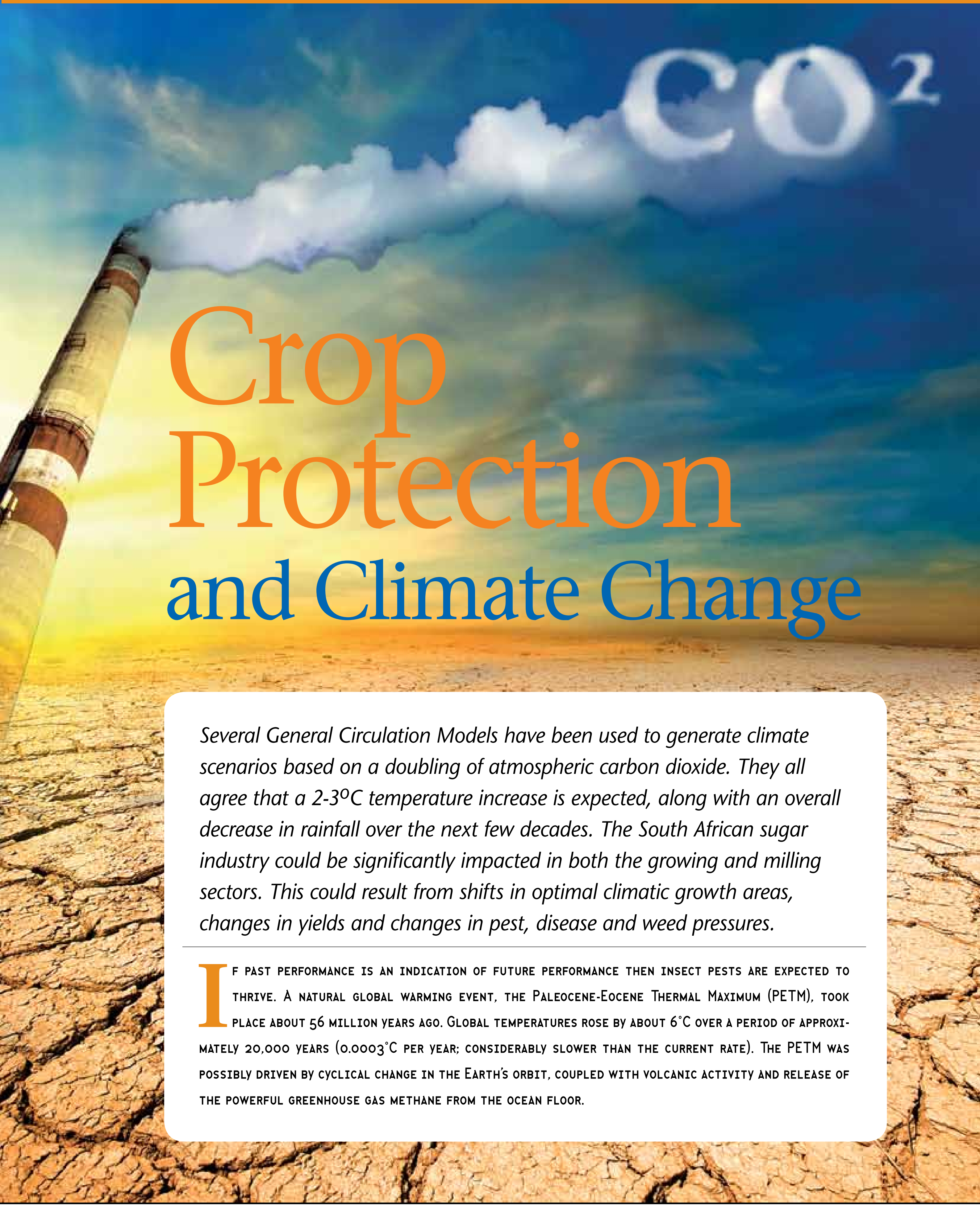

Crop Protection and Climate Change

Several General Circulation Models have been used to generate climate scenarios based on a doubling of atmospheric carbon dioxide. They all agree that a 2-3ºC temperature increase is expected, along with an overall decrease in rainfall over the next few decades. The South African sugar industry could be significantly impacted in both the growing and milling sectors. This could result from shifts in optimal climatic growth areas, changes in yields and changes in pest, disease and weed pressures.

