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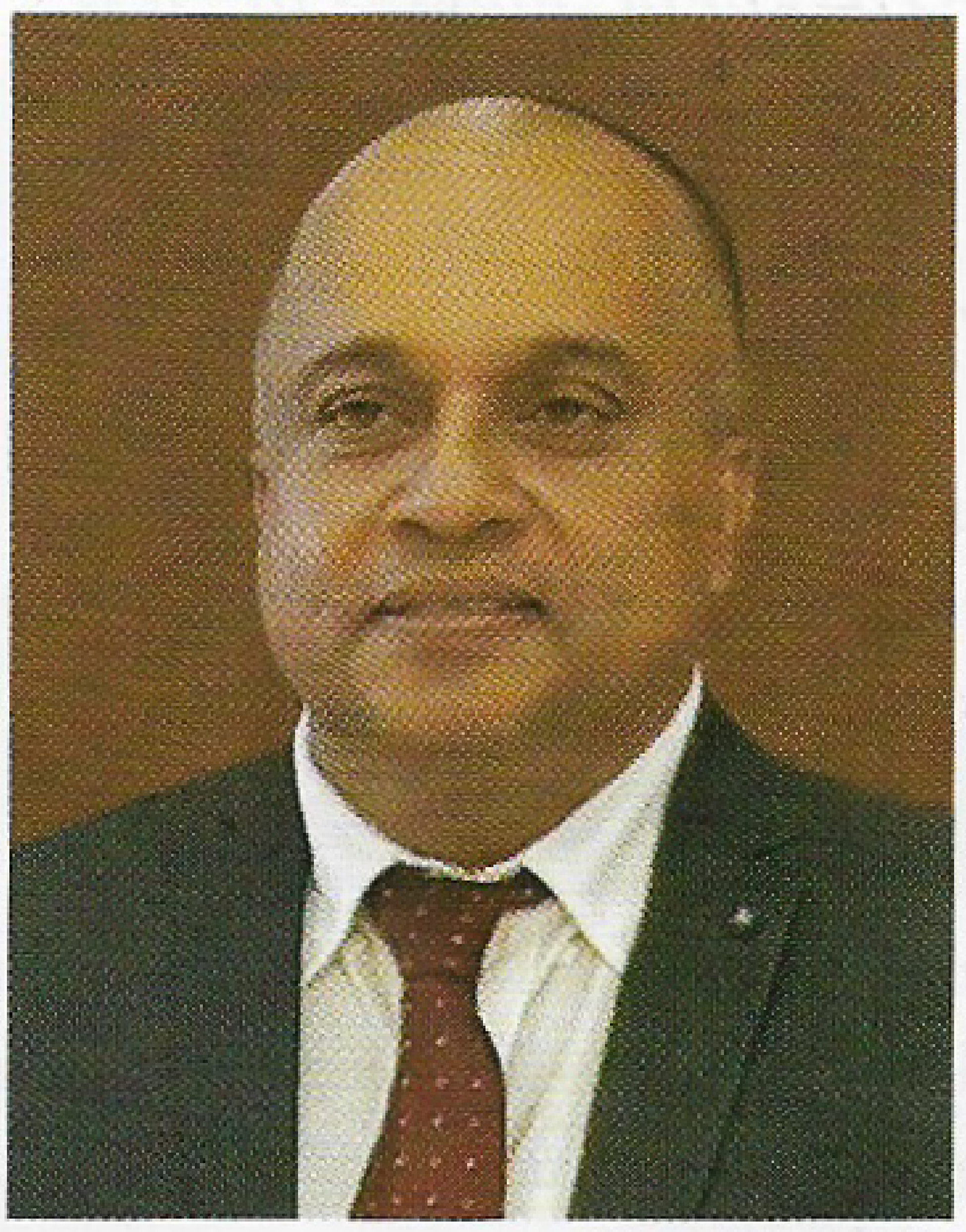
Rising atmospheric [CO_2] concentration alters the plants' primary and secondary metabolism: Consequences for future human nutrition

