INTRODUCTION

In commercial agriculture, regulations or standards for environmental protection are perceived by the agricultural community to be associated with lower profits/increased costs and thus are considered a hindrance to productivity. This perception has created mistrust between producers and the general public. There is an urgent need to show that profitable agriculture can be pursued without adversely affecting the environment. Research and development on sugar cane in Mauritius and elsewhere have accomplished the feat of bringing sugar cane production and environmental cleanliness, from their diametrically opposed positions, to one where they are in synchrony with each other. The research effort to achieve this harmony is not restricted to a specific scientific discipline but instead encompasses numerous fields of study such as breeding and selection for higher-yielding varieties; plant protection; cultural practices, agricultural chemistry, production systems and sugar technology. Concern for the quality of the environment thus spans the whole production cycle from crop improvement through cultivation systems to the disposal of factory wastes after the sugar manufacturing processes. Examples of R&D achievements, which are contributing towards sustainable agriculture and environmental protection in Mauritius, are illustrated below.

CROP IMPROVEMENT

- Production of new varieties which are resistant to diseases and pests thereby eliminating the need for fungicides and insecticides during their cultivation.
- The use of self-trashing varieties to provide mulch to prevent soil erosion.
- High fibre cane for cogeneration thereby minimizing the need for fossil fuel.

CROP PROTECTION

- Biological control, including the use of entomopathogens, to minimize the use of insecticides within a strategy of Integrated Pest Management.
- Trash blanketing to eliminate or at least reduce the amount of herbicides used.
- Trashing to control pests, especially scale insects.

BIOTECHNOLOGY

- Improved disease diagnosis not only to minimize yield losses but also to render movement of germplasm safer thereby preventing the introduction of pests and diseases into new environments.
- Tissue culture and rapid multiplication of new high-yielding varieties to economize land resources and reduce the risks to the environment associated with traditional nurseries.
- Prescribe biosafety regulations to render products derived from genetic engineering (e.g. disease-, pest- and herbicide-resistant clones) safer.
- Recourse to molecular markers for more efficient selection of new high-performance varieties.
CROP MANAGEMENT

- Wide adoption of contour planting and minimum tillage on slopes to minimize erosion. Erosion hazards are further reduced by planting barrier crops such as Vetiveria on edges and banks of sugar cane fields.
- Extension of minimum tillage practice to flat lands to avoid soil disturbance and susceptibility to degradation.

NUTRITION

- Site-specific fertilization according to yield potential and after soil analysis to prevent over-fertilization or depletion of soil reserves.
- Efficient use of fertilizers through appropriate timing of application, mode of placement, and chemical form.
- Application of foliar diagnosis to ensure soil is not being mined of its nutrient reserves leading ultimately to its degradation.
- Safe disposal of waste products from sugar industry, sewage sludge and municipal waste through their use as fertilizers.

IRRIGATION

- Replacement of surface irrigation by more efficient techniques such as drip and centre pivot systems.
- Resort to deficit or prescription irrigation, based on crop water requirements, to avoid drainage below the root zone and runoff which carries sediments and chemicals into neighbouring waterways.
- Safe disposal of waste water from the sugar industry and of sewage effluents as irrigation water to enhance sugar cane production.

MECHANIZATION

- Green cane harvesting ultimately extended to eliminate burning and its deleterious consequences, e.g. emission of smoke, greenhouse gases and particulate matter to the atmosphere; the resulting trash blanket acts as a mulch to conserve moisture, reduce herbicide use and as a protective cover against erosion.
- Timing of mechanical operations to prevent soil compaction and its associated degradative effects on soils.

LAND MANAGEMENT

- Creation of databases with various physical characteristics (such as soil type, slope, climatic data, land use, suitability ratings for sugar cane and other crops, constraints to production, incidence of weeds, pests and diseases) and their integration through satellite-based technology, Geographical Information System (GIS) and spatial analysis to assess production potential (especially for marginal land) and to evaluate risks of cultivation to the environment.

CROP DIVERSIFICATION

- Interline cultivation to increase productivity per unit area while simultaneously reducing bare soil exposure to the erosional processes.
Cultivation of leguminous crops between two sugar cane rotations to fix nitrogen and thus reduce dependence on mineral nitrogen fertilizers and also to act as a protective cover against erosion

INFORMATION TECHNOLOGY

Application of existing mathematical models, e.g. CANEGRO, APSIM, IRRICANE to simulate various management scenarios that can enhance productivity and permit attainment of yield potential with as little negative impact as possible on the environment

EXTENSION

Transfer of more efficient and environmentally sound technologies to producers with respect to use of agrochemicals, adoption of high-yielding varieties, cultural operations, crop protection, natural resource management, etc.

SUGAR TECHNOLOGY

Treatment of factory effluents in waste water ponds and other techniques to meet environment standards to enable their use in irrigation

Optimal water balance of factories to avoid wastage and to increase water availability for irrigation

Removal of particulate matter from fly ash through the fly ash de-watering and disposal unit patented by MSIRI in 1976

Disposal of bagasse through cogeneration thereby increasing viability of the industry

Water pollution surveys to determine compliance with limitation standards and to identify options to minimize pollutants in effluents

Reduce sugar losses in condensate water and filter cake thereby improving sucrose recovery and reducing COD of effluents

Harmony between productivity and environmental protection has to a significant extent been attained through research and development that has become increasingly entrenched along specialized disciplinary and even sub-disciplinary lines. There are clear indications that this compartmentalization is no longer tenable if the delicate balance between the economics of crop production and natural resource utilization / environmental protection is to be sustained.

Many problems facing agricultural productivity and its impact on the environment are increasingly being shown to require an interdisciplinary approach and also regional/international collaboration. For example, a collaborative project between the Australian Centre for International Agricultural Research (ACIAR) and the Mauritius Sugar Industry Research Institute (MSIRI) on measurement and prediction of agrochemical movement in tropical sugar production has as its ultimate aim the development of new strategies for agrochemical use. These strategies must necessarily hinge on changes in cultural practices, mode and frequency of chemical application, irrigation scheduling and erosion control. Yet, the actual impact of any of the new strategies on the environment will be additionally influenced by soil and pesticide properties, water movement and distribution, climate and so on. To ensure that pollutants are not simply shifted from one part of the hydrologic cycle to another, research strategies and methodologies must encompass inputs from not only the agronomist but also from the soil scientist, the pesticide chemist, the hydrologist, the modeller, the environmentalist, the extension officer and the economist.

The shift towards multidisciplinary approaches in research and development can also be seen in the move from general recommendations for growers to precision or prescription farming – targeting of inputs to field crops
according to locally determined requirements to maintain/improve existing sustainability. The concept of precision agriculture is indeed developing rapidly because of the emergence of advanced technologies such as the Global Positioning System (GPS), at affordable prices. However, precision agricultural systems are unlikely to progress much further from its still infancy status without combined inputs from the agroonomists, modellers, pedologists and engineers to develop the necessary sensing and control systems that will allow acquisition and then interpretation of the data on spatial variability.