If past performance is an indication of future performance then insect pests are expected to thrive. A natural global warming event, the Paleocene-Eocene Thermal Maximum (PETM), took place about 56 million years ago. Global temperatures rose by about 6°C over a period of approximately 20,000 years (0.0003°C per year; considerably slower than the current rate). The PETM was possibly driven by cyclical change in the Earth's orbit, coupled with volcanic activity and release of the powerful greenhouse gas methane from the ocean floor.

Leaf fossils from that time document changes in the amount and types of marks left by herbivorous insects. The evidence indicates that there was an increase in the diversity of insect species feeding on plants and an increase in the amount of food consumed. Due to the additional carbon dioxide, photosynthesis was easier and plants were able to effectively photosynthesise without having to invest so much nitrogen into the proteins of the photosynthetic machinery. Consequently insects had to eat more to obtain the same amount of protein nutrition as before. Coupled with increased voracity, it has been estimated that with a 2°C temperature increase, insects might experience one to five additional life cycles per season. Aphids in particular are expected to react strongly because of their short generation time, low developmental threshold temperatures and ability to survive mild winters without winter forms. An increase in the numbers of insect vectors will inevitably lead to a higher risk for infection of plants by existing viruses and the emergence of new viral pathogens.

It is also projected the leaf canopies will become denser and more humid, perhaps further favouring aphids as well as pathogens e.g. the rusts. However, under elevated CO^2 conditions some plants such as sugarcane will experience a reduction in stomatal opening and number, and this could inhibit the rusts since these are stomata-invading pathogens.

Insects may colonise new areas. Historically, sugarcane growing in the Midlands of KwaZulu-Natal was thought safe from attack by the stalk borer *Eldana saccharina*, because of its higher altitude cooler climate. However, conditions appear to be becoming more suitable for eldana development, and this insect has been found in areas as diverse as Potchefstroom in the North West Province, and Thohoyandou in Limpopo Province. New pest species could also emerge from natural habitats. SASRI scientists now consider the borer *Chilo partellus* to be an imminent threat to sugarcane. A host shift may occur if its current habitats continue to be disturbed by man and by alien invasive plant species.

At the landscape level, models have been used to project climate change effects on alien invasive plant species, including *Chromolaena odorata*, the range of which is projected to expand within the sugar industry. As well as disturbing natural habitats, chromolaena is an attractant for the African grasshopper, a defoliator of maize and other crops.

It can be argued that good management of natural habitats and the adoption of Integrated Pest Management will mitigate against some of the effects of climate change on pest pressures. An avenue for mitigation research is in the area of chemical induction of resistance to stress. Certain fungicides and insecticides appear to have the additional effect of directly increasing the plants' tolerance to drought and heat stress. The extent of these effects appears to be plant genotype dependent. Consequently there should be opportunities to select more responsive crop genotypes in plant breeding programmes.

It is also important that new sugarcane varieties are bred for likely future climate conditions with increased drought and heat stress tolerance. Due to the length of plant-breeding and selection processes the present rate of climate change is taken into account on an on-going basis. However, future conditions such as warmer and drier winters favour both eldana and sugarcane smut. Due to plant physiological antagonisms between the different types of resistance pathways triggered by eldana and smut, resistance to both is difficult to obtain in current breeding material. Alternative resistance mechanisms and sources of resistance need to be identified and incorporated into the breeding programme, sooner rather than later.

Stuart Rutherford
Senior Pathologist
South African Sugarcane Research Institute
South African Sugar Association