Saman Seneweera

National Institute of Fundamental Studies, Hanthana Road, Kandy, Sri Lanka
**seneweera@ifs.ac.lk, seneweera@gmail.com*

Over geological time scales, atmospheric CO_2 concentrations accompanied climate change has had a profound influence on the evolution, diversification and productivity of plants. CO_2 concentration is thought to have been 1500-3000 L CO_2 L-1 during the Cretaceous period when C3 angiosperms evolved, while C4 plants evolved about 70 million years ago when the CO_2 concentrations were closer to the present day levels. The evolution and diversification of C3 species was a key milestone in plant biology, and thus, the commencement of agriculture was a key point in human civilization. Since the industrial revolution, atmospheric CO_2 concentration is rapidly increasing, the current [CO_2] concentration of 408 L CO_2 L-1 is expected to reach 550 L CO_2 L-1 by the middle of this century. As CO_2 is the primary substrate for photosynthesis, increased atmospheric CO_2 will have a significant impact on plant growth, development, and quality. Whole process of plant response to elevated [CO_2] is moderated by post-photosynthetic secondary metabolism that include carbon and nitrogen metabolism, cell cycle functions, and hormonal regulation. In the past, most studies have focused on photosynthesis and stomatal conductance in response to elevated CO_2, despite emerging evidence of the role elevated CO_2 plays in moderating secondary metabolism processes in plants. Secondary metabolites have evolved to enhance plant fitness to interact with their environment. This group of plant metabolites also reveals many pharmaceutically important characteristics, which can be modified for potential therapeutic purposes in a future CO_2 rich world. Therefore, a better understanding of the biosynthesis of secondary metabolites and its association with other biological processes is essential to plan for the inevitable climate change.

On the other hand, elevated [CO_2] alters plant nutrient assimilation and thus reduces grain quality attributes such as protein, iron (Fe) and zinc (Zn). Declines in protein and minerals essential for humans, including iron and zinc, have been reported for crops in response to rising atmospheric carbon dioxide concentration, CO_2. For this century, estimates of the potential human health impact of these declines range from 138 million to 1.4 billion, depending on the nutrient. Large reductions in protein, iron, and zinc are well documented for a range of crops along with consistent declines in vitamins B1, B2, B5, and B9. Finally, the potential health risks associated with the anticipated CO_2-induced deficits of protein, minerals, and vitamins in rice, well correlates with the lowest overall gross domestic product per capita for the highest rice-consuming countries.



Professor Saman Seneweera

National Institute of Fundamental Studies

Professor Saman Seneweera is the Director at the National Institute of Fundamental Studies (NIFS) Sri Lanka, Professor University of Southern Queensland, Honorary Prof University of Melbourne, Australia and Adjunct Professor of Ruhuna University, Sri Lanka. He has also worked at the University of Western Sydney, Australia, Tohoku University, Japan and the University of Illinois, Chicago, USA. Professor Seneweera's research focus is on understanding the impact of climate stress on the physiological processes of plants aiming to mitigate stress and improve quality and crop yield potential. His research also focuses on improving grain quality such as protein, iron and zinc of cereal crops. In his work, Professor Seneweera uses cutting edge techniques including genomics, proteomics, metabolomics and ionomics tools to identify new physiological traits to develop climate resilient crops. He has been instrumental in building the Australian Grain Free Air CO2 at the University of Melbourne and the Plant Biology Platform at the University of Southern Queensland. To date, Professor Seneweera has supervised over 25 PhD students internationally. He is on the editorial board of many journals and also reviews for a large number of journals like, Nature, Plant Physiology, Plant, Cell and Environment and New Phytologist. Professor Seneweera has published more than 200 research articles in top ranking journals including Nature and Science. He has been an invited speaker at international conferences and has presented many keynote addresses. Professor Seneweera is the recipient of multiple awards including the 'MSLE Research Excellence Award – 2011' from the University of Melbourne, Japan Society for the Promotion of Science Fellowship, 2001, Science and Technology Fellow, Japan, 1999.