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Keynote speech

'Socioeconomic and Environmental Sustainability through Integrated Research for Development – A Sri Lankan Focus'

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Sri Lanka with a documented history of over 3000 years has a rich past as a civilization based on agriculture. Although only one third of its population is now engaged directly or indirectly in agriculture, it is imperative to feed its' citizens while exporting certain commodities to bring revenue to the country. As a developing country, Sri Lanka needs to focus its efforts to invigorate the socio-economic and environmental sustainability through an integrated approach through research and development. The socio-economics of a country is highly dependent on a few key indicators, such as health, income, education, housing and occupation. The health and wellbeing of its citizens are connected to the attainment of these key indicators. This presentation will focus mainly on the needs seen through the eyes of an agriculturist who works on research methods to develop sustainable approaches to the advancement of agricultural processes to gain high yields while protecting our environment.

The very nature of development requires continuous and rapid change. While agriculture has its roots around the civilization or vice versa, the island contains tropical rain forests and a diverse landscape with a high amount of biodiversity, many being endemic. With abundance in biodiversity, Sri Lanka can and should focus its efforts at protecting these valuable resources, whether it is fauna, flora or its water resources. Though development in all areas is required as a nation building on capacity, it is equally important to maintain its air and water quality while protecting the environment. On the other hand, the very nature of development dictates pollution of environment through deforestation, ozone depletion, excessive carbon dioxide emission,

threat to biodiversity, freshwater and oceans. This calls for good governance through adequate research and development.

Sri Lanka has gone through several types or periods of agricultural success. The green revolution brought high yields while using a record amount of inorganic fertilizers and pesticides (insecticides, herbicides and fungicides). While these key inputs helped the growers with high yields, it was also the beginning of pollution in air and water quality. Excess or indiscriminate use of these products needs to be monitored and if required phased out. However, we also need to be proactive in making sure that there are several strategies in place to protect our crops. Some of these are the use of natural enemies of crop pests and pathogens, also known as biological control. Biological control is an environmentally friendly alternative to the use of pesticides to reduce pests and diseases. This tri-partite interaction(s) occurs in nature as a natural phenomenon, and once well researched, could be augmented to the benefit of the host crop. Beneficial microorganisms occupy niches in the soil, rhizosphere and the phyllosphere. By creating an environment more suitable for the beneficial microorganisms, biological control of the crop pathogen could be increased. Breeding for disease and pest resistance is one of the environmentally safest and most economical methods with no costs to the grower. Understanding the genetics of the hosts, pests and their interactions, help develop resistance to these pests through conventional breeding methods. Developing disease and pest forecasting systems for major diseases is another environmentally friendly method in reducing pesticide applications. For crops such as potatoes which may require multiple applications of a pesticide (10 to 14 applications of a fungicide to control Late blight disease) could be reduced to 5 to 7 by a sound and reliable late blight forecasting system. In addition, some plants may have their defenses against pests/pathogens enhanced when challenged by the pest/pathogen (systemic acquired resistance - SAR) and at times when primed through the presence of a beneficial microorganism (induced systemic resistance - ISR). All these methods are environmentally friendly and provide adequate protection to the crop. Some microorganisms in soil are capable of increasing the nutrients in soil or directly in the plant, or by helping in the nutrient uptake (i.e. rhizobia that fixes nitrogen, vesicular arbuscular mycorrhizae in phosphorus uptake). Long term agricultural systems could be made more self-sustainable through improvement of the

soil structure, and increasing a rich abundance of beneficial microbial populations. In addition it could be further improved by amendment of soil with organic matter. A good example is tea plantations where soils could be improved through expert knowledge of the soil system. Soil amendments that increase water retention, reduction of root, stem and foliar diseases and pests should be achieved if we are to be the world leaders in the production of quality tea. The crop/soil scouting and application of chemicals as nutrients can be improved with precision farming techniques using recent advances in nanotechnology. These changes should be done to suit our Sri Lankan agricultural systems through the invention of machinery by engineers working with agricultural scientists. The reliance on inorganic fertilizers and pesticides could be reduced, and help maintain a sustainable environment while increasing yields. This can only be achieved with efforts in research and development, using conventional and modern techniques. Advancing our understanding of these processes could be further improved with modern techniques such as molecular biology techniques, and the Omics (i.e. genomics, transcriptomics and proteomics).

Agriculture, aquaculture, biodiversity and other important environmental indicators may be challenged by a new threat; that is global warming and its subsequent impact on climate change. Therefore research and development should be cognisant of this impeding challenge to nature and attempt understanding the likely changes to fauna, flora, our water capacity and the need for changes in agricultural crops and practices. Another challenge that may be posed by climate change is the activity of plant pathogens and pests. For example, groundnuts are infected by *Aspergillus* sp. that produce toxins (i.e. mycotoxins) that are capable of causing health problems including being carcinogenic in humans and animals when consumed. Production of mycotoxins on crops is mainly dependent on climatic factors such as temperature and relative humidity. Aflatoxin producing fungi are native to tropical, warm, arid, and semi-arid regions: changes in climate result in large alterations in the quantity of aflatoxin producing fungi. Therefore change in climate has a direct impact on mycotoxin production. The Intergovernmental Panel on Climate Change (IPCC) stated in its Fourth Assessment Report (AR4), published in 2007, that temperature will rise by approximately 4ºC in 100 years.

Increasing global temperatures would have significant impacts on agriculture worldwide. Increasing temperatures of 1-3°C are predicted to increase global agricultural production on the whole resulting more crops in currently cooler regions (eg: parts of Northern Europe) and fewer crops in currently warmer regions (eg: areas in Africa). Although, it is predicted that the increased temperatures can increase the global food production in currently cooler regions, a number of agricultural entities could be affected by these climatic factors, including soil quality, crop yields, and the biological environment of crops such as the abundance of beneficial microbial populations in soils, pests and plant pathogens. Among these many agricultural entities, climatic alterations may have a greater impact on plant–pathogen interactions. Most of the plant pathogens have optimum temperatures for their growth and mycotoxin production. Mycotoxins are among the major foodborne risks that are most vulnerable to climatic changes. The ability of fungi to produce mycotoxins is largely influenced by temperature, relative humidity, insect attack, and stress conditions of the plants. Additionally, it has been reported that more extreme rainfall and drought events would favour formation of mycotoxins. Therefore changes in global temperature would directly affect their growth and mycotoxin production capability. Global warming will not only act on patho-systems already present in certain regions, but will facilitate the emergence of new diseases and new pathogens because the changes in climatic factors can modify the present behaviour of pathogens and enhance the development of new mechanisms to fit into the new environment. This would ultimately result in emergence of new diseases and newer mycotoxins with novel characteristics.

In conclusion, rapid development and climate change will add new challenges to the future food production and food security; therefore it is imperative to continuously monitor the changes in climate and the environment while maintaining high standards in food production systems and food security. Significant efforts should be taken to reduce factors that enhance environmental pollution, global warming and the rate of climate change thus ensuring our fauna, flora, agricultural crops, water and biodiversity is preserved for generations to come. A country that can boast on a civilization that was built around agriculture should heed to making history again!